A 25: Poster IV

Time: Wednesday 17:00–19:00 Location: Tent A

A 25.1 Wed 17:00 Tent A

Analysing Single Particle Trajectories Of Ultracold Atoms With Artificial Intelligence — •Marco Mohler, Silvia Hiebel, Dennis Wagner, Sabrina Burgardt, Julian Fess, Marius Kloft und Artur Widera — University of Kaiserslautern-Landau, Kaiserslautern, Germany

Artificial Intelligence can be a helpful tool in analysing large datasets. In the presented work, we analyze the diffusion of Cs atoms, which are trapped in a far-detuned optical dipole trap and driven by an optical molasses. As the atoms absorb and reemit photons from the molasses laser beams they receive small momentum kicks in a random direction. This fluctuating force together with Doppler damping due to the laser beams detuning results in diffusive behaviour and is similar to Brownian motion. A small imbalance in the power of the counterpropagating molasses beams results in a small drift away from the stronger beam. This is to be avoided as it is a disturbance to experiments. Here, we present a neural network trained to learn the underlying force field behind the diffusive cesium trajectory which originates from the details of the laser setup. Applying the network to experimental data might reduce everyday readjustment time by telling which parameters to adjust to negate the drift from a reduced number of recorded trajectories. Initial training is carried out on simulated data because producing this data requires less ressources. Therefore trajectories are calculated for different laser imbalances and presented to the neural network so that it learns how the imbalance affects the atoms‘ movement. Currently the simulation is being tested before the neural network is set up.

A 25.2 Wed 17:00 Tent A

High Fidelity transport of trapped-ion qubits in a multilayer array — •Deviprasath Palani, Florian Hasse, Apurba Das, Leon Goepfert, Ole Pikkemaat, Ulrich Warring, and Tobias Schaetz — Physikalisches Institut, Universitaet Freiburg, Freiburg, Germany

Trapped ion arrays, facilitated by Radio-Frequency surface electrode traps, offer a promising platform for extending analog quantum simulations in size and dimension. Our prototype, fabricated by Sandia National Laboratories, creates a three-dimensional potential landscape housing 13 strongly confined ion storage sites alongside intermittently weakly confined areas featuring transport channels. An equilateral triangular array, situated closer to the surface with a side length of 40 μm, enables local site control, 2D inter-site coupling, and Floquet-engineering coupling via motional degrees of freedom[1-3]. Extending these methods, we enable deterministic ion redistribution using an ancilla site approximately 13 μm above the array. Ramsey spectroscopy confirms the preservation of electronic degree-of-freedom information during ion transport. Our current focus lies in addressing noise predominantly arising from surface contaminants using argon-ion bombardment and tackling other technical limitations[5].

[1] Mielenz, M. et al. Nat. Commun. 7, 11839 (2016). [2] Hakelberg, F. et al. Phys. Rev. Lett. 123, 100504 (2019). [3] Kiefer, P. et al. Phys. Rev. Lett. 123, 213605 (2019). [4] Palani, D. et al. Phys. Rev. A. 107, L050601 (2023). [5] Warring, U. et al. Adv. Quantum Technol. 1900137 (2020).

A 25.3 Wed 17:00 Tent A

Construction of a versatile platform for Rydberg atom experiments — •Aaron Thielmann, Mirza Akbar Ali, Sven Schmidt, Suthep Pomjaksilp, Thomas Niederprüm, and Herwig Ott — Department of Physics and research center OPTIMAS, RPTU Kaiserslautern-Landau

In recent years, atomic arrays emerged as a ground-breaking platform in quantum physics. These setups do not only feature single-atom control, additionally exciting addressable atoms to Rydberg states introduces further possibilities to study physical problems in different geometric configurations.

Using a metallic vacuum-chamber, our aim is to get a versatile platform for research on arrays of single atoms or small samples while having as much control over sorrounding parameters as possible. Through a high resolution objective not only tweezer trap generation and observation but also site-selective (de-)excitation will be possible. This will enable us to investigate different phenomena like transport with dissipation in arbitrarily arranged arrays of Rubidium atoms. Additional features include electric and magnetic field control as well as the ability for global application of microwave and optical fields. Furthermore a second species of Rubidium could enable even more possibilities.

A 25.4 Wed 17:00 Tent A

Ultracold LiCr Feshbach dimers: prospects for doubly-polar ground-state molecules — •Maximilian Schemmer[1,2], Stefano Finelli[1,2], Alessio Ciamei[1,2], Beatrice Restivo[1,2], Antonio Cosco[1,2], Andreas Trenkwalder[1,2], and Matteo Zaccanti[1,2] — [1]Istituto Nazionale di Ottica del Consiglio Nazionale delle Ricerche (CNR-INO), 50019 Sesto Fiorentino, Italy — [2]European Laboratory for Nonlinear Spectroscopy (LENS), 50019 Sesto Fiorentino, Italy

We report the creation and study of ultracold ^{6}Li^{53}Cr Feshbach molecules. Leveraging on the Fermi statistics of the parent atomic mixture, we adiabatically associate up to 50×10^3 LiCr at a peak phase-space density of about 0.1, thereby populating a weakly-bound rotationless level of the electronic ground-state $^6\Sigma^+$. We directly observe the paramagnetic nature of $^6\Sigma^+$ by measuring the magnetic dipole moment of closed-channel dimers, and we show precise control of the open-channel fraction close to the Feshbach resonance pole. We characterize the loss mechanisms induced by trap light and inelastic collisions. We show that a pure molecule sample trapped at a convenient wavelength of 1560nm features lifetimes exceeding 0.2 s. According to recent ab-initio calculations, efficient and coherent transfer to the absolute ground-state will deliver doubly-polar molecules for novel quantum simulation and computation as well as ultracold chemistry.

A 25.5 Wed 17:00 Tent A

Optical tweezer for immersion of single Cs impurities in an ultracold Rb bath — •Levi Geier, Sabrina Burgardt, Silvia Hiebel, Julian Fess, and Artur Widera — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern-Landau, Kaiserslautern 67663, Germany

Optical tweezers, i.e. tightly focussed laserbeams, have evolved into versatile tools in the study of many-body quantum systems with control on the single-particle level. Their range of application is very broad since devices such as spatial light modulators and acousto-optical deflectors allow arbitrary and time-dependent optical potentials. In the scope of this work an optical tweezer setup based on an acousto-optical defletor is presented, which will be used to control single Caesium atoms dynamically inside a 3-dimensional Rubidium BEC. As optical tweezers rely on the optical dipole force only, manipulation of the atomic states is enabled, and coherence is preserved. We aim to investigate the coherence dynamics of a single Caesium qubit when immersed in a Rubidium BEC.

A 25.6 Wed 17:00 Tent A

Collisional energy effects on atom-ion Feshbach resonances — •Joachim Siemund[1], Fabian Thielemann[1], Daniel Hönig[1], Wei Wu[1], Krzysztof Jachymski[2], Thomas Walker[1,3], and Tobias Schätz[1] — [1]Physikalisches Institut, Albert-Ludwigs Universität Freiburg — [2]Faculty of Physics, University of Warsaw — [3]Blackett Laboratory, Imperial College, London

We investigate the inelastic loss dynamics around Feshbach resonances between neutral atoms and ions depending on the collision energy. By immersing a single ^{138}Ba$^+$ ion in an ultracold cloud of ^{6}Li, we have demonstrated the enhancement of two- and three-body interactions through changes in the ion's electronic state and radial kinetic energy. We probe the atom-ion interaction rate while tuning the ion's kinetic energy and atomic cloud temperature. We observe the enhancement and suppression of inelastic loss processes depending on the collision energies and specific Feshbach resonance. This energy dependence could provide insight into the fundamental nature of the interaction dynamics, which also will be discussed in a parallel talk by Fabian Thielemann.

A 25.7 Wed 17:00 Tent A

Theoretical study of radio-frequency induced Floquet-Feshbach resonances in ultracold Lithium-6 gases — •Alexander Guthmann, Felix Lang, and Artur Widera — RPTU Kaiserslautern-Landau, 67663 Kaiserslautern, Germany

Feshbach resonances play a crucial role in the exploration of ultracold atoms. The magnetic field position of these resonances is determined by the point at which the energy of a dimer-bound state intersects the asymptotic atomic threshold. This contribution discusses the utilization of an oscillating magnetic field in the radio frequency range to couple colliding atom pairs to the dimer state, generating new resonances at different magnetic field values. Employing Floquet theory, we transform the time-dependent problem into a time-independent equivalent, yielding a Hamiltonian suitable for coupled-channel calculations. Using Lithium-6 as an example, which exhibits a notably broad s-wave resonance at 832G due to a weakly bound halo state, our results from coupled-channel calculations reveal that this halo state enables the creation of radio frequency-induced resonances with significant widths and tunability at modulation strengths achievable in practice. Theoretical findings will be presented, and the feasibility of experimental observation, along with associated technical challenges, will be explored.

A 25.8 Wed 17:00 Tent A

Topological pumping of vortices through Bloch-like oscillations of a magnetic soliton — Franco Rabec, Guillaume Chauveau, •Guillaume Brochier, Sylvain Nascimbene, Jean Dalibard, and Jérôme Beugnon — Laboratoire Kastler Brossel, Collège de France, France

Bloch oscillations are a striking feature of the counterintuitive motion of particles created by a lattice potential. However, one can reproduce such an effect with a system that is translationally invariant, provided that the dispersion relation remains periodic. An example is realized by a magnetic soliton which can be mapped onto an immiscible spin mixture in a quasi-1D Bose gas. We report on the observation of such Bloch-like oscillations. We experimentally investigate this phenomenon with both strict boundary conditions and periodic boundary conditions, the latter revealing the presence of a backflow and the formation of a topological vortex pump in this system.

A 25.9 Wed 17:00 Tent A

Hundreds of atoms in an array of optical tweezers in a cryostat — Etienne Bloch[1], Gert-Jan Both[1], Lilian Bourachot[1], •Davide Dreon[1], Thierry Lahaye[2], Desiree Lim[1], Gregoire Pichard[1], and Julien Vaneecloo[1] — [1]Pasqal SAS, 7 Rue Léonard de Vinci, 91300 Massy, Francee — [2]Université Paris-Saclay, Institut d'Optique Graduate School, CNRS, Laboratoire Charles Fabry, 91127 Palaiseau Cedex, France

We will present the work done on a new generation of quantum processors that we are developing at PASQAL, a spin-off company of the Institut d'Optique, which is building neutral atom quantum computers. This machine incorporates optical tweezer technology in a cryogenic environment. We have recently incorporated high numerical aperture optics that allow us to trap hundreds of single atoms in the tweezer array. In addition to that, we are demonstrating improved vacuum-limited lifetime compared to room temperature setups. This prototype represents a significant milestone, bringing us closer to the realisation of a neutral atom processor with more than a thousand qubits.

A 25.10 Wed 17:00 Tent A

Quantum-gas microscopy of the Bose-Hubbard model with ^{84}Sr — Sandra Buob[1], Jonatan Höschele[1], Vasiliy Makhalov[1], •Antonio Rubio-Abadal[1], and Leticia Tarruell[1,2] — [1]ICFO - Institut de Ciències Fotòniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels (Barcelona), Spain — [2]ICREA, Pg. Lluís Companys 23, 08010 Barcelona, Spain

Atomic species with two-valence electrons, such as alkaline-earth atoms, offer exciting spectroscopic tools that can bring quantum simulation with ultracold atoms into new directions.

Here we present an experimental setup capable of preparing ultracold bosonic strontium in a two-dimensional optical lattice. By performing fluorescence imaging of a 2D quantum gas with site-resolved resolution, we realize a strontium quantum-gas microscope. In this poster, we discuss the main technical features of our setup, its current status, and possible future directions.

A 25.11 Wed 17:00 Tent A

Characterisation of Drifts and Non-Linearity of Data Acquisition Electronics for Metallic Magnetic Calorimeter Detectors — •Daniel A. Müller[1,3], Philip Pfäfflein[1,2,3], Marc O. Herdrich[1,3], Christoph Hahn[1,2], Felix M. Kröger[1,2,3], Bastian Löher[2], Günter Weber[1,2], and Thomas Stöhlker[1,2,3] — [1]HI-Jena, Jena, Germany — [2]GSI, Darmstad, Germany — [3]Friedrich-Schiller-Universität Jena, Jena, Germany

Recent experiments employing novel metallic magnetic calorimeter detectors have shown the excellent spectral resolution (better than 100 eV FWHM at 100 keV) and timing capability of those detectors. The measurement principle of this detector is based on a temperature rise of an absorber by stopping an incident x-ray photon resulting in a change of the magnetisation of a paramagnetic sensor. With a superconducting quantum interference device those changes can be measured with high sensitivity. While providing a wide energy acceptance (0.1 - 100 keV), the entire spectral range can only be fully utilised, if drifts and non-linear effects of the data acquisition electronics are under control. Otherwise precision spectroscopy is only possible if a well-known x-ray or gamma line is close to the line of interest for establishing an absolute energy scale. In the present work, we report on the characterisation of STRUCK SIS3316 digitizer modules in terms of integral non-linearity and temperature-dependent drifts. It has been shown that these effects have a sizeable impact on the spectral performance of the detectors. Furthermore, a calibration and correction method to mitigate these effects on the recorded spectrum was developed.

A 25.12 Wed 17:00 Tent A

Polarization Phenomena of Compton Scattering in the Hard X-Ray Regime Revealed by Compton Polarimetry — •Tobias Over[1,2,3], Alexandre Gumberidze[1], Marc O. Herdrich[2,3], Thomas Krings[4], Wilko Middents[1,2,3], Philip Pfäfflein[1,2,3], Uwe Spillmann[1], Günter Weber[1,2], and Thomas Stöhlker[1,2,3] — [1]GSI GmbH, Planckstraße 1, 64291 Darmstadt — [2]HI Jena, Fröbelstieg 3, 07743 Jena — [3]FSU Jena, Leutragraben 1, 07743 Jena — [4]FZ Jülich, Wilhelm-Johnen-Straße, 52425 Jülich

For photon energies from several tens of keV up to a few MeV, Compton polarimetry is an indispensable tool to gain insight into subtle details of fundamental radiative processes in atomic physics. Within the SPARC collaboration several segmented semiconductor detectors have been developed that are well suited for application as efficient Compton polarimeters. For electron-photon and photon-photon scattering processes in the hard x-ray regime these kind of detectors enable revealing photon polarization effects in great detail. Particular emphasis is given to processes common in astrophysical objects. For processes such as radiative recombination, electron bremsstrahlung, Rayleigh and Compton scattering where spin-effects and polarization transfer phenomena are of great importance. In our presentation, an overview of recent results obtained for inelastic scattering in the hard x-ray regime as well as ongoing experimental projects will be presented. In particular, we will discuss the extension to photon energies of several hundreds of keV, using a novel Compton telescope detector.

A 25.13 Wed 17:00 Tent A

Wigner vs. Smith: Time delays in anisotropic potentials — •Ulf Saalmann and Jan M Rost — Max-Planck-Institut für Physik komplexer Systeme, Dresden/Germany

Scattering properties and time delays for non-symmetric potentials are discussed paradigmatically in one dimension in comparison to symmetric ones. Only for the latter the Wigner and Smith time delays coincide. We further discuss the importance of the potential position and give a criterion how to identify a potential with intrinsic symmetry which behaves like an asymmetric one if it is merely offset from the scattering center. `[arxiv.org/abs/2309.02059]`

A 25.14 Wed 17:00 Tent A

The attoclock and its interpretation, real-valued tunneling time and superluminal tunneling — •Ossama Kullie — 1 Theoretical Physics, Institute of Physics, University of Kassel

Tunneling is a quantum mechanical phenomena. The time required for the tunneling or field-ionization of an electron from an atom through a laser field can be measured using the so-called attoclock. However, some authors claim that the time delay measured by the attoclock is not an indicator of the tunneling time. We present a model that describes the tunnel- or field-ionization of the attoclock experiment for He- [1] and H-atom [2], in the adiabatic and nonadiabatic field calibrations [3]. And we show that one can interpret the attoclock measurement in such a way that it is possible to determine the tunneling time or the time delay due the barrier region or the classically forbidden region. We also show that for the weak measurement [4], in which the time is usually measured by the Larmor clock [5], the attoclock offers a possibility to measure the interaction time for thick barrier and even superluminal tunneling is possible [6].

[1] A. S. Landsman et al, Optica **1**, 343 (2014), U. S. Sainadh et al, Nature **586**, 75 (2019). [2] C. Hofmann et al. J. Mod. Opt. **66**, 1052 (2019). [3] O. Kullie, Phys. Rev. A **92**, 052118 (2015), O. Kullie and I. A. Ivanov, arXiv:2005.09938v6. [4] Y. Aharonov, Phys. Rev. A. **65**, 052124 (2002). [5] R. Ramos, Nat. 538, 529 (2020). [6] Work in preparation.

A 25.15 Wed 17:00 Tent A

A Coincidence Unit for Ultracold Quantum Gases combining Electron Velocity-Map-Imaging and Ion-Microscopy — •Lasse Paulsen[1], Jette Heyer[1,2], Julian Fiedler[1,2], Mario Grossmann[1,2], Klaus Sengstock[1,2], Markus Drescher[1,2], Juliette Simonet[1,2], and Philipp Wessels-Staarmann[1,2] — [1]Center for Optical Quantum Technologies, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, Hamburg, Germany

By combining femtosecond laser pulses with ultracold quantum gases, new states of matter ranging from atom-ion hybrid sytems over dense Rydberg gases to ultracold microplasma can be created using local strong-field excitation and ionization.

In order to access the dynamics of these complex systems, a high spatial, spectral and angular resolution of the generated electrons and ions is necessary. Therefore, a coincidence unit consisting of a velocity-map-imaging spectrometer for electrons and an ion microscope will be implemented in the experimental setup. This allows mapping the electron momenta with a simulated energy resolution of $\Delta E/E \leq 10\%$ over a range of 0.05 meV - 3.2 eV and imaging of the ions with a spatial resolution of 100 nm. Furthermore, coincidence detection is enabled via pulsed extraction allowing to study the dynamics and correlations in many-body-systems with long-range interaction.

A 25.16 Wed 17:00 Tent A

Probing Axions and Axion Like Particles through Cosmic Axion Spin Precession Experiment- High-field — •Malavika Unni for the CASPEr-Collaboration — Helmholtz-Institut, GSI Helmholtzzentrum fuer Schwerionen-forschung, 55128 Mainz, Germany

Cosmic Axion Spin Precession Experiment (CASPEr) [1,2] investigates pseudoscalar bosons, axions, and axionlike particles (ALPs), through their interactions with standard model particles. Axions offer a solution to the formidable strong CP problem and provide a compelling link to Dark Matter. In this work, we study the coupling of the axion and ALP field with fermions. Utilizing Nuclear Magnetic Resonance (NMR) spectroscopy, we search for the coupling between Axions (and ALPs) and nuclear spins. In the CASPEr high-field setup featuring a 14.1 T magnet, we explore the frequency range of 70 to 600 MHz using tunable LC circuits cooled to cryogenic temperatures. In conjunction with a shim coil integrated into the cryostat, we employ an additional shim stack to ensure field homogeneity. We also examine various hyperpolarization techniques and identify the most suitable samples for achieving high sensitivity. Further details on our experimental setup and the NMR-detection system will be elaborated in the presentation. [1]. P. W. Graham, S. Rajendran, Phys. Rev. D 88, 035023 (2013) [2]. D. Budker, P. W. Graham, M. Ledbetter, S. Rajendran, A.O.Sushkov, Phys. Rev. X 2014.

A 25.17 Wed 17:00 Tent A

Automated loading of Highly Charged Ions in a Paul Trap — •Lukas Fabian Storz — Max-Planck-Institut für Kernphysik, Heidelberg

Automatizations for experiments are crucial to maximize productivity and accuracy. We have implemented an algorithm using the fluorescence of Be-Ions detected on a CCD camera to automatically load large Be-Crystals. The presence of an HCI causes a void of Be^{+} in the crystal, which shows as a hole in the image. Its radius depends on the HCI charge state, and HCI recombination with residual gas changes it, allowing us to monitor the density at the trap over several months. Simultaneously the secular frequencies also yield the charge state. Our algorithm is applicable to similar ion trapping experiments and serve for their optimization.

A 25.18 Wed 17:00 Tent A

Automated loading of Highly Charged Ions in a Paul Trap — •Lukas Fabian Storz, Vera M. Schäfer, Elwin A. Dijck, Stepan Kokh, José R. Crespo López-Urrutia, and Thomas Pfeifer — Max-Planck-Institut für Kernphysik, Heidelberg

Automatizations for experiments are crucial to maximize productivity and accuracy. We have implemented an algorithm using the fluorescence of Be-Ions detected on a CCD camera to automatically load large Be-Crystals. The presence of an HCI causes a void of Be^{+} in the crystal, which shows as a hole in the image. Its radius depends on the HCI charge state, and HCI recombination with residual gas changes it, allowing us to monitor the density at the trap over several months. Simultaneously the secular frequencies also yield the charge state. Our algorithm is applicable to similar ion trapping experiments and serve for their optimization.

A 25.19 Wed 17:00 Tent A

Catalyzation of supersolidity in binary dipolar condensates — •Daniel Scheiermann[1], Luis Ardila[1], Thomas Bland[2,3], Russell Bisset[3], and Luis Santos[1] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover, Germany — [2]Institut für Quantenoptik and Quanteninformation, Innsbruck, Austria — [3]Institut für Experimentalphysik, Universität Innsbruck, Austria

Breakthrough experiments have newly explored the fascinating physics of dipolar quantum droplets and supersolids. The recent realization of dipolar mixtures opens further intriguing possibilities.

We show that under rather general conditions, the presence of a second component catalyzes droplet nucleation and supersolidity in an otherwise unmodulated condensate. For miscible mixtures, droplet catalyzation results from the effective modification of the relative dipolar strength, and may occur even for a surprisingly small impurity doping. We show that different ground-states may occur, including the possibility of two coexisting interacting supersolids. The immiscible regime provides a second scenario for double supersolidity in an array of immiscible droplets.

Further we will discuss how the superfluidity of this mixture can be tested.

A 25.20 Wed 17:00 Tent A

A cavity-microscope for micrometer-scale control of atom-photon interactions — •Ekaterina Fedotova, Francesca Orsi, Rohit Bhatt, Jonas Faltinath, Gaia Bolognini, Nick Sauerwein, and Jean-Philippe Brantut — Institute of Physics and Center for Quantum Science and Engineering, EPFL, Lausanne, Switzerland

Cavity quantum-electrodynamics enables measurements of atoms with sensitivity limited by quantum backaction. Over the last decade, the possibility to observe and control the motion of few or individual atoms using cavity-enhanced light-matter coupling has been exploited to realize various quantum technological tasks. A principle limitation of these experiments lies in the mode structure of the cavity, which is hard-coded in the distance and geometry of the mirrors, effectively trading spatial resolution for enhanced sensitivity.

In this poster, I will present our cavity-microscope device allowing for spatio-temporal programming of the light-matter coupling of atoms in a high finesse cavity. This is achieved through local Floquet engineering of the atomic structure, imprinting a corresponding light-matter coupling. We illustrate this capability by engineering micrometer-scale coupling, using cavity-assisted atomic measurements and optimization. Our system has the same footprint and complexity as a standard Fabry-Perot cavities or confocal lens pairs, and can be used for any atomic species. This technique opens a wide range of perspectives from ultra-fast, cavity-enhanced mid-circuit readout to the quantum simulation of fully connected models of quantum matter such as the Sachdev-Ye-Kitaev model.

A 25.21 Wed 17:00 Tent A

Towards measurements of axionic Dark Matter with the CASPEr-gradient low-field experiment — •Julian Walter and Yuzhe Zhang for the CASPEr-Collaboration — Helmholtz-Institut, GSI Helmholtzzentrum fuer Schwerionenforschung, 55128 Mainz, Germany

Axions and other light pseudoscalar bosons (< 1 eV$/c^2$) which are collectively referred to as axion-like particles (ALPs) have become well-motivated dark matter candidates. The Cosmic Axion Spin Precession Experiment (CASPEr) [1] aims at detecting ALPs with nuclear magnetic resonance techniques. CASPEr-Gradient in Mainz probes the hypothetic coupling of nuclear spins to the gradient of the ALP field [2]. The experimental apparatus was designed to scan ALPs with Compton frequencies of up to 600 MHz, corresponding to a mass range of approximately up to 10^{-6} eV. We performed a test measurement on a thermally polarized liquid methanol sample at a 317 G leading field, which corresponds to searching for ALP fields at 1.348568 MHz within a 238-Hz bandwidth. The data analysis strategy and preliminary results are presented.

[1] D. F. J. Kimball et al. "Overview of the Cosmic Axion Spin Precession Experiment (CASPEr)". In: *Microwave Cavities and Detectors for Axion Research.* Cham: Springer International Publishing, 2020, pp. 105-121. ISBN: 978-3-030-43761-9
[2] P. W. Graham and S. Rajendran. "New observables for direct detection of axion dark matter". In: *Phys. Rev. D* 88 (3 Aug. 2013), p. 035023. DOI: 10.1103/PhysRevD.88.035023.

A 25.22 Wed 17:00 Tent A

Probing resonant absorption in helium using intense XUV FEL pulses — •Arikta Saha[1], Alexander Magunia[1], Harijyoti Mandal[1], Muwaffaq Ali Mourtada[1], Carlo Kleine[1], Yu He[1], Marc Rebholz[1], Gergana D. Borisova[1], Hannes Lindenblatt[1], Florian Trost[1], Robert Moshammer[1], Stefan Düesterer[2], Tino Lang[2], Ulrike Fruehling[2], Christina Papadopoulou[2], Christina Böemer[2], Dietrich Krebs[2], Skirmantas Alisaukas[2], Christoph Heyl[2], Ingmar Hartl[2], Steffen Palutke[2], Markus Braune[2], Elisa Appi[3], Doriana Vinci[4], Milutin Kovacev[5], Philip Mosel[5], Peer Biesterfeld[5], Christian Ott[1], and Thomas Pfeifer[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Deutsches Elektronen Synchrotron DESY, 22607 Hamburg, Germany — [3]Lund University, 22100 Lund, Sweden — [4]European XFEL, 22869 Schenefeld, Germany — [5]Universität Hannover, 30167 Hannover, Germany

We studied excited state dynamics of helium using intense XUV FEL pulses. The XUV-driven nonlinear dynamics was measured by transient absorption spectroscopy. In the absorption spectrum, we look at 1s4p lineshape modifications in helium. The absorption lineshape is first excited by XUV pulses from high harmonic generation(HHG) and further modified by intense XUV FEL pulses, which leads to a change in the absorption feature. We observe absorption line shape modifications in the 1s4p line in time-resolved measurements on the femtosecond and picosecond timescale, as well as a function of FEL photon energy, FEL intensity, and helium target gas pressure.

A 25.23 Wed 17:00 Tent A

Nuclear photoabsorption in ^{229}Th using twisted light — •Tobias Kirschbaum and Adriana Pálffy — Julius-Maximilians-Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Twisted light refers to light beams that carry orbital angular momentum. The past decade has witnessed several studies of the interaction of these beams with matter, in particular with atomic systems. Among others, twisted light beams are used in quantum metrology to minimize the unwanted light shift in atomic clock transitions [1]. A compelling alternative for these atomic clocks, hardly affected by such shifts, is the ^{229}Th nucleus which has a long-lived first excited state at ≈ 8 eV [2].

Here, we investigate new avenues for the photoexcitation of the ^{229}Th nuclear isomer using vortex beams. We focus on spatial and temporal excitation patterns induced by the twisted light field for the magnetic dipole and electric quadrupole channels of the nuclear transition. Nuclear excitation in both solid-state targets presenting nuclear hyperfine splitting as well as single ions is investigated and the advantages compared to plane wave driving are highlighted.

[1] R. Lange *et al.*, Phys. Rev. Lett. **129**, 253901 (2022).
[2] E. Peik *et al.*, Quantum Sci. Technol. **6**, 034002 (2021).

A 25.24 Wed 17:00 Tent A

Two-colour cooling for 40K-87Rb quantum gas mixtures — •Yann Hendrick Kiefer[1,2], Max Hachmann[2], and Andreas Hemmerich[2] — [1]ETH Zürich, Zürich, Schweiz — [2]Universität Hamburg, Hamburg, Deutschland

We present an efficient cooling scheme for fermionic 40-potassium atoms, using laser light red and blue detuned with respect to the D2 and D1 principle flourescence lines, respectively. The cooling scheme is found to significantly increase the saturation level for loading of a 40-potassium magneto-optical trap (MOT), resulting in increased atom numbers or decreased cycle times. While the attainable 40-potassium atom number is approximately doubled if exclusively 40-potassium atoms are cooled, the scheme is particularly powerful for dual-species MOTs, for example, if 40-potassium and 87-rubidium atoms are cooled simultaneously in the same MOT configuration. The typical atom losses due to light-assisted hetero-nuclear collisions between 40-potassium and 87-rubidium seem to be reduced giving rise to a threefold improvement of the 40-potassium atom number as compared to that in a conventional dual-species MOT, operating merely with D2 light. Our scheme can be a useful extension to most dual-species experiments, aiming to reach simultaneous degeneracy of both species.

A 25.25 Wed 17:00 Tent A

Cost Effective Modernization of the Aging Computerized Control System of the Buffergas-Cell Setup for Studies of the ^{229m}Th Isomer — •Georg Holthoff, Daniel Moritz, Lilli Löbell, and Peter G. Thirolf — LMU, Munich, Germany

We discuss the ever more prevalent issue of aging and failing computers used for the control of long running experimental setups, which, in the worst-case scenario, can lead to complete loss of operation of an experiment and necessitate immense recovery efforts. How these systems can be modernized at low cost, either by virtualization and adaption of existing hardware, or by complete replacement using customized microcontroller based solutions, is the main focus. Both paths are compared and possible advantages and disadvantages laid out, which may offer guidance for the proper choice in similar situations.

As example, the modernization of a system, built in the early 2000s to run an experimental setup for the identification and characterization of the low-energy nuclear clock thorium isomer ^{229m}Th as part of the LMU Nuclear Clock Project, is presented. This system originally was run by an Intel Pentium4 based computer using proprietary PCI-cards (PCI is a now deprecated interface standard) to communicate with an elaborate Siemens Simatic S7 SPS, running multiple pumps, ion optics and a buffer-gas stopping cell. It is assumed that this age range and complexity make it a representative example for the challenges generally faced in such an upgrade scenario. Both routes for replacement are explored as developments for both were undertaken at our setup.

Supported by the European Research Council (ERC): Grant 856415.

A 25.26 Wed 17:00 Tent A

Development of multi-wavelength cavity ring-down spectroscopy for radiocarbon analysis — •Erik Thiel[1,2], Naoki Matsumoto[2], Momo Mukai[2], Keisuke Saito[2], Yuta Suzuki[2], Hideki Tomita[2], Kota Tsuge[2], and Klaus Wendt[1] — [1]Institut für Physik, Johannes Gutenberg-Universität, Mainz — [2]Department of Applied Energy, Nagoya University, Japan

Cavity ring-down laser spectroscopy provides a highly sensitive method for detection of elements and even individual isotopes in gas samples. Combined with a multichannel laser source, as provided e.g. by a frequency comb, environmental or technical samples can be analysed with the highest efficiency, rapidly and with high significance. Aside of presenting the technique and its capabilities for ultratrace determination of ^{14}C the presentation focusses specifically on the data acquisition procedure and electronics for the ringdown signal which is adapted and optimized for the multiple laser frequency excitation. It is providing a proof of concept for the determination of ring-down decay rate based on time interval analysis which utilizes the discrete recording and processing of two or more timing signals.

A 25.27 Wed 17:00 Tent A

Trapping Ion Coulomb Crystals in an Optical Lattice — •Daniel Hoenig[1], Fabian Thielemann[1], Wei Wu[1], Thomas Walker[1], Leon Karpa[2], Amir Mohammadi[1], and Tobias Schaetz[1] — [1]Albert-Ludwigs Universität Freiburg — [2]Leibniz Universität Hannover

We present recent advancements in trapping $^{138}Ba^{+}$ ions in a one-dimensional optical lattice at a wavelength of 532 nm and the first successful trapping of linear ion Coulomb crystals ($N \leq 3$) in such a trap array. The observed eigenfrequencies of the ions in the lattice and the increased robustness of the trapping probability against axial electric fields provide evidence for confinement of the ions at individual lattice sites.

As optical lattices are extendable in size and dimension, they might allow for the realization of ion-microtrap structures in 2D and 3D. This could enable new pathways towards analog quantum simulation of systems incorporating long-range interactions. Additionally, the absence of micromotion in optical traps could give them an edge over rf-traps in applications, where heating and decoherence induced by micromotion become limiting factors. This includes the study of atom-ion interactions at ultracold temperatures, as well as the creation and study of coherent superpositions of structural crystal phases and their entanglement.

A 25.28 Wed 17:00 Tent A

Enhancing spectroscopic resolution for coherent control of photoionization with a novel XUV photon spectrometer — •Harijyoti Mandal[1], Muwaffaq Ali Mourtada[1], Alexander Magunia[1], Weiyu Zhang[1], Yu He[1], Hannes Lindenblatt[1], Florian Trost[1], Lina Hedewig[1], Cristian Medina[1], Arikta Saha[1], Marc Rebholz[1], Ulrike Frühling[2], Carlo Kleine[1], Gergana D. Borisova[1], Steffen Palutke[2], Evgeny Schneidmiller[2], Mikhail Yurkov[2], Stefan Düsterer[2], Rolf Treusch[2], Chris H. Greene[3], Yimeng Wang[3], Robert Moshammer[1], Christian Ott[1], and Thomas Pfeifer[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Deutsches Elektronen Synchrotron DESY, 22607 Hamburg, Germany — [3]Purdue University, West Lafayette, IN 47907, USA

Extreme-ultraviolet (XUV) free-electron lasers (FELs) can be used for nonlinear multiphoton excitation or ionization of atoms and molecules. Interfering pathways of the second harmonic of the FEL pulses can be used for coherent control experiments, however their spectral content is typically not measured, which is particularly important for stochastic FEL pulses with spectral fluctuations from shot to shot. We present a novel XUV photon spectrometer capable of simultaneously measuring fundamental (ω) and second harmonic (2ω) of FEL spectra. The spectrometer is installed at FLASH, Hamburg, and operates at a repetition rate of 100 kHz. We use phosphor screens and out-of-vacuum imaging onto two GOTTHARD detectors, allowing us to resolve the intrinsic spectral pulse structure of both ω and 2ω FEL pulses. Using a reaction microscope we measured the three-dimensional momentum distributions of helium recoil ions by tuning FLASH in the vicinity of intermediate singly excited states.

A 25.29 Wed 17:00 Tent A

Partial-wave representation of the strong-field approximation: length versus velocity gauge — Fang Liu[1,2,3], •Kefei Zou[1,2,3], and Stephan Fritzsche[1,2,3] — [1]Helmholtz Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [2]Theoretisch-Physikalisches Institut, Friedrich- Schiller-Universität Jena, 07743 Jena, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

The strong-field approximation (SFA) is a commonly used method to study ionization of atoms by intense laser field. Recently, a reformulation of the SFA in terms of partial waves expansion has been presented in [Phys. Rev. A 102, 053108 (2020)]. In this contribution, we investigate the above threshold ionization of the atom driven by elliptically polarized light pulse. In addition, we calculate the angular distribution of photoelectrons in both velocity and length gauge. Our results show differences between the two gauges. Moreover, we find that the angular distribution of the photoelectrons calculated in length gauge are in better agreement with the experimental data than those from velocity gauge. This highlights the importance of choosing the gauge to perform theoretical calculations in SFA.

A 25.30 Wed 17:00 Tent A

Active stabilization of a standing wave in a femtosecond enhancement cavity with a cw laser interferometer — •Lukas Matt, Tobias Heldt, Lennart Guth, Jan-Hendrik Oelmann, Thomas Pfeifer, and José R. Crespo López-Urrutia — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

To study the strong field emission of electrons from metallic nanotips or noble gases, we have developed a passive enhancement cavity for a frequency comb at 1039 nm [1]. Two different coupling arms into the ring cavity allow counter-propagating pulses to be timed to collide at the focus of the cavity forming a standing wave. Different thermal fluctuations and vibrations of the two coupling paths limit the stability of the standing wave. To maintain a stable phase relationship between the standing wave and the nanotip target we designed an active stabilization system using a narrow-band cw laser at 976 nm forming a Michelson interferometer. The interference signal allows to lock the length difference using Pancharatnam's phase via a piezo-actuated mirror [2]. We present the technical realization of this system.

[1] J.-H. Oelmann et al., Rev. Sci. Instrum., 93(12), 123303 (2022).
[2] M. U. Wehner et al., Opt. Lett., 22(19), (1997)