A 12: Poster I

Time: Tuesday 16:30–19:00 Location: Empore Lichthof

A 12.1 Tue 16:30 Empore Lichthof

Femtosecond-modulated attoscond dynamics in atomic resonant ionization — •Hao Liang[1], Meng Han[2], and Jan Micheal Rost[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Laboratorium für Physikalische Chemie, ETH Zürich, Zürich, Switzerland

Reconstruction of attosecond harmonic beating by interference of two-photon transition (RABBITT) techniques were recently used to measure the resonance transition among bound states of atomic and molecular systems. In those studies, changing the relative delay between infrared pulse and attosecond pulse train is solely regarded as the carrier envelope phase scanning. However, in the case that the relative delay is comparable to the pulse duration, the resonance ionization dynamics itself also dramatically alters, including both the ionization time and phase. In this work, by performing experimental measurement and time-dependent Schrödinger equation simulation, we investigate $1s^2$-$1s3p$ transition of Helium atom, and reveal the importance of ac-stark shift and population accumulation during resonant process.

A 12.2 Tue 16:30 Empore Lichthof

Study of Rydberg states in ultra cold ytterbium — •Alexander Miethke and Axel Görlitz — Institut für Experimentalphysik, Heinrich-Heine-Universität, Düsseldorf, Deutschland

In recent years Rydberg atoms with their special features, like dipole-dipole interaction or van-der-Waals blockade, have become more and more important for quantum optics. Particularly ultra cold Rydberg atoms are of great interest for the investigation of long range interaction.

A special feature of ytterbium is that due to its two valance electrons atoms in Rydberg states can be easily manipulated and imaged using optical fields. A first step towards studies of ultra cold ytterbium is to gain precise knowledge on the Rydberg states.

Here we present the study of the Rydberg states of ultra cold ytterbium. Using a Micro-Channel-Plate to detect the Rydberg atoms it is possible to measure lifetimes and hyperfine structures of several states. In addition we could measure the energy and polarizability of s, p and d states in the region of high principal quantum numbers n (n=70-90).

A 12.3 Tue 16:30 Empore Lichthof

Dynamical phase transition in an open quantum system — •Julian Fess[1], Ling-Na Wu[2], Jens Nettersheim[1], Alexander Schnell[2], Sabrina Burgardt[1], Silvia Hiebel[1], Daniel Adam[1], André Eckardt[2], and Artur Widera[1] — [1]Department of Physics and State Research Center OPTIMAS, RPTU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

Phase transitions correspond to the singular behavior of physical systems in response to continuous control parameters. Recently, dynamical quantum phase transitions have been observed in the non-equilibrium dynamics of isolated quantum systems, with time as the control parameter. However, signatures of such dynamical phase transition in open systems, were so far elusive. Here, we demonstrate that dynamical phase transitions can also occur in open quantum systems. We measure the relaxation dynamics of the large atomic spin of individual Caesium atoms induced by the dissipative coupling via spin-exchange processes to an ultracold Bose gas of Rubidium atoms. For initial states far from equilibrium, the entropy of the spin state is found to peak in time, transiently approaching its maximum possible value, before eventually relaxing to its lower equilibrium value. Moreover, a finite-size scaling analysis shows that it corresponds to a dynamical phase transition. Our results show that dynamical phase transitions are not restricted to occur in isolated systems, but, surprisingly, are possible also during the dissipative evolution of open quantum systems.

A 12.4 Tue 16:30 Empore Lichthof

QRydDemo - A Rydberg atom quantum computer demonstrator — •jiachen zhao[1], ratnesh kumar gupta[1], philipp ilzhöfer[1], govind unnikrishnan[1], jennifer krauter[1], achim scholz[1], sebastian weber[2], hans peter büchler[2], simone montangero[3], jürgen stuhler[4], florian meinert[1], and tilman pfau[1] — [1]5th Institute of Physics, University of Stuttgart, Germany — [2]Institute for Theoretical Physics III, University of Stuttgart, Germany — [3]Department of Physics and Astronomy, University of Padova, Padova, Italy — [4]TOPTICA Photonics AG, Gräfelfing, Germany

Quantum computing is attracting great interest due to its potential for solving computationally hard problems. The QRydDemo project aims to build a quantum computer based on neutral strontium atoms individually trapped in an optical tweezer array. We will study a so far unexplored qubit encoded in the 3P0 and 3P2 fine-structure states of Strontium. This qubit provides "triple magic trapping" and the potential to improve the coherence time by a factor of 1000 from previous demonstrations of 10 microseconds to 10 milliseconds. We will combine this qubit with a novel tweezer architecture which allows for reshuffling of the qubits during the quantum computation. Such a dynamically adjustable qubit array allows for new algorithmic possibilities by effectively increasing the connectivity for deep quantum circuits to solve real-world problems. We plan to offer access to the hardware through a currently developed compiler software stack via our website www.thequantumlaend.de.

A 12.5 Tue 16:30 Empore Lichthof

Investigation of ultrashort FEL pulses utilizing the split-and-delay unit at FLASH2 — •Matthias Dreimann[1], Evgeny Schneidmiller[3], Dennis Eckermann[1], Frank Wahlert[2], Sebastian Roling[2], Michael Wöstmann[1], Victor Kärcher[1], Tobias Reiker[1], Marion Kuhlmann[3], Sven Toleikis[3], Rolf Treusch[3], Elke Plönjes-Palm[3], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience, Westfälische Wilhelms-Universität Münster — [2]Physikalisches Institut, Westfälische Wilhelms-Universität Münster — [3]Deutsches Elektronen-Synchrotron DESY

A split-and-delay unit for the XUV and soft X-ray spectral range has been installed at beamlines FL23 and FL24 at the FLASH2 Free-Electron Laser at DESY. It enables time-resolved pump-probe experiments from 30 eV up to 1800 eV including the whole spectral range of FLASH2. Using wavefront beam splitting and grazing incidence mirrors a relative pulse delay of -5 ps $< \Delta\tau <$ +18 ps is achieved. With a measured timing jitter of tj = 121 as and a nominal time resolution of tr = 66 as a sub-fs resolution of this device enables time-resolved experiments with ultrashort FEL pulses. The development of ultrashort FEL pulses with few-fs and sub-fs pulses is a research field in the FEL community with promising applications. One of theses applications are pump/probe experiments with ultrashort FEL pulses, as the temporal dynamic of the system is a key to the fundamental understanding of its underlying physics. We present first results of the investigation of ultrashort FEL pulses which in future will allow sub-fs temporal resolution in experiments.

A 12.6 Tue 16:30 Empore Lichthof

Optimizing optical potentials with physics-inspired learning algorithms — •Martino Calzavara[1,4], Yevhenii Kuriatnikov[2], Andreas Deutschmann-Olek[3], Felix Motzoi[1], Sebastian Erne[2], Andreas Kugi[3], Tommaso Calarco[1,4], Jörg Schmiedmayer[2], and Maximilian Prüfer[2] — [1]Forschungszentrum Jülich GmbH, Peter Grünberg Institute, Quantum Control (PGI-8), 52425 Jülich, Germany — [2]Vienna Center for Quantum Science and Technology, Atominstitut, TU Wien, Stadionallee 2, 1020 Vienna, Austria — [3]Automation and Control Institute, TU Wien, Gußhausstraße 27-29, 1040 Vienna, Austria — [4]Institute for Theoretical Physics, Universität zu Köln, 50937 Cologne, Germany

We present our new experimental and theoretical framework which combines a broadband superluminescent diode (SLED/SLD) with fast learning algorithms to provide speed and accuracy improvements for the optimization of 1D optical dipole potentials, here generated with a Digital Micromirror Device (DMD). We employ Machine Learning (ML) tools to train a physics-inspired model acting as a digital twin of the optical system predicting the behavior of the optical apparatus including all its imperfections. Implementing an algorithm based on Iterative Learning Control (ILC), we optimize optical potentials an order of magnitude faster than heuristic optimization methods. We compare iterative model-based "offline" optimization and experimental feedback-based "online" optimization. Our methods provide a new route to fast optimization of optical potentials which is relevant for the dynamical manipulation of ultracold gases.

A 12.7 Tue 16:30 Empore Lichthof

Exploring time-, frequency- and phase-resolved measurement techniques with Mössbauer nuclei — •Lukas Wolff and Jörg Evers — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Mössbauer nuclei form a versatile platform for spectroscopy and quantum optics at hard x-ray energies owing to their extremely narrow line-widths and exceptional coherence properties. The development of novel x-ray sources and recent theoretical progress in x-ray cavity-QED can open a path towards a plethora of nonlinear and non-equilibrium phenomena. To characterize these phenomena in experiment and to compare with theoretical predictions, advanced measurement and data analysis techniques are required.

As one example, this poster reviews a data acquisition technique which uses single-line nuclear reference absorbers to record time- and frequency-resolved Nuclear Resonant Scattering spectra at accelerator-based x-ray sources. These spectra can be interpreted via a Fourier transform along the time axis thus providing direct access to the nuclear target spectrum, including phase information. This is of primary interest for the characterization of collective level schemes in thin-film x-ray cavities. Our findings are validated by evaluation of numerical data using the software package pynuss.

The poster further discusses a perturbative expansion of the nuclear density matrix that can be used to devise multi-pulse experiments with Mössbauer nuclei to access nonlinear and time-dependent phenomena. These multi-pulse schemes can build upon recent experimental work on coherent control of nuclei and x-ray pulse-shaping.

A 12.8 Tue 16:30 Empore Lichthof

Feshbach Resonances in a hybrid Atom-Ion System — •Joachim Siemund[1], Fabian Thielemann[1], Wei Wu[1], Thomas Walker[1], Pascal Weckesser[1,2], Daniel Hönig[1], Amir Mohammadi[1], and Tobias Schätz[1] — [1]Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, Hermann-Herder-Straße 3, 79104 Freiburg, Germany — [2]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, 85748 Garching, Germany

We present the observation of Feshbach resonances between neutral atoms and ions [1,2]. These resonances - a quantum phenomenon only observable at ultracold temperatures - allow the 2-body and 3-body interaction rates between particles to be tuned with the possibility to even switch them off. This can be used to enhance sympathetic cooling. While Feshbach resonances are commonly utilized in neutral atom experiments, reaching the ultracold regime in hybrid rf-optical traps is challenging, as the driven motion of the ion by the rf trap limits the achievable collision energy [3]. Having reached the onset of the quantum regime even in hybrid traps paves the way for all-optical trapping of both species, circumventing the fundamental rf-heating, and for new applications, such as the coherent formation of molecular ions and simulations of quantum chemistry [4].

[1] WECKESSER, Pascal, et al. arXiv:2105.09382, 2021.
[2] SCHMIDT, J., et al. Phys.Rev.Lett. 2020, 124-5.
[3] CETINA, Marko et al. Phys.Rev.Lett. 2012, 109-25.
[4] BISSBORT, Ulf, et al. Phys.Rev.Lett. 2013, 111-8.

A 12.9 Tue 16:30 Empore Lichthof

Coherent and Dephasing Spectroscopy for Single-Impurity Probing of an Ultracold Bath — •Sabrina Burgardt[1], Daniel Adam[1], Quentin Bouton[2], Jens Nettersheim[1], and Artur Widera[1] — [1]Department of Physics and Research Center OPTIMAS, University of Kaiserslautern-Landau, Kaiserslautern 67663, Germany — [2]Laboratoire de Physique des Lasers, CNRS, UMR 7538, Universite Sorbonne Paris Nord, F-93430 Villetaneuse, France

We report Ramsey spectroscopy on the clock states of individual Cs impurities immersed in an ultracold Rb bath. We record both the interaction-driven phase evolution and the decay of fringe contrast of the Ramsey interference signal to obtain information about bath density or temperature nondestructively. The Ramsey fringe is modified by a differential shift of the collisional energy when the two Cs states superposed interact with the Rb bath. This differential shift is directly affected by the mean gas density and the details of the Rb-Cs interspecies scattering length, affecting the phase evolution and the contrast of the Ramsey signal. Additionally, we enhance the temperature dependence of the phase shift preparing the system close to a low-magnetic-field Feshbach resonance where the s-wave scattering length is significantly affected by the collisional (kinetic) energy. Analyzing coherent phase evolution and decay of the Ramsey fringe contrast, we probe the Rb clouds density and temperature. Our results point at using individual impurity atoms as nondestructive quantum probes in complex quantum systems.

A 12.10 Tue 16:30 Empore Lichthof

Inner-Shell Ionization of Low-Charged Silicon and Iron Ions — •Stefan Schippers[1], Alfred Müller[1], Simon Reinwardt[2], Michael Martins[2], and Stephan Fritzsche[3,4,5] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen — [2]Institut für Experimentalphysik, Universität Hamburg — [3]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [4]Helmholtz-Institut Jena — [5]Institut für Theoretische Physik, Friedrich-Schiller-Universität Jena

We report on recent experimental and theoretical work on single and multiple L-shell photoionization of low-charged iron ions (Fe^+, Fe^{2+}, Fe^{3+}) [1-3] and on single and multiple K-shell photoionization of low-charged silicon ions (Si^-, Si^+, Si^{2+}, Si^{3+}) [4,5]. The experiments were carried out at the photon-ion end-station PIPE of beamline P04 of the PETRA III synchrotron light source. The results are particularly relevant for the determination of the elemental abundances in the interstellar medium. Our data are decisive for being able to answer the question how much of the interstellar iron and silicon is in the gas phase and how much is chemically bound in dust grains. [1] S. Schippers et al., Astrophys. J. 849, 5 (2017). [2] R. Beerwerth et al., Astrophys. J. 887, 189 (2019). [3] S. Schippers et al., Astrophys. J. 908, 52 (2021). [4] A. Perry-Sassmannshausen et al., Phys. Rev. A 104, 053107 (2021). [5] S. Schippers et al., Astrophys. J. 931, 100 (2022).

A 12.11 Tue 16:30 Empore Lichthof

K-shell Photodetachment of Carbon, Oxygen and Silicon Anions — Alexander Perry-Sassmannshausen[1], Alexander Borovik Jr.[1], Ticia Buhr[1], Angelika Hamann[1], Simon Reinwardt[2], Sebastian Stock[3,4], Florian Trinter[5,6], Michael Martins[2], Stephan Fritzsche[3,4,7], Alfred Müller[1], and •Stefan Schippers[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen — [2]Institut für Experimentalphysik, Universität Hamburg — [3]Helmholtz-Institut Jena — [4]Institut für Theoretische Physik, Friedrich-Schiller-Universität Jena — [5]Institut für Kernphysik, Goethe-Universität, Franfurt am Main — [6]Molecular Physics, Fritz-Haber-Institut der MPG, Berlin — [7]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Using the PIPE end-station at PETRA III, we have measured cross sections σ_m for multiple (m-fold) photodetachment of C^- [1], O^-[2], and Si^- [3] in the photon energy ranges 280–1000 eV, 525–1500 eV, and 1830–1900 eV, respectively. All cross sections exhibit near-threshold resonances. For C^- and O^-, the cross section σ_5 shows signatures of double-core hole formation, in addition. The measured threshold energies agree with results of atomic-structure calculations, which also treat the complex deexcitation cascades that set in after the initial creation of one or two inner-shell holes. [1] A. Perry-Sassmannshausen et al., Phys. Rev. Lett. 124, 083203 (2020). [2] S. Schippers et al., Phys. Rev. A 106, 013114 (2022). [3] A. Perry-Sassmannshausen et al., Phys. Rev. A 104, 053107 (2021).

A 12.12 Tue 16:30 Empore Lichthof

JAC – A platform for Just Atomic Computations — •Stephan Fritzsche — Helmholtz-Institut Jena, Germany – Friedrich-Schiller University Jena

Electronic structure calculations of atoms and ions have a long tradition in physics with applications in basic research and spectroscopy. With the Jena Atomic Calculator (JAC), I here present a modern implementation of a (relativistic) electronic structure code for the computation of atomic amplitudes, properties as well as a large number of excitation and decay processes for open-shell atoms and ions across the periodic table. JAC [1,2] is based on Julia, a new programming language for scientific computing, and provides an easy-to-use but powerful platform to extent atomic theory towards new applications.

[1] S. Fritzsche. A fresh computational approach to atomic structures, processes and cascades. Comp. Phys. Commun., 240, 1 (2019), DOI:10.1016/j.cpc.2019.01.012. [2] S. Fritzsche. JAC: User Guide, Compendium & Theoretical Background. https://github.com/OpenJAC/JAC.jl, unpublished (02.11.2022).

A 12.13 Tue 16:30 Empore Lichthof

Orientation Recovery of Single-shot Scattering Images of Molecules and 3-Dimensional Density Reconstruction using Machine Learning — •Siddhartha Poddar, Ulf Saalmann, and

Jan Michael Rost — Nöthnitzer Str. 38, 01187, Dresden, Germany

As an orientation recovery technique of coherent diffractive images at X-ray free-electron lasers for a single molecule, we have applied a pair-wise distance learning algorithm to pairs of scattering images with the help of a deep learning network called Siamese Neural Network (SNN) or popularly known as twin network. With this a priori orientation information in the knowledge, now it is possible to successfully reconstruct the 3D electronic density of the corresponding molecule using many tomographic techniques available. So, the implementation of our reconstruction procedure, from 2D images to 3D molecular structure, has two successive steps. First, we train the twin network with a dataset consisting of approximately 100000 scattering images of an asymmetric 4-atomic test molecule and predict the orientations of a new unseen set of images for the same molecule. Second, we align and arrange this small subset of oriented images to compute the overall structure of the molecule using tomography.

A 12.14 Tue 16:30 Empore Lichthof

A dipolar quantum gas microscope — •Paul Uerlings, Jens Hertkorn, Kevin Ng, Lucas Lavoine, Ralf Klemt, Tim Langen, and Tilman Pfau — 5. Physikalisches Institut and Center for Integrated Quantum Science and Technology IQST, Universität Stuttgart

We present the progress towards the construction of a dipolar quantum gas microscope using dysprosium atoms. This new apparatus combines the single-site resolution of a quantum gas microscope with the long-range and anisotropic interactions found in dipolar quantum gases. We will use fermionic and bosonic isotopes of dysprosium trapped in an ultraviolet optical lattice with a lattice spacing of 180 nm. Combined with the long-range dipole interaction, the short lattice spacing will significantly enhance nearest neighbor coupling to be on the order of 200 Hz (10 nK). We will combine this lattice setup with a single-particle, spin-, and energy resolved super-resolution imaging technique. This will allow us to experimentally study strongly correlated dipolar Bose- and Fermi-Hubbard physics, where even next-nearest-neighbor interactions could become visible. The strong and tunable dipolar interactions open up the possibility to explore a wide range of problems ranging from quantum magnetism and lattice spin models to topological matter.

A 12.15 Tue 16:30 Empore Lichthof

Identification of highly-forbidden optical transitions in highly charged ions — •Shuying Chen[1], Lukas J. Spiess[1], Steven A. King[1], Alexander Wilzewski[1], Malte Wehrheim[1], José R. Crespo López-Urrutia[2], and Piet O. Schmidt[1,3] — [1]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [2]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [3]Institut für Quantenoptik, Leibniz Universität Hannover, Germany

Optical clocks are the most accurate measurement devices and have been used in many applications from metrology to fundamental physics. Highly charged ions (HCI) have advantages as references in optical clocks, being less sensitive to external fields perturbations [1]. Recently, our group has demonstrated the first HCI clock based on Ar^{13+} [2], using quantum logic spectroscopy (QLS) to to readout the internal state of the HCI. The statistical uncertainty was mostly limited by the excited state lifetime of 10 ms. An improved HCI clock is under consideration using a transition with an excited state lifetime >1s. The biggest challenge of the proposed HCI clock species is the large frequency uncertainty of their transitions, mostly obtained from ab initio atomic structure calculations with percent-level uncertainties corresponding to a few terahertz. Here we propose and assess various experimental search techniques, including an off-resonant optical dipole force [3], to find transitions for the next generation HCI clocks in a feasible time scale. [1] M. G. Kozlov, *et al.*, Rev. Mod. Phys. **90**, 045005 (2018) [2] S. A. King, L. J. Spieß, *et al.*, Nature **611**, 43-47 (2022). [3] F. Wolf, *et al.*, Nature **530**, 457-460 (2016).

A 12.16 Tue 16:30 Empore Lichthof

Ellipticity studies in high-order harmonic generation from endohedral fullerenes — •km akanksha dubey[1,2], oren cohen[3], and marcelo f. ciappina[1,2] — [1]Physics Program, Guangdong Technion - Israel Institute of Technology, Shantou 515063, Guangdong, China — [2]Technion - Israel Institute of Technology, Haifa 32000, Israel — [3]Solid State Institute and Physics Department, Technion - Israel Institute of Technology, Haifa 3200003, Israel

Endohedral fullerenes (A@C_{60}), fullerenes with an encaged atom/molecule (A), are capable of controlling resonant HHG, when driven by a strong laser pulse [1]. Being giant molecules, the multi-center nature of HHG arises naturally [2-3]. Thus, elliptical HHG could be generated even with a linearly polarized ultrafast laser pulse [4]. Elliptical HHG in fullerenes/carbon clusters are found to be very rich owing to the complex nature of these molecular targets [5]. Employing the molecular SFA, we aim at evaluating the ellipticity dependence of HHG from A@C_{60} under linearly and elliptically polarized ultrafast laser pulses. Further, to account for electron correlations in the HHG spectrum [6], we perform TDDFT simulations. 1. P. V. Redkin, M. B. Danailov, and R. A. Ganeev, Phys. Rev. A *84*, 013407 (2011). 2. M. F. Ciappina, A. Becker, and A. Jaroń-Becker, Phys. Rev. A *76*, 063406 (2007). 3. M. F. Ciappina, A. Becker, and A. Jaroń-Becker, Phys. Rev. A *78*, 063405 (2008). 4. A. Etches, C. B. Madsen, and L. B. Madsen, Phys. Rev. A *81*, 013409 (2010). 5. F. Cajiao - Vélez, and A. Jaron, arXiv:2203.15933v1 [quant-ph]. 6. O. Neufeld, and O. Cohen, Phys. Rev. Res. *2*, 033037 (2020).

A 12.17 Tue 16:30 Empore Lichthof

Temperature Dependence of Atom-Ion Feshbach Resonances — •Fabian Thielemann, Joachim Siemund, Wei Wu, Thomas Walker, and Tobias Schaetz — Albert-Ludwigs Universität, Freiburg, Deutschland

We recently observed magnetic Feshbach resonances between atoms and ions using inelastic loss spectroscopy. In our experiment we immerse a single, Doppler-cooled $^{138}Ba^{+}$ ion into a cloud of ultracold, spin-polarized ^{6}Li atoms. Collisions lead to sympathetic cooling of the ion to temperatures that allow us to resolve individual Feshbach resonances. The final collision energy depends on many parameters, such as the excess micromotion of the ion in the rf trap, the atom-ion mass ratio and the temperature of the atomic cloud. In this poster, we present experimental results on how the properties of a Feshbach resonance change when the temperature of the atomic bath - and thus the atom-ion collision energy - is varied. This could aide in the partial wave assignment of the surprisingly large number of resonances.

A 12.18 Tue 16:30 Empore Lichthof

Quadrupole transitions with continuous dynamical decoupling — •Víctor José Martínez Lahuerta[1], Lennart Pelzer[2], Ludwig Krinner[2], Kai Dietze[2], Piet Schmidt[2], and Klemens Hammerer[3] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Schneiderberg 39 30167 Hannover — [2]Physikalisch-Technische Bundesanstalt (PTB), Bunde- sallee 100, 38116 Braunschweig, Germany — [3]Institute for Theoretical Physics and Institute for Gravitational Physics (Albert-Einstein-Institute), Leibniz University Hannover

We consider the mechanism of continuous dynamical decoupling, focusing on gaining insensitivity to magnetic field fluctuations and quadrupole shifts. This mechanism consists in the application of a radio-frequency magnetic field orthogonal to the quantization axis of a given spin manifold. We account for the approximations realized during the calculations perturbatively by using the so-called Magnus expansion, showing that they can be considered as an effective shift of the Zeeman splitting of the manifolds. We can apply our formalism to properly describe a quadrupole transition between two manifolds, where the particular case of a transition between $S = 1/2$ and $D = 5/2$ of $^{40}Ca^{+}$ is studied with a comparison with experimental data. We finish by considering the implementation of a Mölmer-Sörensen gate within the framework of continuous dynamical decoupling.

A 12.19 Tue 16:30 Empore Lichthof

Detecting the external magnetic field alignment using the vortex light atom interaction. — •Shreyas Ramakrishna[1,2,3], Riaan P Schmidt[4,5], Anton A Peshkov[4,5], Andrey Surzhykov[4,5,6], and Stephan Fritzsche[1,2,3] — [1]Helmholtz Institute Jena, Frobelstieg 3, D-07749 Jena, Germany — [2]GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Planckstrasse 1, D-64291, Germany — [3]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universitat Jena, Max-Wien-Platz 1, D-07743 Jena, Germany — [4]Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig, Germany — [5]Institut für Mathematische Physik, Technische Universität Braunschweig, D-38106 Braunschweig, Germany — [6]Laboratory for Emerging Nanometrology, Langer Kamp 6a/b, 38106 Braunschweig, Germany

We analyze photoexcitation of atoms by cylindrically polarized Bessel beams in the framework of density matrix theory based on the Liouville-von Neumann equation. In particular, we study the dependence of the population of excited atomic states on the direction of the external magnetic field for the case of the $(5s^2S_{1/2}(F=1) \rightarrow 5p^2P_{3/2}(F=0))$ electric dipole transition in ^{87}Rb. Moreover, we demonstrate that the steady-state excited-state population is very sensitive not only to the polarization and OAM of the incoming light field, but also to the position of the atom within the beam cross-section. The results of our calculations agree well with the experimental findings of F. Castellucci et.al [Phys. Rev. Lett. 127, 233202 (2021)] and can be useful to plan future measurements.

A 12.20 Tue 16:30 Empore Lichthof

Status of the Alphatrap *g*-factor experiment — •Valentin Hahn, Fabian Heisse, Charlotte König, Jonathan Morgner, Fabian Raab, Sven Sturm, and Klaus Blaum — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Quantum electrodynamics (QED) is considered to be the most successful quantum field theory in the Standard Model. Its most precise test is conducted via the comparison of QED calculations with the measurement of the free electron *g*-factor. However, this test is restricted to low electrical field strengths. Consequently, it is of utmost importance to perform similar tests at high field strengths.

The Alphatrap experiment is a dedicated cryogenic Penning-trap setup to measure the *g*-factor of bound electrons in highly charged ions beyond hydrogen-like lead [1]. There, an electric field strength on the order of 10^{16} V/cm acts on the electron, allowing to test bound state QED with highest precision.

Our latest measurements of the *g*-factor for different charge states of a single highly charged tin ion are presented. Furthermore, an outlook on upcoming studies and prospects will be given.

[1] S. Sturm et al., Eur. Phys. J. Spec. Top. 227, 14251491 (2019)

A 12.21 Tue 16:30 Empore Lichthof

A study of the Hanle effect with twisted light — •Riaan Philipp Schmidt — Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig, Germany — Institute of Mathematical Physics, Technical University Braunschweig, D-38106 Braunschweig, Germany

We analyze the depolarization of resonance fluorescence from atoms exposed to twisted (Bessel) radiation. Special attention has been paid to the dependence on the external magnetic field strength, known as the Hanle effect, which is investigated within the framework of the density-matrix theory based on the Liouville-von Neumann equation. While the derived expressions can be employed to study the Hanle effect for any atomic system, detailed calculations of the P_1 and P_3 Stokes parameters of the emitted radiation have been performed for the $6s^2\,{}^1\mathrm{S}_0 - 6s6p\,{}^3\mathrm{P}_1$ transition in mercury. Our results indicate how the fluorescence depolarization may be affected by the spatial structure and polarization of the incident light field, as well as by the applied magnetic field. This study contributes to a better understanding of the potential of twisted light in atomic spectroscopy.

A 12.22 Tue 16:30 Empore Lichthof

Interaction of twisted light with the ^{229}Th nuclear clock candidate — •Tobias Kirschbaum and Adriana Pálffy — Julius-Maximilians-Universität Würzburg, Germany

Twisted light refers to light beams that carry orbital angular momentum. The interaction of twisted light with matter is a rapidly developing topic in optics and related fields thereof [1], in particular due to the modification of selection rules in atomic photo-excitation rendering dipole forbidden channels possible. In turn, these channels become attractive for next-generation atomic clocks.

A compelling alternative for these novel atomic clocks is the ^{229}Th nucleus which has its first excited state at ≈ 8 eV accessible by narrow-band VUV lasers. The transition from the ground to the excited state has a radiative lifetime of a few hours [2] and presents $M1/E2$ multipole mixing in which the $M1$ channel strongly dominates. Here, we present a theoretical approach to excite the ^{229}Th isomer with twisted light fields. Thereby, we investigate how the efficiency of the direct radiative excitation of the isomeric state can be increased and study the selective driving in targets with nuclear hyperfine splitting.

[1] A. Afanasev *et al.*, Phys. Rev. A **97**, 023422 (2018).
[2] E. Peik *et al.*, Quantum Sci. Technol. **6**, 034002 (2021).

A 12.23 Tue 16:30 Empore Lichthof

Non-Hermiticity and parity-time symmetry at x-ray wavelengths — •Fabian Richter and Adriana Pálffy — Julius-Maximilians-Universität Würzburg, Germany

A certain class of Hamiltonians which are non-Hermitian but obey parity-time (PT) symmetry exhibit real spectra thus mimicking Hermitian properties. This theoretical concept has recently found fertile ground in optics and photonics where non-Hermitian eigenstates can be created and superposed through optical gain and loss [1]. So far, these concepts have been mostly discussed in the optical regime. Similar control of x-rays is desirable due to their superior penetration power, high focusability and detection efficiency.

Here, we investigate theoretically non-Hermitian x-ray photonics based on PT symmetry in a thin-film cavity setup containing Mössbauer nuclei resonant to the x-ray radiation. These cavities present loss which is modelled by a Lindblad term in the master equation [2]. The presence of an external magnetic field introduces PT-symmetry breaking which could be used to control the properties of x-ray scattering.

[1] L. Feng *et al.*, Nature Photon. **11**, 752-762 (2017).
[2] X. Kong, D. Chang, A. Pálffy , Phys. Rev. A **102**, 033710 (2020).

A 12.24 Tue 16:30 Empore Lichthof

Enhancing atom-photon interaction with integrated nanophotonic resonators — •Xiaoyu Cheng — 5. Physikalisches Institut, Universität Stuttgart

We study hybrid devices consisting of thermal atomic vapor and nanophotonic structures for manipulating the interaction between atoms and photons.

We exploit cooperative effects to develop a compact, on-demand and highly efficient single-photon-source using the Rydberg blockade effect. In order to couple to the Rydberg states efficiently, the light field is locally enhanced by ultralow-loss micro-ring resonators. Due to the large spatial extent of Rydberg atoms, we carefully design the ring resonators to realize sufficient interactions between Rydberg atoms and the evanescent mode of the resonator. In order to create individual photons deterministically, we use the Four-Wave-Mixing (FWM) process in the Rydberg blockade regime to develop a single-photon-source at room temperature.

In parallel, we also explore the coherent atom-light interaction in the strong coupling regime with the help of the photonic crystal cavity (PhC). The strong field confinement and relatively high quality factor of PhCs overcome the dephasing during the short atom-light interaction period. This allows us to investigate cavity QED effects that are sensitive to single photons and single atoms. We also study topological edge states in arrays of ring resonators coupled to thermal atoms to study the effect of optical nonlinearity on the bulk and edge modes.

A 12.25 Tue 16:30 Empore Lichthof

Search for double core-hole states in Xe clusters — •Niklas Golchert[1], Nils Kiefer[1], Lutz Marder[1], Catmarna Küstner-Wetekam[1], Emilia Heikura[1], Johannes Viehmann[1], Francis Penent[2], Jérôme Palaudoux[2], Christophe Nicolas[3], Arno Ehresmann[1], and Andreas Hans[1] — [1]Institut für Physik und CINSaT, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Sorbonne Université, CNRS, Laboratoire de Chimie Physique-Matière et Rayonnement, LCPMR, F-75005 Paris Cedex 05, France — [3]Synchrotron SOLEIL, L'Orme des Merisiers, Saint-Aubin, BP 48, F-91192 Gif-sur-Yvette Cedex, France

Excited or ionized loosely bound atomic or molecular systems like clusters may undergo new interatomic and intermolecular relaxation processes being impossible in isolated systems. Noble-gas clusters are, due to their low chemical reactivity, well suited to investigate such fundamental relaxation processes. In the present work, the formation and decay of double core-holes (DCHs) in the 4d shell of xenon clusters upon photoionization is investigated. DCHs can enhance the chemical shift in molecules, which makes them important in ESCA (Electron Spectroscopy for chemical analysis). Two different paths were used to create the double core-holes, namely single-photon double ionization, and via $M_{4,5}N_{4,5}N_{4,5}$ Auger after single-photon 3d-electron photoionization. Measurements were performed with a multi-electron coincidence technique using a magnetic-bottle-type time-of-flight spectrometer and synchrotron radiation. Here, we present first results of the outlined processes.

A 12.26 Tue 16:30 Empore Lichthof

The Attoclock and its Interpretations, Theoretically and Experimentally — •Ossama Kullie — Institute for Physics, University of Kassel.

The measurement of the tunneling time in experiments with intense short laser pulse, termed attoclock, triggered a hot debate about the tunneling time and the separation into two regimes of ionization, the multiphoton and the tunneling. Theoretically, a crucial issue is the tunneling time, whether it is a real, which implies that time is an observable in QM, or an imaginary quantity, which implies that time is a parameter in QM. Another point is the statistical interpretation of the tunneling time. nevertheless, our real tunneling time is conform with the statistical point of view. Experimentally the issue is crucial since the result depends on the field strength calibration, and its consequence for the tunneling or multiphoton ionization regimes and hence the interpretation of the theoretical result. In our picture we illustrate these issues in the theory with comperision to experimental result. [1] O. Kullie. Phys. Rep. 2020,2, 233. [2] O. K. Phys. Rev. A. **92**, 052118 (2015), [3] O. K. Ann. of Phys. **389**, 333 (2018), [4] O. K. Mathematics **6**, 192 (2018). [5] O. K. J. Phys. B **49**, 095601, (2016).

A 12.27 Tue 16:30 Empore Lichthof

Sensitivity to new physics of forbidden optical transitions in highly charged ions — •Nils-Holger Rehbehn[1], Michael Karl Rosner[1], Julian C. Berengut[1,2], Piet O. Schmidt[3,4], and José R. Crespo López-Urrutia[1] — [1]Max-Planck Institut für Kernphysik, Heidelberg, Germany — [2]School of Physics, University of New South Wales, Sydney, Australia — [3]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [4]Leibniz Universität, Hannover, Germany

One potential dark matter candidate is a light boson coupling neutrons and electrons. Such a hypothetical fifth force could be detected through so-called King plots, where the isotope shifts of two optical transitions are plotted against each other for a series of isotopes. Deviations from the expected linearity could reveal such a fifth force. To extract non-linearity effects by higher-order SM, the generalized King plot can be used, which requires an extended number of transitions and isotopes. For this, we investigate in calcium and xenon forbidden transitions in highly charged states. We analyze theoretically their King plot sensitivity to a hypothetical fifth-force, for future high-precision coherent laser spectroscopy measurements.

A 12.28 Tue 16:30 Empore Lichthof

Coherent x-ray double-pulse generation — •Junhee Lee and Jörg Evers — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

A scheme for producing coherent x-ray double-pulses of nanosecond-scale duration and temporal separation is devised, based on the Mössbauer effect of ^{57}Fe operating at 14.4 keV. Our work is motivated by the recent demonstration of the coherent control of nuclear dynamics using double-pulses with tunable relative phase [1]. The temporal phase of the x-rays can be employed to shape their pulse spectra [2], similar to pulse-shape control at lower frequencies. Also the splitting of γ-ray photons into double-pulses or trains has been demonstrated [3]. However, further progress in the coherent manipulation of nuclear dynamics requires more versatile pulse control. Here, we propose a new method to control the time-dependent phase and temporal intensity. Our approach is based on the coherent scattering enabled by the Mössbauer effect, with additional phase control realized using mechanical displacements. By using multiple Mössbauer targets, interference between the different scattering channels can be engineered in such a way that the desired intensity modulation is achieved.

[1] K. P. Heeg et al., *Coherent x-ray-optical control of nuclear excitons*, Nature 590, 401 (2021).
[2] K. P. Heeg et al., *Spectral narrowing of x-ray pulses for precision spectroscopy with nuclear resonances*, Science 357, 375 (2017).
[3] F. Vagizov et al., *Coherent control of the waveforms of recoilless γ-ray photons*, Nature 508, 80 (2014).

A 12.29 Tue 16:30 Empore Lichthof

Polarons and bipolarons in a two-dimensional square lattice — •Gustavo Alexis Dominguez Castro — Institute for Theoretical Physics, Hannover university

Quantum simulation experiments with cold atoms have in recent years advanced our understanding of isolated quasiparticles, but so far they have provided limited information regarding their interactions and possible bound states. Here, we show how exploring mobile impurities immersed in a Bose-Einstein condensate in a two-dimensional lattice can address this problem. First, the spectral properties of individual impurities are examined, and in addition to the attractive and repulsive polarons known from continuum gases, we identify a new kind of quasiparticle stable for repulsive boson-impurity interactions. The spatial correlations between the impurity and the bosons are calculated showing that there is an increased density of bosons at the site of the impurity both for repulsive and attractive interactions. We then derive an effective Schrödinger equation describing two polarons interacting via the exchange of density oscillations in the BEC. Using this, we show that the attractive nature of the effective interaction between two polarons mediated by the BEC combined with the two-dimensionality of the lattice leads to the formation of bound states. Our results show that optical lattices are a promising platform to explore the spatial properties of polarons as well as to finally observe the elusive bipolarons.

A 12.30 Tue 16:30 Empore Lichthof

Towards a compound ^{27}Al - ^{40}Ca and multi-ion ^{40}Ca clock — •Lennart Pelzer[1], Johannes Kramer[1,2], Kai Dietze[1,2], Fabian Dawel[1,2], Marek Hild[1,2], Victor Martinez-Lahuerta[2], Klemens Hammerer[2], and Piet O. Schmidt[1,2] — [1]Physikalisch-Technische Bundesanstalt, 38116 Braunschweig — [2]Leibniz Universität Hannover, 30167 Hannover

Optical atomic clocks based on a single aluminium ion reach a record fractional frequency systematic uncertainty below 10^{-18}. This outstanding precision allows for applications like relativistic geodesy on the cm-level and helps to tighten the bounds for physics beyond the standard model. But single ion clocks are impeded by their low signal-to-noise ratio and require therefore long averaging times. Even state-of-the-art laser stabilization is not sufficient to enable lifetime-limited interrogation of ^{27}Al$^+$. Thus, pre-stabilization of the clock laser via a ^{40}Ca$^+$ multi-ion reference could further improve the coherence time of the laser and thus increase the interrogation time on ^{27}Al$^+$. Here we present the status of PTB's ^{27}Al$^+$ clock and the implementation of a multi-ion Ca$^+$ reference based on dynamical decoupling. The estimated error budget of 1×10^{-18} of the ^{27}Al$^+$ clock is based on measurements using a ^{40}Ca$^+$ ion as a sensor. A continuous dynamic decoupling scheme is used to suppress inhomogeneous broadening from quadrupole and tensor ac Stark shifts in multi-ion ^{40}Ca$^+$ crystals. Simultaneous suppression of first order Zeeman shifts allows interrogation of the crystal close to its natural lifetime limit.

A 12.31 Tue 16:30 Empore Lichthof

Numerical Description of Single-Cycle Electron Emission from Tungsten Nanotips — •Elisabeth Anne Herzig, Lennart Seiffert, and Thomas Fennel — University of Rostock, Institute of physics, Albert-Einstein-Straße 23, 18059 Rostock

Exposing nanostructures to strong fields enables the emission of energetic electrons via near-field driven elastic backscattering [1]. The availability of intense single cycle or sub-single cycle waveforms [2, 3] will enable to explore the formation and propagation of attosecond electron pulses in previously inaccessible regimes of the strong-field interaction. Here, the electron emission from tungsten nanotips under intense single-cycle pulses is inspected theoretically via one-dimensional TDSE simulations. The calculated carrier-envelope phase-dependent photoelectron energy spectra reveal prominent signatures with pronounced differences to previous studies performed with many-cycle pulses [4]. The physical origins behind the observed spectral features are disentangled by extending the famous Simple Man's Model of strong-field physics. Furthermore, collective effects can be unveiled within the one-dimensional time-dependent density functional theory. Here, first insights will be presented and discussed.

[1] M. F. Ciappina et al., Rep. Prog. Phys. 80, 054401 (2017)
[2] A. Wirth et al., Science 334, 195 (2011)
[3] M. T. Hassan et al., Nature 530, 66 (2016)
[4] L. Seiffert et al., J. Phys. B 51, 134001 (2018)

A 12.32 Tue 16:30 Empore Lichthof

Highly stable optical benches for the BECCAL ISS mission — •Jean Pierre Marburger[1], Faruk Alexander Sellami[1], Marc Kitzmann[3], Esther del Pino Rosendo[1], André Wenzlawski[1], Ortwin Hellmig[2], Klaus Sengstock[2], Tim Kroh[3], Victoria Henderson[3], Patrick Windpassinger[1], and the MAIUS and BECCAL team[1,3,4,5,6,7,8,9,10,11] — [1]Institut für Physik, JGU, Mainz — [2]ILP, UHH, Hamburg — [3]Institut für Physik, HU Berlin, Berlin — [4]FBH, Berlin — [5]IQ & IMS, LUH, Hannover — [6]ZARM, Bremen — [7]Institut für Quantenoptik, Universität Ulm, Ulm — [8]DLR-SC, Braunschweig — [9]DLR-SI, Hannover — [10]DLR-QT, Ulm — [11]OHB SE, Bremen

The NASA-DLR BECCAL mission is a multi-user experimental facility that will enable many quantum optical experiments aboard the

ISS, using different isotopes of rubidium and potassium. For intensity control and distribution of the required light fields, we make use of our fiber-to-fiber coupled optical bench toolkit which has previously been and will be employed in sounding rocket missions such as KALEXUS, FOKUS, MAIUS-1/2/3. In contrast, the ISS imposes even harsher conditions, such as a further limited SWAP budget and a much longer mission duration, necessitating further improvements. The presented poster will cover technical demonstrators and tests we have performed to ascertain the suitability of these improvements. Our work is supported by the German Space Agency DLR with funds provided by the Federal Ministry for Economic Affairs and Energy (BMWi) under grant number 50 WP 1433, 50 WP 1703 and 50 WP 2103.

A 12.33 Tue 16:30 Empore Lichthof

Setup of a calcium beam clock — •Lukas Möller, Anica Hamer, Lara Becker, and Simon Stellmer — Physikalisches Institut der Universität Bonn, Nussallee 12, 53115 Bonn, Germany

The use of optical transitions as frequency standards for highly accurate and precise time keeping is well-established around the world. A calcium beam clock offers the high performance of an optical clock, inside a compact design. The goal of this project is to build a calcium beam clock, which will at first be used as a test setup for high precision isotope shift measurements. We plan to eventually make the setup available as an experiment as part of a masters-level laboratory course. On this poster I will report on the current progress of the setup.

A 12.34 Tue 16:30 Empore Lichthof

Exploring the Many-Body Dynamics Near a Conical Intersection with Trapped Rydberg Ions — •Abdessamad Belfakir[1], Filippo Gambetta[2], Chi Zhang[3], Markus Hennrich[3], Igor Lesanovsky[4], and Weibin Li[1] — [1]School of Physics and Astronomy, University of Nottingham, Nottingham, NG7 2RD, UK — [2]Phasecraft Ltd, Bristol, United Kingdom — [3]Department of Physics, Stockholm University, 10691 Stockholm, Sweden — [4]Institut für Theoretische Physik, University of Tübingen, 72076 Tübingen, Germany

We demonstrate that trapped Rydberg ions are a platform to engineer conical intersections and to simulate their ensuing dynamics on larger length scales and timescales of the order of nanometres and microseconds, respectively; all this in a highly controllable system. In this context, the shape of the potential energy surfaces and the position of the conical intersection can be tuned thanks to the interplay between the high polarizability and the strong dipolar exchange interactions of Rydberg ions. We study how the presence of a conical intersection affects both the nuclear and electronic dynamics demonstrating, in particular, how it results in the inhibition of the nuclear motion. These effects can be monitored in real time via a direct spectroscopic measurement of the electronic populations in a state-of-the-art experimental setup. We further explore topological dynamics of the spin-phonon coupled dynamics near the conical intersection.

A 12.35 Tue 16:30 Empore Lichthof

A calcium beam clock for high-precision isotope shift measurements — •Anica Hamer and Simon Stellmer — Physikalisches Institut, Nussallee 12, Universität Bonn, 53115 Bonn, Germany

In the pursuit of finding new particles and new physics beyond the standard model (BSM), the isotope shift of optical transitions treasures a wealth of information on the interaction between the nucleus and the electrons. It can be an approach to find evidence for novel types of interactions between neutrons and electrons that might be mediated by new bosons as force carriers with masses in the 1 keV to 100 MeV mass range [Berengut, PRL 120, 091801].

Calcium is an excellent candidate for BSM searches via isotope shift spectroscopy possessing five stable bosonic isotopes. Where in heavier elements like Ytterbium BSM effects are hard to distinguish from SM effects like quadratic field shift and nuclear deformations [Hur, PRL 128, 163201], the latter are strongly suppressed in the Ca nucleus. We can also benefit from King plot comparisons to ionic Ca data, where latest precision isotope spectroscopy [Solaro, PRL 125, 123003; Gebert, PRL 115, 0530039] down to the Hz-level can already put a limit on BSM scenarios.

The goal of this project is a highly precise determination of the isotope shifts in Ca on the $^1S_0 \to {}^3P_1$ (657 nm, 370 Hz linewidth) and $^1S_0 \to {}^1D_2$ transitions (458 nm, $<$ 1 kHz) with target uncertainties in the 10 mHz range. The concept is based on Ramsey-Bordé atomic clock setup where two isotopes are interrogated co-located and simultaneously to suppress systematic shifts.

A 12.36 Tue 16:30 Empore Lichthof

Lattice control of non-ergodicity in a polar lattice gas — •Henning Korbmacher — Leibniz Universität Hannover, Institut für theoretische Physik, Hannover, Germany

Inter-site interactions in polar lattice gases may result, due to Hilbert-space fragmentation, in a lack of ergodicity even in absence of disorder. We show that the inter-site interaction in a one-dimensional dipolar gas in an optical lattice departs from the usually considered 1/r^3 dependence, acquiring a universal form that depends on the transversal confinement and the lattice depth. Due to the crucial role played by the nearest- and next-to-nearest neighbors, the Hilbert-space fragmentation and particle dynamics are very similar to that of a power-law model 1/r^b, where b<3 is experimentally controllable by properly tailoring the transversal confinement. Our results are of direct relevance for experiments on dipolar gases in optical lattices and show that the particle dynamics may be remarkably different if the quasi-1D lattice model is realized in a strong 3D lattice or by means of a strong transversal harmonic confinement.

A 12.37 Tue 16:30 Empore Lichthof

Probing the spatio-temporal dynamics of Ion-Rydberg hybrid systems using a high-resolution ion microscope — •Viraatt S. V. Anasuri[1], Moritz Berngruber[1], Yi-Quan Zou[1], Óscar Andrey Herrera Sancho[1,2], Ruven Conrad[1], Nicolas Zuber[1], Florian Meinert[1], Robert Löw[1], and Tilman Pfau[1] — [1]5. Physikalisches Institut and Center for Integrated Quantum Science and Technology, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Escuela de Física and Centro de Investigación en Ciencias Atómicas Nucleares y Moleculares, Universidad de Costa Rica, 2060 San Pedro, San José, Costa Rica

The long-range interaction between an ion and a highly excited Rydberg atom lead to fascinating dynamical phenomena with exaggerated spatial and temporal properties that are accessible using our high-resolution ion microscope. We study the vibrational dynamics of molecular bound states that are formed in the potential wells located at the avoided crossings between the Rb nP Rydberg state and the hydrogenic manifold. We observe oscillations of the wavepacket within the molecular potential with a frequency, orders of magnitude slower than that observed in conventional molecules. To investigate the fermionic correlations in a Fermi gas, we are upgrading our apparatus to produce an ultracold gas of Lithium atoms. To this end, we are currently planning a dual species atomic source for Rb and Li, which in combination with our currently being used dual species Zeeman slower will aid us in our goal to extend our current studies to a multi-species hybrid system.

A 12.38 Tue 16:30 Empore Lichthof

Addressing Rydberg s- and p-states in optical tweezers — •Roxana Wedowski, Ludwig Müller, Lea-Marina Steinert, Philip Osterholz, Arno Trautmann, and Christian Gross — Eberhard Karls Universität, Tübingen, Germany

Rydberg atom-based quantum simulators offer unique capabilities to implement strongly correlated many-body phenomena. An experimental system with single potassium-39 atoms placed in 2D arrays of optical tweezers allows us to study renowned models in spin physics, such as XYZ-type spin interactions. So far, this has been realized by off-resonant coupling via a single photon transition to Rydberg states. Here, we present an upgrade to the UV Laser system for the one photon excitation by elimination of limiting factors like phase noise. Additionally, a two-photon excitation scheme is implemented offering increased tunability. The flexible design of the simulated Hamiltonian, combined with the geometrical versatility of the system, is expected to reveal exciting prospects for the implementation of quantum magnets and nonlinear enhanced detection.

A 12.39 Tue 16:30 Empore Lichthof

Direct Frequency Comb Spectroscopy of the 1S-3S Transition in Hydrogen — •Derya Taray[1], Alexey Grinin[1], Vitaly Wirthl[1], Omer Amit[1], Arthur Matveev[1], Dylan Yost[3], Randolf Pohl[4], Thomas Udem[1,2], and Theodor W. Hänsch[1,2] — [1]Department for Laser Spectroscopy, Max Planck Institute of Quantum Optics, 85748 Garching, Germany — [2]Ludwig Maximilian University, 80539 Munich, Germany — [3]Department of Physics, Colorado State University, Fort Collins, CO, USA — [4]Institute of Physics, QUANTUM and Cluster of Excellence PRISMA+, Johannes Gutenberg University, 55128 Mainz, Germany

The energy levels of the hydrogen atom can be both calculated and measured very precisely. Precision spectroscopy on these transitions therefore, allows the determination of fundamental constants and testing the theory of QED for completeness.

Here we present the latest measurement of the 1S-3S transition, using two photon direct frequency comb spectroscopy. Its implications for the purposes mentioned above are shown together with additional measurements in hydrogen. Also we give an outlook on the next anticipated measurements, current problems and improvements of the experiment.

A 12.40 Tue 16:30 Empore Lichthof

Experimental quantification of Interatomic Coulombic Decay in rare gas clusters after inner-shell ionization — Catmarna Küstner-Wetekam, Lutz Marder, Dana Bloss, Nils Kiefer, •Isabel Ludwig, Arno Ehresmann, and Andreas Hans — Institut für Physik und CINSaT, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany

Non-local decay mechanisms like Interatomic Coulombic Decay (ICD) are of great interest to understand radiation damage in biologically relevant samples. Weakly bound rare gas clusters can be used as a prototype system to study these processes in a less complex sample. In order to measure comparatively weak processes such as ICD after inner-shell ionization, it is neccessary to use multicoincidence spectroscopy, particularly electron-electron and electron-electron-photon coincidences. Here, we present a method to quantify the branching ratio of the core-level ICD to competing local Auger decays in pure argon and krypton clusters.

A 12.41 Tue 16:30 Empore Lichthof

Theoretical study of radio-frequency induced Floquet Feshbach resonances in ultracold Lithium-6 gases — •Alexander Guthmann and Artur Widera — Physics Department and Research Center OPTIMAS, University of Kaiserslautern-Landau, Germany

Feshbach resonances are an indispensable tool in the research of ultracold atoms. The position of magnetic Feshbach resonances is determined by the magnetic field value where the energy of a dimer bound state crosses the asymptotic atomic threshold. By applying an oscillating magnetic field in the radio frequency regime, the colliding atom pair can be coupled to the dimer state, and new Feshbach resonances at different magnetic field values can be produced. Using techniques of Floquet theory, we convert the time-dependent problem into an equivalent time-independent problem, and derive a Hamiltonian which can be used for coupled-channel calculations. We use the example of Lithium-6 featuring an unusually broad s-wave resonance at 832G caused by a weakly bound halo state. Results from coupled-channel calculations show that this halo state allows the creation of RF-induced resonances with large widths and tunability at technically achievable modulation strengths. These theoretical investigations will be presented, and the possibilities of experimental observation and associated technical challenges will be discussed.