A 26: Poster Session II

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

A 26.1 Wed 17:00 P OGs

Quench-induced resonant tunneling mechanisms of bosons in an optical lattice with harmonic confinement — •Georgios Koutentakis[1,2], Simeon Mistakidis[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, Luruper Chaussee 149, 22761 Hamburg, Germany

The non-equilibrium dynamics of small boson ensembles in a one-dimensional optical lattice is explored upon a sudden quench of an additional harmonic trap from strong to weak confinement. We find that the competition between the initial localization and the repulsive interaction leads to a resonant response of the system for intermediate quench amplitudes, corresponding to avoided crossings in the many-body eigenspectrum with varying final trap frequency. In particular, we show that these avoided crossings can be utilized to prepare the system in a desired state. The dynamical response is shown to depend on both the interaction strength as well as the number of atoms manifesting the many-body nature of the tunneling dynamics.

A 26.2 Wed 17:00 P OGs

A reaction microscope for few-body Rydberg dynamics — •Philipp Geppert, Dominik Arnold, Cihan Sahin, Andreas Müllers, and Herwig Ott — Department of Physics and Research Center OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

On the basis of our deterministic ion source experiment (see talk of C. Sahin), we are developing a reaction microscope that is inspired by the well-known MOTRIMS technique. For this, a sample of 10^6 ^{87}Rb atoms will be prepared in a crossed dipole trap. Using a 3-level excitation scheme, some atoms can be excited to atomic or molecular Rydberg states and photoionised by a short laser pulse from a high power CO_2 laser after a variable evolution time. Following small homogeneous electric fields generated by Wiley-McLaren-type ion optics, the produced ions are subsequently detected by a time and position sensitive micro channel plate detector. By analysing the trajectories of the recoil ions, we aim to measure momentum distributions of Rydberg molecule wave functions. In this context, special focus lies on butterfly and trilobite molecules, which can be addressed efficiently due to the opportunity of exciting Rydberg p- and f-states. As a next step, stroboscopic monitoring of the internal decay of Rydberg molecules as well as measurements regarding forces between pairs of Rydberg atoms will be performed.

A 26.3 Wed 17:00 P OGs

Towards Quantum Link Models in Ultracold Atoms — •Alexander Mil, Fabian Olivares, Pradyumna Paranjape, Markus Oberthaler, and Fred Jendrzejewski — Kirchhoff Institute for Science, 69120, Heidelberg, Germany

We discuss possible experimental realizations of dynamical gauge fields in ultracold atoms. The goal is to built an analog quantum simulator for quantum electrodynamics through quantum link models. We suggest a realization comprised of bosonic 23Na and fermionic 6Li atoms in an optical lattice. The bosonic sodium atoms are located at the link position between the fermionic lattice sites and lead to correlated hopping through well tuned interspecies interactions. We present first steps towards the experimental implementation.

A 26.4 Wed 17:00 P OGs

Dark-bright Soliton Dynamics and Interactions Beyond the Mean-Field approximation — Garyfallia Katsimiga[1], Georgios Koutentakis[1,2], •Simeon Mistakidis[1], Panagiotis Kevrekidis[3], 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 — [3]Department of Mathematics and Statistics, University of Massachusetts Amherst, Amherst, MA 01003-4515, USA

The dynamics of dark bright solitons beyond the mean-field approximation is investigated. We first examine the case of a single dark-bright soliton and its oscillations within a parabolic trap. Subsequently, we move to the setting of collisions, comparing the mean-field approximation to that involving multiple orbitals in both the dark and the bright component. Fragmentation is present and significantly affects the dynamics, especially in the case of slower solitons and in that of lower atom numbers. The employed multi-orbital approximation allows for bipartite entanglement between the distinguishable species to be also generically observed. The above mentioned interplay leads to the decay of the initial mean-field dark-bright solitons into fast and slow fragmented dark-bright structures. A variety of excitations including dark-bright solitons in multiple orbitals is observed. Dark-antidark states and domain wall-bright soliton complexes arise spontaneously possessing an important role in the interpretation of the dynamics.

A 26.5 Wed 17:00 P OGs

Single Cesium Atoms Interacting with an Ultracold Rubidium Bath — •Steve Haupt[1], Daniel Mayer[1,2], Felix Schmidt[1,2], Tobias Lausch[1], Daniel Adam[1], Michael Hohmann[1], Farina Kindermann[1], Nicolas Spethmann[1], and Artur Widera[1,2] — [1]Department of Physics, University of Kaiserslautern, Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern , Germany — [2]Graduate School Materials Science in Mainz, Gottlieb-Daimler-Str. 42, 67663 Kaiserslautern, Germany

We immerse single neutral Cesium (^{133}Cs) atoms into an ultra cold Rubidium (^{87}Rb) cloud and study their dynamics. Tight external control over the Cs atoms' degrees of freedom as well as high-resolution single atom imaging allows studying various quantum phenomena and applications. This includes cooling dynamics of impurity atoms employed as quantum bits or the realisation of polaronic quasi-particles.

We will review the recent developments in gaining further independent control over the two species, including species-selective optical trapping as well as various measures to deduce the temperature of single atoms. This allows employing single atoms as local, non-destructive temperature probes for an ultracold gas, yielding access to the local thermalisation dynamics within the bath.

A 26.6 Wed 17:00 P OGs

Towards Ultracold Ba$^+$-Li - Interactions: The Lithium setup — •F. Thielemann, P. Weckesser, Y. Minet, A. Lambrecht, J. Schmidt, L. Karpa, M. Debatin, and T. Schaetz — Albert-Ludwigs-Universitaet Freiburg

The interplay of ultracold atoms and ions has recently gained interest in the atomic community [1], due to its wide applications in quantum chemistry [2] and quantum control [3]. To control the atom-ion interaction it is necessary to prepare the mixture at ultracold temperatures. Optical trapping of ions [4,5] provides a new pathway to achieve ultracold atom-ion mixtures, as it overcomes the intrinsic micromotion heating effects of a conventional Paul trap [6], currently limiting experiments to collision energies on the order of a few mK.

We present our novel setup aiming to combine Ba$^+$ ions and Li atoms in an optical dipole trap. On this poster we focus on the Li branch of the setup. Our design of the oven, the Zeeman slower and the MOT laser system will be introduced in more detail.

[1] A. Haerter et al., Contemporary Physics, volume 55, issue 1, pages 33-45 (2014).
[2] R.Cote et al. Phys.Rev.Lett. 89.093001 (2002).
[3] Idziaszek et al., Physical Review A 76.3 (2007): 033409.
[4] T.Huber et al., Nat. Comm. 5,5587 (2014).
[5] A. Lambrecht et al., arXiv preprint arXiv:1609.06429 (2016).
[6] M.Cetina et al., Phys.Rev.Lett. 109,253201 (2012).

A 26.7 Wed 17:00 P OGs

Towards Ultracold Ba$^+$ – Li Interactions: The Barium Setup — •P. Weckesser, F. Thielemann, Y. Minet, A. Lambrecht, J. Schmidt, L. Karpa, M. Debatin, and T. Schaetz — Albert-Ludwigs-Universitaet Freiburg

The interplay of ultracold atoms and ions has recently gained interest in the atomic community [1], due to its wide applications in quantum chemistry [2] and quantum control [3]. To control the atom-ion interaction it is necessary to prepare the mixture at ultracold temperatures. Optical trapping of ions [4,5] provides a new pathway to achieve ultracold atom-ion mixtures, as it overcomes the intrinsic micromotion heating of conventional Paul traps [6], currently limiting experiments to collision energies on the order of a few mK.

Here we present our novel experimental setup combining Ba^+ ions and Li atoms. On this poster we focus on the Barium branch of the experiment. We present the Barium laser setup, including a home build frequency doubler, generating laser light at 615nm. Furthermore we discuss a new ion trap suitable to transfer and detect Ba^+ ions and Li atoms in an optical dipole trap.

[1] A. Haerter et al., Contemporary Physics, volume 55, issue 1, pages 33-45 (2014).
[2] R.Cote et al. Phys.Rev.Lett. 89.093001 (2002).
[3] Idziaszek et al., Physical Review A 76.3 (2007): 033409.
[4] T.Huber et al., Nat. Comm. 5,5587 (2014).
[5] A. Lambrecht et al., arXiv preprint arXiv:1609.06429 (2016).
[6] M.Cetina et al., Phys.Rev.Lett. 109,253201 (2012)

A 26.8 Wed 17:00 P OGs

Ablation Loading and Tuning Techniques for the electrical potential in Surface-Electrode Ion Traps — •Leonard Nitzsche, Frederick Hakelberg, Philip Kiefer, Henning Kalis, Ulrich Warring, and Tobias Schaetz — Atom-, Molekül- und optische Physik, Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

Precise and individual control of motional degrees of freedom of trapped ions is needed for the advent of larger scale quantum simulations and computations in microfabricated trap arrays. Key techniques include, e.g., reduction of aging effects such as contamination of the trap surfaces as well as tuning of mirco potentials adressing single ions without affecting the overall performance of the array. Here we present preliminary results in optimising laser ablation loading of Mg^+ and shaping the trap potential adressing individual ions via control potentials up to the fourth order.

A 26.9 Wed 17:00 P OGs

Characterization and Control of Anharmonic Trapping Potentials in Surface-Electrode Ion Traps — •Frederick Hakelberg[1], Philip Kiefer[1], Leonard Nitzsche[1], Henning Kalis[1], Ulrich Warring[1], and Tobias Schaetz[1,2] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg — [2]Freiburg Institute for Advanced Studies

Trapped ions present a promising system for quantum simulations [1]. However scaling the systems to larger size and dimension presents a major challenge. Surface-electrode traps offer a promising approach towards scalable ion traps [2, 3]. With decreasing length scales of trap electrodes and ion-electrode distances higher order terms of electric potentials become relevant. This includes contributions to the confining radio-frequency potential as well as to static control and stray potentials. Building on previous work [4] we present methods using motional excitation measurements to control higher order, anharmonic contributions and stray potentials. Furthermore we show how anharmonic radio-frequency potentials lead to a position dependent trace of the local curvature tensor that can be derived from established measurements of the motional frequencies. We present experimental results for both methods including the variation of anharmonic contributions using dedicated control potentials.

[1] Ch. Schneider *et al.*, Rep. Prog. Phys. **75**, 024401 (2012)
[2] T. Schaetz *et al.*, New J. Phys. **15**, 085009 (2013)
[3] M. Mielenz *et al.*, Nature Communications **7**, 11839 (2016)
[4] H. Kalis *et al.*, Phys. Rev. A **94**, 023401 (2016)

A 26.10 Wed 17:00 P OGs

Structural Defects in Anharmonic Trapping Potentials — •Philip Kiefer[1], Jonathan Brox[1], Miriam Bujak[1], Frederick Hakelberg[1], Leonard Nitzsche[1], Henning Kalis[1], Ulrich Warring[1], Haggai Landa[2], and Tobias Schaetz[1] — [1]Atom-, Molekül- und optische Physik, Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg — [2]LPTMS, Université Paris Sud, Orsay, France

We study topological defects [1], so called kinks, in Coulomb crystals consisting of Mg-Ions. We demonstrate that the appearance of such defects, as well as the normal mode spectrum of the crystal and escape directionalities depend on the trap potential. Depending on defect type and anharmonic contributions to the trap potential, the defects get a preferred escape direction [2].

Linear surface electrode traps offer one possibility to control the trapping potential up to higher orders. We present numerical calculated control potentials, that are modifiable on relevant time scales of the crystal. This system offers a promising platform to further study and exploit the properties of such topological defects.

[1] Ch. Schneider et al., Rep. Prog. Phys. **75**, 024401 (2012)
[2] J. Brox et al., publication in preparation

A 26.11 Wed 17:00 P OGs

Impurity Atoms as a Quantum Probe Using Radiofrequency-Dressed Adiabatic Potentials — •Kathrin Luksch, Tiffany Harte, Elliot Bentine, Adam Barker, Benjamin Yuen, and Christopher Foot — Clarendon Laboratory, Parks Road, Oxford, OX1 3PU

Ultracold atoms can be confined in adiabatic potentials formed by radiofrequency (RF) dressing of magnetically trapped atoms. We demonstrate this approach can be extended by using multiple RFs to generate versatile trap geometries, such as a double-well potential generated by three distinct RFs.

In a new approach to probing complex quantum systems for quantum simulations, we plan to probe the dynamics of a BEC using a second impurity species to look at non-equilibrium phenomena.

Utilising the species-selectivity of the multi-RF dressed adiabatic potentials, we will immerse impurity atoms trapped in a double-well (^{85}Rb) into a bath of atoms of another species (^{87}Rb). The tunnelling rate of the impurity in the double-well will then be correlated to excitations in the bath.

An optical dipole trap combined with a 2D-acousto-optic deflector setup allows further shaping of the trapping potentials. Imaging of the small number of impurity atoms will be achieved using fluorescence imaging in a near-detuned optical lattice.

A 26.12 Wed 17:00 P OGs

A Homogeneous 2D Fermi Gas — •Niclas Luick, Klaus Hueck, Lennart Sobirey, Jonas Siegl, Thomas Lompe, and Henning Moritz — Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

Ultracold 2D Fermi gases in the BEC-BCS crossover provide a model system to investigate e.g. the Kosterlitz-Thouless transition to superfluidity. So far, ultracold 2D Fermi gases have been studied in harmonic trapping potentials. This results in an inhomogeneous density distribution, which complicates the theoretical description of the system and only allows for the extraction of trap averaged quantities when utilizing non-local measurement methods such as time of flight imaging.

Here, we present our realization of an ultracold 2D Fermi gas trapped in a homogeneous disk-shaped potential. The radial confinement is realized by a ring-shaped blue-detuned beam with steep walls. Additionally, a digital micromirror device can be used to remove residual inhomogeneities and to imprint arbitrary repulsive potentials onto the system. Technical details about the generation of optical potentials as well as the current status of our experiment will be presented.

A 26.13 Wed 17:00 P OGs

Three-body losses in Dysprosium — •Fabian Böttcher, Matthias Schmitt, Matthias Wenzel, Carl Bühner, Igor Ferrier-Barbut, and Tilman Pfau — 5. Physikalisches Institut and Center for Integrated Quantum Science and Technology, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

Strongly dipolar quantum gases enable the observation of many-body phenomena with anisotropic, long-range interactions. These interactions lead to a spectrum with a background of chaotic distributed narrow Feshbach resonances, as well as some universal broad resonances [1]. With Feshbach resonances it is well known that the scattering length can be tuned and that at the same time also the three-body recombination rate changes.

Motivated by the fact that the lifetime of the selfbound quantum droplets [2] is limited by the three-body loss rate, we present an extensive study of the three-body loss rate.

[1] T. Maier et al., Phys. Rev. A 92, 060702 (2015)
[2] M. Schmitt et al., Nature 539, 259-262 (2016)

A 26.14 Wed 17:00 P OGs

Trapped ions in strongly polarizable atomic media — •Norman Ewald[1], Henning Fürst[1], Jannis Joger[1], Thomas Secker[2], Thomas Feldker[1], and René Gerritsma[1] — [1]Institute of Physics, University of Amsterdam, Netherlands — [2]Institute for Coherence and Quantum Technology, TU Eindhoven, Netherlands

We report on our experiment which aims at studying trapped ions interacting with ultra-cold atoms that are coupled to Rydberg states. Since the polarizability of the Rydberg-dressed atoms can be very large, the interactions between the ions and atoms will increase dramatically as compared to the ground state case. Such interactions may be mediated over micrometers and could be used to entangle atoms and ions, to mediate spin-spin interactions or to study spin-phonon couplings [1]. Furthermore, we discuss how to employ Rydberg dressing on a dipole-forbidden transition to generate a repulsive atom-ion potential. This prevents collision-induced heating of the ions, typically limiting attainable temperatures in hybrid atom-ion experiments. We discuss our experimental approach for Rydberg excitation of Li atoms as well as a detailed theoretical analysis of Rydberg atom-ion interaction.

[1] T. Secker et al., Phys. Rev. A 94, 013420 (2016).

A 26.15 Wed 17:00 P OGs

Bichromatic control of multi-photon ionization — •Daniela Johannmeyer, Stefanie Kerbstadt, Dominik Pengel, Lars Englert, Tim Bayer, and Matthias Wollenhaupt — Carl von Ossietzky Universität Oldenburg, Institut für Physik, Carl-von-Ossietzky-Straße 9-11, 26129 Oldenburg

Polarization-shaped bichromatic laser fields have attracted much interest for the control of coherent electron dynamics. In view of quantum control, the benefit of bichromatic fields lies in the ability to disentangle different quantum pathways. Recently, we introduced a novel technique for the shaper-based generation of ultrashort bichromatic fields with freely adjustable spectral amplitude profile, phase and polarization state of each color [1]. Here we combine bichromatic polarization shaping with angular resolved photoelectron spectroscopy using velocity map imaging. The 3D photoelectron angular and energy distribution (PAD) is retrieved by tomographic methods. We study resonance enhanced multi-photon ionization of atoms as a prototype scenario for multi-path coherent control. In a bichromatic pump-probe scheme, we study the time evolution of a resonantly excited spin wave packet in the PAD.

[1] S. Kerbstadt, L. Englert, T. Bayer, M. Wollenhaupt, J. Mod. Opt., accepted (2016)

A 26.16 Wed 17:00 P OGs

Carrier-envelope phase stability and control of shaped few-cycle laser pulses from a $4f$ white light shaper — •Daniel Timmer, Stefanie Kerbstadt, Lars Englert, and Matthias Wollenhaupt — Institut für Physik, Carl von Ossietzky Universität Oldenburg, Carl-von-Ossietzky-Straße 9-11, 26129 Oldenburg

Few-cycle IR laser pulses are a well-established tool for control of coherent electron dynamics on the sub-fs timescale. For successful realization of such experiments stabilization and control of the carrier envelope phase (CEP) are essential. In order to exploit advanced coherent control strategies, the availability of tailored few-cycle pulses is highly desirable. Here we use a liquid crystal based $4f$ whitelight shaper to control the CEP of a supercontinuum from a gas-filled hollow-core fiber compressor. Using a home-built f-$2f$-interferometer capable of single shot measurements we verify both the CEP stability behind the setup and the CEP changes introduced by the shaper. In addition to the control over the temporal shape of the laser electric field, the shaper-based approach provides built-in dispersion management and pulse diagnostics. We present initial results of CEP-stable shaped few-cycle waveforms from our setup.

A 26.17 Wed 17:00 P OGs

Combining absorption and photoelectron spectroscopy on ultrashort timescales — •Maximilian Hartmann, Alexander Blättermann, Paul Birk, Veit Stooss, Gergana Borisova, Christian Ott, and Thomas Pfeifer — Max-Planck- Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Femtosecond laser pulses (1fs = 10^{-15}s) have enabled the study of electron dynamics in atoms, molecules and solids on their natural time scale.

Two techniques for these studies—namely transient absorption spectroscopy (TAS) and photoelectron spectroscopy (PES)—make use of such laser pulses to drive high-harmonic generation in rare gases in order to produce attosecond bursts of XUV radiation for pump probe-type experiments. The two methods are complementary in the sense that TAS is most sensitive to bound state dynamics, while PES has direct access to ionization dynamics.

Using TAS we have studied the evolution and manipulation of inner-valence transitions and autoionizing states in noble gases [C. Ott et al., Science 340, 716 (2013); A. Kaldun et al. Phys. Rev. Lett. 112, 103001 (2014); T.Ding et al., Opt. Lett. 41, 709 (2016)]. Here we present the integration of an electron time-of-flight spectrometer into our setup to be able to perform TAS and PES simultaneously. With this new dual approach we aim to gather complementary information of the electron dynamics in atoms and molecules.

A 26.18 Wed 17:00 P OGs

Spin-dependent rescattering in strong-field ionization of Helium — •Danilo Zille[1,2], Daniel Seipt[3,4], Max Möller[1,2], Stephan Fritzsche[2,3], Stefanie Gräfe[5,6], Carsten Müller[7], and Gerhard G. Paulus[1,2] — [1]Institute of Optics and Quantum Electronics, Friedrich Schiller University Jena, 07743 Jena, Germany — [2]Helmholtz Institut Jena, 07743 Jena, Germany — [3]Theoretisch-Physikalisches Institut, Friedrich Schiller University Jena, 07743 Jena, Germany — [4]Physics Department, Lancaster University, Lancaster LA1 4YB, United Kingdom — [5]Institute for Physical Chemistry, Friedrich Schiller University Jena, 07743 Jena, Germany — [6]Abbe Center of Photonics, Friedrich Schiller University Jena, 07743 Jena, Germany — [7]Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany

We investigate the influence of singlet and triplet spin states on rescattered photoelectrons in strong-field ionization of excited helium. Choosing either a symmetric or antisymmetric spatial wave function as the initial state results in different scattering cross sections for the $1s2s$ ^1S and ^3S states. These cross sections are used in the semiclassical model of strong-field ionization. Our investigations show that the photoelectron momentum distributions of rescattered electrons exhibit a significant dependence on the relative spin state of the projectile and the bound electron which should be observable in experiments. The proposed experimental approach can be understood as a testbed for probing the spin dynamics of electrons during strong-field ionization and the presented results as a baseline for their identification.

A 26.19 Wed 17:00 P OGs

Two-timescale Kramers-Henneberger Bloch-Floquet approach for low frequency pulsed laser fields — •Lukas Medišauskas, Ulf Saalmann, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems Nöthnitzer Straße 38 D-01187 Dresden

An efficient numerical method to solve large Floquet problems in Kramers-Henneberger reference frame is proposed. A two-timescale formulation is used that enables to apply the Floquet picture for pulsed laser pulses. The approach is applied to the dynamics of atoms in strong and low frequency laser fields, where explicit treatment of few hundred Floquet states is necessary. Typical strong field effects like high harmonic generation and above threshold ionization are demonstrated. Finally, the existence of the so-called Kramers-Henneberger atom in strong laser field is addressed.

A 26.20 Wed 17:00 P OGs

Laser-solid interaction using time-dependent density functional theory — •Tobias Deffge and Dieter Bauer — Institut für Physik, Universität Rostock, 18051 Rostock, Germany

Strong-field physics in solid targets is of fundamental interest because the dispersion relation of the electrons (and all the quasi particles involved) can be tailored via the field-dressed band structure. Applications in ultrafast electronics or novel radiation sources are conceivable. Much of the recent, pioneering theoretical work on the subject is based on the single-active-electron approximation and the assumption that only a few bands are important for the dynamics. Further, surface effects are difficult to take into account in momentum-space approaches.

In our work, we consider a one-dimensional model of a solid slab interacting with a laser field. The band structure is calculated self-consistently using density functional theory. The laser-induced dynamics is studied by solving the time-dependent Kohn-Sham equation in local spin-density approximation. By freezing and unfreezing the Kohn-Sham potential the influence of electron-electron interaction on Bloch oscillations and harmonic generation is investigated. Surface effects are identified.

A 26.21 Wed 17:00 P OGs

Two-color laser pulses and the phase of the phase — •Mohammad Adel Almajid and Dieter Bauer — Institut für Physik, Universität Rostock, 18051 Rostock, Germany

Phase of the phase (PoP) spectroscopy using two-color colinearly polarized laser pulses has been introduced and applied to the tunneling regime of strong-field ionization [1]. Briefly, the momentum-resolved photoelectron yield as a function of the relative phase between the strong ω and weak 2ω component of a colinearly polarized two-color pulse is measured and Fourier-transformed. This tells us how much and with which phase lag the yield changes with varying relative phase. We present results for the multiphoton regime. We find that the alternating PoP along the above-threshold ionization rings generates a characteristic checkerboard pattern in the PoP spectra. In the case of counter-circularly polarized ω-2ω. laser pulses a three-fold symmetry in the PoP spectra is obtained, as previously found in "ordinary" photoelectron spectra. There is a jump in the PoP signature at a particular radial photoelectron momentum.

[1] S. Skruszewicz *et al.*, Phys. Rev. Lett. 115, 043001 (2015).

A 26.22 Wed 17:00 P OGs

How classical physics emerges from quantum tunneling: Experimental evidence for Wigner tunneling time — •E. Yakaboylu, N. Camus, L. Fechner, M. Klaiber, M. Laux, Y. H. Mi, K. Z. Hatsagortsyan, T. Pfeifer, C. H. Keitel, and R. Moshammer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The classically forbidden tunneling process has intrigued scientists for decades. Recently, the invention of high-precision attoclock techniques in strong laser ionization as well as so-called reaction microscopes for high-resolution momentum measurements have allowed to raise the fundamental question on how classical dynamics emerges in quantum tunneling. Combining experimental and theoretical investigations, we confirm that the leading quantum mechanical Wigner treatment of tunneling in strong field ionization reveals a nonzero tunneling delay time as well as a nonvanishing longitudinal momentum [1].

[1] arXiv preprint arXiv:1611.03701 (2016)

A 26.23 Wed 17:00 P OGs

Isotopic shift of $^{36}Ar/^{40}Ar$ measured with a spin-orbit wave packet — •Sofia Botsi, Nicolas Camus, Lutz Fechner, Thomas Pfeifer, and Robert Moshammer — 1 Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

High precision measurements of isotopic shifts in noble gases can provide a very good test of relativistic and quantum electrodynamic effects. In our experiment, we measured the isotopic shift between ^{36}Ar and ^{40}Ar for the $3s^2 3p^5$ ($^2P_{3/2} \rightarrow {}^2P_{1/2}$) transition for singly ionized argon atoms. We measured the shift by implementing a Ramsey scheme using two ultra-short ($\sim$ 6fs) laser pulses. The first laser pulse excites the system in a coherent superposition of the aforementioned states. This superposition leads to a spin-orbit wave packet whose dynamics can be investigated by applying a second delayed probe pulse. A Mach-Zehnder interferometer was built, introducing a 3.97ns time delay between the two pulses.To detect the different argon isotopes we used a reaction microscope spectrometer (REMI). The isotopic shift is found to be $(1.22 \pm 0.12) \cdot 10^{-7}$eV and it is the first time it has been measured for this transition to the best of our knowledge.

A 26.24 Wed 17:00 P OGs

VMI spectrometer for studying interaction of atoms and molecules with Terahertz radiation — •Patrick Fross, Yonghao Mi, Nicolas Camus, Lutz Fechner, Thomas Pfeifer, and Robert Moshammer — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Thanks to the advancements in strong laser technologies, generation and detection of strong Terahertz (THz) radiation has become possible in the recent years. Because of their low frequencies, they appear as ideal to study ultrafast phenomena in atoms and molecules without disturbing/interacting with the interrogated systems. In order to investigate the effect of THz and their imprint on particles arising from ionization with visible light, we build a dedicated spectrometer. First, this spectrometer has focusing optics which overcome the difficulties due to a low THz power inherent from the low power conversion efficiency of current pulsed THz generation. Second, the spectrometer frame is such that the voltage settings can be changed between Reaction Microscope (ReMi) settings allowing coincident measurement of all charged particles and VMI settings in which the multi-hit limitation of usual ReMis is overcome allowing to record statistics faster. An MCP-phosphor-screen-detector records a collective image of the charged particles that can mathematically be transformed to get the original 3D-momentum-distributions. The particle trajectories were simulated to find a potential configuration with optimal VMI-properties for the ReMi-spectrometer frame. First experimental results were obtained from photoionization of Argon with 25fs-IR-laser-pulses.

A 26.25 Wed 17:00 P OGs

Optical control of electron emission direction at a gold nanotip on a chip — •Constanze Sturm, Takuya Higuchi, Peyman Yousefi, Christian Heide, and Peter Hommelhoff — Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen

Electron pulses from a sharp metal nanotip triggered by ultrashort laser pulses via multiphoton and above-threshold photoemission are extremely confined both in space and time. Employing these short-pulsed electrons as carriers in electronic devices may drastically improve their operation speed [1]. We propose and demonstrate an experiment to steer the electron emission direction at two dimensional nanotips fabricated with lithography on top of a substrate. This is achieved by illuminating the tip with a pair of two laser pulses with orthogonal polarizations. By tuning the relative delay between the two pulses, we change the near-field distribution at the surface of the tip, resulting in a modification of the electron emission sites on the tip. The resultant shift in emission direction is measured as a current difference of two detecting electrodes.

Numerical simulations and the current status of the experiment will be presented.

[1] T. Higuchi et al., Appl. Phys. Lett. 106, 051109 (2015).
[2] H. Yanagisawa et. al., Phys. Rev. Lett. 103, 257603 (2009).

A 26.26 Wed 17:00 P OGs

Strong-Field Approximation with Twisted Light Beams — •Birger Böning[1], Willi Paufler[1], and Stephan Fritzsche[1,2] — [1]Friedrich-Schiller-Universität, Jena, Germany — [2]Helmholtz-Institut Jena, Germany

The strong-field approximation has successfully been used to theoretically describe a variety of phenomena related to atoms in strong laser fields, e. g. above-threshold ionization and high-harmonic generation. Usually these studies are performed for the case of plane wave fields. On the other hand, the interaction of light beams with a more complex spatial structure (e. g. Bessel beams) with atomic systems has only been treated perturbatively and has, for example, been shown to lead to a modification of the selection rules of atomic transitions and photoelectron momentum spectra. We discuss the possibility to study the photoionization of atoms by intense Bessel beams beyond perturbation theory. To this extend, we adapt the strong-field approximation to include these light fields.

[1]: D. B. Milosevic et al., J. Phys. B: At. Mol. Opt. Phys. 39, R203–R262 (2006)
[2]: O. Matula et al., J. Phys. B: At. Mol. Opt. Phys. 46, 205002 (2013)

A 26.27 Wed 17:00 P OGs

Dynamic interference in atomic hydrogen — •Mehrdad Baghery, Ulf Saalmann, and Jan-Michael Rost — MPIPKS, Dresden, Germany

In the double-slit experiment two incoming wavepackets interfere due to their spatially varying relative phase. A similar phenomenon occurs if the relative phase varies with energy.

The goal is to ionise the electron wavepacket into identical continuum states at two different times. This can be done in multiple ways, 1. using two consecutive laser pulses of moderate intensity, 2. using one ultra strong laser pulse well into the stabilisation regime, 3. using one laser pulse below the stabilisation threshold but strong enough to induce a noticeable Stark shift.

This poster focuses mainly on the third alternative, which proves much more involved than perceived at first glance. In contrast to many previously published results, we show that this is only possible at frequencies in the x-ray regime.

A 26.28 Wed 17:00 P OGs

Sudden regime of laser-nucleus interaction — •Sergei Kobzak, Adriana Pálffy, and Hans Weidenmüller — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Recent experimental developments in laser physics and laser-driven acceleration promise to deliver coherent photon beams with energies ranging up to several MeV. The prospect of a laser beam with photon energies comparable to typical nuclear excitation energies raises a number of questions and opens new unexplored avenues for nuclear physics [1,2].

In this work we investigate theoretically the interaction between coherent gamma-ray laser pulses and medium-weight or heavy nuclei in the case of sudden regime. In this regime the compound nucleus statistical equilibration rate is slower than the average photon absorption rate. Consequently, nucleons are excited independently and are expelled from the common average potential. Multiple photon absorptions may lead to complete evaporation of the nucleus if the duration of the laser pulse of several MeV per photon is long enough. The time evolution of such processes is studied with help of master equations which take into account neutron decay and feeding, dipole absorption and emission and the nucleon-nucleon interaction.

[1] A. Pálffy and H. A. Weidenmüller, Phys. Rev. Lett. 112, 192502 (2014).
[2] A. Pálffy, O. Buss, A. Hoefer and H. A. Weidenmüller, Phys. Rev. C 92, 044619 (2015).

A 26.29 Wed 17:00 P OGs

Time-resolved photoelectron spectroscopy of IR-driven electron dynamics in a charge transfer model system — Mirjam Falge[1], •Friedrich Georg Fröbel[2], Volker Engel[1], and Stefanie Gräfe[2] — [1]Institut für Physikalische und Theoretische Chemie, Universität Würzburg — [2]Institut für Physikalische Chemie und Abbe Center for Photonics, Universität Jena

We numerically investigate the coupled nuclear and electronic dynamics induced by a moderately intense IR-pulse in a charge transfer model system. We examine two limiting cases, one, where the Born-Oppenheimer approximation is valid, and a second, where it breaks down. Calculating the time-resolved photoelectron momentum distributions, a pronounced difference is found. In the case of weak coupling, electrons adiabatically adjust to the nuclear motion. Strong coupling on the other hand leads to diabatic electron dynamics. The IR-pulse may modify the electron dynamics in the respective situation and thus influence the charge-transfer dynamics. Using an ultrashort XUV pulse as a probe, we illustrate that the electron-nuclear dynamics is reflected in the asymmetry of the photoelectron momentum distribution.

A 26.30 Wed 17:00 P OGs

Coulomb-corrected strong-field quantum orbits beyond the dipole approximation — •Thomas Keil and Dieter Bauer — Institut für Physik, Universität Rostock, 18051 Rostock, Germany

Small nondipole effects in photoelectron spectra of rare gas atoms have been recently observed in experiments using 3.4-micron radiation at 2–8 $\times 10^{13}$ W/cm^2 [1]. Taking nondipole effects into account in 3D simulations based on the time-dependent Schrödinger equation (TDSE), let alone the Dirac equation, are extremely demanding and do not yield much insight into the underlying physics. The plain strong-field approximation (SFA), on the other hand, is oversimplified because it lacks the very essential effect of the Coulomb potential on the outgoing electrons. As a result, differential photoelectron momentum spectra obtained with the plain SFA are in very poor agreement with experiment and TDSE. Coulomb corrections can be incorporated via quantum orbits [2–4], and the equations of motion for these quantum orbits can be easily corrected for taking the $\vec{v} \times \vec{B}$-force into account as well. We analyze the effect of this correction and compare with the experimental findings.

[1] A. Ludwig *et al.*, Phys. Rev. Lett. 113, 243001 (2014).
[2] S.V. Popruzhenko and D. Bauer, J. Mod. Opt. 55, 2573 (2008).
[3] S.V. Popruzhenko *et al.*, Phys. Rev. A 77, 053409 (2008).
[4] Tian-Min Yan *et al.*, Phys. Rev. Lett. 105, 253002 (2010).

A 26.31 Wed 17:00 P OGs

Strong field dissociation of small heteronuclear molecules into excited fragments — •Sven Meise, Henri Zimmermann, and Ulrich Eichmann — Max-Born-Straße 2a, 12489 Berlin

We investigate the dissociation processes of small molecules in intense short laser fields which yield excited fragments. Recently, experimental coincidence measurements revealed that a fraction of H_2−molecules undergoing Coulomb explosion (CE) fragment into an excited H-atom and an proton [1]. The underlying physical process can be understood by applying the semi-classical model of frustrated tunneling ionization (FTI). Here, we present experimental results of strong field dissociation of small heteronuclear molecules (CH_4, CO_2) into excited fragments which proves that the excitation mechanism (FTI) is not unique to H_2 or other homonuclear molecules. Calculations based upon the CE which lead to excited fragments exhibit main features of the experimental results. Further insight is gained by looking at the excited state distribution of the molecular fragments using pulsed field ionization.

[1] B. Manschwetus *et al.*; PRL **102** 113002 (2009)

A 26.32 Wed 17:00 P OGs

Robust enhancement of high harmonic generation via attosecond control of ionization — Barry D. Bruner, •Michael Krüger, Oren Pedatzur, Doron Azoury, Gal Orenstein, and Nirit Dudovich — Weizmann Institute of Science, 76100 Rehovot, Israel

Advancements in high harmonic generation (HHG) have led to the development of table-top XUV and soft x-ray light sources for attosecond science. However, the very low conversion efficiency from the strong driving laser fields to short wavelength HHG light poses a significant practical limitation for the use of these sources in experimental applications. We show that a two colour driving field produces a considerable enhancement of the ionization rate compared to that of a single colour field, leading to huge increases in the HHG efficiency. We use a tunable mid-IR (1300-1600 nm) source as a driving field and a weaker 800 nm beam as an assisting field. By systematically varying the field parameters we can observe increases in HHG efficiency of over two orders of magnitude. The enhancement is achieved via sub-cycle control of the tunnel ionization dynamics in the bichromatic driving field. Most schemes for increasing the HHG efficiency rely on phase matching and involve careful control of a large number of experimental parameters. However, our scheme is robust to phase matching effects and requires control of just a single parameter, namely the ionization rate. The robustness of this approach makes great strides toward improving the simplicity and practicality of high flux HHG sources.

A 26.33 Wed 17:00 P OGs

XUV-Pump-Probe Transient Absorption Spectroscopy on Neon at the Free Electron Laser in Hamburg (FLASH) — •Thomas Ding[1], Marc Rebholz[1], Lennart Aufleger[1], Maximilian Hartmann[1], Kristina Meyer[1], Alexander Magunia[1], David Wachs[1], Veit Stooss[1], Paul Birk[1], Gergana Borisova[1], Andrew Attar[2], Thomas Gaumnitz[3], Zhi Heng Loh[4], Sebastian Roling[5], Marco Butz[5], Helmut Zacharias[5], Stefan Düsterer[6], Rolf Treusch[6], Christian Ott[1], and Thomas Pfeifer[1] — [1]Max-Planck Institut für Kernphysik, Heidelberg, Germany — [2]University of California Berkeley, Berkeley, USA — [3]Eidgenössische Technische Hochschule Zürich, Zürich, Switzerland — [4]Nanyang Technological University Singapore, Singapore — [5]Westfälische Wilhelms-Universität Münster, Münster, Germany — [6]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

We present first transient-absorption spectroscopy experiments with extreme ultraviolet (XUV) pump and probe pulses delivered by FLASH. Applying our pump-probe scheme at photon energies around 50 eV and pulse durations of about 50 fs to neon, we traced strong-field-induced spectral modifications in the bound-electron response of the neutral and the ionized atom. The method also provides in-situ temporal diagnostics of self-amplified spontaneous emission (SASE) FEL pulses from the measured spectral cross-correlation signatures. In the near future, this scheme will be extended to a multi-pulse nonlinear spectroscopy technique to probe the excitation transfer and electronic redistribution dynamics among different sites of a molecule.

A 26.34 Wed 17:00 P OGs

Modification of Coulomb focusing of tunneled electrons in intense elliptically polarized mid-IR laser fields — •Jiří Daněk[1], Karen Z. Hatsagortsyan[1], Jochen Maurer[2], Benjamin Willenberg[2], Benedikt W. Mayer[2], Christopher R. Phillips[2], Lukas Gallmann[2,3], Ursula Keller[2], and Christoph H. Keitel[1] — [1]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [2]Department of Physics, ETH Zurich, Switzerland — [3]Institute of Applied Physics, University of Bern, Switzerland

Photoelectron momentum distributions (PMD) in the tunneling regime of ionization in an elliptically polarized laser field (3.4 μm) are investigated using classical-trajectory Monte-Carlo simulations. The signatures of the Coulomb field of the atomic core are identified and explained. In addition to the known Coulomb effect on the rotation of the PMD ellipse due to the Coulomb momentum transfer at the tunnel exit along the laser instantaneous polarization direction, we find the effect of the recollisions in the PMD at small values of the ellipticity. The recollisions are essentially modified in the elliptically polarized laser field, as the Coulomb focusing (CF) is very sensitive to all forces acting on the tunneled electrons. However, similarity of the CF in a linearly polarized case and in a case of a small ellitpicity can be found. The appearance and visibility of new features of PMD depend strongly on ellipticity and regimes can be identified where different features dominate. We focus on the theoretical analysis and investigate the PMD modifications analytically in the recollision picture, and present a qualitative analysis via the modified classical trajectories.

A 26.35 Wed 17:00 P OGs

The Effect of Electron Correlation on the Ionisation of Helium in Strong and Short Laser Pulses — •Gergana Borisova, Veit Stooss, Andreas Fischer, Alexander Blättermann, Thomas Ding, Andreas Kaldun, Christian Ott, and Thomas Pfeifer — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Here, we present theoretical results from our study of the electron dynamics in the helium atom interacting with strong laser fields (XUV-excitation and NIR-perturbing pulse) on the attosecond timescale.
We investigate the role of electron-electron correlation dynamics to explain the experimentally observed abrupt ionisation of N = 2 doubly excited states in helium above a certain critical NIR-laser intensity. For this we employ a numerical quantum-mechanical model based on solving the one-dimensional time-dependent Schrödinger equation for two electrons. The theoretical method ensures direct access to the time-dependent population of the relevant atomic states during and right after the laser pulse. The simulation results obtained confirm our experimental observations and give important clues to the role of the electron-electron interaction in the ionisation processes.

A 26.36 Wed 17:00 P OGs

Direct Observation and Characterization of Multiple Strong-Field Ionization Continua Participating in Electron Rescattering — •Felix Schell, Timm Bredtmann, Serguei Patchkovskii, Marc Vrakking, Claus Peter Schulz, and Jochen Mikosch — Max Born Institute, Berlin, Germany

In laser-driven electron rescattering, the field of an intense fs laser pulse first ionizes a molecule and then accelerates the released electron back to the core, from which it scatters elastically. For polyatomic molecules, multiple ionization continua originating from the homo and lower-lying states are known to be populated and thus expected to contribute to the signal of rescattered electrons. In this study, we separate electron rescattering correlated to different ion states in the strong-field ionization of 1,3-butadiene molecules. We extend the crati technique [1] to the recollision regime using a reaction microscope. We measure the channel-resolved rescattering yield as a function of ellipticity and - for laser-aligned molecules - in the molecular frame. The observed trends are rationalized by the anticipated nodal structure of the continuum electron wavepackets originating from the respective Dyson orbitals. These qualitative expectations are confirmed by multi-orbital td-ris [2] calculations.

[1] Science **335**, 1336 (2012).
[2] Phys. Rev. A **80**, 063411 (2009).

A 26.37 Wed 17:00 P OGs

Simulation of CEP-dependent above-threshold ionization with few-cycle laser pulses at 1800 nm — •Yinyu Zhang[1,2], Danilo Zille[1,2], Philipp Kellner[1], Daniel Adolph[1,2], Daniel Wüzler[1,2], Philipp Wustelt[1,2], Max Möller[1], Arthur Maxwell Sayler[1,2], and Gerhard G. Paulus[1,2] — [1]Institut für Optik und Quantenelektronik, Max-Wien-Platz 1, 07743, Jena, Germany — [2]Helmholtz Institut Jena, Fröbelstieg 3, 07743, Jena, Germany

The carrier-envelope(CE)-phasemeter, which is based on a stereographic above-threshold ionization (ATI) measurement, has been proven to be a precise, real-time, single-shot CEP tagging and pulse length characterization technique at 800 nm [1]. However, for longer wavelengths, the higher ponderomotive energy increases electron return energies. This reduces the scattering probability and thus reduces the corresponding yield of the high energy back-scattered electrons detected by the CE-phasemeter, which makes the measurements challenging. Nevertheless, recent preliminary results have shown that determination of the CEP of 1800 nm pulses using stereo-ATI of Xenon is possible. Here, the stereo-ATI spectra in few-cycle pulses at 1800 nm are simulated using the semi-classic three-step model of strong-field ionization and are compared with experimental results. The simulation results provide guidelines for optimizing CE-phasemeter technology to allow measurements at longer wavelength with increased precision.

[1]T.Rathje et al.J.Phys.B:At.Mol.Opt.Phys.45(2012)074003

A 26.38 Wed 17:00 P OGs

Charge Redistribution in Clusters revealed by XFEL Photoelectron Spectra — •Abraham Camacho Garibay, Ulf Saalmann, and Jan-Michael Rost — MPI-PKS, Dresden

Photoelectron spectroscopy in the sequential regime is usually expected to produce a plateau in the energy spectra for direct electrons of sufficiently high energy. This has been shown to be no longer the case if the cluster potential is high enough to trap the innermost emitted photoelectrons, but this effect appears to be hard to measure. We study a new case where field ionization sets in due to a deep cluster potential, this makes the charge distribution inhomogeneous, showing itself in the photoelectron spectra.

A 26.39 Wed 17:00 P OGs

Sum rules for the polarization correlations in electron-nucleus bremsstrahlung — •Doris Jakubassa-Amundsen[1] and Richard Pratt[2] — [1]Mathematisches Institut, LMU Munich, Germany — [2]Department of Physics and Astronomy, University of Pittsburgh, USA

The knowledge of polarization transfer from a spin-polarized beam electron to the emitted bremsstrahlung photon is important for beam diagnostics or for the production of polarized positrons in conversion targets. Allowing for an arbitrary direction of the electron spin, the polarization transfer is characterized by seven parameters in the case of coplanar geometry. The squares of these parameters obey a strict sum rule, irrespective of the atomic or nuclear interaction potential, which can be used to test the accuracy of the calculations. Approximate sum rules connecting only three parameters can help to determine one particular polarization correlation if the other two are known. Examples for light and heavy nuclei bombarded with electrons in the MeV region will be given, based on the partial-wave Dirac theory for bremsstrahlung.

A 26.40 Wed 17:00 P OGs

Collision energies in inelastic electron-ion interaction at the CSR — •Sunny Saurabh[1], Arno Becker[1], Roman Čurík[2], Claude Krantz[1], Chris Greene[3], Oldřich Novotný[1], Marius Rimmler[1], Stephen Vogel[1], Patrick Wilhelm[1], and Andreas Wolf[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Academy of Sciences of the Czech Republic, Prague, Czech Republic — [3]Purdue University, Indiana, United States of America

In the Cryogenic Storage Ring (CSR) at MPIK, molecular ions are stored over 1000 s in a low blackbody radiation field environment of ∼10 K. Under these conditions molecular ions can radiatively relax toward the ro-vibrational ground state. To facilitate electron-ion collision experiments, a new electron cooler device is being implemented at the CSR. The electrons are produced at cold photocathode and magnetically guided and merged with ion beam in the CSR orbit. The merged beam geometry of the electron cooler is envisaged giving us tunable center of mass (COM) frame collision energies from 0 to several eV. The geometry of the merging and de-merging region of cooler, temperature of electrons and space-charge effects in the electron-ion interaction region cause a position dependence of the COM collision energy with also non-zero values for velocity matched electron-ion mean collision velocities. To understand this, detailed studies have been carried out. Lastly the role of electron induced excitation and de-excitation of HeH^+ ions will be presented for the first time in cold environment (∼10 K). Electron induced excitation and cooling enter in competition with destruction and neutralization processes.

A 26.41 Wed 17:00 P OGs

(e, 2e + ion) study of electron-impact ionization and fragmentation of tetrafluoromethane at low energies (E0 =35.7 eV, 38 eV, 45 eV and 67 eV) — •Khokon Hossen[1,3], Xueguang Ren[1], S. V. K. Kumar[2], and Alexander Dorn[1] — [1]Max Planck Institute for Nuclear Physics, 69117 Heidelberg, Germany — [2]Tata Institute of Fundamental Research, Homi Bhabha Road, Colaba, Mumbai 400 005, India — [3]University of Santiago de Compostela,15782 Santiago de Compostela, Spain

We present our recent results for the ionization and fragmentation dynamics of tetrafluoromethane (CF4) molecules induced by low-energy electron impact (E0 = 35.7 eV, 38 eV, 45 eV, and 67 eV). One goal of this experiment is to clarify the origin of a resonance structure for the CF2+ fragment channel around 36 eV impact energy. Experimentally, we use a reaction microscope and a pulsed photoemission electron beam [1]. The momentum vectors of the two outgoing electrons (energies E1, E2) and one fragment ion are detected in triple coincidence (e, 2e + ion). After dissociation, the fragment products from CF4 are CF3+, CF2+, CF+, F+ and C+. For all fragmentation channels, we observe the ionized orbital binding energy (BE) [E0 - E1 - E2], the kinetic energy release (KER) of the fragments and two-dimensional (2D) correlation map between BE and KER. E.g., from binding energy spectra, we can conclude which molecular orbitals are responsible to form the fragments of CF4. [1] X. Ren et al, J. Chem. Phys. 141 134314 (2014).

A 26.42 Wed 17:00 P OGs

Coulomb- and quantum-corrected strong-field approximation — •Michael Klaiber[1], Jiří Daněk[1], Enderalp Yakaboylu[2], Karen Z. Hatsagortsyan[1], and Christoph H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]IST Austria, Wien

Signatures of the Coulomb quantum corrections in the photoelectron momentum distribution during laser-induced ionization of atoms or ions in tunneling and multiphoton regimes are investigated analytically in the case of an 1D problem. Extended Coulomb corrected strong-field approximation (SFA) is applied, where the exact continuum state in the S-matrix is approximated by the eikonal Coulomb-Volkov state including quantum corrections. Although, without quantum corrections our theory coincides with the known analytical R-matrix (ARM) theory, we propose a simplified procedure for the matrix element derivation. Rather than matching the eikonal Coulomb-Volkov wave function with the bound state to remove the Coulomb singularity, as it was carried out in ARM theory, we calculate the matrix element via the saddle-point integration method by time as well as by coordinate which is avoiding the Coulomb singularity. The momentum shifts in the photoelectron momentum distribution with respect to the ARM-theory due to quantum corrections are analyzed for tunneling and multiphoton regimes.

A 26.43 Wed 17:00 P OGs

Investigation of two-frequency Paul traps for antihydrogen production — Nathan Leefer[1,2], •Kai Krimmel[1,3], William Bertsche[4,5], Dmitry Budker[1,3,2,6], Joel Fajans[2], Ron Folman[7], Hartmut Häffner[2], and Ferdinand Schmidt-Kaler[1,3] — [1]Helmholtz-Institut Mainz, Mainz 55128, Germany — [2]Department of Physics, University of California at Berkeley, Berkeley, CA 94720 — [3]QUANTUM, Institut für Physik, Johannes Gutenberg-Universit\"at Mainz, Mainz 55128, Germany — [4]University of Manchester, Manchester M13 9PL, UK — [5]The Cockcroft Institute, Daresbury Laboratory, Warrington WA4 4AD, UK — [6]Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 — [7]Department of Physics, Ben-Gurion University of the Negev, Be'er Sheva 84105, Israel

Radio-frequency (rf) Paul traps operated with multifrequency rf trapping potentials provide the ability to independently confine charged particle species with widely different charge-to-mass ratios. In particular, these traps may find use in the field of antihydrogen recombination, allowing antiproton and positron clouds to be trapped and confined in the same volume without the use of large superconducting magnets. We explore the stability regions of two-frequency Paul traps and perform numerical simulations of small samples of multispecies charged-particle mixtures of up to twelve particles that indicate the promise of these traps for antihydrogen recombination.

A 26.44 Wed 17:00 P OGs

Pros and cons of time-dependent renormalized-natural-orbital theory — •Martins Brics, Julius Rapp, and Dieter Bauer — Institut für Physik, Universität Rostock, 18051 Rostock, Germany

Recently introduced time-dependent renormalized-natural-orbital theory (TDRNOT) is a promising approach to describe correlated electron quantum dynamics, even beyond linear response. It has been shown [1-4] that TDRNOT is capable of describing correlated phenomena such as doubly excited states, autoionization, and Fano profiles in absorption and photoelectron spectra, nonsequential double ionization, single photon double ionization, high-harmonic generation and Rabi oscillations.

In this work, we compare how TDRNOT performs against standard methods such us multiconfiguration time-dependent Hartree-Fock (MCTDHF). The main focus is the truncation error, which is a consequence of the fact that numerical calculations necessarily require a truncation of the number of natural orbitals/configurations.

[1] M. Brics, D. Bauer, Phys. Rev. A 88, 052514 (2013).
[2] J. Rapp, M. Brics, and D. Bauer, Phys. Rev. A 90, 012518 (2014).
[3] M. Brics, J. Rapp, and D. Bauer, Phys. Rev. A 90, 053418 (2014).
[4] M. Brics, J. Rapp, and D. Bauer, Phys. Rev. A 93, 013404 (2016).

A 26.45 Wed 17:00 P OGs

Comparison of three modes of operation for an optical magnetometer for exotic physics searches. — •Hector Masia-Roig, Arne Wickenbrock, and Dmitry Budker — Helmholtz Institute, Johannes Gutenberg University, Mainz

GNOME is a novel experimental scheme which enables the investigation of couplings between nuclear spins and exotic fields generated by astrophysical sources. It consists of a network of geographically separated, time synchronized, ultrasensitive ($\sim$ fT/$\sqrt{\text{Hz}}$) optical atomic magnetometers that measure atomic spin precession in multilayer magnetic shielding. Such a configuration enables the study of global transient effects due to non-magnetic interactions.

Currently, there are six magnetometers placed around the world which are able to measure synchronously. Here is presented a comparison between three different modes of operation of an atomic magnetometer. The bandwidth and sensitivity is analyzed for an open loop, phase lock loop and self-oscillating configurations. The outcome points the phase lock loop configuration as optimal for the GNOME network. With this configuration an optimal compromise between sensitivity and bandwidth is reached.

A 26.46 Wed 17:00 P OGs

CASPEr: The Cosmic Axion Spin Precession Experiment — •Nataniel Figueroa Leigh[1], Gary Centers[1], Marina Gil Sendra[1], Arne Wickenbrock[1], John Blanchard[1], Dmitry Budker[1], and CASPEr Collaboration[2] — [1]Helmholtz Institute, Johannes Gutenberg University, Mainz — [2]Various Locations

Out of all the mass in the universe, no one knows what $\sim 85\%$ of it is made of; this makes dark matter one of the biggest open questions in physics. In this context, the axion rises as a prime candidate that could account for the dark matter content of the universe. The CASPEr experiment seeks to exclude parameter space of (or find) axions by using a spin ensemble that transduces the usually inert axion wind field into a measurable magnetic signal, which can then be detected using conventional methods. What makes this challenging is that the coupling of the axions to the spin "antenna" -and thus, the signal- is small, which must be accounted for by using techniques that enhance the signal. This poster presents the overall CASPEr experiment and recent advances towards a working CASPEr-Wind experiment in Mainz.

A 26.47 Wed 17:00 P OGs

Progress towards hyperpolarized liquid xenon for the Cosmic Axion Spin Precession Experiment (CASPEr-Wind) — •Gary Centers[1], John Blanchard[1], Nataniel Figueroa[1], Marina Gil Sendra[1], Arne Wickenbrock[1], Dmitry Budker[1], and CASPEr Collaboration[2] — [1]Helmholtz Institute Mainz, Johannes Gutenberg University, 55128 Mainz, Germany — [2]Various locations

The Cosmic Axion Spin Precession Experiment (CASPEr), particularly the CASPEr-Wind, is a detection scheme searching for light particles that have a coupling to nuclear spin; some examples being dark matter candidates like the axion/axion-like particles, hidden photons, or any pseudo-Goldstone boson[1,2,3].

Current progress towards the condensation of hyperpolarized xenon (Xe) gas as the main sample for the CASPEr is presented. Included will be an overview of condensation process, a review of gas and liquid Xe relaxation processes, components designed for maintaining polarization during the condensation, and preliminary process/component characterizations.

[1] D. Budker et al., Phys. Rev. X 4, 021030 (2014).

[2] P. W. Graham and S. Rajendran, Phys. Rev. D 88, 035023 (2013).

[3] P. W. Graham et al., Annu. Rev. Nucl. Part. Sci. 65, 485514 (2015).

A 26.48 Wed 17:00 P OGs

Characterization of Xenon polarizer for the Cosmic Axion Spin Precession Experiment — •Marina Gil Sendra — Johannes Gutenberg Universität Mainz — Helmholtz Institute Mainz

In this poster we present a scheme for the atomic polarizer for the CASPEr collaboration.

CASPEr aims for the detection of possible candidates for dark matter, axions, via their interaction with atomic nuclei. The signals from these particles will be weak so all possibilities for signal enhancement need to be considered. The chosen nuclei for the experiment are ^{129}Xe that are hyperpolarized using the spin-exchange optical pumping technique, in which the polarizarion is transferred via Fermi Contact Interaction from an alkali metal, Rubidium. The hyperpolarized Xenon is to be placed in a magnetic field that will be swept from ultralow field up to 14 T.