A 20: Poster Session I

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

A 20.1 Tue 17:00 P OGs

Towards quantum many-body physics with Sr in optical lattices — •Annie Jihyun Park[1], André Heinz[1], Stephan Wissenberg[1], Stepan Snigirev[1], Jean Dalibard[2], Immanuel Bloch[1], and Sebastian Blatt[1] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, 85784 Garching, Germany — [2]Laboratoire Kastler Brossel, Collège de France, ENS-PSL Research University, CNRS, UPMC-Sorbonne Universités, 11 place Marcelin Berthelot, 75005 Paris, France

Within the last decade, fermionic alkaline earth atoms in optical lattices have become a platform for precision measurements, culminating in the realization of an atomic clock with the currently highest stability and accuracy at the 2e-18 level. In the meantime, quantum degenerate gases of all bosonic and fermionic isotopes of Sr have been realized. With the extension of the quantum gas microscopy technique to fermionic alkali metal atoms, experiments with quantum degenerate gases in optical lattices have taken another step towards full control over the internal and external degrees of freedom of fermions in optical lattices.

Here, we report on the construction of a new experiment with quantum degenerate gases of Sr in optical lattices. Our experiment aims to combine the high spatial control over the atomic degrees of freedom from quantum gas microscopy with the precision control over the internal degrees of freedom enabled by optical lattice clock techniques.

A 20.2 Tue 17:00 P OGs

Disspative processes in interacting bosonic systems — •Arya Dhar, Andreas Geissler, Tao Qin, and Walter Hofstetter — Institut für Theoretische Physik, Goethe-Universität, 60438 Frankfurt am Main, Germany

Rydberg atoms in recent years have emerged as an efficient tool to engineer long-range interactions and simulate a variety of spin Hamiltonians. Off-resonant coupling to Rydberg states creates 'Rydberg dressing' leading to great flexibility of tuning the interaction strengths. The interplay between the kinetic energy and the interactions gives rise to a number of novel quantum phases in the equilibrium scenario such as the Devil's staircase, and supersolid phases [A. Geißler et al., arXiv:1509.06292]. But in realistic situations in the experiment, there are always dissipative processes present such as spontaneous emission from the excited Rydberg states or intermediate states and dephasing due to black-body radiation. In this work we demonstrate progress on the development of a novel numerical method to study dissipative effects in Rydberg-dressed many-body systems. The goal is to combine dynamical mean field theory (DMFT) with the Lindblad formalism using the auxiliary master equation approach proposed recently [I. Titvinidze et al, Phys. Rev. B 92 , 245125 (2015)]. Using this method, we study the effects of dissipation on the various ordered states already predicted in the equilibrium case. Our studies are relevant for current experiments, which can also control the different dissipation processes to some degree.

A 20.3 Tue 17:00 P OGs

Real-space Floquet DMFT study of spectral functions of time-periodically driven systems — •Tao Qin and Walter Hofstetter — Institut für Theoretische Physik, Goethe-Universität, 60438 Frankfurt/Main, Germany

Time-periodically driven cold atom systems are versatile toolboxes for realizing artificial gauge fields in quantum simulations. Great progress has been made in simulating topologically non-trivial models such as the Hofstadter- and Haldane-Hamiltonians. Up to now most experiments focus on the non-interacting regime. Introducing interactions into systems with artificial gauge fields will be of high interest. Floquet DMFT is a non-perturbative method to study the non-equilibrium steady state in interacting time-periodically driven systems. Using its generalization to real-space Floquet DMFT for inhomogeneous systems we studied the spectral function of the Hofstadter-Falicov-Kimball Hamiltonian and its realization in a time-periodically driven system. We calculated the effect of interactions on edge states in this system and discuss possible ways to observe them in experiments. We also discuss the possibility to study spectral functions of the Hofstadter-Hubbard Hamiltonian in time-periodically driven systems.

A 20.4 Tue 17:00 P OGs

Towards a Bose polaron in an ultracold Fermi-Bose mixture of ^{6}Li and ^{133}Cs — •Binh Tran, Stephan Häfner, Manuel Gerken, Melina Filzinger, Bing Zhu, Juris Ulmanis, and Matthias Weidemüller — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg

In our experiment we are working towards the creation of a Bose polaron in an ultracold Bose-Fermi mixture of ^{133}Cs and ^{6}Li atoms with a large mass imbalance. The Bose polaron is a quasiparticle that describes a single Li impurity which is immersed into a Cs BEC and interacts with its phonon excitations. Therefore, this scenario is similar to the Fröhlich polaron from condensed matter physics. Via Li-Cs Feshbach resonances we can tune the interparticle interaction strength and change the sign of interaction, thus enabling us to investigate both attractive and repulsive polarons.

We describe the creation of a Cs BEC by means of evaporative cooling in an optical dipole trap, after the atoms have been brought to a temperature of around 1 μK in previous cooling stages. In order to reach a high phase-space density we modify our trapping potential by adding a second dipole trap with a smaller waist and applying two consecutive evaporation steps. Furthermore, we give an overview of our approach towards the experimental investigation of the Bose polaron, its energy spectrum and dynamic properties.

A 20.5 Tue 17:00 P OGs

Diatomic and triatomic ultra long-ranged Rydberg molecules — •Frederic Hummel[1], Christian Fey[1], and Peter Schmelcher[1,2] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg — [2]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg

We present recent results of our study of ultra long-range Rydberg molecules (ULRM), which include polyatomic molecules with spin dependent interactions as well as their stretching and bending dynamics. An ULRM is the manifestation of a novel molecular binding mechanism occuring in ultra cold atomic quantum gases due to the scattering of an exited Rydberg electron with neutral ground state atoms in its vicinity. The diverse potential energy landscapes arising from Born-Oppenheimer approximation gives way to a plethora of molecular states, partly with, for all practical purposes, large permanent electric dipole moments in the kilo Debye magnitude, even for homonuleic systems. Typical binding energies range from 10 up to 10^4 MHz for so called Butterfly molecules. Inculsion of fine- and hyperfine structure can lead to longrange spin-spin interaction between the Rydberg and neutral atom with typical separations of 400-1000 atomic units.

A 20.6 Tue 17:00 P OGs

Mode coupling of interaction quenched ultracold bosons in periodically driven lattices — •Simeon Mistakidis[1] and Peter Schmelcher[1,2] — [1]Zentrum fuer Optische Quantentechnologien, Universitaet Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, Universitaet Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

The out-of-equilibrium dynamics of interaction quenched finite ultracold bosonic ensembles in periodically driven one-dimensional optical lattices is investigated. It is shown that periodic driving enforces the bosons in the outer wells of the finite lattice to exhibit out-of-phase dipole-like modes, while in the central well the atomic cloud experiences a local breathing mode. The dynamical behavior is investigated with varying driving frequency, revealing a resonant-like behavior of the intra-well dynamics. An interaction quench in the periodically driven lattice gives rise to admixtures of different excitations in the outer wells, an enhanced breathing in the center and an amplification of the tunneling dynamics. We observe then multiple resonances between the inter- and intra-well dynamics at different quench amplitudes, with the position of the resonances being tunable via the driving frequency. Our results pave the way for future investigations on the use of combined driving protocols in order to excite different inter- and intra-well modes and to subsequently control them.

A 20.7 Tue 17:00 P OGs

Experimental studies of the disordered Bose-Hubbard model in two dimensions — •Jae-yoon Choi[1], Antonio Rubioabadal[1], Johannes Zeiher[1], Simon Hollerith[1], Sebastian Hild[1], Immanuel Bloch[1,2], and Christian Gross[1] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopermann straße 1, 85748 Garching, Germany — [2]Fakultät für physik, Ludwig-Maximilians-Universität München, Schellingstraße 4, 80799 München, Germany

The study of disordered systems with ultracold atoms has been extended by the advent of quantum gas microscopy, making it possible to prepare an out-of-equilibrium initial state and measure local quantities rather than bulk properties. In this poster, we summarize our recent experimental work on two-dimensional disordered optical lattice systems. Studying relaxation dynamics of out-of-equilibrium initial states, we observe a many-body localized phase and investigate the phase transition in the 2D system. Moreover, motivated by recent proposals, we probed the Bose glass phase locally by measuring an Edward-Anderson parameter analogue. Our measurements provide a chemical resolved characterization of the disordered Bose-Hubbard model in the low energy limit.

A 20.8 Tue 17:00 P OGs

Commensurate-incommensurate transition in optical cavities — •Andreas Alexander Buchheit[1], Haggai Landa[2], Cecilia Cormick[3], Thomas Fogarty[4], Vladimir Stojanovic[5], Eugene Demler[5], and Giovanna Morigi[1] — [1]Universität des Saarlandes, D-66123 Saarbrücken, Germany — [2]LPTMS, CNRS, Univ. Paris-Sud, Université Paris-Saclay, 91405 Orsay, France — [3]IFEG, CONICET and Universidad Nacional de Cordoba — [4]Okinawa Institute of Science and Technology, Japan, — [5]Department of Physics, Harvard University, Cambridge, MA 02138, USA

In this work we report on the optomechanical dynamics of chains of trapped ions, which couple to the high-Q mode of an optical standing-wave cavity. Their dynamics results from the interplay between the trapping potential, long-range Coulomb repulsion and the cavity-induced interactions. The latter are due to multiple scatterings of laser photons inside the cavity and become relevant when the laser pump is sufficiently strong to overcome photon decay. We study the stationary states of the ions as a function of the cavity and laser parameters, when the typical length scales of the two self-organizing processes, Coulomb crystallization and photon-mediated interactions, are almost commensurate. We analyze the phase diagram as a function of the ratio between the two wavelengths and recover the commensurate-incommensurate transition when cavity backaction can be neglected. We discuss the features of the emerging phases and analyse how they can be detected in the radiation emitted by the cavity.

A 20.9 Tue 17:00 P OGs

Quantum phases of ultracold dipolar molecules in low dimensions — Florian Cartarius[1,2], •Lukas Himbert[1], Anna Minguzzi[2], and Giovanna Morigi[1] — [1]Theoretische Physik, Universität des Saarlandes, 66123 Saarbrücken, Germany — [2]Université Grenoble-Alpes, CNRS, LPMMC, BP166, 38042 Grenoble, France

We consider ultracold dipolar bosonic molecules in a 1D optical lattice in tight anisotropic harmonic confinement, leading to a quasi one-dimensional geometry. If the confinement along one of the directions perpendicular to the optical lattice is relaxed, the system undergoes a structural linear-zigzag transition. We show that close to the transition this system can be mapped onto a multi-orbital extended Bose-Hubbard model, where the coefficients can be determined by means of a low-energy theory. The system displays a rich phase diagram resulting from the interplay between tunneling, on-site repulsion, the external confinement and dipolar interaction and we determine the ground state at the linear-zigzag structural instability by means of exact diagonalization. This study sets the basis for a systematic investigation on the interplay between structural and quantum order in interacting quantum gases.

A 20.10 Tue 17:00 P OGs

Spectroscopy of discrete solitons in Coulomb crystals — •Miriam Bujak[1], Jonathan Brox[1], Philip Kiefer[1], Haggai Landa[2], and Tobias Schaetz[1] — [1]Atom-, Molekül- und optische Physik, Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg — [2]LPTMS, Université Paris Sud, Orsay, France

We study structural defects (solitons) which are formed during laser triggered first order phase transition from a cloud of Mg-ions to a Coulomb crystal in a Paul trap [1]. The formation of kink configurations as well as the lifetime of such structural defects are experimentally investigated. We study the dependence on parameters, such as laser cooling ($-\Gamma/2$) and heating ($+\Gamma/10$) rate, the duration of the process to optimize the kink creation propability and explore the relevant time scales of the formation mechanism during the phase transition. We present first results of kink spectroscopy, i.e. of localized vibrational eigenmodes of the Coulomb crystal [2].

[1] M. Mielenz et al., Phys. Rev. Lett. 110, 133004 (2013)
[2] J. Brox et al., in preparation

A 20.11 Tue 17:00 P OGs

Sympathetic cooling of OH- ions using Rb atoms in a MOT — •Jonas Tauch[1], Henry Lopez[1], Bastian Höltkemeier[1], Tobias Heldt[1], Eric Endres[2], Roland Wester[2], and Matthias Weidemüller[1] — [1]Physikalisches Institut Heidelberg, INF 226, 69120 Heidelberg — [2]Institut für Ionenphysik und Angewandte Physik, Technikerstraße 25/3, 6020 Innsbruck

In this poster I will present the current status and first results of our hybrid atom-ion trap (HAITrap) experiment. Our setup combines an octupol radio frequency ion trap and a magneto optical trap (MOT). We can store up to 500 OH^- anions in the radio frequency trap, which provides sufficient optical access to superimpose laser cooled rubidium atoms in the MOT on the anion cloud. A dark spontaneous force optical trap (darkSPOT) configuration is used to bring most rubidium to the ground state, hence avoiding ion loss by inelastic collisions, as well as allowing higher densities up to $3 \cdot 10^{11}$ atoms/cm^3. This setup allows us to investigate sympathetic cooling of molecular anions with five times heavier buffer gas atoms, which is predicted to be possible by localizing the ultracold buffer gas atoms in the center of the anion cloud.

A 20.12 Tue 17:00 P OGs

Dynamical Instabilities in Trapped Bose-Einstein Condensates — •Torsten Victor Zache[1], Valentin Kasper[2], and Jürgen Berges[1] — [1]Institut für Theoretische Physik, Philosophenweg 16, 69120 Heidelberg — [2]Physics Department, Harvard University, Cambridge MA 02138, USA

We study the nonlinear phenomenon of secondary instabilities (secondaries), which was proposed in the context of inflationary particle production, with ultracold atom systems. Specifically, we consider a one-dimensional two-component Bose gas that can be realized in different experimental setups and show analytically that it exhibits a primary instability characterized by exponentially growing occupation numbers of certain momentum modes. The primary instability is triggered by initial quantum fluctuations and leads to an amplified occupation of primarily stable modes at later times. We demonstrate the existence of these secondary instabilities in trapped Bose-Einstein condensates numerically employing the classical-statistical approximation. The process underlying the generation of secondaries can be identified with a nonlinear loop correction, which leads to an interpretation in terms of Feynman diagrams and allows us to analytically estimate the secondary growth rates to be integer multiples of the primary one.

A 20.13 Tue 17:00 P OGs

QUANTUS-2 - Towards a Dual-Species Matter-Wave Interferometer in Free Fall — •Merle Cornelius[1], Tammo Sternke[1], Sven Herrmann[1], Claus Lämmerzahl[1], and The QUANTUS-Team[1,2,3,4,5,6] — [1]ZARM, Universität Bremen — [2]Institut für Quantenoptik, Leibniz Universität Hannover — [3]Institut für Physik, Humboldt-Universität zu Berlin — [4]Institut für Physik, Johannes Gutenberg Universität Mainz — [5]Institut für Quantenphysik, Universität Ulm — [6]Institut für angewandte Physik, TU Darmstadt

The goal of the QUANTUS-2 experiment is to perform dual-species matter-wave interferometry in microgravity at the drop tower in Bremen. Aiming for precision measurements to test the equivalence principle, long interferometer times in the range of seconds are crucial to increase the sensitivity of the measurement. Therefore ultra-low residual expansion rates of the used atomic ensembles are required, which can be achieved by magnetic lensing - also known as delta-kick cooling. Here we present our results of a magnetic lens to collimate a rubidium BEC in microgravity, enabling the observation of the ensemble after 2.7s of free evolution time. Optimization of the lens to reduce the aberrations lowers the expansion rate further and will thus provide an ideal source for precision atom interferometry in microgravity. Resulting future prospects will be discussed.

The QUANTUS project is supported by the German Space Agency DLR with funds provided by the Federal Ministry for Economic Affairs and Energy (BMWi) under grant number DLR 50WM1555-1557.

A 20.14 Tue 17:00 P OGs

State selective probing of weakly bound molecular products after three-body recombination — •Joschka Wolf[1], Artjom Krükow[1], Amir Mohammadi[1], Amir Mahdian[1], Markus Deiss[1], Johannes Hecker Denschlag[1], and Eberhard Tiemann[2] — [1]Institut für Quantenmaterie, Universität Ulm, 89069 Ulm, Germany — [2]Institut für Quantenoptik, Leibniz Universität Hannover, 30167 Hannover, Germany

Three-body recombination in an ultra-cold atomic cloud is a fundamental reaction process. Until now, it has mainly been studied as a particle loss phenomenon limiting the lifetime of dense atomic clouds and Bose-Einstein condensates. However, the underlying reaction channels and product states remained unexplored. In a recent experiment we were able to measure the population distribution of diatomic molecular reaction products for the regime of lowest binding energies and to extract absolute numbers for the fractions of molecules produced in the individual states. Our method allows us to determine the vibrational, rotational and partially also the hyperfine quantum numbers. In this poster we focus on the experimental technique and summarize the results.

A 20.15 Tue 17:00 P OGs

Ion source development for PIPE — •Alexander Perry-Sassmannshausen, Ticia Buhr, and Stefan Schippers — Justus-Liebig-Universität Gießen

We report on the development of a new ion source for measurements with the Photon-Ion-Spectrometer (PIPE) at beam line P04 of PETRA III at DESY in Hamburg. The new source is a Middleton type versatile negative ion source (VNIS) [1]. It produces intense negative ion currents by sputtering of caesium ions on a target material. Negative ions are prominent in low temperature plasmas like the upper atmosphere oder the interstellar medium. The main difference to positive ions is the way the additional electron is bound to the atom. Instead of by the coulomb force the electron is bound by polarization of the atomic core. Another interesting topic within respect is the study of inner shell ionization processes [2]. The design of the source was originally developed at Max-Planck-Institut für Kernphysik (MPI-K) at Heidelberg [3]. The new source was built in Gießen where also the tests will be performed at an ion source testbench. We will present mass spectra of ions produced in the source and show the behaviour of the source under various conditions.

[1] R. Middleton, A Negative-Ion Cookbook, 1990
[2] S. Schippers et al., Phys. Rev. A 94 (2016) 041401(R)
[3] J. Meier, Diploma thesis, University of Heidelberg, 2007

A 20.16 Tue 17:00 P OGs

Multi-electron processes in K-shell double and triple photodetachment of oxygen anions — •Stefan Schippers[1], Randolph Beerwerth[2,3], Levente Abrok[4], Sadia Bari[5], Ticia Buhr[1], Michael Martins[6], Sandor Ricz[4], Jens Viefhaus[5], Stephan Fritzsche[2,3], and Alfred Müller[1] — [1]Justus-Liebig-Universität Gießen — [2]Helmholtz-Institut Jena — [3]Friedrich-Schiller-Universität Jena — [4]ATOMKI, Debrecen, Hungary — [5]DESY, Hamburg — [6]Universität Hamburg

The photon-ion merged-beams technique was used at a synchrotron light source for measuring absolute cross sections of double and triple photodetachment of O^- ions [1]. The experimental photon energy range of 524–543 eV comprised the threshold for K-shell ionization. Using resolving powers of up to 13000, the position, strength and width of the below-threshold $1s\,2s^2\,2p^6\;{}^2S$ resonance as well as the positions of the $1s\,2s^2\,2p^5\;{}^3P$ and $1s\,2s^2\,2p^5\;{}^1P$ thresholds for K-shell ionization were determined with high-precision. In addition, systematically enlarged multi-configuration Dirac-Fock calculations have been performed for the resonant detachment cross sections. Results from these *ab initio* computations agree very well with the measurements for the widths and branching fractions for double and triple detachment, if *double* shake-up (and -down) of the valence electrons and the rearrangement of the electron density is taken into account. For the absolute cross sections, however, a previously found discrepancy between measurements and theory is confirmed.
[1] S. Schippers et al., Phys. Rev. A **94** (2016) 041401(R).

A 20.17 Tue 17:00 P OGs

X-Ray Quantum Optics with Novel Light Sources — •Jeremy Gallant, Kilian P. Heeg, Christoph H. Keitel, and Jörg Evers — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Theoretically and experimentally, x-ray quantum optics has been studied using Mössbauer nuclei in the single photon excitation regime. In this theoretical work we study multi-photon effects that will be accessible with novel x-ray sources [1]. We discuss methods for inducing Kerr-type non-linearities in Mössbauer nuclei excited by fluctuating free electron laser pulses and we describe a method to detect these effects interferometrically. Such methods could be used to produce electromagnetically induced transparency in the x-ray regime. [1] K. P. Heeg, C. H. Keitel, and J. Evers, arXiv:1607.04116 [quant-ph] Inducing and detecting collective population inversions of Mössbauer nuclei

A 20.18 Tue 17:00 P OGs

Towards coherent time-resolved all-XUV spectroscopy — •Andreas Wituschek[1], Lukas Bruder[1], Ulrich Bangert[1], Tim Laarmann[2,3], and Frank Stienkemeier[1] — [1]Universität Freiburg, Physikalisches Institut, Hermann-Herder-Str. 3, 79104 Freiburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [3]The Hamburg Centre for Ultrafast Imaging CUI, Luruper Chaussee 149, 22761 Hamburg, Germany

Coherent time-resolved spectroscopy is a powerful tool to study ultrafast dynamics in complex systems. Extending these techniques to the XUV spectral region would allow studying core excitations, thus providing site specific information. However, demands on phase stability increase significantly when going to short wavelengths and advanced pulse manipulation in the XUV is challenging. Recent experiments have shown that in seeded HGHG free electron lasers (FEL) the emitted XUV pulses inherit the coherence properties of the seed pulses [1]. We suggest an approach based on acousto-optical phase modulation on the seed laser with subsequent seeding of the FEL and lock-in detection at the harmonics of the seed modulation. In this way, pulse manipulation can be performed with standard optics. Moreover, demands on phase stability are drastically reduced and signals are efficiently isolated and amplified. We present the first step towards this approach: extending the phase modulation scheme towards UV wavelengths (260nm) and high intensity femtosecond laser pulses in combination with detection in dilute samples.

[1] Gauthier et al., PRL 116, 024801 (2016)

A 20.19 Tue 17:00 P OGs

Observation of strong non-dipole effects in sequential multi-photon ionization using VUV FEL radiation — •Gregor Hartmann[1,2], Markus Ilchen[3], Michael Meyer[3], and Jens Viefhaus[2] — [1]Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, 22607 Hamburg, Germany — [3]European XFEL GmbH, Albert-Einstein-Ring 19, 22761 Hamburg, Germany

One of the fundamental principles of light-matter interaction is the dipole approximation that is commonly assumed to be valid at low photon energies including the soft X-ray region. Although it has been shown at synchrotron radiation facilities that this approximation has limitations, it has been unclear how they impact the ionization characteristics of ions. Recently, ultrafast and ultra-intense Vacuum UltraViolet pulses from free-electron lasers such as FERMI have been used to efficiently study photoionization properties of noble gas ions by angle resolved photoelectron spectroscopy. We present evidence of a forward-backward symmetry breakdown in such a sequential ionization process in the vicinity of the Cooper Minimum of argon, at 46 eV excitation energy. In particular, we show that the electron angular distribution of ionic argon gains a pronounced forward-backward asymmetry with respect to the beam by interference between the electric dipole and the electric quadrupole amplitudes.

A 20.20 Tue 17:00 P OGs

The Small Quantum Systems - SQS Instrument at the European XFEL — •Patrik Grychtol, Alexander Achner, Thomas M. Baumann, Alberto De Fanis, Markus Ilchen, Tommaso Mazza, Yevheniy Ovcharenko, Jones Rafipoor, Haiou Zhang, Pawel Ziolkowski, and Michael Meyer — Small Quantum System Group, European XFEL, 22869 Schenefeld

This contribution will present the Small Quantum System (SQS) scientific instrument, which is one of six experimental end stations at the European XFEL planned to open for user operation in autumn 2017. This experimental platform is designed for investigations of atomic and molecular systems, as well as clusters, nano-particles and small bio-molecules. It is located behind the SASE 3 soft x-ray undulator, which will provide horizontally polarized FEL radiation in a photon energy range between $260\,eV$ and $3000\,eV$ ($4.8\,nm$ to $0.4\,nm$) with 0.1 to 2×10^{14} photons per pulse and up to 27000 pulses per second. Two high-quality elliptical mirrors in Kirkpatrick-Baez configuration will focus the FEL beam to a FWHM spot size of approximately $1\,\mu m$ diameter. This is going to result in an intensity of more than $10^{18}\,W/cm^2$ within the interaction region, which will allow for studying non-linear multi-photon processes. Furthermore, the short FEL pulse duration between $2\,fs$ and $100\,fs$ in combination with a synchronized optical femtosecond laser will enable time-resolved studies of dynamic processes, thus capturing the motion of electrons and nuclei with unprecedented resolution in space on ultrafast time scales.

A 20.21 Tue 17:00 P OGs

X-ray lasing via K-shell ionization of highly charged ions — •Chunhai Lyu, Stefano M. Cavaletto, Christoph H. Keitel, and Zoltán Harman — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

X-ray lasing by inner-shell stimulated emission of highly charged ions (HCIs) is considered in theoretical simulations. Spiky, partially coherent x-ray free-electron lasers pulses are used to pump the lasing by ionizing K-shell electrons. Because there is no cavity to choose a specific frequency from the HCI's amplified spontaneous emission spectrum, the linewidth of the x-ray laser approximates the gain profile of the HCI medium. A frequency-dependent gain is calculated by means of time-dependent density-matrix simulations. Compared to similar approaches with neutral atoms in former experiments, certain HCIs promise a much narrower bandwidth of x-ray laser light.

A 20.22 Tue 17:00 P OGs

IR-assisted XUV multiphoton ionization of N2 at FLASH — •yifan liu[1], kirsten schnorr[1], georg schmid[1], sven augustin[1], severin meister[1], hannes lindenblatt[1], yuhai jiang[2], thomas ding[1], rolf treusch[3], stefan düsterer[3], kamal p singh[4], mathieu gisselbrecht[5], thomas pfeifer[1], and robert moshammer[1] — [1]Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117, Heidelberg, Germany — [2]Shanghai Advanced Research Institute, Zhangjiang, 201210, Shanghai, China — [3]Deutsches Elektronen-Synchrotron, Notkestrasse 85, 22607, Hamburg, Germany — [4]Indian Institutes of Science Education and Research, Sector 81, 140306, Manauli, Indian — [5]Lund University, Lund, Post Box 118, 22100, Sweden

IR-assisted XUV multiphoton experiments on molecule N2 were performed at the free-electron-laser in Hamburg(FLASH). Within an XUV-pump/IR-probe scheme, the fragmentation and Multiple Ionization dynamics of N2 has been investigated using a dedicated Reaction-Microscope(ReMi). By adjusting the delay between the optical laser and XUV pulse, the ionization yields as a function of delay were recorded. By tracing the kinetic energy release of coincidence channels N(1,1) and N(2,1)as a function of delay in different laser fields, we find an enhanced yield of coincident fragments produced by XUV multiphoton absorption with the presence of a delayed NIR pulse. Sequential ionization is to be the dominant process. The enhanced ionization process is as well related to the polarization direction of the NIR laser pulse.

A 20.23 Tue 17:00 P OGs

Spectral characterization of SASE bunch trains — •Philipp Schmidt, Philipp Reiss, Gregor Hartmann, Christian Ozga, Martin Wilke, André Knie, and Arno Ehresmann — Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany

The recent availability of short wavelength Free-Electron-Lasers (FELs) enabled the investigations of the nonlinear response of matter in the X-ray wavelength regime, i.e. at photon energies where the dominant interaction involves the strongly bound core electrons. Streak camera-type detectors are ideally suited to analyze the spontaneous and stimulated photon emissions after an target excitation driven by FELs. In combination with a suitable spectrometer they are able to spectrally and temporally resolve a single X-ray flash on the picosecond time scale. The inclusion of the spectral distribution of the laser pulse allows for an explicit selection of desired beam parameters that can vary greatly due to the statistical nature of the underlying SASE effect. This also applies to FEL sources like the FLASH facility in Hamburg and the upcoming European XFEL that employ long bunch trains of up to 3000 individual bunches to achieve high repetition rates. Here we want to present first results using an x-ray streak camera at FLASH to investigate the spectral and temporal correlations between SASE bunches in these bunch trains in realtime and for each shot.

A 20.24 Tue 17:00 P OGs

Observing Ultrafast Dissociation of CH3Cl with a COLTRIMS-Reaction Microscope — •Gregor Kastirke, Miriam Weller, Kilian Fehre, Markus S. Schoeffler, and Reinhard Dörner — Institut für Kernphysik, Universität Frankfurt, Max-von-Laue-Str.1, 60438 Frankfurt, Germany

Ultrafast Dissociation can be observed after resonant photoexcitation of an innershell electron of a small molecular system like CH3Cl. Because of populating a strongly repulsive potential energy curve, the dissociation of the molecule takes place within a few femtoseconds. At some point during the dissociation, the molecule deexcites as an Auger Decay occurs. The emitted Auger Electron carries information on the internuclear distance of the molecular fragments at the instant of the decay. By measuring the momenta of the electron and ionic fragment in coincidence, different scenarios can be observed: An emission of the electron from a molecular orbital at early decay times, emission during the bond breakage and emission from an atomic orbital in cases the molecule completely dissociated into separated fragments. In order to investigate ultrafast dissociation in CH3Cl we performed the above mentioned experiment at the SOLEIL Synchrotron, France using a COLTRIMS setup. From the coincidence measurement of the Auger electron and the fragment ion, it is possible to yield molecular frame angular emission distributions of the electron. By furthermore exploiting the measured Auger electron energy, snapshots of the temporal evolution of a decaying orbital of a molecule fragmenting into separated atoms are obtained.

A 20.25 Tue 17:00 P OGs

Control of X-Ray Interferences with Nuclei via Magnetic Switching — Gregor Ramien, •Jonas Gunst, Xiangjin Kong, Christoph H. Keitel, and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

While Moore's law predicts the fast evolution of miniaturization, for future photonic devices the optical diffraction limit will emerge as bottleneck. This motivates the investigation of information carriers or flying qubits with particularly short wavelengths, e.g., x-ray photons, which range on the energy scale of low-lying nuclear transitions. Versatile control of the basic properties of such photons is the key requirement for short wavelength photonic qubits. Nuclear forward scattering, as it occurs with ^{57}Fe Mössbauer nuclei, presents a great basis for exerting coherent control on x-ray photons. The nuclear response can be controlled by subjecting the sample to a hyperfine magnetic field and to fast variations, i.e., switchings, of the latter. For instance, a timed on-/off-switching can lead to a coherent storage of the x-ray photon over a period of several dozen nanoseconds [1]. In this work, we investigate the implementation of periodic switching sequences: the switching affects the behaviour of the interference pattern of the nuclear forward scattering signal, the so-called quantum beat. Our focus lies on the field variation effects on the time and frequency spectrum, and identifying emerging patterns herein.

[1] W. Liao, A. Pálffy, C. H. Keitel, Phys. Rev. Lett. **109**, 197403 (2012).

A 20.26 Tue 17:00 P OGs

Fragmentation Dynamics of Argon Dimers studied by XUV-IR Experiments at FLASH — •Georg Schmid[1], Kirsten Schnorr[1], Sven Augustin[1], Hannes Lindenblatt[1], Severin Meister[1], Patrick Paluch[1], Yifan Liu[1], Thomas Ding[1], Defu Luo[1], Ann-Sophie Hilkert[1], Lutz Fechner[1], Kamal P. Singh[2], Mathieu Gisselbrecht[3], Harald Redlin[4], Stefan Düsterer[4], Rolf Treusch[4], Claus-Dieter Schröter[1], Thomas Pfeifer[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]IISER, Mohali, India — [3]Lund University, Sweden — [4]DESY, Hamburg

XUV-IR pump-probe experiments on Argon dimers (Ar_2) were performed at the free-electron laser in Hamburg (FLASH).

Different XUV ($\hbar\omega$ = 27eV) multiphoton ionization pathways such as interatomic coulombic decay (ICD), radiative charge transfer (RCT), or frustrated multiple ionization could be identified by measuring the kinetic-energy release of the Coulomb-exploded dimer fragments using a reaction microscope. By applying an intense IR probe pulse ($I_{\mathrm{IR}} \sim 10^{14}$ W/cm^2), we were able to follow the dynamics of those fragmentation pathways in real time. Amongst other things, we could deduce an average RCT lifetime for excited $Ar^{2+}(3p^{-3}nl)$−Ar states.

A 20.27 Tue 17:00 P OGs

Multiphoton double ionisation of Neon studied at FLASH2 — •Hannes Lindenblatt[1], Kirsten Schnorr[1], Sven Augustin[1], Georg Schmid[1], Severin Meister[1], Florian Trost[1], Yifan Liu[1], Sandra Erbel[1], Markus Braune[2], Rolf Treusch[2], Thomas Pfeifer[1], Claus-Dieter Schröter[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]DESY, Hamburg

The ionisation of Neon was studied by an XUV pump-probe experiment at the new Reaction-Microscope endstation at FLASH2. The variable gap undulators provide the opportunity to quickly change the central wavelength of the FEL photons. Combined with the Online Photoionisation Spectrometer (OPIS) for single-shot monitoring of the wavelength, this allows sampling of processes sensitive to the photon energy at the high intensity provided by a free-electron laser.

The production of doubly charged Ne^{2+} yield is analysed as a function of the photon intensity and energy around the Ne^{+} $2s^22p^5 \rightarrow 2s2p^6$ transition energy of 26.9 eV.

A 20.28 Tue 17:00 P OGs

The Reaction Microscope at FLASH2: First Experiments at a versatile AMO Endstation — •Florian Trost[1], Kirsten Schnorr[1], Sven Augustin[1], Georg Schmid[1], Severin Meister[1], Hannes Lindenblatt[1], Yifan Liu[1], Sandra Erbel[1], Markus Braune[2], Marion Kuhlmann[2], Stefan Düsterer[2], Rolf Treusch[2], Thomas Pfeifer[1], Claus-Dieter Schröter[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]DESY, Hamburg

A reaction microscope was set up and commissioned as a permanent user endstation at the free-electron laser in Hamburg (FLASH2). First XUV pump-probe experiments including ICD observation of neon-dimers were carried out at this endstation with a back-reflecting split-mirror. We varied the delay between pump and probe pulse to find the temporal overlap of the pulses and to obtain the average pulse duration via autocorrelation measurements of Ne^{2+} and Ar^{2+} ion rates.

Part of the setup is a newly designed jet source using supersonic expansion for target production. Being able to process both gaseous and liquid substances as well as a combination of both, the new source greatly expands the range of available targets. We used the new source to trace proton transfer in water-dimers, which were produced by seeding light and heavy water with helium.

A 20.29 Tue 17:00 P OGs

Resonance-enhanced ICD in Neon Dimers — •Severin Meister[1], Kirsten Schnorr[1], Georg Schmid[1], Sven Augustin[1], Hannes Lindenblatt[1], Florian Trost[1], Yifan Liu[1], Viktor Adam[1], Sandra Erbel[1], Claus Dieter Schröter[1], Thomas Pfeifer[1], Robert Moshammer[1], Rolf Treusch[2], Marion Kuhlmann[2], and Markus Braune[2] — [1]Max-Planck-Institut für Kernphysik — [2]Deutsches Elektron Sychrotron

Interatomic Coulombic Decay (ICD) is an efficient de-excitation mechanism in weakly bound environments. The released ICD-electron has a distinct energy and could possibly trigger successive processes. A first step towards the control of ICD, is to intentionally switch it on and off. For this, we employed the 2s-2p transition at 26.9eV (46.1nm) in Neon dimers.

In the two-photon absorption process, the first photon creates a 2p outer valence vacancy, while the second photon resonantly drives the transition $Ne^+(2p^{-1}) \rightarrow Ne^+(2s^{-1})$ within the same atom. The following relaxation leads to the emission of a 2p ICD-electron in the neighboring Neon atom. Finally the two $Ne^+(2p^{-1})$ ions Coulomb-explode.

As one of the first experiments at FLASH2, we used the variable-gap undulators to quickly tune the photon wavelength. By scanning the resonance, we found an enhancement of a factor 2.5 for coincident $Ne^+(2p^{-1})$+$Ne^+(2p^{-1})$ ions. Full momentum resolved, coincidence measurements were performed with a reaction microscope (FLASH-REMI).

A 20.30 Tue 17:00 P OGs

XUV-pump—XUV-probe transient absorption experiments in small halogenated hydrocarbons — •Marc Rebholz[1], Thomas Ding[1], Maximilian Hartmann[1], Lennart Aufleger[1], Alexander Magunia[1], David Wachs[1], Veit Stooss[1], Paul Birk[1], Gergana Borisova[1], Kristina Meyer[1], Andrew Attar[2], Thomas Gaumnitz[3], Zhi Heng Loh[4], Sebastian Roling[5], Marco Butz[5], Helmut Zacharias[5], Stefan Düsterer[6], Christian Ott[1], and Thomas Pfeifer[1] — [1]MPI für Kernphysik, Heidelberg, Germany — [2]UC Berkeley, Berkeley, USA — [3]ETHZ, Zürich, Switzerland — [4]NTU Singapore, Singapore — [5]WWU Münster, Münster, Germany — [6]DESY, Hamburg, Germany

We present preliminary results of an XUV-pump-XUV-probe transient absorption experiment at the free-electron laser FLASH in Hamburg. The goal of our experiment is to determine how charge-rearrangement dynamics influence the dissociation of a molecule. In the experiments, we used small halogenated hydrocarbon molecules containing two iodine sites. We resonantly excited the 4d -> σ^* transition with the first XUV pulse. This induces a breaking of one C-I bond. Shortly thereafter the exact same transition was probed with the second XUV pulse to investigate how the modified electronic environment can be accessed via the absorption spectrum of the dissociating molecule. To drive the experimental scheme the XUV pulses were split into two identical copies and the time delay between them was varied from -1 ps to +3 ps. In addition, we varied the intensity of the FEL pulses by attenuating the full beam with a nitrogen gas absorber.

A 20.31 Tue 17:00 P OGs

Shake-up Processes in Auger Cascades of Light and Medium Elements — •Randolf Beerwerth[1,2] and Stephan Fritzsche[1,2] — [1]Helmholtz Institut Jena, Fröbelstieg 3, 07743 Jena, Germany — [2]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, 07743 Jena, Germany

In recent years, coincidence spectroscopy of photo and Auger electrons helped to investigate the de-excitation of atoms, molecules and solids after the creation of inner shell holes. The kinetic energies of the emitted electrons allow to obtain information not only about the spectrum and population of the final states, but also about the decay pathways of an Auger cascade.

Our studies reveal that many Auger cascades are strongly affected by shake-up (or down) transitions, in which the two-electron Auger process is accompanied by an additional (de-)excitation of a valence electron. For example, in the de-excitation of resonantly excited negative oxygen ions [1], complex electron correlation effects lead to a strong contribution of shake transitions to the total decay width. Furthermore, the population of higher lying intermediate states also enables the occurrence of three-step Auger cascade decays that are otherwise not possible due to energetic reasons.

We will discuss the effects of shake-up transitions on Auger cascades of different elements and the theoretical models that are needed to account for the underlying electron correlation effects.

[1] S. Schippers et al., Phys. Rev. A **94**, 041401 (2016).

A 20.32 Tue 17:00 P OGs

Tunneling time in attosecond experiments, Time in Quantum Mechanics and the realization of the Bohr-Einstein photon box Gedanken experiment. — •Ossama Kullie — Institute of Physic, University of Kassel, Germany

Tunneling time in attosecond and strong field experiments is one of the most controversial issues in today's research, because of its importance to the theory of time, the time operator and the time quantum mechanics. In [1,2] I present a theoretical model of the tunneling time for attosecond experiment of the He atom [3]. The model offers a relation which performs an excellent estimation for the tunneling time in attosecond and strong-field experiments (for the He atom [3]). The tunneling time estimation is found by utilizing the time-energy uncertainty relation and represents a quantum clock. The tunneling time is also featured as the time of passage through the barrier similar to Einsteins photon-box Gedanken experiment [1]. This work tackles an important case study for the theory of time in quantum mechanics and is very promising for the search for a (general) time operator in quantum mechanics [4]. The work can be seen as a fundamental step in dealing with the tunneling time in strong-field and ultrafast science and is appealing for more elaborate treatments using quantum wave-packet dynamics and especially for complex atoms and molecules [2,4].

[1] O Kullie 2015 Phys. Rev. A 92 052118. [2] O Kullie 2016 J. Phys. B 49, 095601. [3] P Eckle et al 2008 Nat.phys. 4 565. [4] M. Bauer, arxiv1608.03492v1 (2016).

A 20.33 Tue 17:00 P OGs

Attosecond Transient Absorption Spectroscopy of Molecular Core-to-Valence Transitions — •Lorenz Drescher, Geert

Reitsma, Martin Galbraith, Tobias Witting, Oleg Kornilov, Marc Vrakking, and Jochen Mikosch — Max-Born-Institut, Berlin, Germany

Transient absorption spectroscopy with attosecond pulses and pulse trains from high harmonic generation has recently become a versatile tool to study ultrafast phenomena, from photochemical dynamics on the femtosecond scale [1] to electron wave-packet dynamics in atoms [2] and molecules [3] on the few-femtosecond to attosecond scale.

Besides the intriguing potential of combining both high spectral and temporal resolution in an attosecond experiment, the study of core-to-valence transitions in the extreme ultraviolet (XUV) to soft X-ray absorption offers a local view into the valence shell dynamics, due to the localization of the initial state's core orbital. This paves the way to study ultrafast correlation driven phenomena from a site-specific point of view.

Here, we present first results and interpretations from our recent study of the attosecond transient absorption spectrum of core-to-valence transitions in a molecular system manipulated by a strong few-cycle near infrared (NIR) laser pulse.

[1] L. Drescher et al., J. Chem. Phys. 145, 011101 (2016); [2] E. Goulielmakis et al., Nature 466, 739-743 (2010); [3] M. Reduzzi et al., J. Phys. B 49, 065102 (2016)

A 20.34 Tue 17:00 P OGs

Transition rates of E1, M1, E2 and M2 transtions in Ni XII — •Moazzam Bilal[1,2], Randolf Beerwerth[1,2], and Stephan Fritzsche[1,2] — [1]Helmholtz-Institut Jena, Germany — [2]Friedrich-Schiller-Universität, Jena, Germany

Lines from Cl-like Ni XII have been observed in soft X-rays and EUV range from n = 3 → 3 transitions in spectra of sun and many solar type stars. These lines are also important in the Tokamak plasma. We report systematically enlarged calculations for allowed E1 and optically forbidden transitions (M1, E2, M2) among the fine structure levels of $3s^2 3p^5$, $3s3p^6$ and $3s^2 3p^4 3d$ configurations. We incorporated QED effects along with the effects of relativity, electron correlation and rearrangement of the electron density. We found that Breit interactions and leading QED corrections have reasonable effects on Dirac Hartree Fock wave-functions. Our calculated energy levels are in excellent agreement with experiments wherever available. Additionally emission rates, wavelengths and oscillator strength are reported for all E1, M1, E2 and M2 transitions among lowest 31 levels. From transition probabilities, lifetimes of lowest 31 levels are derived and compared with experiments. We believe that our extensive *ab initio* calculations are helpful for plasma physics community to identify the fine structure levels and plasma diagnostics. [1] Del Zanna, G. and Badnell, N. R., 2016 *A&A* **585** A118. [2] Mattioli, M. et al., 2004 *J. Phys. B: At. Mol. Opt. Phys.* **37** 13. [3] Jönsson, P., Gaigalas, G. et al., 2013 *Comput. Phys. Commun.* **184** 2197.

A 20.35 Tue 17:00 P OGs

The ALPHATRAP Double Penning-Trap Experiment — •Ioanna Arapoglou[1,2], Alexander Egl[1,2], Martin Höcker[1], Sandro Kraemer[1,2], Tim Sailer[1,2], Andreas Weigel[1,2], José Ramón Crespo López-Urrutia[1], Robert Wolf[1], Sven Sturm[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Fakultät für Physik und Astronomie, Universität Heidelberg

The ALPHATRAP double Penning-trap apparatus is a high-precision experiment that aims for the most stringent test of bound state quantum electrodynamics (BS-QED) in the strong field regime of 10^{16} V/cm. These fields are provided by the nucleus of a heavy highly charged ion (HCI), such as hydrogen-like $^{208}Pb^{81+}$. Determining the g-factor of the bound electron to the desired precision not only creates the means required for high-precision tests of BS-QED but also enables the determination of fundamental constants such as the fine structure constant α. The setup includes several ion creation possibilities for offline ion production, complementary to the online injection of heavy HCI from the Heidelberg Electron Beam Ion Trap. The latter is coupled, via an ion beam-line, to the cryogenic double Penning-trap system which consists of the so called Precision Trap for high-precision measurements in a homogeneous magnetic field and the Analysis Trap for spin state determination in a magnetic bottle configuration. The setup as well as the current status of the experiment will be presented.

A 20.36 Tue 17:00 P OGs

Gamma spectroscopy to measure the ^{229}Th isomer energy using a 2-dimensional array of metallic magnetic microcalorimeters — •P. Schneider[1], D. Hengstler[1], J. Geist[1], M. Krantz[1], C. Schötz[1], S. Kempf[1], L. Gastaldo[1], A. Fleischmann[1], C. Enss[1], G.A. Kazakov[2], S.P. Stellmer[2], and T. Schumm[2] — [1]Heidelberg University — [2]Vienna University of Technology

The isotope ^{229}Th has a nuclear isomer state with the lowest presently known excitation energy, which possibly allows to connect the fields of nuclear and atomic physic with a potential application in a nuclear clock. In order to verify and improve the accuracy of the currently most accepted energy value, (7.8 ± 0.5) eV, we want to resolve the 29.18 keV doublet in the γ-spectrum following the α-decay of ^{233}U, corresponding to the decay into the ground and isomer state, to measure the isomer transition energy without additional theoretical input parameters.

We developed the detector array maXs-30 consisting of 8x8 metallic magnetic calorimeters with an expected energy resolution below 6 eV, providing a large detection area of 16 mm^2 to face the low rate of the 29.18 keV transitions.

In first measurements we observed the 29.18 keV transitions as a single peak with an instrumental resolution of 33 eV. A strong background contribution due to β-radiation from accumulated decay products in the ^{233}U-source was discovered. We present the experimental setup and the obtained results. We discuss the present sensitivity to the isomer energy and how this will improve in a next experiment based on a cleaned source and dc-SQUIDs with improved flux noise.

A 20.37 Tue 17:00 P OGs

High-precision X-ray spectroscopy of highly-charged ions at storage rings using silicon microcalorimeters — •Damian Müll[1], Artur Echler[2,3], Saskia Kraft-Bermuth[1], and Pascal Scholz[1] — [1]1. Physikalisches Institut, Justus-Liebig-Universität, Giessen, Germany — [2]GSI Helmholtz Center, Darmstadt, Germany — [3]Institute of Physics, Johannes-Gutenberg University, 55099 Mainz, Germany

The precise determination of the energy of the Lyman-α lines in hydrogen-like heavy ions provides a sensitive test of quantum electrodynamics in very strong Coulomb fields. Silicon microcalorimeters, which detect the X-ray energy as heat rather than by charge production, have already demonstrated their potential to improve the precision of such experiments due to their excellent energy resolution for X-ray energies around 100 keV. The application of microcalorimeters for hard X-rays, based on silicon thermistors and tin absorbers, has been pursued by our collaborating groups for more than two decades. Two detector arrays have been successfully applied in two experiments at the Experimental Storage Ring (ESR) of the GSI Helmholtz Center for Heavy Ion Research. In order to improve the energy resolution, parts of the electronics have to be changed. In this contribution the results of measurements on the characteristics of the junction field transistors, implemented on a newly designed printed circuit board, will be presented.

A 20.38 Tue 17:00 P OGs

Doppler Laser Cooling of ^{9}Be^{1+} for the ALPHATRAP g-Factor Experiment — •Alexander Egl[1,2], Ioanna Arapoglou[1,2], Martin Höcker[1], Sandro Kraemer[1,2], Tim Sailer[1,2], Andreas Weigel[1,2], Robert Wolf[1,3], Klaus Blaum[1], and Sven Sturm[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Fakultät für Physik, Universität Heidelberg — [3]ARC Centre of Excellence for Engineered Quantum Systems, School of Physics, The University of Sydney, NSW Australia

The Penning-trap experiment ALPHATRAP at the Max-Planck-Institut für Kernphysik is currently being set up. It aims to test bound-state quantum electrodynamics by determining the g-factor of the bound electron in the electric field of heavy highly-charged ions with unprecedented precision. The accuracy achieved in previous experiments using established techniques can be improved by further cooling of the trapped ion, which also leads to a reduction of unwanted systematic shifts due to the magnetic inhomogeneities and the relativistic mass increase. Therefore ALPHATRAP will employ sympathetic laser cooling to the stored highly-charged ions using ^{9}Be^{1+} ions stored adjacent to the ion of interest. To this end a setup for the creation and Doppler laser cooling of ^{9}Be^{1+} is in development. An overview and the current status of this project will be presented.

A 20.39 Tue 17:00 P OGs

Formation studies of mesocsopic ion Coulomb crystals at SpecTrap — •Stefan Schmidt[1,2], Tobias Murböck[3], Zoran Andelkovic[4], Gerhard Birkl[3], Wilfried Nörtershäuser[1], Richard Thompson[5], and Manuel Vogel[4] — [1]Institut für Kernphysik, TU Darmstadt — [2]Institut für Kernchemie, Johannes Gutenberg Universität Mainz — [3]Institut für Angewandte Physik, TU Darmstadt — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [5]Imperial College London, SW7 2AZ

We have investigated the formation and geometric structure of mesoscopic Coulomb ion crystals of singly charged magnesium ions stored in a Penning trap [1]. For this purpose, a combination of buffer-gas cooling and Doppler laser cooling was used for rapid crystallization of a sample of externally produced magnesium ions. The presented studies include detailed information of the evolution and dynamics of these ion crystals. In addition, two-species ion crystals were investigated over a large range of charge-to-mass ratios. These results represent an important step towards high-precision laser spectroscopy of highly charged ions as a fundamental test of bound-state QED.

Further, we present the design and concept of a dedicated low-noise charge amplifier [2] for non-destructive single-pass detection of charged particles in a beamline. In our setup, the detector is used as both a sensitive charge counter as well as a timing circuit.

[1] T. Murböck et al.: Phys. Rev. A 94, 043410 (2016)
[2] S. Schmidt et al.: Rev. Sci. Intr. 86, 113302 (2015)

A 20.40 Tue 17:00 P OGs

Influence of the nuclear shape on the hyperfine splitting of heavy muonic ions — •Niklas Michel, Natalia S. Oreshkina, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

When a muon is bound by a heavy atomic nucleus, it is located much closer to the nucleus than the corresponding electrons, thus the muonic wave function has a considerable overlap with the nuclear one and the transition energies in muonic atoms can provide information on the nuclear structure. Therefore, we aim at an accurate description of the energy levels of heavy muonic atoms in the framework of relativistic quantum mechanics with an extended nuclear charge distribution. In addition, we also take into account the screening correction due to the interaction of the muon with the electrons and the leading corrections for the bound muon from quantum electrodynamics.

A 20.41 Tue 17:00 P OGs

ARTEMIS: A Penning trap experiment for measurements of the electron magnetic moment in highly-charged ions via double-resonance spectroscopy — •Zhexi Guo[1,2], Marco Wiesel[1,3], Mohammad Sadegh Ebrahimi[1,4], Wolfgang Quint[1,4], Gerhard Birkl[3], and Manuel Vogel[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [2]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [3]Institut für Angewandte Physik, TU Darmstadt, Darmstadt, Germany — [4]Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany

The ARTEMIS experiment at GSI Darmstadt currently aims to precisely measure the electron magnetic moment of Ar^{13+} ions using laser and microwave spectroscopy within a 7 T magnetic field at pressures down to 10^{-14} mbar. In the first of two Penning traps, we have been able to produce ion charge-states up to Ar^{16+} via electron impact ionisation and achieve storage times of more than three days. With the stored waveform inverse Fourier transform technique, we can attain a high relative concentration of Ar^{13+} before transportation to a second Penning trap dedicated to storing the ions for spectroscopy. These measurements are projected to be performed on much heavier ions, such as Bi^{82+}, extracted from the HITRAP facility at GSI eventually. Results herein would enable fine assessments of the theoretical propositions of bound-state QED.

A 20.42 Tue 17:00 P OGs

The g-factor of highly charged ions — •Halil Cakir[1], Bastian Sikora[1], Natalia S. Oreshkina[1], Nikolay A. Belov[1], Vladimir A. Yerokhin[2], Christoph H. Keitel[1], and Zoltán Harman[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Center for Advanced Studies, Peter the Great St. Petersburg Polytechnic University, 195251 St. Petersburg, Russia

Recent high-precision measurements on the g-factor of highly charged ions with Penning traps, together with a correspondingly accurate theoretical description, allow detailed tests of QED in strong fields. Furthermore, fundamental constants such as the electron mass and the fine-structure constant α can be extracted in such studies.

Due to their comparably simple structure, one-electron ions are most suited for testing strong-field QED effects (see e.g. [1]). A determination of α however also necessitates an accurate description for three-electron ions, as discussed recently in [2], because employing a specific weighted difference of the g-factors of both ions, the detrimental nuclear structural effects can be effectively suppressed. Therefore, we present recent theoretical calculations for one- and three-electron ions. – [1] N. A. Belov *et al.*, submitted; arXiv:1610.01340 (2016); [2] V. A. Yerokhin *et al.*, Phys. Rev. Lett. 116, 100801 (2016).

A 20.43 Tue 17:00 P OGs

Precision description of the atomic structure. Example of the odd configuration system of La I — •Jerzy Dembczyński[1], Magdalena Elantkowska[2], and Jarosław Ruczkowski[1] — [1]Institute of Control and Information Engineering, Poznan University of Technology, Piotrowo 3A, 60-965 Poznań, Poland — [2]Institute of Materials Research and Quantum Engineering, Poznan University of Technology, Piotrowo 3, 60-965 Poznań, Poland

We developed the method, which allows to analyze a complex electronic system composed of the configuration of up to four open shells, taking into account all electromagnetic interactions expected in an atom, in accordance with the second-order perturbation theory [1,2].

In order to show the effectiveness of our method, we decided to choose the odd configuration system of lanthanum atom, with a large amount of new experimental data [3].

The hyperfine structure constants were calculated using the fine structure eigenvectors and adjusting radial integrals in a least-squares procedure which compare the calculated constants with the experimental values. Moreover, the values of energy for the levels up to now unidentified and their hyperfine structure constants were predicted.

This work was supported by the Research Projects of the Polish Ministry of Sciences and Higher Education: 04/45/DSPB/0148

[1] J. Dembczyński et al., J Phys B 43, 06500 (2010)
[2] M. Elantkowska, J. Ruczkowski, J. Dembczyński, Eur Phys J Plus 130, 14 (2015)
[3] Gü. Başar et al., J Quant Spectrosc Radiat Transf 187, 505 (2017)

A 20.44 Tue 17:00 P OGs

Laser photodetachment of radioactive ions - towards the electron affinity of astatine — •S Rothe[1,2,3], J Sundberg[1,2], J Welander[2], K Chrysalidis[1,4], T Day Goodacre[1,3], V Fedosseev[1], O Forstner[5], R Heinke[4], K Johnston[1], T Kron[4], U Köster[6], Y Liu[7], B Marsh[1], A Ringvall-Moberg[1,2], R E Rossel[1,4], Ch Seiffert[1], D Studer[4], K Wendt[4], and D Hanstorp[2] — [1]CERN, Geneva, Switzerland — [2]Department of Physics, Gothenburg University, Sweden — [3]School of Physics and Astronomy, The University of Manchester, UK — [4]Institut für Physik, Johannes Gutenberg-Universität, Mainz, Germany — [5]Friedrich Schiller Universität, Jena, Germany — [6]Institut Laue-Langevin (ILL), Grenoble, France — [7]Physics Division, Oak Ridge National Laboratory (ORNL), Tennessee, USA

Negatively charged ions are mainly stabilized through the electron correlation effect. A measure of the stability of a negative ion is the electron affinity, which the energy gain by attaching an electron to a neutral atom. This fundamental quantity is, due to the almost general lack of bound excited states, the only atomic property that can be determined with high accuracy for negative ions. We will present the results of the first laser photodetachment studies of radioactive negative ions at CERN-ISOLDE. The photodetachment threshold for the radiogenic iodine isotope ^{128}I was measured successfully, demonstrating the performance of the upgraded GANDALPH experimental beam line. The first detection of photo-detached astatine atoms marks a milestone towards the determination of the EA of this radioactive element.

A 20.45 Tue 17:00 P OGs

First results of a high-precision high-voltage measurement based on laser spectroscopy — •Phillip Imgram[1], Christopher Geppert[2], Kristian König[1], Jörg Krämer[1], Bernhard Maass[1], Ernst Otten[3], Tim Ratajczyk[1], Johannes Ullmann[1], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt — [2]Institut für Kernchemie, Johannes Gutenberg-Universität Mainz — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz

The ALIVE experiment at the TU Darmstadt is a new collinear laser spectroscopy setup. The purpose of the experiment is the measure-

ment of high voltages in the range of 10 to 100 kV using precise laser spectroscopy of ions with a well-known transition frequency. Our aim is to achieve an accuracy of 1 ppm, which is of interest for many applications.
First experiments were done with a $^{40}Ca^+$ beam. Here, the well-known $4S_{1/2} \rightarrow 4P_{3/2}$ transition was driven with a diode-laser based system to pump the atoms to the metastable $3D_{5/2}$ state to mark a velocity class. Probing was achieved by reexcitation to the $4P_{3/2}$ level with a Ti:Sa laser which was stabilized to a frequency comb and subsequent detection of fluorescence light from the decay to the ground state. In order to evaluate the laser-based high-voltage measurements, their results are compared to a direct measurement with a voltage divider that has an active thermal stabilization and reaches a relative precision of 10^{-5}. We will present the current status of the experiment with results from the measurements with $^{40}Ca^+$ and an outlook for the future measurements with indium ions.

A 20.46 Tue 17:00 P OGs

Experimental setup for quantum logic inspired cooling and detection of single (anti-)protons — •Johannes Mielke[1], Teresa Meiners[1], Malte Niemann[1], Anna-Greta Paschke[1,2], Matthias Borchert[3,1], Amado Bautista-Salvador[2,1], Juan Manuel Cornejo[1], Stefan Ulmer[3], and Christian Ospelkaus[1,2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover — [2]Physikalisch Technische Bundesanstalt, Braunschweig — [3]Ulmer Initiative Research Unit, RIKEN

We present concepts for cooling and manipulation of an (anti-)proton in a Penning trap using a co-trapped laser-cooled atomic ion, inspired by the proposal by Heinzen and Wineland [1]. Within the BASE collaboration [2], these techniques could be applied to g-factor based tests of CPT invariance with trapped (anti-)protons.

We discuss trap geometries, laser systems and imaging optics for loading, cooling, manipulation and detection of the trapped atomic ion and report on the current status of the experiment. We acknowledge funding by ERC StG "QLEDS" and DFG SFB DQ-mat and support by the BASE collaboration.

[1] Heinzen and Wineland, PRA **42**, 2977 (1990)
[2] C. Smorra *et al.*, EPJ-ST **224**, 3055 (2015)

A 20.47 Tue 17:00 P OGs

Laser spectroscopic investigation of singly and doubly charged thorium ions — •Johannes Thielking, David-Marcel Meier, Przemyslaw Glowacki, Maksim V. Okhapkin, and Ekkehard Peik — Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany

The ^{229}Th isotope possesses a unique, low-energy nuclear isomeric state at about 7.8(5) eV. This fact has stimulated the development of novel ideas in the borderland between atomic and nuclear physics, for example the use as an optical nuclear clock. Since the required precise information on the isomer energy is not yet available, it is intensely searched for using different experimental approaches.

For the excitation of the nuclear isomer via electronic bridge or NEET processes, we plan to use two-photon laser excitation of highlying electronic levels in Th^+. We recently expanded our search range to higher energies and measured 38 previously unknown energy levels in the range from 7.8 eV to 8.7 eV.

We also prepare to study the nuclear structure of the isomeric state in cooperation with the Maier-Leibnitz-Laboratorium at LMU Munich, using trapped recoil ions, where the isomeric state is populated via α-decay from ^{233}U. For this purpose we investigate the hyperfine structure of suitable transitions of Th^{2+}.