A 42: Poster Session IIIb

Time: Thursday 16:15–18:15 Location: Zelt Ost

A 42.1 Thu 16:15 Zelt Ost

Probing ferromagnetism in few-fermion correlated spin-flip dynamics — •Georgios Koutentakis, Simeon Mistakidis, and Peter Schmelcher — Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

According to the Stoner instability, the ferromagnetic phase of a spin-1/2 Fermi system occurs for strong interparticle repulsion, resulting in the occupation of states with anti-oriented spins being energetically forbidden. However, the clean realization of a ferromagnetic phase in quantum gases verifying this viewpoint is elusive. We unravel the stability of a fully polarized one-dimensional ultracold few-fermion spin-1/2 gas subjected to inhomogeneous driving of the itinerant spins. The existence of a ferromagnetic-like regime for interaction strengths comparable to the confinement energy is revealed. The two-body spin-spin correlator unveils that the itinerant spins remain close to be maximally aligned throughout the dynamics, despite the magnitude of the average single-spin polarization fluctuating between zero and unity. This implies that the interaction is not able to stabilize the spin-polarization and hence the magnetization of a trapped Fermi gas.

A 42.2 Thu 16:15 Zelt Ost

Preparing and controlling optically trapped Barium Ions for ultracold Atom-Ion Interactions — •Pascal Weckesser, Fabian Thielemann, Yannick Minet, Julian Schmidt, Leon Karpa, Markus Debatin, and Tobias Schaetz — Albert-Ludwigs-Universitaet Freiburg

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

Here we present our novel experimental setup combining $^{138}Ba^{+}$ ions and ^{6}Li atoms. On this poster we focus on the Barium segment of the experiment. We demonstrate our new ion loading scheme, realised by laser ablation. Furthermore, first optical trapping attempts of the Barium ions in a visible dipole trap (532 nm) will be presented.

[1] A. Haerter et al., Cont. Phys., Vol. 55, issue 1, pages 33-45 (2014).
[2] R.Cote et al. Phys.Rev.Lett. 89.093001 (2002).
[3] Idziaszek et al., Physical Review A 76.3 (2007): 033409.
[4] A. Lambrecht et al., Nature Photonics 11.11 (2017): 704.
[5] M.Cetina et al., Phys.Rev.Lett. 109,253201 (2012)

A 42.3 Thu 16:15 Zelt Ost

Many-Body Quantum Dynamics in the Decay of Bent Dark Solitons of Bose-Einstein Condensates — •Simeon Mistakidis[1], Garyfallia Katsimiga[1], Georgios Koutentakis[1,2], Panagiotis Kevrekidis[3], and Peter Schmelcher[1,2] — [1]Zentrum für optische Quantentechnologien Luruper Chaussee 149 22761 Hamburg — [2]he Hamburg Centre for Ultrafast Imaging, Universit at Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Department of Mathematics and Statistics, University of Massachusetts Amherst, Amherst, MA 01003-4515, USA

We examine the case of a bent dark soliton comparing the mean-field dynamics to a correlated approach. Dynamical snaking of this bent structure is observed, signaling the onset of fragmentation. In contrast to the mean-field approximation "filling" of the vortex core is observed, leading to the formation of filled-core vortices. We show that this filling owes its existence to the dynamical building of an antidark structure developed in the next-to-leading order orbital. We further demonstrate that the aforementioned beyond mean-field dynamics can be experimentally detected using the variance of single shot measurements. Additionally, a variety of excitations including vortices, oblique dark solitons, and open ring dark soliton-like structures building upon higher-lying orbitals is observed. Signatures of the higher-lying orbital excitations emerge in the total density, and can be clearly captured by inspecting the one-body coherence. In the latter context, the localization of one-body correlations exposes the existence of the multi-orbital vortex-antidark structure.

A 42.4 Thu 16:15 Zelt Ost

A Versatile Strontium Quantum Gas Machine with a Microscope — •Oleksiy Onishchenko, Sergey Pyatchenkov, Alexander Urech, Georgios Siviloglou, and Florian Schreck — Institute of Physics, University of Amsterdam, Amsterdam, The Netherlands

Strontium opens new perspectives for Hamiltonian engineering because it is an alkaline-earth element with narrow intercombination lines, metastable excited electronic states, and ten collisionally-stable SU(N)-symmetric nuclear spin states.

We have built a new versatile Sr machine with quantum gas microscope capability. After precooling on a broad blue transition, we collect 10^7 atoms at 2 μK in a narrow-line red MOT, load them into a 1064 nm dipole trap, and evaporatively cool them to obtain either a BEC of 8×10^4 atoms or a degenerate Fermi gas with $T/T_F = 0.3$. We have now also observed for the first time the doubly-forbidden $^1S_0$ - $^3P_2$ transition in ^{87}Sr by direct laser excitation, which opens up possibilities for quantum computation [1] and gauge field engineering.

[1] Daley, A.J., Quant. Inform. Process. 10, 865 (2011).

A 42.5 Thu 16:15 Zelt Ost

Quench-induced phase separation dynamics in a many-body multi-component Bose-Einstein condensate — •Garyfallia Katsimiga[1], Simeon Mistakidis[1], Panagiotis Kevrekidis[2], and Peter Schmelcher[1,3] — [1]Zentrum für optische Quantentechnologien Luruper Chaussee 149 22761 Hamburg — [2]Department of Mathematics and Statistics, University of Massachusetts Amherst, Amherst, MA 01003-4515, USA — [3]The Hamburg Centre for Ultrafast Imaging, Universitat Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

We examine the quenched dynamics of a binary Bose-Einstein condensate crossing the miscibility-immiscibility threshold and vice versa, both within and beyond the mean-field approximation. Increasing the interspecies repulsion leads to the filamentation of the density of each component, involving shorter wavenumbers (and longer spatial scales) in the many-body approach. These filaments appear to be strongly correlated both at the one- and the two-body level, exhibiting domain-wall structures. Furthermore, following the reverse quench process dark-bright soliton trains are spontaneously generated and subsequently found to decay in the many-body scenario. We utilize single-shot images to provide a clean experimental realization of our current findings via which the filamentation process is clearly captured. To expose further the many-body nature of the observed dynamics direct measurements of the variance of single-shots are performed, verifying the presence of fragmentation but also the entanglement between the species.

A 42.6 Thu 16:15 Zelt Ost

Tailor-made optical potentials with Spatial Light Modulators — •Antonia Klein, Marvin Holten, Luca Bayha, Puneet Murthy, Philipp Preiss, Gerhard Zuern, and Selim Jochim — Physikalisches Institut, University of Heidelberg, Germany

Initializing a system in a desired low entropy state is one of the main challenges of quantum simulation employing ultracold atoms. In most experiments a bulk gas is evaporatively cooled down and loaded into the desired potential.

On this poster we present our new setup following a different bottom-up approach. The idea is to assemble a complicated potential out of many separately prepared building blocks, which can be initialized with very low initial entropy. The required tailor made potentials are created by using a phase modulating Spatial Light Modulator implemented in our group's 2D lithium experiment.

We show first measurements performed with the extended setup. Starting with the simple building block of a double well, we explore the feasibility of several lattice geometries. We also investigate the possibility to study 1D physics with the long term goal of creating topological edge states.

A 42.7 Thu 16:15 Zelt Ost

Single-shot simulations for bosonic and fermionic mixtures

— •Georgios Koutentakis[1], Simeon Mistakidis[1], Garyfalia Katsimiga[1], Panagiotis Kevrekidis[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Department of Mathematics and Statistics, University of Massachusetts Amherst, Amherst, MA 01003-4515, USA

ML-MCTDHX offers as a versatile tool for the simulations of bosonic and fermionic atomic mixtures [1]. We extend the recently developed single-shot simulation procedure for single-species bosonic ensembles [2] for the case of atomic mixtures and spinor gases. This extension allows us to track and quantify the correlation dynamics on the level of the full many-body wavefunction relying solely on experimentally tractable quantities.

[1] L. Cao, V. Bolsinger, S. I. Mistakidis, G. M. Koutentakis, S. Krönke, J. M. Schurer, and P. Schmelcher, J. Chem. Phys. **147**, 044106 (2017).

[2] K. Sakmann and M. Kasevich, Nat. Phys. **12**, 451 (2016).

A 42.8 Thu 16:15 Zelt Ost

Many-Body Dark-Bright Soliton Dynamics — •Simeon Mistakidis[1], Garyfallia Katsimiga[1], Georgios Koutentakis[1,2], Panagiotis Kevrekidis[3], and Peter Schmelcher[1,2] — [1]Zentrum für optische Quantentechnologien Luruper Chaussee 149 22761 Hamburg — [2]he Hamburg Centre for Ultrafast Imaging, Universitat Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Department of Mathematics and Statistics, University of Massachusetts Amherst, Amherst, MA 01003-4515, USA

The dynamics of dark-bright solitons beyond the mean-field approximation is investigated. We first examine the case of a single dark-bright soliton and its oscillations within a parabolic trap. Subsequently, we move to the setting of collisions. Fragmentation is present and significantly affects the dynamics, especially in the case of slower solitons and in that of lower atom numbers. It is shown that the presence of fragmentation allows for bipartite entanglement between the distinguishable species. Most importantly the interplay between fragmentation and entanglement leads to the splitting of each of the parent mean-field dark-bright solitons, placed off- center within the parabolic trap, into a fast and a slow daughter solitary wave. The latter process is in direct contrast to the predictions of the mean-field approximation. A variety of excitations including dark-bright solitons in multiple (concurrently populated) orbitals is observed. Dark-antidark states and domain-wall-bright soliton complexes can also be observed to arise spontaneously in the beyond mean-field dynamics.

A 42.9 Thu 16:15 Zelt Ost

Bosonic quantum dynamics following a linear interaction quench in finite optical lattices of unit filling — •Simeon Mistakidis[1], Georgios Koutentakis[1,2], and Peter Schmelcher[1,2] — [1]Zentrum für optische Quantentechnologien Luruper Chaussee 149 22761 Hamburg — [2]he Hamburg Centre for Ultrafast Imaging, Universitat Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

The nonequilibrium ultracold bosonic quantum dynamics in finite optical lattices of unit filling following a linear interaction quench from a superfluid to a Mott insulator state and vice versa is investigated. The resulting dynamical response consists of various inter and intraband tunneling modes. We find that the competition between the quench rate and the interparticle repulsion leads to a resonant dynamical response, at moderate ramp times, being related to avoided crossings in the many-body eigenspectrum with varying interaction strength. Crossing the regime of weak to strong interactions several transport pathways are excited. The higher-band excitation dynamics is shown to obey an exponential decay possessing two distinct time scales with varying ramp time. Studying the crossover from shallow to deep lattices we find that for a diabatic quench the excited band fraction decreases, while approaching the adiabatic limit it exhibits a non-linear behavior for increasing height of the potential barrier. The inverse ramping process from strong to weak interactions leads to a melting of the Mott insulator and possesses negligible higher-band excitations which follow an exponential decay for decreasing quench rate.

A 42.10 Thu 16:15 Zelt Ost

Tunable spin-exchange interaction in ytterbium-173 — •Oscar Bettermann[1,2], Nelson Darkwah Oppong[1,2], Luis Riegger[1,2], Moritz Höfer[1,2], Bloch Immanuel[1,2], and Simon Fölling[1,2] — [1]Max-Planck-Institut für Quantenoptik, Garching — [2]Ludwig-Maximilians-Universität, München

Ytterbium as an alkaline-earth-like atom features a metastable excited state, the so-called clock state, that can be directly addressed from the ground state with an ultra-narrow laser. The metastable clock state opens up the possibility of probing interacting two-orbital many-body systems.

Since the ground and clock state have, in general, distinct atomic polarizabilities, the confinement and mobility can be tuned in state-dependent optical lattices. In our implementation, atoms in the clock state are pinned on individual lattice sites whereas ground-state atoms remain mobile. Together with the strong spin-exchanging interaction of ytterbium-173, Kondo-like Hamiltonians can be realized.

We find that the spin-exchange coupling is mediated via super-exchange processes and can be tuned resonantly by varying the confinement. This novel tuning mechanism could potentially be used for studying dynamics of the Kondo and Kondo lattice model with ultracold atoms.

A 42.11 Thu 16:15 Zelt Ost

Expansion dynamics of strongly attractive few-fermion systems — Vincent Klinkhamer, •Ralf Klemt, Jan Hendrik Becher, Andrea Bergschneider, Philipp M. Preiss, Gerhard Zürn, and Selim Jochim — Physikalisches Institut, Universität Heidelberg

In this talk, we present correlation measurements in an expanding and attractively interacting few-body system of fermionic 6Li atoms. We prepare deterministic few-body systems in optical microtraps and then release the atoms into a weaker external confinement. After a time-of-flight expansion, we measure both the position and hyperfine state of each atom with single-atom-resolution. In these measurements, we observe strong correlations between the atoms, depending both on the interaction strength and the confinement potential during the expansion. We explain the expansion dynamics with unitary time evolution and connect it to the fluid-dynamic description of strongly coupled quantum fluids.

A 42.12 Thu 16:15 Zelt Ost

QUANTUS-2 - Ultra Low Expansion Atomic Source for Matter Wave Interferometry in Extended Free Fall — •Peter Stromberger[1], Tammo Sternke[5], Naceur Gaaloul[4], Andre Wenzlawski[1], Patrick Windpassinger[1], and the QUANTUS-Team[1,2,3,4,5,6,7] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz — [2]Institut für Physik, Humboldt-Universität zu Berlin — [3]Ferdinand-Braun-Institut, Leibniz Institut für Höchstfrequenztechnik Berlin — [4]Institut für Quantenoptik, Leibniz-Universität Hannover — [5]ZARM, Universität Bremen — [6]Institut für Quantenphysik, Universität Ulm — [7]Institut für angewandte Physik, TU Darmstadt

QUANTUS-2 is a mobile high-flux rubidium BEC source used for experiments under microgravity in the drop tower in Bremen. To further decrease the expansion rate of the BEC, magnetic lensing - also known as delta-kick collimation - is crucial for observations after long evolution times in the range of seconds. Long evolution times are desirable, because the sensitivity of atom interferometers enhances quadratically with the interrogation time. An observability of the BEC of up to 2.7 s after free expansion was demonstrated. We present new analysis methods and results from simulations to increase our understanding of the used magnetic lens.

The QUANTUS project is supported by the German Space Agency DLR with funds provided by the Federal Ministry of Economic Affairs and Energy under grant numbers DLR 50 WM 1552-1557.

A 42.13 Thu 16:15 Zelt Ost

Study on transfer induced BEC dynamics in optical waveguides — Sebastian Bode, •Felix Kösel, and Knut Stolzenberg — Institut für Quantenoptik, Hannover, Deutschland

Presentation of the experimental steps towards optically guided atom-interferometry using ^{87}Rb Bose-Einstein condensates. By applying a waveguide the evolution time of the ensemble is increased leading to higher sensitivity of the atom interferometer [1]. Beam-splitters and mirrors will be implemented via Bragg-pulses coupling to the momentum states of the atoms. Furthermore the transfer behaviour of the BEC from a crossed optical dipole trap into the optical waveguide is studied. The aforementioned behaviour results in complex dynamics which become apparent through fragmentations of the BEC due to phase fluctuations.

[1] G. D. McDonald et al., PRA **87**, 013632 (2013)

A 42.14 Thu 16:15 Zelt Ost

Rydberg Dressed Quantum Many-Body Systems — •Nikolaus Lorenz, Lorenzo Festa, Sarah Hirthe, Anne-Sophie Walter, and Christian Gross — Max-Planck-Institut für Quantenoptik, Munich, Germany

We are setting up a novel experiment for the study of quantum many-body systems with engineered long-range interactions. These interactions are induced by off-resonant laser coupling to Rydberg states, so called Rydberg dressing. Our aim is to explore fundamentally new types of quantum matter based on these tailored long-range interactions. A first goal is to study tailored quantum magnets in microtrap arrays, where Potassium provides interesting prospects for deterministic array loading. The microtrap approach has been chosen in order to have a flexible and fast system for experiments that require high statistics. We are developing also the laser system for the ultraviolett light designed to maximize the coupling to Rydberg states. Here we report on the status of the project and the progress done in the last year with the construction of the experimental apparatus.

A 42.15 Thu 16:15 Zelt Ost

A Reaction Microscope for few-body Rydberg Dynamics — •Philipp Geppert, Dominik Arnold, Cihan Sahin, Andreas Müllers, and Herwig Ott — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany

We report on the development of a reaction microscope that is based on our deterministic ion source experiment (C. Sahin et al 2017 *New J. Phys.*) and allows to measure the dynamical evolution of momentum distributions in interacting Rydberg systems. To this purpose, a sample of 10^6 ^{87}Rb atoms will be prepared in a crossed dipole trap. Using a 3-level excitation scheme, some atoms can be excited to atomic or molecular Rydberg states and photoionized by a short laser pulse from a high power CO_2 laser after a variable evolution time. Following small homogeneous electric fields generated by Wiley-McLaren-type ion optics, the produced ions are subsequently detected by a time and position sensitive delay-line detector. By analyzing the trajectories of the recoil ions, we aim to measure momentum distributions of Rydberg molecule wave functions. In this context, special focus lies on butterfly and trilobite molecules, which can be addressed efficiently due to the opportunity of exciting Rydberg p- and f-states. As a next step, stroboscopic monitoring on the internal decay of Rydberg molecules and measurements regarding forces between pairs of Rydberg atoms will be performed.

A 42.16 Thu 16:15 Zelt Ost

Rydberg Optical Feshbach Resonances — •Tanita Eichert[1], Oliver Thomas[1,2], Carsten Lippe[1], and Herwig Ott[1] — [1]Department of physics and research center Optimas, University of Kaiserslautern — [2]Graduate school materials science in Mainz, Staudingerweg 9, 55128 Mainz

In a cloud of ultracold atoms the scattering interaction between a ground state atom and the highly excited Rydberg electron gives rise to an oscillatory potential that supports molecular bound states. We show that by coupling two ground state atoms to a Rydberg molecular state via a laser field, we realize a Rydberg optical Feshbach resonance. By tuning the laser field, the Rydberg optical Feshbach resonance results in a changed interatomic interaction, that we detect as different revival times in collapse and revival experiments in an optical lattice. As off-resonant excitations lead to the formation of Rydberg atoms, we observe an additional interaction shift that is attributed to Rydberg-Rydberg-interactions between the atoms. Long lifetimes of Rydberg molecular states allow us to maintain long sample lifetimes on the order of milliseconds while changing the scattering length by up to 50 Bohr radii. So far optical Feshbach resonances were observed near intercombination transitions in strontium and ytterbium. We believe that Rydberg optical Feshbach resonances open up a whole new field: They are feasible with arbitrary Rydberg molecular states and all atomic species that are able to create Rydberg molecules. Especially this plenitude of molecular states allows to optimize the ratio between the change in scattering length and loss rates in further research.

A 42.17 Thu 16:15 Zelt Ost

Observation of RbSr Feshbach resonances — •Florian Schreck[1], Vincent Barbé[1], Alessio Ciamei[1], Lukas Reichsöllner[1], Benjamin Pasquiou[1], Jacek Szczepkowski[2], Piotr Zuchowski[3], and Jeremy Hutson[4] — [1]University of Amsterdam, The Netherlands — [2]Polish Academy of Sciences, Warsaw, Poland — [3]Nicolaus Copernicus University, Poland — [4]Durham University, United Kingdom

We report the first observation of magnetic Feshbach resonances (FRs) between an alkali and a closed-shell atom, Rb and Sr [1]. In this system none of the strong coupling mechanisms that lead to broad FRs in alkali systems exist. Our work shows that weak coupling mechanisms, as predicted in [2], lead to narrow Rb-Sr Feshbach resonances. We also present spectroscopic studies of the RbSr ground-state potential, performed on several isotopic combinations. These studies enable us to predict the location and width of Feshbach resonances in all stable isotopic mixtures. We identify mixtures for which magnetoassociation of Rb and Sr atoms into molecules should be feasible despite the narrowness of the resonances. This opens a door towards the creation of open-shell, strongly polar molecules.

[1] V. Barbé *et al.*, arXiv:1710.03093 (2017).
[2] P. Żuchowski *et al.*, Phys. Rev. Lett. 105, 153201 (2010).

A 42.18 Thu 16:15 Zelt Ost

Cold Rydberg ions for quantum-technology experiments — •Arezoo Mokhberi[1], Jonas Vögel[1], Justas Andrijauskas[1,2], Patrick Bachor[1,2], Georg Jacob[1], Christian Gumbrich[1,2], Jachen Walz[1,2], and Ferdinand Schmidt-Kaler[1] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, D-55128, Germany — [2]Helmholtz-Institut Mainz, D-55099, Germany

Cold ions confined in radiofrequency (RF) ion traps are among the most promising candidates for quantum information processing and quantum simulation. In these systems, exciting the ionic electron to high-laying Rydberg states offers a unique opportunity for observing novel effects arising from the interplay between the Coulomb interaction and their giant dipole moments. This offers a new router for investigating strongly correlated many-body quantum systems, for simulating complex systems and for the exploration of non-equilibrium dynamics in structural phase transitions and defect formations [1-3]. We have employed coherent VUV radiation at 122.04 nm for Rydberg excitation of calcium ions in a linear, segmented RF trap. The excitation to 52F, 53F, 66F and 22F states was observed and modelled [4,5]. Using sideband spectroscopy on the quadrupole qubit transition, we have characterized the micromotion effect on the line shape of Rydberg transitions.

References: [1] F. Schmidt-Kaler et al., NJP. 13, 075014 (2011). [2] M. Müller et al., NJP 10, 093009 (2008). [3] S. Ulm et al., Nat. comm. 4, 2290 (2013). [4] T. Feldker et al., PRL 115, 173001 (2015). [5] P. Bachor et al., JPB 49, 154004 (2016).

A 42.19 Thu 16:15 Zelt Ost

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

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

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

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

A 42.20 Thu 16:15 Zelt Ost

Is a Steady-State Atom Laser within reach? — •Chun-Chia Chen, Shayne Bennetts, Rodrigo Gonzalez Escudero, Benjamin Pasquiou, and Florian Schreck — Institute of Physics, University of Amsterdam

So far BECs and atom lasers have only been demonstrated as the product of a time sequential, pulsed cooling scheme. Here we will describe a steady-state system demonstrating phase-space densities (PSD) approaching degeneracy and discuss how we might be able to make a steady-state atom laser. By flowing atoms through a series of spatially separated cooling stages and employing a range of novel tricks we recently demonstrated a steady-state strontium MOT with a PSD above 10^{-3} [1], 100 times higher than previous experiments. Now we demonstrate a set of tools, compatible with steady-state operation, to continuously cool and transfer microkelvin-cold atoms from a MOT into a dipole trap reservoir. Furthermore, by combining our novel machine architecture with a lighshift engineering technique we previously demonstrated [2], we protect a BEC from the strong fluorescence of a nearby MOT. Using all these tools on our high PSD MOT, quantum degeneracy in a steady-state system and a steady-state atom laser seem within reach. A steady-state source of degenerate atoms offers great advantages for applications such as next generation degenerate atomic clocks, super-radiant lasers or atom-interferometers for gravitational wave detection.

[1] S. Bennetts *et al.*, Phys. Rev. Lett. 119, 223202 (2017).
[2] S. Stellmer *et al.*, Phys. Rev. Lett. 110, 263003 (2013).

A 42.21 Thu 16:15 Zelt Ost

Towards Ultracold Interactions between Lithium and Barium in an Optical Trap — •Fabian Thielemann, Pascal Weckesser, Yannick Minet, Julian Schmidt, Leon Karpa, Markus Debatin, and Tobias Schaetz — Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

The fields of ultracold atoms and trapped ions are important pillars of experimental quantum optics. Recently the expertise of both fields has been combined in hybrid trapping setups to prepare atom-ion mixtures at low temperatures. For joint systems features like Feshbach resonances at magnetic fields on the order of tens of Gauss or the formation of mesoscopic, weakly bound molecules have been predicted [1,2]. As reaching the ultracold regime in hybrid setups is an experimentally challenging task, this phenomena remain yet to be observed.

In our novel experimental setup we plan to reach the ultracold regime by sympathetically cooling Ba^+ ions in a cloud of ^6Li atoms. The atoms and ions will be confined in a combined optical dipole trap to overcome fundamental temperature limits imposed by micromotion of an ion in a radio frequency trap [3,4]. On this poster we will focus on the ^6Li branch of the setup. We present characterising measurements of our magneto-optical trap. Further the current state of atom transfer to the dipole trap will be put forward.

[1] M. Tomza et al., Physical Review A 91.4 (2015): 042706.
[2] R.Cote et al. Phys.Rev.Lett. 89.093001 (2002).
[3] M. Cetina et al., Phys.Rev.Lett. 109,253201 (2012).
[4] A. Lambrecht et al., Nat. Phot. 11, 704-707 (2017)

A 42.22 Thu 16:15 Zelt Ost

An Autonomous Clock Based on a Single-Ion Phonon Laser — •Martin Wagener, David von Lindenfels, Thomas Ruster, Ulrich Poschinger, and Ferdinand Schmidt-Kaler — Institut für Physik, Johannes Gutenberg-Universität Mainz

Self-oscillating systems are ubiquitous in nature and technology and can evidently be used for time keeping. Recent theoretical work shows that there exists a connection between time measurement accuracy and thermodynamics [1]. These results suggest, that the minimum dissipated heat is bounded by the clock accuracy and vice versa.

To test this hypothesis in an experiment, we use laser-induced oscillation of a single Ca^+ ion in a Paul trap as a time keeping device. Simultaneous irradiation of cw laser beams red and blue detuned from an optical transition leads to a sustained oscillation at a secular trap frequency - an effect which has been coined 'phonon laser' [2]. We present ongoing measurements investigating the connection between the ion's total photon scattering rate, i.e. the dissipated heat, and the stability of the oscillation in order to test the universality of the connection between time measurements and thermodynamics.

[1] P. Erker et al., Phys. Rev. X 7, 031022 (2017)
[2] K. Vahala et al., Nature Physics 5.9, 682 (2009)

A 42.23 Thu 16:15 Zelt Ost

Optical Trap for an Ultracold 2D Fermi Gas — •Andreas Kell, Martin Link, Kuiyi Gao, and Michael Köhl — Physikalisches Institut, University of Bonn, Wegelerstraße 8, 53115 Bonn, Germany

Interacting atomic Fermi gases in two dimensions feature various interesting phenomena and have been the target of many experimental studies in this decade. Our experimental setup produces a large degenerate gas of fermionic lithium in the BEC-BCS crossover. It is upgraded with a new trap geometry, which strongly confines the atoms only along one direction. This leads to a very large aspect ratio required to enter the 2D regime with high atom number. For this purpose a highly elliptical focused blue-detuned beam with a TEM01-like mode profile is employed. The mode profile is generated by phase-shifting one half of the originally Gaussian beam with a phase plate.