A 31: Poster Session III

Time: Thursday 17:00–19:00 Location: P OGs

A 31.1 Thu 17:00 P OGs

A two-species quantum gas experiment for the preparation of ultracold polar NaK molecules — Matthias W. Gempel, Torsten Hartmann, Torben A. Schulze, •Kai K. Voges, Alessandro Zenesini, and Silke Ospelkaus — Institut für Quantenoptik, Universität Hannover

Ultracold atomic quantum gas mixtures provide the starting point for the preparation of ultracold polar ground state molecules, which are excellent candidates for the study of quantum chemistry and exotic dipolar quantum phases. Here, we present an experimental apparatus for the preparation of ultracold Na and K quantum gas mixtures.

Sodium and potassium are two favorable candidates for a mixture experiment due to the well-known cooling strategies for the individual atoms and due to the large dipole moment of NaK molecules in their electronic and vibrational ground state.

We describe our experimental setup including a high resolution objective providing an experimentally verified resolution of approx. 700nm and a versatile electrode configuration for the manipulation and control of molecules in external electric fields. We present our approach towards the preparation of quantum degenerate Na+K mixtures, our progress on the measurement of the up-to-now unknown scattering properties of the boson-boson mixture and our envisioned pathway for the efficient conversion of NaK Feshbach molecules into ground state molecules.

A 31.2 Thu 17:00 P OGs

Cavity Optomechanics and Spin-Optodynamics with Cold Atoms — •Nicolas Spethmann[1], Jonathan Kohler[2], Sydney Schreppler[2], Lukas Buchmann[2], and Dan Stamper-Kurn[2,3] — [1]Department of Physics and Research Center OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Physics, University of California, Berkeley, CA 94720, USA — [3]Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

Cold atom experiments routinely deliver samples with excellent control over both external and internal degrees of freedom. We combine these quantum systems with quantum-limited sensing facilitated by a high-finesse optical cavity, opening the initially well isolated quantum system to the environment in a controlled manner.

We employ the sensitive detection of motion of the atomic ensemble to demonstrate force sensing near the standard quantum limit, achieving a sensitivity of $(42yN)^2/Hz$. We further demonstrate cavity-mediated coupling of two near-groundstate mechanical oscillators limited by quantum back-action. Employing the interaction of the atomic spin with the cavity light, we create a spin-analog of a harmonic oscillator, allowing for measurement and coherent control of collective atomic spin oscillators. This gives us access to unique features of spin-optodynamics, such as a negative temperature, high-energy 'ground state'. Our results point to the potential, and also the challenges, of detecting and coupling quantum objects with quantum light.

A 31.3 Thu 17:00 P OGs

Towards time-resolved, weakly-destructive measurements of strongly interacting Fermi gases. — •Kevin Roux, Barbara Cilenti, Oscar Bettermann, and Jean-Philippe Brantut — Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland

We present the design of a new apparatus aimed at trapping an ultracold gas of fermionic lithium in a high-finesse optical resonator. The optical cavity will serve as a deep, far off resonant dipole trap, allowing for efficient capture and evaporative cooling, and as a measurement tool. With a high finesse for close to resonance light, the cavity will allow to perform weakly destructive measurements of slow transport processes, following the density evolution in real time, with a signal to noise ratio approaching the single atom sensitivity. We plan to apply this technique to measure low currents through mesoscopic channels (both 1D and 2D). The cavity could also be used to induce long range, photon mediated interactions leading to a rich phase diagram. We will present the general design of the system and the progresses of the experimental setup.

A 31.4 Thu 17:00 P OGs

Realization of uniform synthetic magnetic fields by periodically shaking an optical square lattice — Charles Creffield[1], •Gregor Pieplow[1], Fernando Sols[1], and Nathan Goldman[2] — [1]Departamento de Física de Materiales, Universidad Complutense de Madrid, E-28040 Madrid, Spain — [2]CENOLI, Faculté des Sciences, Université Libre de Bruxelles (U.L.B.), B-1050 Brussels, Belgium

A powerful method to create effective magnetic fields is to shake a lattice of cold gases trapped in an optical lattice. Typically such schemes produce space-dependent effective masses and non-uniform flux patterns. In this work we try to tackle this problem by proposing several lattice shaking protocols, theoretically investigating their associated effective Hamiltonians and their quasienergy spectra. This allows the identification of novel shaking schemes, which simultaneously provide uniform effective mass and magnetic flux, with direct implications for cold-atom experiments and photonics.

A 31.5 Thu 17:00 P OGs

Optical trapping of ion crystals — •Yannick Minet, Julian Schmidt, Alexander Lambrecht, Pascal Weckesser, Fabian Thielemann, Markus Debatin, Leon Karpa, and Tobias Schaetz — Physikalisches Institut, Albert-Ludwigs Universitaet Freiburg, Germany

Trapped cold ion crystals provide a well suited platform for realising quantum simulations due to long-range Coulomb interactions, which allow coupling of electronic and motional states on the quantum level via the crystal phonons [1]. Controling quantum phenomena in Paul traps in higher dimensional crystals is severely affected by rf-driven micromotion. Optical trapping of ions has been proposed as a solution to this limitation while providing versatile trapping geometries, including lattices.

We now demonstrate trapping of ion crystals with up to six Barium ions by an optical dipole trap [2,3] without any rf-fields. We are able to directly observe their Coulomb interaction and resonantly measure the frequencies of normal modes. We discuss the influence of various trapping parameters, such as beam waist, Rayleigh length, laser power, axial confinement by dc electric fields and additional changes in the trapping potential due to interactions between the ions. Finally, we discuss prospects of 2D and 3D quantum simulations in optical lattices.

[1] D.J. Wineland, Rev. Mod. Phys. 85, 1103 (2013)
[2] T. Huber *et al.*, Nat. Comm. 5, 5587 (2014)
[3] A. Lambrecht *et al.*, arXiv preprint arXiv:1609.06429 (2016)

A 31.6 Thu 17:00 P OGs

Realization of a Quantum Galvanometer — •Malte Reinschmidt, Carola Rogulj, Peter Federsel, Lukas Gussmann, Andreas Günter, and József Fortágh — Physikalisches Institut, Universität Tübingen, Germany

Developing new quantum sensors is the biggest challenge in today*s quantum technology. Thereby, quantum fluctuations play an important role as they provide direct access to the quantum information of a system. Our goal is to develop a quantum galvanometer, which allows for quantum transport phenomena to be measured in various solid state systems such as quantum dots or topological insulators. In a first attempt, we are planning to realize the quantum galvanometer by coupling a current driven nanomechanical oscillator to a Bose-Einstein condensate. The correlations in the electron current should then be transferred onto an atom laser, which we measure with single atom sensitivity.

We show the current status of the experiment, including the realization and characterization of the nanomechanical oscillator, and its implementation to a cold-atom apparatus. We also give insight into the ion-optical detection system and its sensitivity with respect to electro-magnetic field fluctuations. Using fluctuating microwave fields, we show that field correlations are coherently transferred onto the atom laser and can be reconstructed from the single atom detection signal.

A 31.7 Thu 17:00 P OGs

Microscale integrated atom-photon junction — •Elisa Da Ros, Jonathan Nute, Pierre Jouve, Vineetha Naniyil, Daniele Bandolini, Nathan Cooper, and Lucia Hackermüller — Nottingham University, United Kingdom

The goal of this project is to develop a highly integrated and scalable device for coherently interfacing light and matter with potential applications in quantum memory and quantum sensing. Our system relies on the interaction between photons guided through a single-mode optical fiber and an ensemble of cold Cs atoms tightly confined by an optical dipole trap, formed in a microscopic void that has been laser etched through the fibre itself. This device is a prototype for the insertion of cold atoms into otherwise purely photonic systems such as optical waveguide chips.

A 31.8 Thu 17:00 P OGs

Home-built second harmonic generation: from near infrared to visible — •Andreas Hasenfratz, Pascal Weckesser, Ulrich Warring, and Tobias Schätz — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

Experiments in atomic physics, e.g. experiments with trapped atomic ions, often require custom-made laser sources in the VIS to near UV regime, where commercial laser systems are expensive or not available. In these cases frequency doubled solid state lasers represent a common solution. To achieve this frequency doubling, we use in our setups nonlinear crystals for second harmonic generation that are placed within a ring-resonator cavity. Here, we present our latest home-built doubling setup converting light from NIR to VIS and discuss its characteristics.

A 31.9 Thu 17:00 P OGs

Interatomic interactions in ultracold mixtures — •Vineetha Naniyil, Pierre Jouve, Elisa Da Ros, Jonathan Nute, Daniele Bandolini, Nathan Cooper, and Lucia Hackermüller — Nottingham University, United Kingdom

Experimental studies on degenerate Bose-Fermi mixtures suggest that they are a promising candidate for use in quantum information technologies. Our experimental work aims to generate ultracold mixtures of 6Li and 133Cs that would allow us to study interspecies interactions like heteronuclear Efimov states and fermionic molecules. Here we present some initial results in which we use in situ optical density measurements of molecular 6Li Bose-Einstein condensates to compare different theoretical models for the atomic density distribution. We also describe the design and characterisation of a dual-species collimated oven source and Zeeman slower for 6Li and 133Cs.

A 31.10 Thu 17:00 P OGs

Interplay of excitation hopping and electron-spin dynamics in Rydberg aggregates with spin-orbit coupling — •Karsten Leonhardt[1], Sebastian Wüster[1,2], and Jan-Michael Rost[1] — [1]Max Planck Institute for the Physics of Complex Systems — [2]Indian Institute of Science Education and Research, Bhopal

Atoms became viable candidates of analog quantum simulators for condensed matter many-body Hamiltonians due to tremendous advances in cooling, trapping and selective manipulations. The key are (off)-resonant excitations to Rydberg states, which induce strong, long-range interactions whereby the atomic systems exhibit coherent dynamics between many-body states on mesoscopic time and length scales. So far the focus was on demonstrating implementations of Ising-type Hamiltonians [1,2] realized through van der Waals interactions of identical Rydberg (dressed) states, and, spin-exchange Hamiltonians realized through resonant dipole-dipole interactions between different Rydberg states [3,4]. Here we discuss implications arising from spin-orbit coupling, which enable the interplay of orbital angular momentum excitation hopping and electron-spin-flip dynamics. **References**

[1] P. Schauß et al. Science **347**, 1455 (2015).
[2] J. Zeiher et al. Nat. Phys. **12**, 1095 (2016).
[3] G. Günther et al. Science **342**, 954 (2013).
[4] D. Barredo et al. PRL **114**, 113002 (2015).

A 31.11 Thu 17:00 P OGs

Parallel preparation of few body systems with Spatial Light Modulators — •Marvin Holten, Puneet Murthy, Benjamin Classen, Mathias Neidig, Ralf Klemt, Philipp Preiss, Gerhard Zuern, and Selim Jochim — Physikalisches Institut, University of Heidelberg, Germany

One of the main challenges of quantum simulation with cold atoms is the initialization of the system in the desired state. The most common approach is to cool the atoms in a bulk gas and then transfer them into the desired potential (e.g. an optical lattice). Here, the temperature in the bulk systems sets a lower limit to the temperature in the potential. We want to address this issue with a novel bottom-approach, where a many-body state is assembled from small, individually prepared building blocks.

One of the main challenges of the parallel preparation of small blocks is the creation of tailor-made optical potentials. To this end, we introduced a Spatial Light Modulator (SLM) to our 2D lithium experiment. On this poster, we present first results of atoms trapped inside different potentials created by the SLM. We show how phase-modulation together with several aberration correction methods are used to achieve very accurate light intensity distributions.

Finally, we investigate the utilization of these capabilities for the parallel creation of many double wells, loaded with two fermions each. By adiabatically merging several of these double wells into a larger lattice, we wish to access the fermionic Hubbard model at very low temperature, in the near future.

A 31.12 Thu 17:00 P OGs

Detecting correlations in deterministically prepared quantum states with single-atom imaging — •Andrea Bergschneider, Vincent M. Klinkhamer, Jan Hendrik Becher, Philine L. Bommer, Justin F. Niedermayer, Gerhard Zürn, Philipp M. Preiss, and Selim Jochim — Physikalisches Institut der Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg

We deterministically prepare quantum states consisting of few fermions in single- and double-well potentials. Here we report on a new imaging scheme for ^{6}Lithium with which we detect the correlations of the quantum state on a single-atom level and with spin resolution.

The detection method uses fluorescence imaging at high magnetic field where the optical transitions for the used hyperfine states are almost closed. With a high-resolution objective we image about 15 scattered photons per atom on an EMCCD camera. This is sufficient to identify and locate single atoms in our imaging plane. We can perform this scheme in-situ or after an expansion in time-of-flight and additionally resolve the spin by subsequently adressing the different hyperfine states.

By combining this scheme with our deterministic preparation, we measure the two-point momentum correlations to probe the spatial symmetry of the two-particle wavefunction. The high contrast and the scalability of the detection technique allows us to go beyond measuring two-point correlations and characterize many-body quantum states.

A 31.13 Thu 17:00 P OGs

Pairing in the normal phase of a quasi-2D Fermi gas — •Ralf Klemt[1], Marvin Holten[1], Mathias Neidig[1], Puneet Murthy[1], Philipp M. Preiss[1], Gerhard Zuern[1], Igor Boettcher[2], Tilman Enss[3], and Selim Jochim[1] — [1]Physikalisches Institut, Universität Heidelberg, Germany — [2]Department of Physics, Simon Fraser University, Burnaby, British Columbia, Canada — [3]Institute for Theoretical Physics, University of Heidelberg, Germany

Pairing is the crucial ingredient for fermionic superfluidity. For weakly interacting superfluids, Bardeen Cooper Schrieffer (BCS) theory successfully predicts important properties as for example the critical temperature T_C, the specific heat, the pairing gap and the second order nature of the phase transition. Here, pairing occurs at same temperature as the phase transition. However, the nature of pairing for strongly interacting systems is not yet well understood. In particular, strong interactions can drive pairing even above T_C. This is especially true for 2D systems, where the nature of pairing is still a matter of debate.

Here we report on our experimental results on pairing in the normal phase of a two component 2D Fermi gas. We use spatially resolved radio-frequency (RF) spectroscopy to probe the onset of pairing at different interaction strengths across the 2D BEC-BCS crossover. As we can probe our inhomogeneous system locally, also the density dependence is recorded. We map out a large pairing regime above the critical temperature, where we observe pairing to be influenced by many body effects in the strongly interacting regime.

A 31.14 Thu 17:00 P OGs

Atom Lithography with a high flux Atom Laser beam — •Amir Kordbacheh and Nick Robins — Research School of Physics and Engineering, The Australian National University, Canberra, ACT 0200 Australia

The focusing of neutral atoms by use of near-resonant light fields is the subject of intense interest in our project. This interest has been driven to a large extent by the possibility of generating focal spots on the nanometer scale by use of specially configured laser intensity profiles. The result is a technique for nanostructure fabrication with possibilities for both high resolution and massive parallelism [1]. In this configuration, each node of the standing wave acts as an individual lens, and the entire standing wave acts as a lens array. Because a standing-wave light field repeats with a periodicity of order $\lambda/2$, where λ is the wavelength of the light, a large array of structures can be fabricated in parallel. What we are aiming is to use a Rubidium, Bose Einstein Condensate (BEC) as a source of perfectly collimated Atom Laser beam in order to deposit the atoms on a given substrate. The most significant goal in this project is to reduce the resolution (FWHM) of the flux structure width as much as possible. Due to improving the resolution of the write beam, by some numerical simulations we are trying to optimize all the parameters regarding atoms and standing wave lens to find the best focal points and minimizing the effects of aberrations for our desired elements. Considering the s-wave interaction between atoms (the mean field potential) by the semi classical Gross- Piaevskii (GP) model, would be of a great importance which is taken into account.

A 31.15 Thu 17:00 P OGs

HILITE - High-Intensity Laser Ion-Trap Experiment — •Nils Stallkamp[1,2], Stefan Ringleb[2,3], Sugam Kumar[4], Tino Morgenroth[1,3], Gerhard Paulus[2,3], Wolfgang Quint[1,5], Thomas Stöhlker[1,2,3], and Manuel Vogel[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [2]Helmholtz-Institut Jena — [3]Institut für Optik und Quantenelektronik, Universität Jena — [4]Inter-University Accelerator Centre, New Delhi, India — [5]Physikalisches Institut, Universität Heidelberg

We are currently setting up a Penning-trap experiment to investigate laser-ion interaction in high-intensity photon fields and study non-linear processes like multi-photon and tunnel ionization of trapped ions. The setup is designed to be transported to different high-intensity laser facilities, like FLASH at DESY, or JETI/POLARIS in Jena. The trap is designed as an open-endcap Penning trap, which allows free access from both sides for particle loading and the laser beam. Beside the two endcap electrodes, it consists of a split-ring electrode for excitation and detection in the center and two conical-shaped capture electrodes for dynamic capture of ions from external sources. A non-destructive detection technique of the ion motion, as well as a selection of specific ion species of interest will be implemented. The complete setup is located at the center of a superconducting magnet with a field strength of up to 6 T. A pulse-tube cooler is used for cooling the trap and the electronics to 4 K. Initially, a Ti:sapphire laser system with 10 mJ pulse energy and a pulse duration of 30 fs will be used. We will present the current status as well as planned measurements.

A 31.16 Thu 17:00 P OGs

Performance tests of a new electron gun for electron-ion crossed-beams experiments — •Tobias Molkentin[1], Alexander Borovik Jr[1], B. Michel Döhring[1], Benjamin Ebinger[1], Alfred Müller[2], and Stefan Schippers[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen — [2]Institut für Atom und Molekülphysik, Justus-Liebig-Universität Gießen

Reliable atomic input data are of crucial importance for the modeling of ionized-matter environments and other plasma related applications. Cross sections for electron impact ionization of atoms and ions are particularly important. The sensitivity of an electron-ion crossed-beams experiment is mainly determined by the densities of both beams in the interaction region. To achieve an extension of the available range of accessible electron energies and densities a new electron gun [1,2], which delivers a ribbon-shaped beam, has been integrated into the experimental crossed-beams setup in Giessen. Its designed range of electron energies reaches from 10 to 3500 eV with high electron currents at all energies. The gun consists of ten different electrodes allowing for a variety of operation modes. Here, we present the results of performance tests investigating the different operation modes of the new electron gun. Due to the high intensity of the electron beam we observed space charge related effects [3], which are currently being investigated in detail.

[1] Shi et al., Nucl. Instr. Meth. Phys. Res. B 205 (2003) 201-206
[2] Borovik et al., J. Phys.: Conf. Ser. 488 (2014) 142007
[3] A. Müller et al., Nucl. Instr. Meth. Phys. Res. B 24 (1987) 369

A 31.17 Thu 17:00 P OGs

Preparation of an EBIT ion source for HILITE — •Tino Morgenroth[1,2], Nils Stallkamp[1,3], Stefan Ringleb[2], Oliver Forstner[1,2,3], Manuel Vogel[1,3], and Thomas Stöhlker[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [2]Institute of Optics and Quantumelectronics, Friedrich Schiller Universität Jena — [3]Helmholtz Institut Jena

The HILITE experiment is an open-endcap Penning trap setup, which is currently under construction at the GSI facility in Darmstadt. It allows the study of laser-ion interaction with highly-charged ions at high-intensity laser-systems such as JETI and POLARIS in Jena or FLASH in Hamburg. The main topic of our studies will be the observation of non-linear laser-ionisation effects, for which a well-defined ion-target in a desired charge distribution is a basic requirement. The need of the production of well-prepared ions is covered by a commercial EBIT ion source from the Dreebit company. This device produces highly-charged ions by consecutive impact ionization by an electron beam. The EBIT is optimized with respect to the ionisation process, to get a specific charge state of a distinct ion species, as well as the extraction, to get an optimal capturing of highly charged ions in the HILTE Penning trap. The experimental setup as well as results of the measurements of properties of the extracted ions and capture efficiency with HILITE will be presented. An outlook on the planned experimental work will be given.

A 31.18 Thu 17:00 P OGs

Electron-impact ionisation of xenon ions — •B. Michel Döhring[1], Alexander Borovik Jr.[1], Benjamin Ebinger[1], Tobias Molkentin[1], Alfred Müller[2], and Stefan Schippers[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Gießen, Deutschland — [2]Institut für Atom- und Molekülphysik, Justus-Liebig-Universität Giessen, Gießen, Deutschland

Reliable atomic data are important for modelling of ionised gases in many different areas of physics, like astrophysics, plasma physics/spectroscopy and in atomic fusion research. Especially, cross sections for electron-impact ionisation of atoms and ions are required in such applications. The electron-impact ionisation process is fundamental in atomic physics. There is a new upcoming interest in xenon because it is proposed as a cooling gas in Tokamaks and as a propellant for ion micro-thrusters. Additionally, the xenon plasma can emit light in the extreme ultraviolet range and therefore it is a possible source of radiation in next-generation lithography devices.

We will present measurements of electron-impact single-ionisation cross sections of xenon ions. These data were measured at the electron-ion crossed-beams setup at the University of Giessen employing the well-known animated-crossed-beams technique [1]. We can now measure cross sections at energies up to twice the maximum accessible with our previous electron gun. The results are in good agreement with literature data. In the future the measurements will be extended to higher ion charge states like Xe^{23+} which were out of reach before.

[1] Müller et al., J. Phys. B. 18 (1985) 2993-3009

A 31.19 Thu 17:00 P OGs

Spectroscopy of highly charged ions using a main magnetic focus ion trap — •Marc Keil[1], Alexander Borovik Jr.[1], Stefan Schippers[1], and Alfred Müller[2] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen — [2]Institut für Atom- und Molekülphysik, Justus-Liebig-Universität Gießen

The Main Magnetic Focus Ion Trap (MaMFIT [1]), a compact tool for spectroscopy of highly-charged ions, has been recently installed in Giessen and has already been employed for investigation of dielectronic recombination in highly-charged iridium ions [2]. The present construction, however, restricts the experimental access exclusively to ions of the cathode material, which, in the present case is iridium. We report on an effort to upgrade the presently available MaMFIT device to enhance its versatility thus enabling experimental access to ions of a wider spectrum of elements. This construction and the installation of a ballistic gas inlet system [3] should facilitate fine-dosed delivery of the desired working gas directly into the ion trap region. The development of a system for periodic ion-trap dumping should prevent the accumulation of iridium ions sputtered from the cathode thus enabling us to trap light ions. Test measurements involving Ar^{q+} ions are envisaged for the near future.

[1] V. P. Ovsyannikov, A.V. Nefiodov, Nucl. Instr. Meth. Phys. Res. B 370 (2016) 32-41.
[2] A. Borovik, Jr et al., to be published.
[3] K. Fahy, Phys. Rev A 75 (2007) 032520.

A 31.20 Thu 17:00 P OGs

Nuclear excitation by electron capture in astrophysical plasmas — •Hyoyin Gan and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Saupfecheckweg 1, 69117 Heidelberg, Germany

The elements in the Universe are formed in the process of nucleosynthesis in hot and dense plasmas which contain a tremendous numbers of photons and electrons. Under these conditions, nuclear excitation and decay processes may occur differently than under laboratory conditions, influencing the nucleosynthesis paths. We investigate the effect of photoexcitation [1] and nuclear excitation by electron capture [2] in the hot dense stellar plasma. In particular we address specific cases of nuclear isotopes which have a sensitive level scheme with respect to excitation mechanisms, for instance because of the presence of a long-lived isomeric state. Possible effects for the nucleosynthesis process are discussed.

[1] J. Gunst *et al.*, Phys. Rev. Lett. **112**, 082501 (2014).
[2] A. Pálffy, W. Scheid and Z. Harman, Phys. Rev. A **73**, 012712 (2006).

A 31.21 Thu 17:00 P OGs

Strong higher-order resonant contribution to x-ray line polarization in hot anisotropic plasmas — •Chintan Shah[1], Pedro Amaro[2], René Steinbrügge[1], Sven Bernitt[1,3], Stephan Fritzsche[3], Andrey Surzhykov[4], José Ramón Crespo López-Urrutia[1], and Stanislav Tashenov[2] — [1]Max-Plank-Institut für Kernphysik, Heidelberg, Germany — [2]Physikalisches Institut, Heidelberg, Germany — [3]Friedrich-Schiller-Universität Jena, Jena, Germany — [4]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

The angular distribution and polarization of x rays emitted due to resonant recombination were experimentally studied using an electron beam ion trap. The electron-ion collision energy was scanned over the *KLL* dielectronic, trielectronic and quadruelectronic recombination resonances of $Fe^{18+..24+}$ and $Kr^{28+..34+}$ with an excellent resolution of $\sim$ 6 eV. The angular distribution of x rays was measured along and perpendicular to the beam axis. Subsequently, polarization was measured using Compton polarimetry [1]. We observed that most of the x-ray transitions lead to polarization including higher-order trielectronic and quadruelectronic resonances. These channels dominate the polarization of the dominant K_α x-ray line emitted by hot plasmas [2]. We conclude that accurate plasma polarization diagnostics can only be obtained with the careful inclusion of relativistic Breit interaction [3] and hitherto neglected higher-order resonances [2].

[1] C. Shah et al., PRA 92, 042702 (2015)
[2] C. Shah et al., PRE 93, 061201(R) (2016)
[3] P. Amaro et al., submitted (2016).

A 31.22 Thu 17:00 P OGs

High-resolution studies of resonant photorecombination with an electron beam ion trap — •Chintan Shah[1], Leticia Täubert[1], Julia Jäger[1], Sven Bernitt[1,2], and José Ramón Crespo López-Urrutia[1] — [1]Max-Plank-Institut für Kernphysik, Heidelberg, Germany — [2]Friedrich-Schiller-Universität Jena, Jena, Germany

Dielectronic recombination, the fundamental process where a free electron is captured by the highly charged ion and its kinetic energy is transferred to excite a bound electron, has been intensively investigated due to its interest for fundamental atomic physics and the diagnostic of astrophysical and laboratory plasmas. Besides DR, higher-order resonant photorecombination processes such as trielectronic or quadruelectronic recombination are also relevant, where two or three bound electrons can be simultaneously excited by the capture of a free electron. Significant contributions of trielectronic or quadruelectronic recombination to the total recombination rates make it necessary to consider these processes in the modeling of ionization balance and cooling rate of hot plasmas [1]. Here we present the measurements of these processes with *K*-shell excitation of iron ions, carried out in an electron beam ion trap.

[1] C. Shah et al., PRE 93, 061201(R) (2016)

A 31.23 Thu 17:00 P OGs

Optical spectroscopy of highly ionized ruthenium of astrophysical interest — •Hendrik Bekker[1], Paul Marie[1], Chintan Shah[1], Klaus Werner[2], and José R. Crespo López-Urrutia[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Eberhard Karls Universität, Tübingen

Observations of trans-iron elements in certain stars are a window into the slow neutron capture process (s-process) [1]. To interpret the spectra of these objects, atomic data of highly charged trans-iron ions are required. In this work several charge states of ruthenium (Z = 44) were investigated. The Heidelberg electron beam ion trap (HD-EBIT) was employed to charge-state selectively ionize and excite ruthenium ions through electron impact. The spectra of subsequent fluorescence light were recorded using a grating spectrometer. In total, 47 optical lines of the charge states Ru^{9+} to Ru^{18+} were measured. These were compared to predictions from atomic theory, resulting in tentative identifications of transitions and determination of ionization energies. Ruthenium ions are of interest here as their electronic structures are similar to those of technetium ions (Z = 43), the lightest unstable element. Due to the limited lifetime of Tc, its observation in stars gives insight into the stellar evolution and dredge-up processes [2].

[1] K. Werner et al., ApJL, 753, L7 (2012)
[2] P.W. Merrill, The Astrophysical Journal 116 21 (1952)

A 31.24 Thu 17:00 P OGs

Polar-maXs: Micro-calorimeter based X-ray polarimeters — •Christian Schötz[1], Daniel Hengstler[1], Jeschua Geist[1], Sebastian Kempf[1], Loredana Gastaldo[1], Andreas Fleischmann[1], Christian Enss[1], and Thomas Stöhlker[2,3,4] — [1]KIP, Heidelberg University — [2]Helmholtz-Institute Jena — [3]GSI Darmstadt — [4]IOQ, Jena University

We are presently developing the x-ray detector system Polar-maXs, which will combine for the first time the high energy resolution, large dynamic range and excellent linearity of magnetic micro-calorimeters with the sensitivity to polarization caused by polarization-dependent Compton or Rayleigh scattering in an array of scatterers.

Polar-maXs consists of two layers. The first layer comprises a 4 x 4 array of x-ray scatterers behind a corresponding array of collimator holes. Depending on the energy range of interest and whether Compton or Rayleigh scattering is to be used, these scatterers are fabricated from low-Z or high-Z material. The scattered x-rays are detected by an array of 576 x-ray absorbers read-out by paramagnetic temperature sensors as metallic magnetic micro-calorimeters (MMC). Each absorber covers an area of 0.5mm x 0.5mm and is made of 10 micrometer thick gold, to guarantee high stopping power for x-ray with energies up to 20 keV and an energy resolution of better than 20 eV (FWHM) in the complete energy range. We discuss general design considerations as well as the results of Monte-Carlo simulations for a variety of detector designs. We present the results of first measurements with the Hydra-principle.

A 31.25 Thu 17:00 P OGs

Rydberg Quantum Optics in Ultracold Gases — •Christoph Braun[1,2], Florian Christaller[1,2], Christoph Tresp[1,2], Ivan Mirgorodskiy[1], Asaf Paris-Mandoki[1], and Sebastian Hofferberth[1,2] — [1]5. Phys. Inst. and Center for Integrated Quantum Science and Technology, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Department of Physics, Chemistry and Pharmacy, University of Southern Denmark, 5230 Odense M, Denmark

Mapping the strong interaction between Rydberg excitations in ultracold atomic ensembles onto single photons enables the realization of optical nonlinearities which can modify light on the level of individual photons.

We present the use of an electrically tuned Förster-resonance to enhance the Rydberg-mediated interaction between single-photons. The strong interaction in the vicinity of a Förster-resonance allows performing fine-structure-resolving spectroscopy of the involved Rydberg pair-states.

We also show that an atomic medium smaller than the blockade radius can be utilized to substract exactly one photon from an input pulse over a wide range of input photon-numbers, thus the absorption of a single photon renders the medium from opaque to transperant. Reduced dephasing enables the observation of coherent Rabi-Oscillations of a single "super-atom" interacting with a light field close to the single-photon level.

A 31.26 Thu 17:00 P OGs

Towards a two-species Rydberg experiment for ion-atom scattering in the quantum regime — •Nicolas Zuber, Thomas Schmid, Christian Veit, Thomas Dieterle, Robert Löw, and Tilman Pfau — 5. Physikalische Institut & Center for Integrated Quantum Science and Technology, Universität Stuttgart, Stuttgart, Germany

We are building up an experiment for ultra cold mixtures of rubidium 87 and lithium 6 with the possibility for Rb Rydberg excitation. The setup will allow for the creation and study of heteronuclear Rb*-Li Rydberg molecules by photoassociation spectroscopy. This will enable us to study ion-atom scattering in the ultra cold quantum regime so far not reached by the hybrid ion-atom-trap experiments [1]. For this purpose the anisotropic F-state Rydberg molecules will be used for the alignment of the lithium atom with respect to the ionic Rb^+ core. A two-photon ionization process provides an option for very fast ionization of the Rydberg molecule and thus the precise timing of the Rb^+-Li scattering event. The detection of the scattered ion will be done with an ion microscope and a spatially and temporally resolving delay-line detector with a single particle rate up to several MHz.

[1] R. Saito et al, arXiv:1608.07043

A 31.27 Thu 17:00 P OGs

Detection of single Rydberg impurities coupled to a Bose-Einstein condensate — •Florian Meinert, Kathrin Kleinbach, Felix Engel, Woojin Kwon, Fabian Böttcher, Robert Löw, and Tilman Pfau — 5. Physikalisches Institut and Center for Integrated Quantum Science and Technology, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

Atoms prepared in highly excited Rydberg states constitute remarkable quantum objects with extreme properties. Among others, the electronic wavefunction may extend over mesoscopic distances easily reaching the micrometer scale.

In our experiment, we explore single Rydberg impurities immersed in a Bose-Einstein condensate (BEC), for which thousands of ground-state atoms lie within the Rydberg wavefunction. Based on detailed spectroscopic studies of electron-neutral scattering in the ultracold, we report on the current status of our endeavor to employ the interaction of the Rydberg electron with the condensate atoms to imprint the Rydberg wavefunction onto the BEC density. In combination with high resolution optical addressing and readout, we aim for direct imaging of Rydberg orbitals.

A 31.28 Thu 17:00 P OGs

An optogalvanic flux sensor for trace gases based on Rydberg excitations — •Ralf Albrecht[1], Johannes Schmidt[1,2], Patrick Schalberger[2], Holger Baur[2], Robert Löw[1], Tilman Pfau[1], Norbert Frühauf[2], and Harald Kübler[1] — [1]5. Physikalisches institut, IQST, University of Stuttgart — [2]Institute for Large Area Microelectronics, IQST, University of Stuttgart

Rydberg atoms in thermal vapor are discussed as promising candidates for the realization of quantum devices such as single photon sources and sensors [1]. One example for a classical application could be a gas sensor. We want to exploit the low binding energy of Rydberg states in atoms or molecules which are easily ionized by collisions with other gases. This allows us to convert the optical excitation of the trace gas directly into charges and subsequently measure a current with low background signal [2]. This method of detecting a trace gas is very selective, due to the excitation into a bound state which gets ionized only afterwards. Furthermore, a sensitivity better than parts per million seems to be in reach. As we are able to include electronic devices ranging from simple electrode structures to complex circuits like operational amplifiers [3] into the cell, this sensitivity can be further improved.

[1] J. A. Sedlacek, et al., *Phys. Rev. Lett.* **111**, 063001 (2013)
[2] D. Barredo, et al., *Phys. Rev. Lett.* **110**, 123002 (2013)
[3] P. Schalberger, et al., *JSID* **19**, 496-502 (2011)

A 31.29 Thu 17:00 P OGs

Rydberg superatom dynamics in optical lattices — •Fabian Letscher[1,2], David Petrosyan[3], and Michael Fleischhauer[1] — [1]Department of Physics and research center OPTIMAS, University of Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Gottlieb-Daimler-Strasse 47, 67663 Kaiserslautern, Germany — [3]Institute of Electronic Structure and Laser, FORTH, GR-71110 Heraklion, Crete, Greece

The strong and long-range interactions between Rydberg atoms can suppress more than one optical excitation within a certain blockade volume. A mesoscopic ensemble of atoms then forms a so-called Rydberg superatom. In contrast to a two-level system, strong dephasing during laser excitation of the superatom can lead to its Rydberg excitation probability approaching unity. A lattice of such strongly driven superatoms allow for simulations and studies of various phases and phase transitions of open many-body systems.

Here, we discuss the excitation dynamics and steady-state phases of Rydberg superatom lattices in two regimes of laser excitation, namely: the resonant (blockade) regime and off-resonant (facilitation) regime. In the blockade regime, we show that the systems in the steady state can form a bistable, antiferromagnetically ordered phase with long-range spatial correlations. In the facilitation regime, an excitation cascade may occur leading to a fast growth of Rydberg excitation clusters. We simulate the excitation dynamics on a triangular lattice reminiscent of frustrated spin models in a strongly dissipative environment and study the cluster collisions and the role of resulting defects.

A 31.30 Thu 17:00 P OGs

Rydberg Dressed Quantum Many-Body Systems — Lorenzo Festa, •Nikolaus Lorenz, Marcel Duda, and Christian Gross — Max Planck Institute of Quantum Optics, Munich, Germany

We are setting up a novel experiment for the study of quantum many-body systems with engineered long-range interactions. These interactions are induced by off-resonant laser coupling to Rydberg states, so called Rydberg dressing. Our aim is to explore fundamentally new types of quantum matter based on these tailored long-range interactions. A first goal is to study tailored quantum magnets in microtrap arrays, where Potassium provides interesting prospects for deterministic array loading. Here we report on the status of the project and on the technological implementation of the experimental apparatus. This is designed in order to maximize coupling to Rydberg states via ultraviolett laser excitation and to minimize the experimental cycle time to allow for experiments that require high statistics.

A 31.31 Thu 17:00 P OGs

P-state Rydberg molecules — •Tanita Eichert[1], Thomas Niederprüm[1], Oliver Thomas[1,2], Carsten Lippe[1], Indujan Sivanesarajah[1], and Herwig Ott[1] — [1]Department of Physics and research center OPTIMAS, University of Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Gottlieb-Daimler-Strasse 47, 67663 Kaiserslautern, Germany

Our poster addresses the experimental investigation of P-state Rydberg molecules. The scattering interaction of the highly excited electron of a Rydberg atom and a ground state atom causes an oscillatory potential that supports molecular bound states. In our experiment we use high resolution time-of-flight spectroscopy over a range of several 10 GHz to precisely determine the binding energies and lifetimes of molecular states in the vicinity of the 25P-state. We observe molecular states, which induce a spin-flip of the perturber atom due to the mixing of the atom's hyperfine states by the molecular interaction. We also resolve molecular states, which feature strong entanglement between the orbital angular momentum of the Rydberg electron and the nuclear spin of the ground state atom. The so called butterfly molecules arise in rubidium due to a shape resonance in the p-wave electron-atom scattering. We find states bound up to -50 GHz, corresponding to binding lengths of 100 to 350 Bohr radii and with permanent electric dipole moments of around 500 Debye.

A 31.32 Thu 17:00 P OGs

Electronic tubular image states around metallic nanorings — •Christian Fey[1], Henrik Jabusch[1], Johannes Knörzer[1], and Peter Schmelcher[1,2] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

We investigate theoretically the capability of metallic nanostructures to support so called electronic tubular image states (TIS). These are quantized states of a single electron bound to the nanostructure by the interplay of two different forces: Firstly an attractive image force resulting from the polarization of the neutral metal and secondly a repulsive centrifugal force due to a circular motion of the electron. These states were originally predicted for metallic carbon nanotubes and have many properties in common with atomic Rydberg systems [1]. Our work focuses on TIS around nanorings. We present their image potentials as well as the resulting TIS and elucidate the role of the objects geometry by comparing its image potential to potentials of other nanostructures like spheres and cylinders.

[1] B.E. Granger, P. Král, H.R. Sadeghpour, M. Shapiro; Phys. Rev. Lett. **89** 135506 (2002)

A 31.33 Thu 17:00 P OGs

Perturbation-induced quantum scars and Rydberg atoms in dense background gases — •Perttu Luukko and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, D-01187 Dresden, Germany

Quantum scarring is the tendency of high-energy quantum eigenstates to condense around moderately unstable classical periodic orbits in a chaotic system. Recently we have shown (Luukko et al., Sci. Rep. **6** 37656, 2016) that a similar phenomenon occurs in separable systems with local perturbations in the potential landscape. In this case strong and numerous scars form around periodic orbits of the corresponding unperturbed system even if the perturbations are randomly placed. The scarring can be explained by considering the effect of classical periodic orbits to the level structure of the unperturbed system in a semiclassical theory.

A Rydberg atom interacts with nearby ground-state atoms mainly through a short-range polarization potential, while the unperturbed Coulomb potential is separable. This creates the necessary setting for perturbation-induced scarring. Indeed, our simulations for Rb predict that in the presence of a high number of randomly placed perturbers a significant fraction of lowest-energy electronic states that split from a constant n manifold are scarred. The scarring comes with a shift in energy, which might be relevant for experiments probing Rydberg spectra in cold and dense atom clouds. Ultra-long range bound molecular states in these systems might also be connected to the formation of scars.

A 31.34 Thu 17:00 P OGs

Ion microscopy of ultracold ground state and Rydberg atoms — •Markus Stecker, Jens Grimmel, Raphael Nold, Andreas Günther, and József Fortágh — Center for Quantum Science, Physikalisches Institut, Eberhard-Karls-Universität Tübingen, Germany

We developed a novel quantum gas microscope based on ionization of atoms and high resolution ion optics. The system achieves a magnification up to 1000 and a theoretical resolution limit below 100nm. The microscope consists of four electrostatic lenses and a microchannel plate in conjunction with a delay line detector. This allows the observation of ultracold ground state as well as Rydberg atoms with single atom sensitivity and high temporal and spatial resolution.

We show the ion-optical setup and its experimental implementation to an ultra-cold atom setup. We investigated its performance by spatially patterned ionization of ground state atoms out of a magneto-optical trap. Furthermore, we present excitation and detection of Rydberg atoms. We studied the Stark effect on Rydberg atoms in different electric field ranges. At high fields, we measured the spectra of highly Stark-shifted Rydberg resonances and compared these findings to a newly developed numerical calculation including ionization rates. In the low field region, we investigated Förster resonances and their influence on the excitation statistics.

A 31.35 Thu 17:00 P OGs

Rydberg atoms of ^{87}Rb in crossed electric and magnetic fields — •Manuel Kaiser, Jens Grimmel, Peter Zwissler, Lara Torralbo-Kampo, and József Fortágh — Center for Quantum Science, Physikalisches Institut, Universität Tübingen, Germany

External fields change the energy structure of Rydberg atoms drastically and can therefore be used to measure the fields or to manipulate the atoms but also disturb measurements if stray fields can not be compensated. Therefore precise knowledge of the Stark and Zeeman spectrum is of great interest.

We present measurements and numerical calculations of Stark and Zeeman shifts for Rydberg states of ^{87}Rb. We have extended our previous calculations [1] to a crossed electric and magnetic field situation taking into account the Stark and Zeeman structure as well as the transitions strength between all states in the EIT ladder scheme. We have performed high resolution measurements in various heated vapour cells being able to resolve the Motional Stark Effect in weak magnetic fields.

[1] J. Grimmel, M. Mack, F. Karlewski, F. Jessen, M. Reinschmidt, N. Sándor and J. Fortágh, N. J. Phys. 17, 053005 (2015).

A 31.36 Thu 17:00 P OGs

Towards a hybrid quantum system of Rydberg atoms and superconducting coplanar waveguide resonators — •Li Yuan Ley, Helge Hattermann, Conny Glaser, Daniel Bothner, Benedikt Ferdinand, Lörinc Sárkány, Reinhold Kleiner, Dieter Koelle, and József Fortágh — CQ Center for Collective Quantum Phenomena and their Applications, Physikalisches Institut, Eberhard Karls Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany

Coupling Rydberg atoms to coplanar superconducting resonators has been proposed to enable efficient state transfer between solid state systems and ultracold atoms. This coupling could be used for the generation of an atomic quantum memory or the implementation of new quantum gates [1,2].

After the successful demonstration of magnetic coupling between ultracold ground state atoms and a coplanar waveguide resonator, we progress towards coupling Rydberg atoms to the electric field of the cavity. Due to the large dipole moment of Rydberg atoms, the coupling strength to the cavity is expected to be much larger than in the case of ground state atoms. At the same time, Rydberg states are strongly affected by any detrimental fields, such as the electric field of adsorbates on the chip, leading to spatially inhomogeneous energy shifts. We report on the characterization of these fields, state selective detection of Rydberg atoms and on the progress towards strong coupling.

[1] L. Sárkány et al., Phys. Rev. A 92, 030303 (2015).
[2] J. D. Pritchard et al., Phys. Rev. A 89, 010301 (2014).

A 31.37 Thu 17:00 P OGs

Long-range quantum gate via Rydberg states of atoms in a thermal microwave cavity — •Lorinc Sárkány[1], József Fortágh[1], and David Petrosyan[2,3] — [1]Eberhard Karls Universität Tübingen, Physikalisches Institut, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Institute of Electronic Structure and Laser, FORTH, GR-71110 Heraklion, Crete, Greece — [3]Aarhus Institute of Advanced Studies, Aarhus University, DK-8000 Aarhus C, Denmark

We propose a universal quantum gate based on two spatially separated Rydberg atoms coupled through a non-resonant microwave cavity, which may be in any superposition or mixture of photon number states. Quantum interference of different transition paths from the two-atom ground to the double-excited Rydberg states involving a single microwave photon exchange through the cavity makes both the transition amplitude and resonance largely insensitive to cavity excitations. Our scheme for attaining ultra-long-range interactions and entanglement also applies to mesoscopic atomic ensembles in the Rydberg blockade regime and is scalable to many ensembles trapped within a centimeter-sized microwave resonator.

A 31.38 Thu 17:00 P OGs

Evidence for direct observation of radiative charge transfer photons in noble gas clusters — •Andreas Hans, Xaver Holzapfel, Philipp Schmidt, Christian Ozga, Sascha Apazeller, Catmarna Küstner-Wetekam, Arno Ehresmann, and André Knie — Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany

The environment of an atom is essential for the decay possibilities of excited states. If an atom is bound in a cluster, possible intra-atomic relaxation processes must be extended by several non-local processes like Interatomic Coulombic Decay (ICD) and Electron Transfer Mediated Decay (ETMD). However, fast processes like Auger decay can still happen locally and create doubly charged sites within a cluster. Because a one-site doubly-charged state possesses a much higher potential energy than a two-site singly-charged state, the system can relax by the transfer of an electron from a neutral atom to the doubly charged site. In this Radiative Charge Transfer (RCT), the excess energy is emitted as a photon. The process has been observed several times in the form of lacking energy in electron-ion-coincidence experiments. Here, we present evidence for the direct measurement of the emitted photons from noble gas clusters.

A 31.39 Thu 17:00 P OGs

Ultra-fast interatomic processes investigated by electron impact induced fluorescence spectroscopy — •Catmarna Küstner-Wetekam, Andreas Hans, Philipp Schmidt, Christian Ozga, Xaver Holzapfel, Arno Ehresmann, and André Knie — Institut für Physik and CINSaT, Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany

In weakly bound systems like clusters novel relaxation pathways emerge for electronically excited states via different interparticle reactions such as Interatomic Coulombic Decay (ICD [1]) and Radiative Charge Transfer (RCT [2]). Both are of general interest due to their possible role in radiation damage in biological systems [1,2]. Here, we introduce an experiment using electron impact induced fluorescence spectroscopy (EIFS [3]) for ionization of noble gas clusters and examination of ICD and RCT fluorescence lines [4,5]. The excitation energy can be varied between 5 eV and 3 keV to observe different relaxation mechanisms in clusters by detection of emitted photons in a wavelength range from 40 nm to 650 nm.

[1] F. Trinter et al., Nature, 505, 664 (2014)
[2] X. Ren et al., Nat. Commun., 7, 11093 (2016)
[3] A. Knie et al., J. Elec. Spec., 185, 492-497 (2012)
[4] A. Knie et al., New J. Phys., 16, 102002 (2014)
[5] A. Hans et al., Chem. Phys., In Press (2016)

A 31.40 Thu 17:00 P OGs

Population inversion in atomic clusters — •Andreas Rubisch, Ulf Saalmann, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

High harmonic generation in intense laser pulses is a valuable tool to obtain radiation in the UV and x-ray regime. In order to overcome the typically low conversion efficiency, it was proposed to assist the emission of high harmonics in single atoms or molecules by an intense near-infrared (NIR) driving pulse [1].

Such a mechanism could be powerful in atomic clusters as well. There the NIR pulse generates a nano-plasma, which, however, is highly unstable upon evaporation. Here we study helium droplets doped with a handful of xenon atoms, where by means of dopant-induced ignition a lower-temperature nano-plasma is formed [2,3].

We perform classical molecular-dynamics calculations in order to quantify the competition between population inversion and subsequent recombination on one hand and evaporation through electron-electron collisions on the other hand.

[1] T. Bredtmann et al., PRA 93, 021402(R) (2016)
[2] A. Mikaberidze et al., PRL 102, 128102 (2009)
[3] S.R. Krishnan et al. PRL 107, 173402 (2011)

A 31.41 Thu 17:00 P OGs

Multicoincidence studies of Interatomic Coulombic Decay in neon dimers — •Derya Aslitürk, Till Jahnke, Jonas Rist, Markus Schöffler, Florian Trinter, Markus Weitz, Daniel Trapert, Sebastian Eckart, Pia Huber, Christian Janke, Sven Grundmann, Miriam Weller, Darja Trojanowskaja, Kevin Henrichs, Gregor Kastírke, Maurice Tia, Christoph Goihl, Max Kircher, Nikolai Schlott, Hendrik San, and Reinhard Dörner — Institut für Kernphysik, Goethe Universität Frankfurt, Max von Laue-Str. 1, 60439 Frankfurt am Main

A measurement of resonant ICD [1] has been performed that at the BESSY synchrotron source using Cold Target Recoil Ion Momentum Spectroscopy. The main goal of this measurement was to perform a quantum state resolved investigation by resolving: 1) The initial electronic state which will undergo ICD 2) The Initial vibrational state 3) The ICD lifetime 4) The ICD electron energy 5) The ICD electron angle in the body fixed frame 6) The final electronic state of the fragment 7) The fragment kinetic energy or vibrational state. First experimental results will be presented.

References: [1] S. Barth, S. Joshi, S. Marburger, (2005) "Observation of resonant Interatomic Coulombic Decay in Ne clusters". The Journal of Chemical Physics 122 (24)

A 31.42 Thu 17:00 P OGs

Investigation of metal clusters by multi-reflection time-of-flight mass spectrometry — •Paul Fischer[1], Gerrit Marx[1], Madlen Müller[1], Birgit Schabinger[1], Lutz Schweikhard[1], Florian Simke[1], and Robert Wolf[2] — [1]Institut für Physik, Universität Greifswald — [2]ARC Centre of Excellence for Engineered Quantum Systems, School of Physics, The University of Sydney

Multi-reflection time-of-flight mass spectrometers (MR-ToF MS) are successfully employed for ion investigation and separation, offering advantages e.g. in the study of short-lived radionuclides due to their high mass resolving power and comparatively short measurement time [1,2].

A MR-ToF analyzer recently built at Greifswald has been combined with a laser-ablation/ionization source. Different types of metal clusters - compositions of multiple atoms of the ablated material - have been studied by use of conventional ToF and MR-ToF operation. The experimental results illustrate the possibilities of cluster production and investigation with the new system.

[1] R.N. Wolf et. al, Int. J. Mass spectrom. 349-350 (2013) 123
[2] F. Wienholtz et. al, Nature 498 (2013) 346

A 31.43 Thu 17:00 P OGs

Charging Dynamics of Dopants in Helium Nanoplasmas — •Dominik Schomas[1], Andreas Heidenreich[2,3], Barbara Grüner[1], Frank Stienkemeier[1], Siva Rama Krishnan[4], and Marcel Mudrich[1] — [1]Albert-Ludwigs Universität Freiburg — [2]Kimika Fakultatea, Euskal Herriko Unibertsitatea (UPV/EHU) and Donostia International Physics Center (DIPC), Donostia — [3]IKERBASQUE, Basque Foundation for Science, Bilbao — [4]Indian Institute of Technology - Madras, Chennai

Helium nanodroplets irradiated by intense near-infrared (NIR) laser pulses ignite and form highly ionized nanoplasmas even at laser intensities where helium is not directly ionized by the optical field, provided the droplets contain a few dopant atoms. We present a combined theoretical and experimental study of the helium nanoplasma ignition dynamics for various dopant species. In particular, we elucidate the interplay of dopant ionization inducing the ignition of a helium nanoplasma, and the charging of the dopant atoms driven by the ionized helium host. Most efficient nanoplasma ignition and charging is found when doping helium droplets with xenon atoms, in which case high charge states both of helium (He^{2+}) and of xenon (Xe^{21+}) are detected.

A 31.44 Thu 17:00 P OGs

Correlated electron dynamics in expanding nanoplasmas — •Tim Oelze[1], Bernd Schütte[2], Jan Lahl[1,6], Jan P. Müller[1], Maria Müller[1], Arnaud Rouzée[2], Marc J. J. Vrakking[2], Marek Wieland[3,4], Ulrike Frühling[3,4], Markus Drescher[3], Alaa Al-Shemmary[5], Torsten Golz[5], Nikola Stojanovic[5], and Maria Krikunova[1] — [1]TU Berlin — [2]MBI Berlin — [3]Uni Hamburg — [4]CUI Hamburg — [5]DESY Hamburg — [6]Lund University

When clusters get hit by intense laser pulses a nanoplasma is created within the clusters. Finally the clusters disintegrate while emitting electrons and photons.We investigate the complex nanoplasma dynamics of clusters that are irradiated with intense laser pulses by analysing their electron kinetic energy spectra. In distinct studies we examined those spectra of atomic and molecular clusters of oxygen, carbon dioxide, xenon and krypton as well as xenon-argon mixed clusters upon irradiation of intense near-infrared laser pulses or extreme ultraviolet pulses from the free electron laser FLASH. Pump-probe measurements and terahertz streaking were employed to observe autoionization and correlated electronic decay processes from previously unknown bound states in the samples. Terahertz streaking shows that these states are depopulated at least picoseconds to nanoseconds after the interaction of the respective laser pulses with the samples. The occurence of those late decay processes in a variety of excited cluster samples and by different sources of excitation suggests that those mechanisms are of general relevance for the relaxation of laser induced nanoplasmas.

A 31.45 Thu 17:00 P OGs

Three-dimensional characterization of free nanostructures via two-color coherent diffractive imaging — •Katharina Sander[1], Maxim A. Yurkin[2,3], and Thomas Fennel[1] — [1]Institute of Physics, University of Rostock, Germany — [2]Voevodsky Institute of Chemical Kinetics and Combustion, Novosibirsk, Russia — [3]Novosibirsk State University, Russia

Coherent x-ray diffraction promises high-resolution structural characterization of single free nanoparticles such as biological specimens, aerosols and atomic clusters. Hard x-ray diffraction patterns contain small angle scattering data and allow for efficient reconstruction of the 2D projected target density with well-established phase retrieval algorithms [Fienup, Appl. Opt., 1982]. A 3D reconstruction is feasible by combining multiple scattering patterns for randomly oriented reproducible targets [Ekeberg, Phys. Rev. Lett., 2015] if the particle orientation problem can be solved - typically a highly complex task involving statistical analysis. Here, we propose a 3D phase retrieval scheme based on the simultaneous measurement of hard and soft x-ray diffraction images to mitigate this difficulty. In the wide angle soft x-ray scattering, important additional information about the target orientation is contained in the diffraction images [Barke, Nat. Comm., 2015]. In this theoretical study, we explore routes to assign the target orientation to the respective hard x-ray scattering images using a pre-calculated dataset of the soft x-ray scattering patterns and test retrieval of the 3D target shape including its inner structure.

A 31.46 Thu 17:00 P OGs

A VMI spectrometer for nanoplasma experiments — •Nicolas Rendler[1], Dominik Schomas[1], Robert Moshammer[2], Thomas Pfeifer[2], and Marcel Mudrich[1] — [1]Albert-Ludwigs-Universität Freiburg — [2]Max-Planck-Institut für Kernphysik

We present a new apparatus to explore the dynamics of helium nanoplasmas via NIR and XUV femtosecond pump-probe experiments. Doped helium nanodroplets feature complex plasma ignition dynamics strongly depending on the dopant properties. The newly designed velocity map imaging (VMI) spectrometer is capable of mapping high energy electrons and ions (<250 eV) occurring in Coulomb exploding nanoplasmas. Fragment ions formed in the nanoplasma expansion will be analyzed simultaneously using a high-voltage time-of-flight (TOF) mass spectrometer mounted in the same setup.

A 31.47 Thu 17:00 P OGs

Characterization of the time structure of a pulsed helium nanodroplet source via single-particle diffractive imaging — •Pablo Nuñez von Voigt[1], N. Monserud[2], B. Langbehn[1], T. Möller[1], M. Sauppe[1], A. Spanier[1], K. Sander[3], C. Peltz[3], T. Fennel[3], B. Schütte[2], M. Vrakking[2], A. Rouzée[2], F. Frassetto[4], L. Poletto[4], A. Trabattoni[5], F. Calegari[6], C. Nisoli[5,6], and D. Rupp[1] — [1]IOAP TU Berlin, Germany — [2]MBI, Germany — [3]Universität Rostock, Germany — [4]CNR Padova, Italy — [5]Politecnico di Milano, Italy — [6]CNR Milano, Italy

Single-shot experiments with coherent diffraction imaging enable the structure determination of individual nanoparticles. We used intense high-harmonic XUV-pulses to study the time structure of our pulsed source for helium nanodroplets (Even-Lavie valve, 5K, 80bar). The single-droplet images reveal a varying cluster size along the cluster pulse and an optimal opening time of the valve of 24 μs.

A 31.48 Thu 17:00 P OGs

Time-Resolved Ionization Dynamics of Xenon Clusters — •Katharina Kolatzki[1], M. Sauppe[1], T. Bischoff[1], B. Langbehn[1], M. Müller[1], B. Senfftleben[1], A. Ulmer[1], J. Zimbalski[1], J. Zimmermann[1], L. Flückiger[1,6], T. Gorkhover[5], C. Bostedt[3,7], C. Bomme[2], S. Düsterer[2], B. Erk[2], M. Kuhlmann[2], D. Rolles[2], D. Rompotis[2], R. Treusch[2], T. Feigl[4], T. Möller[1], and D. Rupp[1] — [1]IOAP, Technische Universität Berlin, Germany — [2]FLASH, Deutsches Elektronen-Synchrotron, Germany — [3]DoP, Northwestern University, USA — [4]optiX fav GmbH, Germany — [5]LCLS, Stanford Linear Accelerator Center, USA — [6]ARC CoAMI, LaTrobe University, Australia — [7]Argonne National Lab, USA

We studied the ultrafast dynamics in single large rare gas clusters in an XUV/XUV pump-probe diffraction experiment at the FLASH free-electron laser. The spatial overlap of both microfoci at all time delays could be optimized using the delay-dependent features in the ion spectra of small clusters. Increasing charge states and decreasing ion kinetic energies show the suppressed recombination towards longer time delays.