A 23: Poster II

Time: Thursday 16:30–19:00 Location: Lichthof

A 23.1 Th 16:30 Lichthof

Strong field ionization, drift and rescattering in extreme ultraviolet laser pulses in the stabilization regime — •Hossein Ebadi, Christoph H. Keitel, and Karen Hatsagortsyan — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The strong field ionization dynamics of an atom in a strong extreme-ultraviolet radiation field is investigated using numerical solutions of the time-dependent Schrödinger equation. We show new features of the electron above-threshold ionization (ATI) spectra in the stabilization regime. The phase space analysis of the electron distribution after the interaction allows us to identify the rescattering electron's contribution in the high energy ATI spectra. The latter is different from the well-known rescattering plateau in the case of infrared driving laser field but still explainable in terms of the simpleman model. Moreover, we characterize a rich structure of the electron phase space distribution providing new detailed information on the ionization time evolution. In particular, we demonstrate that the periodic drift of the bound electron wave packet in the highly oscillating field is the reason for periodic bursts of the ionization yield during the interaction. Our findings can be tested in experiments with FLASH laser facility in Hamburg.

A 23.2 Th 16:30 Lichthof

Controlling Two-Electron Threshold Dynamics in Double Photoionization at FLASH — •Michael Schuricke, Gopi Veeravalli, Renate Hubele, Ganjun Zhu, Johannes Albrecht, Jochen Steinmann, Alexander Dorn, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Controlling the dynamics and understanding the time evolution of correlated many-electron systems is one of the major challenges in physics. Special interest lies in multiple-ionization close to of threshold, where the total kinetic energy available in the final state approaches zero resulting in a strongly correlated system. Thus, in theoretical descriptions all independent particle or self-consistent field approximations fail.

In this regime we investigated the double photoionization (DPI) and ionization-excitation (IE) of state prepared and aligned lithium, from 2 to 12 eV above the DPI threshold ($\hbar\omega$ = 81, 85, 91 eV). Thereby combining three state-of-the-art techniques, namely magneto-optically trapped lithium, a Reaction Microscope and the free-electron laser at Hamburg (FLASH). The total and differential DPI cross sections reveal a strong dependence on the initial state and particularly on the alignment of the 2p-orbital with respect to the VUV-light polarization, whereas no such effect is observed for IE. Approaching threshold the alignment sensitivity increases, which can be understood by attributing these findings to dynamical electron correlations at vanishing excess energy.

A 23.3 Th 16:30 Lichthof

Ein hocheffizientes Elektronen-Ionen-Koinzidenzspektrometer zur zeitaufgelösten Untersuchung der Photoionisation von Atomen und Molekülen im XUV — •Sascha Deinert, Leif Glaser, Markus Ilchen, Frank Scholz, Peter Walter und Jens Viefhaus — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg

Hochbrilliante Synchrotronstrahlungsquellen der dritten Generation - wie beispielsweise PETRA III - ermöglichen Untersuchungen der Photoionisationsdynamik von Atomen und Molekülen sowohl mit hoher Auflösung, als auch über einen weiten Photonenenergiebereich.

Das hier vorgestellte Elektronen-Ionen-Koinzidenz-Spektrometer ist an den weiten Photonenenergiebereich der PETRA III P04 Variable Polarization XUV Beamline (DESY, Hamburg) angepasst, die Photonen im Energiebereich von 200-3000 eV mit hoher Intensität bei kleinem Bandpass generieren kann. Dadurch können für unterschiedlichste Targets sowohl Photoelektronen als auch Auger-Elektronen mit hoher Energie erzeugt werden. Speziell für den effizienten Elektronennachweis bei hohen kinetischen Energien hat sich dieses sogenannte "magnetic-bottle"-Spektrometer bewährt, welches hier mit einem Flugzeit-Spektrometer für den Ionen-Nachweis kombiniert wird.

A 23.4 Th 16:30 Lichthof

Threshold photoionization in the presence of neutral perturbers — •Jovica Stanojevic and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, 01187 Dresden, Germany

We explore the influence of nearby ground-state atoms on the photoionization process in ultracold gases. We implement the Green's function method to account for the effects of interactions with surrounding atoms. For energies just above the photoionization threshold, a simpler almost analytical treatment can be devised. This study could offer an alternative way to investigate collisions at ultralow energies.

A 23.5 Th 16:30 Lichthof

Unexpected low-energy structure of photoelectron spectra in mid-infrared strong laser fields: classical description — •Chengpu Liu and Karen Z. Hatsagortsyan — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The recent experiment by Blaga et al. [Nature Phys. **5**, 335-330 (2009)] on the photoionization of atoms and molecules in strong long wavelength laser fields observes previously unknown low-energy structure (LES) in the energy distribution of electrons emitting along the laser polarization direction. This work is devoted to clarification of the mechanism for the appearance of this LES. We use semiclassical Monte-Carlo simulations and successfully reproduce the experimental results. It is confirmed that the origin of LES involves the influence of the long range Coulomb potential and the forward-scattering of the tunneled electrons which unlike the back-scattering contributes to the low-energy domain. Furthermore, we investigate the scaling of the LES with the Keldysh parameter and its dependence on the atomic binding potential. As the essence of LES is the quasistatic laser assisted scattering of low energy electrons from the atomic core, it is not surprising for LES to be general and present in all atomic and molecular systems.

A 23.6 Th 16:30 Lichthof

Vollständig differentielle Wirkungsquerschnitte der Doppelphotoionisation von Neon bei 165, 440 und 800 eV Photonenenergie — •Markus Waitz[1], Florian Trinter[1], Ute Lenz[1], Christian Stuck[1], Matthew P. Jones[3], Hendrik Sann[1], Hong-Keun Kim[1], Markus S. Schöffler[2], Thorsten Weber[2], Till Jahnke[1], Ottmar Jagutzki[1], Achim Czasch[1], Allen L. Landers[3], Ali Belkacem[2], Mike H. Prior[2], Horst Schmidt-Böcking[1] und Reinhard Dörner[1] — [1]Institut für Kernphysik, Universität Frankfurt, Max-von-Laue Str. 1, D-60438 Frankfurt, Germany — [2]Chemical Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA — [3]Department of Physics, Auburn University, Auburn, Alabama 36849, USA

Mit Hilfe der COLTRIMS-Messtechnik sollte die Photodoppelionisation (PDI) von Neon untersucht werden. An der Advanced Light Source am Lawrence Berkeley National Lab (USA) wurden dazu Messungen mit unterschiedlicher Photonenenergie und -polarisation durchgeführt. Es konnten vollständig differentielle Wirkungsquerschnitte gemessen werden.

A 23.7 Th 16:30 Lichthof

Photoionization of Fe^{14+}: Experimental Absolute Cross-Sections — M. C. Simon[1], •C. Beilmann[1], M. Schwarz[1], S. W. Epp[1], B. L. Schmitt[1], Z. Harman[1,2], T. M. Baumann[1], E. Behar[3], R. Follath[4], O. Schwarzkopf[4], S. Bernitt[1], R. Ginzel[1], S. G. Higgins[1], R. Klawitter[1], K. Kubiček[1], V. Mäckel[1], C. H. Keitel[1], P. H. Mokler[1], G. Reichardt[3], J. Ullrich[1], and J. R. Crespo López-Urrutia[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, Planckstrasse 1, 64291 Darmstadt, Germany — [3]Technion Israel Institute of Technology, Physics Department, Haifa 32000, Israel — [4]Helmholtz-Zentrum Berlin, BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

X-ray astrophysics received increasing attention in the last decade, due to the launches of the X-ray observatories *Chandra* and *XMM-Newton*. Photoionization (PI) of highly charged ions (HCIs) plays an important role for the interpretation of the spectra obtained. However, established methods for PI investigations either lack of accuracy or are only applicable to ions in low charge state. We present a novel approch, where the ion cloud of an electron beam ion trap (EBIT) with typical target-ion area densities of 10^{10} ions/cm^2 is exposed to Synchrotron radiation. PI of Fe^{14+} in the photon energy range from 450 to 1100 eV was investigated at BESSY II. A resolving power of up to 6500 and a calibartion limited accuracy of 150 meV were achieved and the feasibility of an absolute cross-section measurement was demonstrated.

A 23.8 Th 16:30 Lichthof

Precision Spectroscopy of Mg$^+$ Cooling Transitions — •Valentin Batteiger, Maximilian Herrmann, Sebastian Knünz, Guido Saathoff, Theodor W. Hänsch, and Thomas Udem — Max-Planck-Institut für Quantenoptik, Garching, Germany

Precision spectroscopy of dipole allowed transitions in trapped ions is plagued by temperature changes induced by the scanning laser. To circumvent this problem we probe single, sympathetically cooled ions [1]. Final results of an isotope shift measurement on the Mg$^+$ D1 and D2 line are presented [2], we also discuss a current attempt to infer the upper state lifetime from the lineshape of the ion's fluorescence spectrum. References: [1] M. Herrmann et al., Phys. Rev. Lett. 102, 013006 (2009). [2] V. Batteiger et al., Phys. Rev. A 80, 022503 (2009).

A 23.9 Th 16:30 Lichthof

Experimente zur Zeitdilatation an relativistischen Schwerionen - „Gestern, Heute, Morgen“ — •Christian Novotny[1], D. Bing[2], B. Botermann[1], C. Geppert[1,4], G. Gwinner[3], G. Huber[1], S. Karpuk[1], T. Kühl[4], W. Nörtershäuser[1,4], S. Reinhardt[5], G. Saathoff[5], R. Sanchez[4], D. Schwalm[2], T. Stöhlker[4] und A. Wolf[2] — [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

Seit der ersten direkten Messung der Zeitdilatation von Ives & Stilwell 1938 wurde eine Vielzahl verschiedener Experimente durchgeführt, welche diesen Effekt der Speziellen Relativitätstheorie (SRT) mit kontinuierlich steigender Präzision bestätigen konnten. Gleichzeitig wurden Modelle entwickelt, die Abweichungen von der SRT zulassen und mit dem Quadrat der Teilchengeschwindigkeit skalieren. In unseren Untersuchungen an Lithiumionen in Speicherringen der GSI und des MPIK konnte die Zeitdilatiation bei verschiedenen Ionengeschwindigkeiten auf eine relative Genauigkeit von 10^{-8} bestätigt werden und in kommenden Messungen soll diese Grenze um einen weiteren Faktor 10 verbessert werden. Für zukünftige Zeitdilatationsexperimente bietet der Ausbau der GSI zur FAIR Anlage neue Möglichkeiten. Hier können Ionen bei noch höheren Geschwindigkeiten gespeichert werden, wodurch die Empfindlichkeit, inbesondere für Effekte höherer Ordnung, nochmals gesteigert werden kann.

A 23.10 Th 16:30 Lichthof

Angular and polarisation correlation in the two photon decay of He-like ions — •Thorsten Jahrsetz[1,2], Filippo Fratini[1,2], Andrey Surzhykov[1,2], Thomas Stöhlker[1,2], and Stefan Fritzsche[2,3] — [1]Physikalisches Institut, Heidelberg University, Germany — [2]Gesellschaft für Schwerionenforschung (GSI), Darmstadt, Germany — [3]University of Oulu, Finland

Studies on the two–photon transitions in atomic systems have a long tradition. While, however, investigations in the past dealt mainly with the decay of light atoms and ions, much of today's interest is placed on the high–Z domain. For example, a series of experiments were performed recently at the GSI storage ring to explore the two–photon decay of helium–like uranium U^{90+} ions. Although until now these experiments were restricted to the total and energy–differential rates [1], the photon–photon angular and polarization *correlations* are likely to be observed in the future and will reveal important information on the relativistic, many–body and parity non–conservation phenomena in heavy atomic systems. In this contribution we present a theoretical analysis of the two–photon decay of helium–like ions with special emphasis on angular and polarization correlations between the emitted photons. In order to describe properly such correlations, we apply the density matrix approach and the second–order perturbation theory. Based on this formalism, detailed calculations are performed for the two–photon decay of $2\,^1S_0$, $2\,^3S_1$ and $2\,^3P_0$ states of helium–like xenon Xe^{52+}, gold Au^{77+} and uranium U^{90+} ions.

[1] A. Kumar *et.al.*, Eur. Phys. J Special Topics **169**, 19 (2009).

A 23.11 Th 16:30 Lichthof

Präzisions-Laserspektroskopie an hoch geladenen Ionen in einer Penning-Falle — •Manuel Vogel[1,2], Wolfgang Quint[2], Wilfried Nörtershäuser[2,3] und Richard Thompson[1] — [1]Imperial College London, SW7 2AZ London — [2]GSI, 64291 Darmstadt — [3]Institut für Kernchemie, Universität Mainz, 55099 Mainz

Wir präsentieren experimentelle Techniken zur präzisen laserspektroskopischen Bestimmung der Energien verbotener Übergänge in hoch geladenen Ionen mit relativen Unsicherheiten bis unterhalb des ppb-Bereichs. Dies sind insbesondere Feinstruktur- und Hyperfeinstruktur-Übergänge, die sich im zugänglichen Bereich für Laseranregung befinden. Grundlage ist die Speicherung und Kühlung extern erzeugter Ionen in einer Penning-Falle sowie spezielle Manipulationen der Speicherbewegungen. Die Nachweismethoden sind entweder optisch oder aber rein elektronisch. Vorgesehen sind Messungen der Feinstruktur in leichten bor- und kohlenstoff-artigen Ionen, sowie der Hyperfeinstruktur-Übergänge in schweren, wasserstoff- und lithium-artigen Ionen. Derartige Messungen stellen hochempfindliche Tests theoretischer Vorhersagen im Rahmen der QED gebundener Zustände dar. Sie erlauben zudem eine Messung des magnetischen Moments des Elektrons, sowie des Atomkerns in Abwesenheit diamagnetischer Abschirmung. Die zugehörigen Experimente werden derzeit im Rahmen des HITRAP-Projekts der GSI, Darmstadt, im Rahmen der SPARC-Kollaboration und des Zukunftsprojektes FAIR aufgebaut.

A 23.12 Th 16:30 Lichthof

Precision Laser Spectroscopy of Beryllium — •Rodolfo Sánchez[1,2], Monika Žáková[1], Zoran Andjelkovic[1], Klaus Blaum[3], Mark L. Bissell[4], Gordon W.F. Drake[5], Christopher Geppert[1,2], Magdalena Kowalska[4], Jörg Krämer[1], Andreas Krieger[1], Thomas Neff[2], Rainer Neugart[1], Ferdinand Schmidt-Kaler[6], Dirk Tiedemann[1], Zong-C. Yan[7], Deyan Yordanov[4], Claus Zimmermann[8], and Wilfried Nörtershäuser[1,2] — [1]Universität Mainz, Germany — [2]GSI Darmstadt, Germany — [3]MPI Heidelberg, Germany — [4]CERN, Geneva, Switzerland — [5]University of Windsor, Canada — [6]Universität Ulm, Germany — [7]University of New Brunswick, Canada — [8]Universität Tübingen, Germany

The neutron-rich isotopes of beryllium exhibit a halo structure. Important information of this structure can be obtained by measuring its nuclear charge radius. We have recently performed high-resolution collinear laser spectroscopy on a 30 keV beryllium-ion beam and measured the isotope shifts in the $2\,S_{1/2} \rightarrow 2\,P_{1/2,3/2}$ transitions of $^{7,10,11}Be^+$ with respect to $^9Be^+$. These measurements were combined with high-accuracy atomic theory calculations and the nuclear charge radius of these isotopes was extracted. In this contribution the results of this experiment are presented and further measurements on $^{12}Be^+$, which has about 1000 times smaller production rates as $^{11}Be^+$, are outline.

A 23.13 Th 16:30 Lichthof

Der g-Faktor des gebundenen Elektrons in mittelschweren Ionen — •Birgit Schabinger[1], Klaus Blaum[2], Wolfgang Quint[3], Sven Sturm[1] und Anke Wagner[2] — [1]Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany — [2]MPI für Kernphysik, 69117 Heidelberg, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Berechnungen der Quantenelektrodynamik der gebundenen Zustände (BS-QED) lassen sich mit hochpräzisen Messungen des magnetischen Moments des gebundenen Elektrons testen. In der Vergangenheit wurden g-Faktor Experimente an leichten Ionen mit einer relativen Unsicherheit $\delta g/g$ von weniger als 10^{-9} durchgeführt [1]. Der Einfluss der BS-QED nimmt mit der Kernladungszahl zu. Im jetzigen Experiment [2, 3] sollen daher mittelschwere Ionen wie Silizium ($Z = 14$) und Calcium ($Z = 20$) untersucht werden. Die Ionen werden in der Falle mittels einer Mini-EBIS [3,4] erzeugt. In einer Doppel-Penningfalle soll unter Ausnutzung des kontinuierlichen Stern-Gerlach-Effekts die Messung des g-Faktors eines einzelnen Ions erfolgen. Hierzu werden die drei Eigenfrequenzen des Ions (ν_+, ν_- und ν_z) und die Spin-Präzessionsfrequenz (ν_L) gemessen. Die Techniken und erste Ergebnisse an einzelnen Ionen werden vorgestellt.

[1] G. Werth *et al.*, Int. J. Mass Spec. **251**, 152 (2006)
[2] K. Blaum *et al.*, J. Phys. B: At. Mol. Opt. Phys. **42**, 154021 (2009)
[3] B. Schabinger *et al.*, J. Phys. Conf. Ser. **163**, 012108 (2009)
[4] B. Schabinger *et al.*, J. Phys. Conf. Ser. **58**, 121 (2007)

A 23.14 Th 16:30 Lichthof

Online Spectroscoy of Trapped Radium Isotopes — •Oscar O. Versolato, Gouri S. Giri, Joost van den Berg, Duurt Johan van der Hoek, Wilbert Kruithof, Bodhaditya Santra, Praveen Shidling, Lorenz Willmann, Hans W. Wilschut, and

Klaus Jungmann — Kernfysisch Versneller Instituut, University of Groningen

Radium ions are of particular interest for a most precise measurement of Atomic Parity Violation. From a single cold and trapped ion one expects a significantly improved measurement of the weak mixing (Weinberg) angle through a determination of the light shift in the forbidden $7^2S_{1/2}$-$6^2D_{3/2}$ transition. In preparation of such precision measurements the transitions relevant for this (7S-7P, 6D-7P) were observed and measured in the isotopes ^{212}Ra, ^{213}Ra and ^{214}Ra. The isotopes were produced at the TRIμP facility of KVI, when a ^{208}Pb beam hit a solid ^{12}C target. The Ra isotopes were stopped and re-ionized to Ra$^+$ in a Thermal Ionizer, mass separated in a Wien Filter and cooled in a gas filled Radio Frequency Quadrupole. The ions were stored as a cloud in a Paul trap, where they also interacted with laser light. All necessary wavelengths were obtained by semiconductor lasers. The setup and the measurements will be discussed.

A 23.15 Th 16:30 Lichthof

Frequenzkamm-Spektroskopie von Waserstoff bei 205 nm — •Sascha Reinhardt, Elisabeth Peters, Thomas Udem und Theodor W. Hänsch — Max Planck Institut für Quantenoptik, Garching, Deutschland

Wasserstoff als einfachstes Atom ist ein ideales System um Theorie und Experiment zu vergleichen. Die Messungen des 1s-2s Übergangs liefern präzise Werte für die Rydberg-Konstante und Lambverschiebungen. Die Genauigkeit ist mit in einer relativen Unsicherheit von 10^{-14} schwer weiter zu verbessern. Daher sind Messungen von anderen Übergängen im Wasserstoff sinnvoll um die Werte für die Rydberg-Konstante und Lambverschiebung weiter zu verbessern [1]. Ein interessanter Übergang ist der zwei Photonenübergang 1s-3s im Wasserstoff, der mit einer Wellenlänge von 205 nm angeregt werden kann. In dem vorgestellten Experiment wird der prinzipielle Aufbau und Stand vorgetragen, insbesondere wird auf die Erzeugung und Verwendung eines Frequenzkamm bei 205 nm zur Spektroskopie eingegangen [2].

[1] F. Biraben, European Physical Journal-Special Topics **172**, 109 (2009)

[2] E. Peters, S. A. Diddams, P. Fendel, S. Reinhardt, T. W. Hänsch, and Th. Udem, Optics Express **17**, 9183-9190 (2009)

A 23.16 Th 16:30 Lichthof

Investigations of Excitation Processes in Stored Highly Charged Ions — •D. B. Thorn, A. Gumberidze, S. Trotsenko, N. Petridis, R. Grisenti, C. Kozhuharov, G. Weber, U. Spillmann, Th. Stoehlker, A. Surzhykov, D. F. A. Winters, S. Geyer, R. Maertin, M. Trassinelli, D. Banas, D. Yu, W. Chen, N. Winters, R. Reuschl, S. Hess, M. Hegewald, A. Simon, R. Dubois, and H. Beyer — Work performed at GSI-Darmstadt. See poster for Affiliation information.

Electron- and proton-impact excitation (EIE and PIE) of bound electrons are among some of the most fundamental spectral line formation processes in the universe. In highly charged high-Z ions these two processes are in principle similar (a coulomb field excites the electron), except that EIE is characterized by a sharp threshold, which is not present in PIE because of the much larger momentum transfer possible between a proton and an electron. Furthermore, QED is predicted to affect the EIE process while the PIE process is left untouched. Previously, there have been no EIE measurements done at heavy ion storage rings and so all previous experiments were either carried out at electron beam ion trap facilities or fusion plasma facilities. At GSI we have made use of the experimental storage ring (ESR) to make studies of EIE and PIE of K-shell transitions in stored hydrogenlike uranium ions during collisions with neutral gas atoms. In this poster we describe a novel approach that utilizes a cryogenically cooled liquid microjet source to differentiate the two processes.

A 23.17 Th 16:30 Lichthof

A cryogenic Paul Trap for highly charged ions — •Maria Schwarz, Franziska R. Brunner, José R. Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

An electron beam ion trap (EBIT) is an effective tool for spectroscopy of highly charged ions (HCIs). However, the deep trapping potential found there can cause high temperatures of the stored ions, thereby limiting the final resolution. To allow for better accuracy we have started building up a linear cryogenic Paul-Trap experiment (CryPTEx) online with an EBIT. Storage times of HCIs could be extended to by orders of magnitude due to the extremely low background pressure which can be achieved in a 4K enclosure. Furthermore, the device allows sympathetic cooling with laser-cooled singly charged ions. Thus, much higher precision in atomic spectroscopy even down to the natural line width of the forbidden transitions of the stored HCIs should be achievable. In addition, addressing individual ions becomes also possible, since these arrange themselves in stable Coulomb crystals.

A 23.18 Th 16:30 Lichthof

Development of a High Current Electron Beam Ion Trap at the MPI-K — •Thomas Baumann, José Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

A novel high current electron beam ion trap (EBIT) charge breeder is currently being constructed at the MPI-K Heidelberg in collaboration with the NSCL (MSU) and TRIUMF. The design is based on the TITAN- and FLASH-EBIT, and will utilize an electron gun capable of producing an electron beam of up to 5 A, which is strongly compressed by a 7 T magnetic field, to produce and trap highly charged ions from any element.

The increased electron beam current will result in an extremely high current density within the trap region that allows for faster charge breeding compared to any other existing EBIT. This enables the new EBIT to produce He-, H-like or bare ions of heavy elements in hundreds of ms. These ions can be studied within the EBIT by various spectroscopic instruments or being extracted to further experiments. First performance tests of the EBIT are presented.

Furthermore the machine allows for the study of charge state optimization and a further reduction of charge breeding times which will support the development of future EBIT charge breeders.

A 23.19 Th 16:30 Lichthof

Extreme-Ultraviolet Spectroscopy on highly charged Fe Ions in an EBIT — •Thomas Baumann, Guiyun Liang, José Crespo López-Urrutia, Hiro Tawara, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Spectra in the extreme-ultraviolet range between 10 and 35 nm emitted from iron ions in charge states ranging from Fe VIII to Fe XXIV have been observed at the Heidelberg electron beam ion trap (EBIT). The emission spectra were recorded sequentially at electron beam energies from 75 eV up to 3 keV using a high precision flat-field grazing-incidence grating spectrometer.

The spectra clearly show the evolution of each ionic state as a function of the electron energy and, by comparison with collisional-radiative simulations, allow for line identification and separation of blends. Furthermore, the ion charge state distribution within the EBIT plasma could be determined from the relative line intensities. By comparing intensity ratios of emission lines from levels directly populated from the ground state to those starting from metastable levels of Fe XXI and Fe X, the effective electron densities within the plasma under different EBIT operation conditions were extracted.

Thus, EUV spectroscopic measurements serve as a precise tool for EBIT plasma diagnosis, and support solar observations by providing a laboratory technique for line identification.

A 23.20 Th 16:30 Lichthof

Absolute determination of X-ray transition energies in H-like and He-like ions — •Katharina Kubiček, Hjalmar Bruhns, Johannes Braun, José R. Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

We present high-precision wavelength measurements for H- and He-like ions performed with the Flash-EBIT using a flat crystal x-ray spectrometer applying a collimation-free technique [Rev. Sci. Instrum. 76 (2005), S. 073105] which allows to determine absolute Bragg angles without the need of reference lines. We have reduced further the already small leading experimental uncertainty by installing the spectrometer coaxially to the electron beam, thus viewing the ion cloud as a point source. This setup reveals a minute curvature of the x-ray lines on the detector plane which hitherto had to be estimated. Results for the Lyman-α_1 and "w" ($1s2p\ ^1P_1 \rightarrow 1s^2\ ^1S_0$) transition wavelengths in H-like and He-like argon, sulfur and iron ions with experimental uncertainties of esimated ΔE $<$ 8 meV are sensitive to the far larger QED contributions of 1 eV.

A 23.21 Th 16:30 Lichthof

Isotope shifts and Hyperfine structure of $^{212-214}$Ra$^+$ — Gouri

S. Giri, Bijaya K. Sahoo, Oscar O. Versolato, •Lotje W. Wansbeek, Lorenz Willmann, Hans W. Wilschut, Klaus Jungmann, and Rob G.E. Timmermans — Kernfysisch Versneller Instituut, University of Groningen, Netherlands

The availability of short lived Ra isotopes at the TRIμP facility of the KVI makes the study of atomic structure of these isotopes possible. $^{212-214}$Ra ions are trapped in a buffer-gas filled Paul trap. Isotope shifts and hyperfine structures of $^{212-214}$Ra$^+$ for several transitions were obtained by laser spectroscopy. Ra$^+$ is of particular interest for a most precise measurement of Atomic Parity Violation (APV), currently underway in our group. Such a measurement will provide a stringent test of the Standard Model of particle physics. However, the interpretation of APV measurements require the determination of the weak matrix elements to better than 1% accuracy in order to extract the weak charge (Weinberg angle). Currently, our calculations are accurate to some 3%. We therefore plan to exploit the fact that radium has a wide range of isotopes by looking at the ratio E1APV/ E1'APV for two -or more- isotopes, and thus canceling atomic uncertainties. Here, nuclear structure effects start to play a role. The extracted isotope shifts and hyperfine interactions provide indispensable information. In addition, the measured hyperfine structure of ^{213}Ra$^+$ is of particular interest for the proposed Radium single ion clock.

A 23.22 Th 16:30 Lichthof

Lineare Polarisation des kurzwelligen Endes der Elektron-Kern Bremsstrahlung — •Renate Märtin[1,2], Roman Barday[3], Joachim Enders[3], Yuliya Poltoratska[3], Uwe Spillmann[1], Günter Weber[1,2] und Thomas Stöhlker[1,2] — [1]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [2]Physikalisches Institut, Universität Heidelberg, Germany — [3]Institut für Kernphysik, TU Darmstadt, Germany

Die Bremsstrahlung ist einer der elementaren radiativen Prozesse in Stößen energiereicher Elektronen mit Materie. Dabei bietet insbesondere das Studium der linearen Polarisation Zugang zur Dynamik von Stoßprozessen geladener Teilchen.

Wir präsentieren vorläufige Ergebnisse zur linearen Polarisation der Bremsstrahlung in Elektron-Atom-Stößen, sowie in Ion-Atom-Stoßprozessen. An der polarisierten Elektronenquelle der TU Darmstadt wurden unterschiedliche Festkörpertargets mit 100 keV Elektronen beschossen. Bei der Messung wurde sowohl die Spineinstellung des Elektronenstrahls als auch die Targetdicke und der Beobachtungswinkel variiert. Zur Messung der linearen Polarisation wurde ein neuartiges Si(Li)-Comptonpolarimeter eingesetzt. Des Weiteren wurde eine Messung der linearen Polarisation der Bremsstrahlung am Gasjet-Target am ESR-Speicherring der GSI durchgeführt. Dabei wechselwirkten hochgeladene Uranionen unterschiedlicher kinetischer Energie mit einem Wasserstoff- bzw. Stickstoffgastarget.

A 23.23 Th 16:30 Lichthof

Towards a Magnesium lattice clock — •Temmo Wübbena[1], André Kulosa[1], Jan Friebe[1], Matthias Riedmann[1], Andre Pape[1], Hrishikesh Kelkar[1], Sana Amairi[1], Sina Malobabic[1], Steffen Rühmann[1], Ernst-Maria Rasel[1], Wolfgang Ertmer[1], Osama Terra[2], Thorsten Feldmann[2], Burghard Lipphardt[2], Gesine Grosche[2], and Harald Schnatz[2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover — [2]Physikalisch-Technische Bundesanstalt

Neutral optical lattice clocks have exceeded the stability of microwave atomic clocks. The accuracy of todays best lattice clocks is limited by the shift of the clock transition due to the black body radiation of the atom's environment [1]. To further improve the accuracy of lattice clocks, the applicability of alternative atomic species with lower sensitivity to the black body shift is studied. On this poster we will specify the relevant properties of neutral Magnesium and compare it to the established elements Ytterbium and Strontium as well as to Mercury. We present the current status of the Mg clock experiment including the latest measurements of the Mg clock transitions. We will also describe the necessary steps to realize a Mg lattice clock. Which include the determination of the magic wavelength which is predicted between 420 nm and 470 nm, the setup of an optical lattice and the development of an efficient loading scheme for loading Mg atoms into the lattice.

[1] A. D. Ludlow, et al.: "Sr Lattice Clock at 1×10^{-16} Fractional Uncertainty by Remote Optical Evaluation with a Ca Clock", Science, Vol. 319, p.1804-1808

A 23.24 Th 16:30 Lichthof

Spectroscopy of atomic Radium — •Bodhaditya Santra, Umakanth Dammalapati, Alexander Groot, Klaus Jungmann, and Lorenz Willmann — Kernfysisch Versneller Instituut, University of Groningen, Netherlands

In preparation for a search for a permanent electric dipole moment (EDM) in the heavy alkaline earth element Ra we perform laser spectroscopy to determine energy levels and hyperfine structure splitting. Ra exhibits the largest known atomic enhancement factors for EDMs which violate parity and time reversal symmetries. The intrinsic sensitivity arises from the specific atomic and nuclear structure of Ra. All Ra isotopes with nuclear spin I are radioactive with lifetimes shorter than 15d. Several Ra isotopes are available at the TRIμP facility at KVI. In an effusive atomic beam from an oven containing about 10^{10} ^{225}Ra atoms we performed Doppler-free laser spectroscopy. The $7s^2\ ^1S_0$ - $7s7p\ ^1P_1$ transition at the wavelength 483nm was calibrated against known lines in molecular $^{130}Te_2$. The hyperfine structure splitting was determined to 4196(4) MHz. This transition is best suited for efficient laser cooling of Ra. Furthermore, we build a laser system for magneto optical trapping of Ra on the $7s^2\ ^1S_0$ - $7s7p\ ^3P_1$ intercombination transition at wavelength 714nm based on semiconductor lasers. The setup of the experiment and the results will be discussed.

A 23.25 Th 16:30 Lichthof

Ground state phase diagram of interacting fermions in a disordered 1d optical lattice — •Julia Wernsdorfer[1], Georg Harder[2], Ulrich Schollwoeck[2], and Walter Hofstetter[1] — [1]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, Max-von-Laue-Str. 1, 60438 Frankfurt am Main, Deutschland — [2]Department für Physik, Ludwig-Maximilians-Universität München, Theresienstrasse 37, 80333 München, Deutschland

In this work we investigate interacting fermions in a one-dimensional optical lattice with box disorder. Using real-space dynamical mean-field theory [1] the ground state phase diagram is obtained. We quantify localization properties via the probability distribution function of the local density of states and the inverse participation ratio. The accuracy of our results is evaluated by comparison with exact results provided by the density-matrix renormalization group.

[1] M Snoek, I Titvinidze, C Toke, K Byczuk and W Hofstetter, *Antiferromagnetic order of strongly interacting fermions in a trap: real-space dynamical mean-field analysis*, New Journal of Physics **10**, 093008 (2008)

A 23.26 Th 16:30 Lichthof

An interferometrically generated optical bottle beam trap — •Johannes Nipper[1], Siyuan Zhang[2], and Mark Saffman[2] — [1]5. Physikalisches Institut, Universität Stuttgart, Germany — [2]Department of Physics, University of Wisconsin, Madison, WI, USA

We report on a blue detuned optical dipole trap for Cs atoms. Destructive interference of two fundamental Gaussian beams in a Mach-Zehnder interferometer with unequal magnifications in the two arms of the interferometer forms an intensity zero in the focus of the interfered beams, surrounded by regions of higher intensity. This so-called bottle beam creates a trapping potential at moderately high laser intensities, sufficiently deep to trap atoms from a magneto-optical trap. Fast optics with a high numerical aperture forms trap sizes suitable for single atom trapping.

Blue detuned dark traps allow simultaneous trapping of ground state atoms and Rydberg atoms. Furthermore scattering rates and inhomogeneous light shifts due to high light intensities are reduced compared to red dipole traps.

A 23.27 Th 16:30 Lichthof

Strong dipolar effects in Chromium Bose-Einstein condensates — Stefan Mueller, •Jonas Metz, Yong Wan, Ashok Mohapatra, Axel Griesmaier, and Tilman Pfau — 5. Physikalisches Institut, Universität Stuttgart

We present an overview of experimental observations of strong dipolar effects in a Bose-Einstein condensate of chromium. Starting with dipolar interactions which perturb the usual contact interactions, we use a Feshbach resonance to reduce and finally switch off the contact interactions. Investigating the stability diagram of a dipolar gas for various trap shapes we find a universal behaviour in the large N case for all dipolar gases. By inducing a dipolar collapse we study its dynamics and observe the d-wave symmetry of the dipolar interaction in the collapse products. Finally, in order to probe the phase coherence of collapsed condensates, we induce the collapse in several condensates simultaneously and let them interfere.

A 23.28 Th 16:30 Lichthof

Phase diagram of spatially indirect excitons with an effective interaction potential — •Jens Böning, Alexei Filinov, Patrick Ludwig, and Michael Bonitz — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität, Leibnizstr. 15, D-24098 Kiel, Germany

We derive an effective interaction potential for spatially indirect excitons in quantum well structures [1]. Using this potential and path integral Monte Carlo simulations, we study exciton crystallization and the quantum melting phase transition in a macroscopic system of 2D excitons. Furthermore, the superfluid fraction is calculated as a function of density and is shown to vanish upon crystallization.

[1] A Filinov et al. *J. Phys. A: Math. Theor.* **42**, 214016 (2009)

A 23.29 Th 16:30 Lichthof

Cold gases under influence of spatiotemporal localized pertubations — •Daniel Kotik[1,2], Martina Hentschel[2], and Walter Strunz[1] — [1]Institut für Theoretische Physik, TU Dresden, 01062 Dresden — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 83, 01187 Dresden

Cold atomic gases have attracted a lot of attention in recent years, not least due to the manifold possibilities to manipulate such systems in experiments. On the other hand, many-body effects have been a long research interest in solid-state physics.

Here, we merge both topics and theoretically study the response of dilute, cold atomic gases in a harmonic trap to a spatially localized, sudden perturbation as can be realized by switching on a laser beam. First, we investigate the effect of perturbations of varying strengths, time dependence, and spatial extent in pure bosonic condensates.

We compare this situation with the fermionic case where the many-body response to a sudden, localized potential is known as Anderson orthogonality catastrophe. Furthermore, we study the time-dependence of the perturbation process and will report recent results from simulations on the time evolution in real space.

A 23.30 Th 16:30 Lichthof

Stability and free expansion of a trapped dipolar Fermi gas — •Liang He[1,2] and Su Yi[1] — [1]Institute of theoretical physics, Chinese Academy of Sciences, Beijing, China — [2]Institut für Theoretische Physik, Johann Wolfgang Goethe Universität Frankfurt (Main), Germany

The amazing experimental progress in making degenerate ultracold polar molecules [1] is making ultracold dipolar systems a fascinating research field. For spin polarized ultracold dipolar Fermi gases, the properties of the systems are determined by the dominant dipolar interactions, since the s-wave short-range interactions are strongly suppressed by the Pauli exclusion principle. We investigate the stability of a trapped spin polarized dipolar Fermi gas by a full numerical calculation of the phase space distribution function of the system. We present a stability phase diagram and show that stabilizing the system by tuning the trap geometry is generally inefficient [2]. We further show that the expanded gas always gets stretched along the direction of dipole moment [2, 3].

[1] S. Ospelkaus, A. Pe'er, K.-K. Ni, J. J. Zirbel, B. Neyenhuis, S. Kotochigova, P. S. Julienne, J. Ye, and D. S. Jin, Nature Physics **4**, 622 (2008).

[2] L. He, J.-N. Zhang, Yunbo Zhang,and S. Yi, Phys. Rev. A **77**, 031605(R) (2008).

[3] T. Sogo, L. He, T. Miyakawa, S. Yi, H. Lu, and H. Pu, New J. Phys. **11**, 055017 (2009).

A 23.31 Th 16:30 Lichthof

Stochastic Mean-Field Theory for the Bose-Hubbard Model with Speckle Disorder — •Ulf Bissbort[1], Ronny Thomale[2], and Walter Hofstetter[1] — [1]Institut für Theoretische Physik, Goethe Universität Frankfurt — [2]Department of Physics Princeton University

Using the recently developed stochastic mean-field theory (SMFT) for the disordered Bose-Hubbard model [1], we investigate the phase diagram of interacting bosons with experimentally realistic speckle disorder [2]. In comparison to prototypical box disorder, we find deviations in the phase diagram at low temperature. At fixed density and sufficiently low temperature, we identify parameter regimes at which disorder-induced superfluidity and multiple reentrant behavior is predicted. Our results at finite temperature explain the absence of this phenomenon in recent experiments. In addition to pure on-site disorder, we furthermore include uncorrelated off-diagonal disorder in the hopping energies within the SMFT formalism. To account for effects of the trapping potential and allow for a quantitative comparison with experiments, we also present results of a SMFT + LDA calculation.

[1] U. Bissbort and W. Hofstetter, EPL **86** 50007 (2009).

[2] M. White et al., Phys. Rev. Lett. **102**, 055301 (2009).

A 23.32 Th 16:30 Lichthof

Real-space Dynamical Mean-Field Theory For an Inhomogeneous Bose-Bose Mixture — •Yongqiang Li, Mohammad Reza Bakhtiari, and Walter Hofstetter — Institut für Theoretische Physik , Frankfurt am Main, Germany

Motivated by recent experiments on Bose-Bose mixtures (e.g [1]), we theoretically investigate a two-component Bose-Hubbard model. We consider such a mixture both in two and three dimensional cubic optical lattices, in the presence of an external confining potential. In order to study this inhomogeneous many-body system, we develop a real-space Bosonic Dynamical Mean-Field Theory (R-BDMFT) [2] which is capable of accurately describing the model over a wide range of parameters. For various total filling of both species, we obtain spin-resolved density distributions and more importantly different spin orders including Mott insulator, XY-ferromagnet and XY-superfluid. When each species is at filling one, we determine the phase diagram which shows a second order phase transition from XY-ferromagnet to a Mott insulator and a first order phase transition from XY-ferromagnet to a one-component superfluid state.

[1] J. Catani et al., Phys. Rev. A 77,011603(R) (2008) [2] A. Hubener. M. Snoek and W. Hofstetter, arXiv:0902.2212

A 23.33 Th 16:30 Lichthof

Three-dimensional Rotons and Supersolids in Rydberg-BECs — •Nils Henkel, Rejish Nath, and Thomas Pohl — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

We study properties of Bose Einstein condensates, in which atoms are optically coupled to highly excited Rydberg states, featuring strong van der Waals interactions. This procedure leads to effective groundstate interactions, whose shape can be widely tuned through the applied laser parameters. The special form of the resulting interaction potential is shown to result in a Roton-Maxon type dispersion relation in stable three-dimensional condensates, and to ultimately induce a transition to a supersolid groundstate. We present a theoretical as well as a numerical approach and find excellent agreement between them. Our results indicate that the Roton instability occurs for realistic laser parameters, suggesting that formation of self-assembled supersolids is feasible in current cold atom experiments.

A 23.34 Th 16:30 Lichthof

Ultracold Atoms near Superconductors — •Florian Jessen, Daniel Cano, Helge Hattermann, Max Kahmann, Dieter Kölle, Reinhold Kleiner, and József Fortágh — Center for Collective Quantum Phenomena and their Applications, Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen

Hybrid quantum systems, which combine ultra-cold atoms with solid state devices, have attracted considerable attention in the last few years. Promising applications are in the areas of precision sensing and quantum information processing. We report on our experimental efforts towards the realization of such systems based on ultracold atoms and superconductors. The experiment consists of a rubidium BEC apparatus and a thermally shielded helium flow cryostat at 4.2 K in the same ultrahigh vacuum system. Atom clouds are loaded into a magnetic microtrap formed near a superconducting niobium microstructure. We observe the impact of the Meissner effect on the trap parameters and measure the spin coherence of atoms near the superconductor. The measured coherence times are the longest yet observed in the vicinity of a highly conducting material and confirm the suppression of Johnson noise in superconductors. The results have implications for the development of coherently coupled cold atom/solid state quantum devices, in which cold atoms serve as long term quantum memory.

A 23.35 Th 16:30 Lichthof

BEC quantum carpets — •Andrey Zhukov[1], Wolfgang Schleich[1], and Enio Arimondo[2] — [1]Ulm University, Ulm, Germany — [2]University of Pisa, Pisa, Italy

The phenomenon of matter wave interference of the BEC in a tilted optical lattice was studied. With the help of theoretical model we describe the emerging interference pattern and achieve good agreement with the experimental data as well as with a numerical simulation.

A 23.36 Th 16:30 Lichthof

The thermal Bose gas - a stochastic approach — •Sigmund Heller and Walter T. Strunz — TU Dresden

Temperature dependent quantities like spatial correlation functions [1,2] density fluctuations [3] and interference contrast [4] 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 often occur for classical field equations. Furthermore, it is possible to solve the equation in position space - 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. Apart from exact results that we obtain for the ideal gas case, we show calculations for an interacting gas in one and three dimensions and obtain good agreement with experimental [2] and theoretical [5,6] work. Results for ground state occupancy, spatial correlation functions and equilibrium density profiles are presented.

[1] I. Bloch et al., Nature 403, 166 (2000).
[2] S. Hofferberth et al., Nature 4, 489-495 (2008).
[3] J. Esteve et al., Phys. Rev. Lett. 96, 130403 (2006).
[4] R. Gati et al., Phys. Rev. Lett. 96, 130404 (2006).
[5]S. Giogini et al., Phys. Rev. A 54, 4633 (1996).
[6] A. Imambekov et al., Phys Rev. A 80, 033604 (2009).

A 23.37 Th 16:30 Lichthof

Atomic mixtures with inelastic scattering — •Eder Santana Annibale, Oleksandr Fialko, and Klaus Ziegler — Universität Augsburg, Augsburg, Deutschland

The interaction of heavy atoms in a Mott state and light spin-1/2 fermionic atoms is studied in a double well potential. Inelastic scattering processes between both atomic species excite the heavy atoms and renormalize the tunneling rate (so called polaronic effect) as well as the interaction of the light atoms. An effective Hamiltonian for the latter is presented, wich describes tunneling of single fermions, tunneling of fermionic pairs and an exchange of fermionic spins. We study the dynamics of quantum states, which enables us to detect the signature of a first order phase transition between Néel and dimer states, as well as the polaronic effect.

A 23.38 Th 16:30 Lichthof

Storing the polarisation state of light in a BEC — •Chris Vo, Matthias Lettner, Stefan Riedl, Dominik Bauer, Simon Baur, Stephan Dürr, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Garching

The polarisation of light is a much used workhorse in quantum cryptography and quantum information applications. We experimentally realise a coherent memory for the polarisation of a light pulse using a Bose-Einstein condensate of ^{87}Rb atoms. Employing electromagnetically induced transparency we can store and retrieve two orthogonal polarisations of a weak probe pulse at the same time. The relative phase of these polarisations is maintained during this procedure. Therefore arbitrary coherent superpositions of these polarisations are stored in our memory. The maximum fraction of the retrieved light power lies above 30%. When storing linearly polarised light the ellipticity of the retrieved polarisation exceeds 80%. We demonstrated 5×10^4 storage and retrieval cycles on a single BEC containing $\approx 10^6$ atoms initially. The number of cycles is limited by heating and loss of atoms induced by the control light. In future experiments this technique could be applied to single photon pulses, realising a quantum memory for the photon polarisation.

A 23.39 Th 16:30 Lichthof

2D flow of a strongly interacting Bose-Einstein condensate — •Eder Santana Annibale — Universität Augsburg, Augsburg, Deutschland

The dynamics of a dilute Bose-Einstein condensate (BEC) can be described to a good approximation by the Gross-Pitaevskii equation (GP). On the other hand, the slave-boson model (SB) has been shown very useful to describe a strongly interacting BEC. In this work we study the dynamics (free expansion) of a strongly interacting BEC using the SB model, in particular the generation of shock waves past an obstacle. This problem was considered using the GP, where it was shown the generation of oblique dark solitons and linear waves. Here, we intend to understand the role of the nonlinearity in the SB for the generation of shock waves.

A 23.40 Th 16:30 Lichthof

Ratchet effect in driven Bose-Einstein condensates — •Martin Heimsoth, Charles Edward Creffield, and Fernando Sols — Facultad de Ciencias Fisicas, Universidad Complutense de Madrid

The generation of a particle current by exposing the system to an unbiased asymmetric periodic driving field is known as the ratchet effect. We demonstrate numerically that a current of a Bose-Einstein condensate whose motion is effectively restricted to a torus can be produced via a driving field with broken spatiotemporal symmetries. We explore the strong driving regime beyond the results presented in Ref [1]. Furthermore, we present a comparison of our numerical results with a recent experimental realization [2].

[1] C.E. Creffield, F. Sols, Phys. Rev. Lett. **103** (2009)
[2] T. Salger et al, Science **326** (2009)

A 23.41 Th 16:30 Lichthof

Nonlinear dynamics of a driven ultracold Bose gas — •Holger Hauptmann, Sigmund Heller, and Walter T. Strunz — Institut für Theoretische Physik, Technische Universität Dresden, Deutschland

We investigate collective modes of ultracold interacting Bose gases in a harmonic potential with a periodic time-dependent perturbation. Comparisons between the full numerics of the Gross-Pitaevskii equation and analytical approximations for the width of the gas cloud are presented. These are valid either in the Thomas-Fermi limit or near the ideal gas limit. For long time propagation the existence of a saddle point of the stroboscopic map in phase space leads to rich and unexpected dynamics.

A 23.42 Th 16:30 Lichthof

Ein Diodenlasersystem für die Atominterferometrie mit zwei Spezies — Jonas Hartwig, Vyacheslav Lebedev, Ernst M. Rasel, Dennis Schlippert, Ulrich Velte, •Nils Winter und Maic Zaiser — Universität Hannover, Welfengarten 1, 30167 Hannover

Wir stellen ein Diodenlasersystem zum simultanen Kühlen und Fangen von Kalium und Rubidium sowie zur Anregung kohärenter Raman-Übergänge für die Atominterferometrie vor. Das Lasersystem zeichnet sich durch sehr gute spektrale Eigenschaften und Stabilität, sowie eine hohe Ausgangsleistung von bis zu 5 W aus. Es wurde modular aufgebaut, um Kompaktheit und Transportabilität bei größstmöglicher Flexibilität zu gewährleisten. Es besteht aus zwei Referenzlasermodulen mit jeweils einem Linearresonatordiodenlaser bei den Wellenlängen 767 nm (K) bzw. 780 nm (Rb), die mittels Frequenzmodulationsspektroskopie auf die jeweilige D2-Linie von K bzw. Rb stabilisiert werden, einem Masterlasermodul dessen Laser mittels Schwebungsmessung frequenz- bzw. phasenstabilisiert werden, sowie einem Verstärkermodul in dem das Licht in mehreren Trapezverstärkern verstärkt wird. Dieser Aufbau ermöglicht eine Verstimmung der Laser um mehrere GHz innerhalb weniger Millisekunden, so dass die Laser sowohl als Rückpumper und Kühler in einer MOT, als auch zum Treiben von Raman-Übergängen eingesetzt werden können. Das vorgestellte Lasersystem soll in Zukunft zur Erzeugung quantenentarteter Bose-Fermi-Mischungen als Quelle für die Atominterferometrie benutzt werden und bildet einen wichtigen Bestandteil für den im Rahmen der Exzellenzinitiative QUEST geplanten Test des Äquivalenzprinzips.

A 23.43 Th 16:30 Lichthof

Measurements of the topography of Carbon Nanotube structures and cold atom-nanotube interactions — •Michael Gierling[1], Philipp Schneeweiss[1], Gabriela Visanescu[1], Johannes Märkle[1], Thomas Judd[1], Michael Häffner[1], Dieter Kern[1], Carsten Weiss[2], Reinhold Walser[3], Andreas Günther[1], and and József Fortágh[1] — [1]Center for Collective Quantum Phenomena and their Applications, Universität Tübingen, Auf der Morgenstelle 14, D- 72076 Tübingen — [2]Institut für Quantenphysik, Universität Ulm, D-89069 Ulm — [3]Institut für Angewandte Physik, TU Darmstadt, Hochschulstraße 4a, D-64289 Darmstadt

We have developed an ultracold atom experiment for studying the interaction between ^{87}Rb atoms and carbon nanotubes (CNTs). We present the setup and the technique that is used for measuring the topography of CNT structures on a chip surface. For the measurements, ultracold atom clouds are used as a scanning surface probe. For the three-dimensional nano-positioning of the atom cloud we use a magnetic conveyor belt. The method allows the resolution of nanotube arrays, nanotube lines, and individual free standing nanotubes. We also present the measurement of loss and heating rates of atom clouds spatially overlapping with a single, free standing CNT. We discuss the acquired data and the possibility to quantitatively describe the interaction between atoms and nanotubes.

A 23.44 Th 16:30 Lichthof

Transition to equilibrium for an interacting Bose gas — •Lena Simon und Walter T. Strunz — Institut für theoretische Physik, TU Dresden, Dresden

We aim to shed light on the transition from a nonequilibrium to an equilibrium state of an interacting quantum many-body system. By solving the full (unitary) Schrödinger equation for a Bose-Hubbard-type model, we investigate the dynamics of the one-particle-density operator. We present fully numerical results and aim to elucidate the irreversible transition to equilibrium.

A 23.45 Th 16:30 Lichthof

Probing an Ultracold Rb Cloud Stored in a Dipole Trap with Few and Single Atoms — •Oskar Fetsch, Wolfgang Alt, Shincy John, Amir Moqanaki, Nicolas Spethmann, Claudia Weber, Artur Widera, and Dieter Meschede — Institut für Angewandte Physik, 53115 Bonn, Deutschland

In this experiment, we aim on combining the advantages of single atom experiments with experiments dealing with ultracold quantum gases. Single and few Cs atoms are captured in a high-gradient magneto-optical trap (MOT) and the loading dynamics are observed through fluorescence detection. A Rb ensemble is cooled in a magnetic trap and then transferred using magnetic transport to a crossed dipole trap at the position of the Cs MOT. In this purely optical trap the Rb can be further cooled to quantum degeneracy. By transferring the Rb to a magnetic field insensitive state, it is possible to switch on the single atom MOT without affecting the Rb cloud. First experiments use few and single atoms trapped in a MOT to probe the ultracold Rb cloud. For further experiments, the internal spin degree of freedom of the Cs atoms needs to be manipulated. To accomplish this a species-selective optical lattice to trap the Cs atoms is set up.

A 23.46 Th 16:30 Lichthof

Towards a three-component Fermi gas in a 2D optical lattice — •Martin Ries[1,2], Philipp Simon[1,2], Thomas Lompe[1,2], Friedhelm Serwane[1,2], Gerhard Zürn[1,2], Timo Ottenstein[1,2], and Selim Jochim[1,2] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Physikalisches Institut, Universität Heidelberg

In our recent experiments, we have been studying a three-component Fermi gas with large scattering lengths. This system can serve as a simplistic model for QCD physics. Unfortunately, the stability of the three-component gas is limited in free space. However, there have been proposals on how to overcome this problem. For instance, the application of an optical lattice can improve the stability of the system drastically [1]. On the poster we present our progress setting up a new apparatus for these kind of experiments. We will use fermionic lithium in a 2D optical lattice. To achieve the necessary trapping and cooling of the atoms, we plan to use established components like a Zeeman slower, a magneto-optical trap as well as an optical dipole trap to cool the atoms to degeneracy. Additionally, there will be more advanced techniques for integrating and loading the optical lattice. A sophisticated imaging system will be needed to observe the atoms in our system.

[1] A. Kantian et al., arXiv.org:0908.3235 (2009)

A 23.47 Th 16:30 Lichthof

Simulation und Herstellung verschiedener zweidimensionaler Ionenfallen für die Quanteninformationsverarbeitung — •Michael Hellwig[1], Amado Bautista-Salvador[1], Frank Ziesel[1], Max Hettrich[1], Michaela Petrich[1], Kilian Singer[1], Günter Werth[2] und Ferdinand Schmidt-Kaler[1] — [1]Universität Ulm, Ulm, Deutschland — [2]Universität Mainz, Mainz, Deutschland

Wir beschreiben Fabrikationsmethoden und Design planarer Penning- und Paul-Fallen für Quanteninformationsverarbeitung. Sehr komplexe 2-dimensionale Fallenstrukturen lassen sich hochpräzise fertigen. Als Beispiel zeigen wir eine vielseitig verwendbare Penning Falle, bei der die Elektrodenkonfiguration in 2 Dimensionen sehr weitgehend modifiziert werden kann [1]. Obwohl das Einschlusspotential nur einige 100 meV beträgt sind Konfigurationen möglich, bei denen Ionen nahe an Oberflächen oder in frei konfigurierbaren 2-dimensionalen Kristallen gespeichert werden. In einer speziellen Paul-Falle können Ionen in starken magnetischen Gradientenfeldern gespeichert werden. Das ermöglicht die Kopplung zwischen Bewegungs- und Spin-Zuständen [2, 3]. Wir beschreiben die numerische Simulation der Fallenpotentiale, den Fertigungsprozess im Reinraum sowie erste experimentelle Resultate.

[1] - arXiv:0912.1533
[2] - Phys. Rev. Lett. 102, 073004 (2009)
[3] - Phys. Rev. A 79, 052324 (2009)

A 23.48 Th 16:30 Lichthof

Towards ultracold mixtures on an atom chip — •Sonali Warriar, Sebastian Nickel, Lucia Hackermüller, and Peter Krüger — University of Nottingham, Nottingham, United Kingdom

Ultracold mixtures hold the promise of understanding new phases of matter and collisions at very low energies. We are planning to set up experiments with Lithium and Cesium mixtures on a chip, i.e. ^{6}Li - ^{7}Li mixtures, heteronuclear LiCs or homonuclear $^6Li_2$ molecules. By combining the capabilities of the atom chip with optical dipole trapping, it would be possible to trap these mixtures in low dimensions and tune their scattering lengths via Feshbach resonances. With atom chips, it would also be possible to realise experiments with additional magnetic potentials or have cold atoms interacting with a 2D electron gas. Here we present the current status of our experiment. This includes the setup of our lithium laser system, i.e. absorption spectroscopy and tapered amplifier laser setup. An illustration of our planned experimental chamber is also given.

A 23.49 Th 16:30 Lichthof

Ring-traps on atom chips — •Anton Piccardo-Selg, James Clewett, Sonali Warriar, Gal Aviv, Lucia Hackermüller, Thomas Fernholz, and Peter Krüger — University of Nottingham, United Kingdom

Atom chips allow for almost arbitrary trapping geometries for atomic ensembles by means of magnetic, electric, optical, microwave and radio-frequency potentials. We report on the setup of a new atom chip apparatus to create ring- and torus-shaped traps. These traps will be used to investigate the transition of a Bose-Einstein condensate when the dimensionality of the trapping geometry changes from 3D to 2D, and from 2D to 1D. Of particular interest are studies of low dimensional systems (2D and 1D) with periodic boundary conditions. Further we intend to use this configuration to create a Sagnac-like interferometer with ultracold atoms. The current progress of the experimental setup will be presented.

A 23.50 Th 16:30 Lichthof

An electric field generator for versatile trapping potentials in segmented microstructured ion traps — •M. T. Baig, M. Ziolkowski, M. Johanning, D. Kaufmann, and Chr. Wunderlich — Fachbereich Physik, Universität Siegen, 57072 Siegen, Deutschland

A collection of laser cooled ions stored in a micro structured Paul trap (microtrap) is a promising tool for investigations in quantum information science. Such microtraps allow for sculpting the electric potential experienced by individual ions and thus to shuttle ions between different trap locations. In addition, the range and strength of magnetic gradient induced coupling (MAGIC [1]) between spins can be varied by changing these potentials.

For controlling the quasi-dc voltages applied to individual electrodes of the microtrap, we set up a prototype electric field generator, initially to create 20 dc electric potentials which can be multiplexed and applied to 70 dc electrodes of the microtrap. Each channel contains its own memory, a digital-to-analog-converter and an amplifier so every channel can be programmed independently to get the desired potential at the output. This system has a 20 MHz update rate, is precise to 1 mV with peak to peak voltages up to 15 V and low in noise ($<\pm0.5$ mV).

[1] M. Johanning, et al.; Phys. Rev. Lett. 102, 073004 (2009)

A 23.51 Th 16:30 Lichthof

Ultralong-range Rydberg Molecules: Investigation of a Novel Binding — •Björn Butscher[1], Vera Bendkowsky[1], Johannes Nipper[1], Jonathan Balewski[1], James P. Shaffer[1,2], Robert Löw[1], and Tilman Pfau[1] — [1]5. Physikalisches Institut, Universität Stuttgart, Germany — [2]Homer L. Dodge Departement of Physics ans Astronomy, University of Oklahoma, USA

For highly excited Rydberg atoms, the scattering of the Rydberg electron from a nearby polarizable ground state atom can generate an attractive mean-field potential which is able to bind the ground state atom to the Rydberg atom within the Rydberg electron wave function at binding energies ranging from a few MHz to hundreds of MHz[1].

We present spectroscopic data on the observation of various bound states including the vibrational ground and excited states of rubidium dimers Rb(5S)-Rb(nS) as well as those of trimer states. Furthermore, we show calculations that reproduce the observered binding energies remarkably well and reveal that some of the excited states are purely bound by quantum reflexion at a shape resonance for p-wave scattering.

To further charcterize the molecular states, we determine lifetimes and stark spectra of these molecules, which allow us to gain insight into the rotational structure of these molecules.

[1] V. Bendkowsky et. al., Nature **458**, 1005 (2009)

A 23.52 Th 16:30 Lichthof

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 dominated by three-body recombination, owing to the strong $\sim T^{-9/2}$ scaling of the recombination rate with the electron temperature. While this law is well established at high temperatures, the unphysical divergence as $T \to 0$ clearly suggests a breakdown in the low-temperature regime. Despite active debates about its extension into the low-temperature domain, and consequently strong coupling regime, a conclusive answer is still missing.

Here, we use a combined molecular dynamics - Monte Carlo method to investigate electron-ion recombination over a wide range of temperatures and densities. Through a careful analysis, we devise an approach that permits to distinguish recombined atoms from the surrounding plasma, i.e. to develop a chemical picture − even in the strongly coupled regime. Our method reproduces the known behavior of the recombination for high temperatures, but reveals significant changes as T decreases. We discuss the fate of the kinetic bottleneck and resolve the divergence-problem in the ultracold domain.

A 23.53 Th 16:30 Lichthof

Collective modes of ultracold neutral plasmas — •Andrei Lyubonko, Thomas Pohl, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

We study collective modes in an ultracold neutral plasma (UNP), as observed in recent experiments via microwave excitation of plasma electrons. The absence sharp boundary in freely expanding UNPs requires different approaches than used to understand the response of confined hot plasmas, but suggests an analogy to the behavior of hot stars.
We present extensive molecular dynamics simulations that reproduce experimental observations, upon a proper inclusion of temperature and charge imbalance effects. In contrast to previous believe, the calculations show that the found high-order resonances are not of Tonks-Dattner type. We elucidate the nature of these unusual modes, based on a hydrodynamical theory. Upon proper understanding such modes can serve as diagnostic tool to monitor the plasma temperature and other properties, such as the degree of neutrality during the expansion of ultracold plasmas.

A 23.54 Th 16:30 Lichthof

Image-potential states: A hydrogen-like system at metal surfaces — •Jens Güdde and Ulrich Höfer — Fachbereich Physik und Zentrum für Materialwissenschaften, Philipps-Universität, 35032 Marburg, Germany

Image-potential states represents a simple model system for the study of the complicated many-body interaction at solid surfaces. Electrons in these normally unoccupied states are bound perpendicular to the surface due to the potential well consisting of the coulomblike attractive image potential and the repulsive surface barrier. The resulting quantized electronic states form a hydrogenlike Rydberg series converging to the vacuum energy.

We present an overview of recent experiments in which the combination of coherent optical excitation with time- and angle-resolved two-photon photoemission (2PPE) has been used to study the coherent and incoherent dynamics of electrons in image-potential states on metal surfaces with femtosecond time resolution. This includes quantum-beat spectroscopy of image-potential states and resonances, their decoupling by rare-gas layers, and the generation and detection of coherently controlled ultrashort electrical current pulses at surfaces.

A 23.55 Th 16:30 Lichthof

The vibrational structure of ultralong-range Rydberg molecules — •Weibin Li, Jovica Stanojevich, Cenap Ates, Thomas Pohl, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Ultralong range Rydberg molecules have been observed by photoassociation spectroscopy recently in cold Rb atomic gases. These weakly bound molecules are formed by low energy scattering of Rydberg electron with ground state atoms, with binding length up to several thousand Bohr for high Rydberg states. A Green's function calculation gives consistent potential curves and is shown to explain most of the observed dimer lines. We reveal a new binding mechanism based on quantum reflection at a shape resonance for electron-atom scattering. Using a simplified model potential we elucidate the role of quantum reflection and the influence of the long-range potential shape onto the properties of the vibrational spectrum.

A 23.56 Th 16:30 Lichthof

Controlled Charge Transport in lattice confined Alkaline-Earth Gases — •Rick Mukherjee[1], Igor Lesanovsky[2], Alexander Eisfeld[1], and Thomas Pohl[1] — [1]Max-Planck-Institute for the Physics of Complex systems, Noethnitzer Str. 38, D-01187 Dresden, Germany — [2]School of Physics and Astronomy, The University of Nottingham, University Park, Nottingham NG7 2RD, UK

We study the dynamics of an ion immersed in an optical lattice of ultracold atoms. Optical dressing to Rydberg states is shown to permit precise and detailed control of charge exchange between neighboring lattice sites, thereby offering unique opportunities to steer coherent charge transport and implement, e.g. a range Holstein-Hubbard type Hamiltonians in optical lattices.

Here, simultaneous trapping of atoms and ions is made possible though the use of alkaline-earth atoms. Focussing on Strontium, we present extensive calculations of the atomic structure of highly excited states, as well as of the properties of molecular ions composed of such two-electron atoms. Our results show that the proposed scheme can be realized in ultracold Strontium lattices, as currently studied in several laboratories.

A 23.57 Th 16:30 Lichthof

Ultracold Rydberg trimers — •Iris Reichenbach, Weibin Li, Jovica Stanojevic, Thomas Pohl, and Jan-Michael Rost — Max Planck Institut für Physik komplexer Systeme, Dresden, Germany

The interactions of cold Rydberg atoms are an interesting system for both basic research as well as interesting novel applications like quantum information processing and ultracold chemistry. Recently, the formation of very large and loosely bound molecules consisting of one Rydberg atom and one other atom was predicted theoretically and realized experimentally. Here, we investigate the formation of similar Rydberg molecules, where the non-Rydberg atom is substituted by a molecular dimer, leading to an even richer but still tractable system, in which the energy of the Rydberg molecule depends on the orientation of the original dimer.