A 40: Poster: Ultra-cold atoms, ions and BEC

Time: Thursday 16:30–19:00 Location: Poster.V

A 40.1 Thu 16:30 Poster.V

Direct synthesis of light polarization for state-dependent transport of atoms — •Anna Hambitzer and Sebastian Hild — Institut für Angewandte Physik, Wegelerstraße 8, 53115 Bonn

We report on a new approach for state-dependent transport in a spin-dependent optical lattice. It is based on a direct synthesis of light polarization by employing RF sources integrated with acousto-optic modulators for phase control.

Circulary polarized states are synthesized by superimposing two linearly polarized beams with controlled phase shift.

An interferometrically stable phase difference between the two beams is guaranteed by locking it actively with a heterodyne technique.

Compared to conventional methods [citation to Bloch & Mandel PRL03 and arXiv:1102.3356] this avoids the need of an electro-optic modulator, where rotations on the Poincare sphere are limited by the applicable voltage and restrictions on manufacturing and crystal quality exist. Overcoming these limitations we expect to reach higher polarization purity and large shift distances in the new design.

A 40.2 Thu 16:30 Poster.V

Beyond the Hubbard model: best effective single dressed band description of interacting atoms in optical lattices — •Ulf Bissbort, Frank Deuretzbacher, and Walter Hofstetter — Institut für Theoretische Physik, Goethe Universität Frankfurt a.M.

We construct the effective lowest-band Bose-Hubbard model incorporating interaction-induced on-site correlations. The model is based on ladder operators for local correlated states, which deviate from the usual Wannier creation and annihilation operators, allowing for a systematic construction of the most appropriate single-band low-energy description in form of the extended Bose-Hubbard model. A formulation of this model in terms of ladder operators not only naturally contains the previously found effective multi-body interactions, but also contains multi-body induced single particle tunneling, pair tunneling and nearest-neighbor interaction processes of higher orders. An alternative description of the same model can be formulated in terms of occupation-dependent Bose-Hubbard parameters. These multi-particle effects can be enhanced using Feshbach resonances, leading to corrections which are well within experimental reach and of significance to the phase diagram of ultracold bosonic atoms in an optical lattice. We analyze the energy reduction mechanism of interacting atoms on a local lattice site and show that this cannot be explained only by a spatial broadening of Wannier orbitals on a single particle level, which neglects correlations.

A 40.3 Thu 16:30 Poster.V

Dynamical molecules in interacting quantum walks — Andre Ahlbrecht[1], Volkher B. Scholz[1], Albert H. Werner[1], Reinhard F. Werner[1], •Andrea Alberti[2], and Dieter Meschede[2] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover Appelstr. 2, 30167 Hannover, Germany — [2]Institut für Angewandte Physik der Universität Bonn, Wegelerstraße 8, 53115 Bonn, Germany

We report on the theoretical prediction of dynamically stable molecular states in a system of two atoms which interact through discrete quantum walks [1]. This novel dynamical binding mechanism is explained in terms of an interference effect which leads to an exponential localization of the relative position of the two atoms. The interference is brought about by the coherent collisional phase accumulated in the on-site interactions. The evolution of the molecular states is studied both in the unperturbed case, showing ballistic spreading of molecule wave packets, and in the case of an applied external force, displaying Bloch oscillations at twice the frequency of single particles.

A proposal to experimentally implement this molecular dynamical binding will be also discussed under the realistic conditions of an existing experiment [2]. Taking advantage of the anomalously large triplet scattering length of Cs atoms (a_T=2400 a_0) we expect sufficiently strong interactions to allow the observation of coherent evolution of molecules in the range of 20–50 quantum walk steps.

[1]: A. Ahlbrecht *et al.*, arXiv:1105.1051v1 (2011)
[2]: M. Karski *et al.*, Science 325, 174 (2009)

A 40.4 Thu 16:30 Poster.V

Atomic collisions with high angular momenta interactions in axially symmetric geometries — •Panagiotis Giannakeas[1], Vladimir Melezhik[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Germany — [2]Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, Russian Federation

We observe and analyze d-wave resonant scattering of bosons in tightly confining harmonic waveguides. It is shown that the d-wave resonance emerges in the quasi-1D regime as an imprint of a 3D d-wave shape resonance. A scaling relation for the position of the d-wave resonance is provided. By changing the trap frequency, ultracold scattering can be continuously tuned from s-wave to d-wave resonant behavior. Additionally, we observed similar effect for fermionic collisions, where an f-wave shape resonance from the free space interferes with a p-wave confinement-induced resonance. The effect can be utilized for the realization of ultracold atomic gases interacting via higher partial waves and opens a novel possibility for studying strongly correlated atomic systems.

A 40.5 Thu 16:30 Poster.V

Cold, Magnetically-Trapped Br Atoms — William Doherty, •Jessica Lam, Christopher Rennick, and Tim Softley — Department of Physical and Theoretical Chemistry, Univeristy of Oxford, Chemistry Research Laboratory, Mansfield Road, Oxford, United Kingdom

Photodissociation of molecular bromine near threshold produces a pair of bromine atoms that recoil along the polarization axis of the laser. At an appropriate wavelength, the velocity vector of one of the atoms can be aligned to exactly oppose the molecular beam velocity; this atom will then be stopped in the lab frame. The stopped atoms are probed by delayed multiphoton ionization. We have constructed a 300 mK deep magnetic trap with the field minimum at the intersection of the molecular beam with the photodissociation laser. The trap is filled from the photofragment velocity distribution, and the Br density accumulates with successive molecular beam pulses. We have developed a molecular dynamics model of the bromine atoms in the magnetic trapping field, including collisions with the molecular beam backing gas and vacuum chamber background pressure. This shows that, while a fraction of the atoms are lost through collisions with xenon, sufficient numbers are re-loaded on each shot to accumulate a steady-state density after a few seconds.

A 40.6 Thu 16:30 Poster.V

Dark-bright ring solitons in Bose-Einstein condensates — •Jan Stockhofe[1], Panayotis G. Kevrekidis[2], Dimitri J. Frantzeskakis[3], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Deutschland — [2]Department of Mathematics and Statistics, University of Massachusetts, USA — [3]Department of Physics, University of Athens, Greece

We study dark-bright (DB) ring solitons in two-component Bose-Einstein condensates. In the limit of large densities of the dark component, we describe the soliton dynamics by means of an equation of motion for the ring radius. The presence of the bright, "filling" species is demonstrated to have a stabilizing effect on the ring dark soliton. Near the linear limit, we discuss the symmetry-breaking bifurcations of DB soliton stripes and vortex-bright soliton clusters from the DB ring and relate the stabilizing effect of filling to changes in the bifurcation diagram. Finally, we show that the stabilization by means of a second component is not limited to the radially symmetric structures, but can also be observed in a cross-like DB soliton configuration.

A 40.7 Thu 16:30 Poster.V

Hybrid quantum systems of Ultracold Atoms and Superconductors — •Helge Hattermann, Florian Jessen, Simon Bernon, Daniel Cano, Daniel Bothner, Martin Knufinke, Matthias Kemmler, Reinhold Kleiner, Dieter Koelle, and Jozsef Fortagh — Physikalisches Institut, Eberhard-Karls-Universität Tübingen, CQ Center for Collective Quantum Phenomena and their Applications, Auf der Morgenstelle 14, D-72076 Tübingen, Germany

Hybridizing quantum systems such as ultracold atoms and superconductors is of very first interest for quantum information processing. In this poster, we will report on the experimental realization and recent progress of our superconducting atom chip experiment. We will, in particular, discuss two physical effects that were shown to affect our magnetic trap properties and that are the Johnson noise and the Meissner effect.

Combining in a single experiment solid state and cold atom physics is also a technical challenge. To succeed, we developed the fabrication and interfacing of integrated niobium thin film superconducting chips to make them compatible to both ultra-high vacuum and cryogenic environment. The microtrap formed by this superconducting chip allowed us to reach a gas in the quantum degeneracy regime showing the feasibility of such hybrid systems. We also report on the recent progress obtained to couple cold atomic sample to superconducting microstructures at liquid helium temperature.

A 40.8 Thu 16:30 Poster.V

Degenerate mixtures of ultracold ^{40}K-^{6}Li Fermions in low dimensions — •Franz Sievers, Norman Kretzschmar, Diogo Fernandes, Frederic Chevy, and Christophe Salomon — Laboratoire Kastler Brossel, Paris

We present the design of our new apparatus for creating cold mixtures of ^{6}Li and ^{40}K Fermions with which we intend to study condensed matter physics phenomena. Our experimental setup will allow us to simulate several Hamiltonians describing interacting many-body Fermionic systems in one, two and three dimensions. We report on the initial performances of our subsystems including a 2D MOT source of Potassium atoms, a Zeeman slowed Lithium beam, a dual species magnetooptical trap and a magnetic transport from the MOT- to the science chamber. We are now working on the evaporative cooling of the mixture in an optically plugged quadrupole trap. In the science chamber with large optical access periodic potentials will be realized using optical lattices and a high resolution imaging system will be installed.

A 40.9 Thu 16:30 Poster.V

Numerical solutions for Bose-Einstein condensates in $\mathcal{PT}$ symmetric double well potentials — •Daniel Haag, Dennis Dast, Holger Cartarius, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart

$\mathcal{PT}$ symmetry has been studied mainly within the context of mathematical physics. Recently it could be experimentally observed in an optical analogue by Rüter et. al.[1]. However it is desirable to observe $\mathcal{PT}$ symmetry in real quantum mechanical systems. For this purpose we investigate Bose-Einstein condensates in $\mathcal{PT}$ symmetric double well potentials. The $\mathcal{PT}$ symmetry is achieved by inducing particles to one well and extracting them from the other. We solve the nonlinear Gross-Pitaevskii equation numerically and examine the behaviour near the $\mathcal{PT}$ symmetry breaking.

[1] C. E. Rüter, K. G. Makris, R. El-Ganainy, D. N. Christodoulides, M. Segev, and D. Kip, Nature Physics 6, 198 (2010)

A 40.10 Thu 16:30 Poster.V

Variational methods for Bose-Einstein condensates in $\mathcal{PT}$ symmetric double well potentials — •Dennis Dast, Daniel Haag, Holger Cartarius, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany

$\mathcal{PT}$ symmetric Hamiltonians can have entirely real spectra [1]. Recently this has been widely studied in optical microwave guide systems with a complex refractive index [2]. However, it would be highly interesting to investigate real quantum systems that are experimentally accessible. Such a system is a Bose-Einstein condensate in a double well potential, where particles are removed in one well and injected into the other well. We examine this system by variational methods. The time-dependent variational principle is used to search stationary solutions of the nonlinear Gross-Pitaevskii equation. In addition this ansatz offers the possibility of investigating the dynamics of the system.

[1] C. M. Bender, and S. Boettcher, Phys. Rev. Lett. 80, 5243 (1998)
[2] C. E. Rüter, K. G. Makris, R. El-Ganainy, D. N. Christodoulides, M. Segev, and D. Kip, Nature Physics 6, 198 (2010)

A 40.11 Thu 16:30 Poster.V

GG-TOP a multidisciplinary atom interferometry project — •Alexander Niggebaum, Tristan Valenzuela, Vincent Boyer, and Kai Bongs — Midlands Ultracold Atom Research Centre, School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom

We present the GG-TOP project, an holistic research program in the field of atom interferometry gravity gradiometry. GG-TOP is a joint effort by physicists, civil engineers and archaeologists to develop an applications driven full tensor gravity sensor based on cutting-edge atom interferometry. The project aims to develop two sensors. On the one hand, we will build a roughed gravity gradiometer capable of field deployment for applications in Civil Engineering and Archaeology. Its sensitivity should allow the detection small underground voids or other high density-contrast features located at depths in the range of 1 to 10 meters. On the other hand we will develop a laboratory sensor where we will seek the ultimate sensitivity using the latest technologies (eg. large momentum transfer, expansion suppression of cold atom clouds, ...).

A 40.12 Thu 16:30 Poster.V

Emergence of exotic condensates from a melting bosonic Mott insulator in a 2D optical lattice — •Ulrike Bornheimer, Julia Wernsdorfer, and Walter Hofstetter — Goethe Universität Frankfurt am Main, Institut für theoretische Physik, Max-von-Laue Str. 1, 60438 Frankfurt am Main, Germany

We investigate the expansion dynamics of a bosonic quantum gas initially prepared in the Mott insulating ground state of an optical lattice. Once released from harmonic confinement, the interacting many-body system is observed to develop coherence while simultaneously populating states with finite quasi-momentum. We demonstrate that for strong and intermediate interactions the emerging condensate fraction depends on the number of particles in the MI phase rather than on the particular interaction or tunneling strength. During expansion, the condensate is observed to develop a spiked structure breaking the initial spherical symmetry of the density distribution. The expanding spikes exhibit the maximal lattice velocity, independent of other system parameters. These dynamical properties of the system are obtained by means of Gutzwiller mean-field theory and confirmed analytically.

A 40.13 Thu 16:30 Poster.V

Millikelvin System for Hybrid Quantum Devices — •Florian Jessen, Martin Knufinke, Petra Vergien, Helge Hattermann, Simon Bernon, Tobias Gaber, Matthias Kemmler, Dieter Kölle, Reinhold Kleiner, and József Fortágh — Center for Collective Quantum Phenomena and their Applications, Eberhard Karls Universität Tübingen

Hybrid quantum systems based on ultracold atoms and superconductors have been proposed to be used in quantum information processing. In these systems the logical operations will be carried out by the solid state devices, while the cold atomic ensemble can be used as a long lived memory for quantum information.

We report on the construction of a Millikelvin system which meets the requirements of long coherence and strong coupling of superconducting devices and ultracold atomic samples. The atoms are loaded into the MOT via a Zeeman slower and transported close to the superconductiong devices by means of a magnetic conveyor belt within the Millikelvin environment.

A 40.14 Thu 16:30 Poster.V

Inelastic Confinement-Induced Resonances in Low-Dimensional Quantum Systems — •Simon Sala, Philipp-Immanuel Schneider, and Alejandro Saenz — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstrasse 15, 12489 Berlin

Ultracold atomic systems of reduced dimensionality show intriguing phenomena like fermionization of bosons in the Tonks-Girardeau gas or confinement-induced resonances (CIRs) which allow for a manipulation of the interaction strength by varying the trap geometry. Here, a theoretical model is presented describing inelastic confinement-induced resonances which appear in addition to the regular (elastic) ones and were observed in the recent loss experiment of Haller et al. in terms of particle losses [1]. These resonances originate from possible molecule formation due to the coupling of center-of-mass and relative motion. The model is verified by ab initio calculations and predicts the resonance positions in 1D as well as in 2D confinement in agreement with the experiment. This resolves the contradiction of the experimental observations to previous theoretical predictions.

[1] E. Haller et al., *Phys. Rev. Lett.* **104**, 153203 (2010).

A 40.15 Thu 16:30 Poster.V

Few-fermion systems in multiple well potentials — •Vincent

Klinkhamer[1,2], Friedhelm Serwane[1,2], Thomas Lompe[1,2], Gerhard Zürn[1,2], Andre Wenz[1,2], and Selim Jochim[1,2] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Physikalisches Institut, Heidelberg

With our current experimental setup it is possible to reliably prepare systems with up to 10 fermionic ^{6}Li atoms in a single optical microtrap. The inter-particle coupling can be tuned to study interacting few-particle systems inside the potential. We will extend the current setup in order to create a small array of such microtraps which will allow us to explore systems in periodic potentials. We present our progress creating this setup. The multiple wells will be created using a high resolution objective with a NA of 0.6 which is optimized for two wavelengths, 1064nm and 671nm. The high numerical aperture ensures a high detection efficiency of the fluorescence signal at 671nm. Starting point of our experiments will be a ground state system in one microtrap. It will be split adiabatically into a multiple well potential using a 2-D acousto-optical deflector. With this setup one can examine the tunneling behavior of the particles leading to magnetic ordering in an ultracold Fermi gas.

A 40.16 Thu 16:30 Poster.V

Semiclassical Dynamics of Ultracold Bosons in Multiple Wells — •Lena Simon and Walter T. Strunz — Institut für theoretische Physik, TU Dresden, Dresden

We aim to shed light on the transition from a nonequilibrium to an equilibrium state of an interacting bosonic manybody system. We investigate the dynamics of an ensemble of Bosons in a multiple well potential, which has been initially set up in a nonequilibrium state. The Bosons display interesting dynamics, gouverned by the interplay of tunneling and the interaction amongst the particles. The dynamics are investigated by solving the full Schroedinger equation for a Bose-Hubbard-model, by introducing the WKB-approximation and finally by means of the so called (semiclassical) Herman-Kluk propagator. The results are also compared to the often applied mean-field approximation.

A 40.17 Thu 16:30 Poster.V

Interaction of ultracold rubidium atoms with trapped OH^--ions — •Bastian Höltkemeier[1], Simone Götz[1], Matthias Weidemüller[1], Thorsten Best[2], Roland Wester[2], and Johannes Deiglmayr[3] — [1]Physikalisches Institut, Philosophenweg 12, 69120 Heidelberg — [2]Institut f. Ionenphysik und Angewandte Physik, Technikerstraße 25/3, 6020 Innsbruck — [3]Laboratory of Physical Chemistry, ETH Hönggerberg, Wolfgang-Pauli-Strasse 10, 8093 Zürich

Based on previous experiments on ion-atom reactions, we present a new setup to investigate the interaction of ultracold rubidium atoms in a Dark-SPOT and mass-selected OH^--water clusters. The ions are trapped in an octupole RF-trap consisting of thin wires instead of metal rods to give maximum optical access.
In first experiments, this setup will be used to investigate cooling of the ions due to collisions with the neutral Rb-atoms. For efficient cooling a dense cloud of atoms preferably in the ground state, to minimize ion-losses due to collisions with excited atoms, is needed. In a recent experiment we succeeded in creating a cloud of 4×10^8 atoms at a peak density of up to 3×10^{11}atoms/cm^3 which can be loaded in less than two seconds from a 2D-MOT. In this Dark-SPOT we estimated that about 95% of the atoms are in the ground state, perfectly fulfilling our requirements for efficient cooling of ions. This setup will now be adapted for our future OH^- experiments.

A 40.18 Thu 16:30 Poster.V

Thermodynamic properties of 2D dipolar gases — •Alexey Filinov und Michael Bonitz — Institute for Theoretical Physics and Astrophysics, Christian-Albrechts-Universität, Kiel, Germany

We perform the path integral Monte Carlo simulations to study the finite temperature properties of interacting dipolar Bose gas in two-dimensional geometry in the grand canonical ensemble. We investigate the equation of state, the temperature dependence of the superfluid fraction, the quasi-condensate n_0, the momentum distribution and the isothermal compressibility κ for temperatures above and below the Berezinskii-Kosterlitz-Thouless crossover to the superfluid phase. The increase in the occupation of the zero-momentum state n_0 leads to suppression of the density fluctuations and a non-monotonic behavior of the compressibility κ in the presuperfluid regime. We also analyse dependence of the phonon-maxon-roton excitation branch and the dynamic structure factor on the chemical potential (or density) and temperature. The spectrum of longitudinal collective modes is reconstructed from the imaginary time density-density correlation function.

A 40.19 Thu 16:30 Poster.V

Anisotropic pair-superfluidity of trapped two-component Bose gases — •Yongqiang Li, Liang He, and Walter Hofstetter — Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, 60438 Frankfurt/Main, Germany

We theoretically simulate the pair-superfluid phase of homogeneous and trapped two-component ultracold gases in an optical lattice with attractive inter-species interactions, by means of Bosonic Dynamical Mean Field Theory. We obtain the phase diagram for filling $n = 1$ at zero and finite temperature for asymmetric parameters in a three dimensional optical lattice, and confirm the stability of pair superfluidity in a wide range of parameters. We calculate the critical temperature of the pair-superfluid phase. In the presence of an external trap, we discuss the effects of inhomogeneity and imbalance between the two species on the pair-superfluid phase.

A 40.20 Thu 16:30 Poster.V

Interference of a Rydberg-dressed Bose-Einstein condensate released from an optical lattice — •Lama Hamadeh, Weibin Li, and Igor Lesanovsky — School of Physics and Astronomy, The University of Nottingham, Nottingham NG7 2RD, UK

We study the interference of bosonic atoms in a superfluid state released from an optical lattice. The electronic ground state of each atom is weakly coupled to a highly excited Rydberg state by a far-off-resonant laser. This admixture of the Rydberg state induces effective short-range and long-range interactions between ground state atoms. We study the influence of the far-off-resonant laser driving on the interference pattern produced when the atoms are released from the optical lattice. For a fixed dressing time, the interference pattern depends strongly on the relative strength of the short-range and long-range interactions. Our study reveals that the corresponding visibility differs significantly for different momentum components of the expanded atomic cloud. As a result, the momentum dependent visibility can be used to distinguish the relative strength of the long-range and the short-range interactions.

A 40.21 Thu 16:30 Poster.V

Towards probing of fermionic quantum many body systems on the single atom level — •Martin Boll[1], Ahmed Omran[1], Thomas Gantner[1], Timon Hilker[1], Michael Lohse[1], Seth Coleman[1], Immanuel Bloch[1,2], and Christian Gross[1] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str.1, 85748 Garching — [2]Ludwig-Maximilians-Universität München, Fakultät für Physik, Schellingstraße 4, 80799 München

Ultracold atoms in optical lattices have proven to be a powerful tool for investigating quantum many body systems. Recent experiments have demonstrated the power of single-site resolved detection in optical lattices for the study of strongly correlated bosonic many body systems. In our new experiment we plan to apply similar techniques to fermionic systems. We will use mixtures of Li-6 and Li-7 atoms to achieve a degenerate bosonic or fermionic many body system trapped in a 3D optical lattice. With a high resolution imaging system, we will be able to resolve single sites in a 2D plane of the lattice and image single atoms. Superimposing an additional small-scale pinning lattice onto the larger-scale physics lattice in order to freeze out the distribution of atoms during imaging, we separate the detector from the physical system under study. This will allow for the investigation of different lattice geometries with in-situ detection of the atoms and precise measurement of the momentum distribution. As a first application we plan to study the quantum phases of the Fermi-Hubbard Hamiltonian locally, and investigate the underlying phenomena associated with condensed matter systems, e.g. quantum magnetism.

A 40.22 Thu 16:30 Poster.V

Spin dynamics and Rydberg excitations on the single-atom level — •Peter Schauss[1], Takeshi Fukuhara Fukuhara[1], Marc Cheneau[1], Manuel Endres[1], Christian Gross[1], Stefan Kuhr[1,2], and Immanuel Bloch[1,3] — [1]Max-Planck-Institut für Quantenoptik, 85748 Garching — [2]University of Strathclyde, SUPA, Glasgow G4 0NG, UK — [3]Ludwig-Maximilians-Universität, 80799 München

Recently, we demonstrated single atom imaging of a quantum gas in an optical lattice [1] and site selective spin manipulation [2]. Here we report on the most recent results obtained using this apparatus: the spreading of a single spin impurity in a fully polarised Mott insulator and the excitation of Rydberg atoms in a quantum gas. In the first project, we make use of a Spatial Light Modulator to flip the spin of a single atom in a fully polarised 1D Mott insulating state. We subsequently record the spreading dynamics of this impurity and distinguish between different regimes depending on the lattice depth. The goal of the second project is to add long-range interactions to our system via Rydberg dressing. The high spatial resolution of our imaging system should allow us, for example, to reveal the strong correlations induced by the long-range interaction.

[1] J. Sherson et al., Nature 467, 68 (2010)

[2] C. Weitenberg et al., Nature 471, 319 (2011)

A 40.23 Thu 16:30 Poster.V

Evaporation limited loading of an atomic trap — Markus Falkenau, •Valentin V Volchkov, Jahn Rührig, Hannes Gorniaczyk, Mesut Ceylan, Tilman Pfau, and Axel Griesmaier — 5.Physikalische Institut, Universität Stuttgart, Pfaffenwaldring 57, Stuttgart, 70569

Recently, we have experimentally demonstrated a continuous loading mechanism for an optical dipole trap from a guided atomic beam [1]. The observed evolution of the number of atoms and temperature in the trap are consequences of the unusual trap geometry. On this poster, we present a model based on a set of rate equations to describe the loading dynamics of such a mechanism. We consider the collision statistics in the non-uniform trap potential that leads to twodimensional evaporation. The comparison between the resulting computations and experimental data allows to identify the dominant loss process and suggests ways to enhance the achievable steady-state atom number and phase-space density.

[1] M. Falkenau, V. V. Volchkov, J. Rührig, A. Griesmaier and T. Pfau, Phys. Rev. Lett. 106, 163002 (2011).

A 40.24 Thu 16:30 Poster.V

Stability and Collapse of a ^{52}Cr BEC in a 1D optical lattice — •Juliette Billy[1], Emanuel Henn[1], Stefan Müller[1], Holger Kadau[1], Thomas Maier[1], Matthias Schmitt[1], Mattia Jona-Lasinio[2], Luis Santos[2], Axel Griesmaier[1], and Tilman Pfau[1] — [1]Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart, Germany — [2]Institut für Theoretische Physik, Leibniz Universität Hannover, D-30167 Hannover, Germany

We have recently measured the stability diagram of a ^{52}Cr dipolar BEC in a 1D optical lattice, showing its strong dependence on the lattice depth [1]. This result opens up the way to investigate the collapse of this system in various regimes. The regime of deep lattice is of particular interest, as for the quasi-2D geometry of the lattice sites, roton features are expected to emerge and be enhanced. We discuss recent results on both lines of investigation, as well as future experiments on dipolar BECs in tailored multi-well potentials.

[1] S. Müller *et al.*, Phys. Rev. A **84**, 053601 (2011)

A 40.25 Thu 16:30 Poster.V

Towards stable groundstate NaK molecules — •Zhenkai Lu, Nikolaus Buchheim, Ingo Laut, Tobias Schneider, Christoph Gohle, and Immanuel Bloch — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Strasse 1, 85748 Garching

Ultracold quantum gases in optical lattices are bench mark systems for strongly interacting manybody physics [1]. Conventional alkali atomic systems at ultra low temperatures exhibit interaction potentials that have essentially zero range. Therefore the associated Hamiltonians are limited to on site interaction. If long range interaction can be achieved, many intriguing effects and new quantum phases will be accessible. This includes real space long range (crystalline) order for bulk systems, supersolids or fractional mott insulators in optical lattices, to mention a few.

Promising candidates for ultra cold particles with long range (anisotropic) interaction include Rydberg atoms as well as photoassociated ground state polar diatomic molecules.

We are setting up an experiment to create ultracold NaK molecules. In this system instability, due to inelastic two body collisions known from pioneering experiments [2] does not exist and chances are good to reach far into the interesting parameter space.

[1] Bloch, I., Dalibard, J., & Zwerger, W. Many-body physics with ultracold gases. Reviews Of Modern Physics, 80, 885*964 (2008).

[2] Ni, K.-K., Ospelkaus, S., et al. A high phase-space-density gas of polar molecules. Science, 322, 231-5 (2008).

A 40.26 Thu 16:30 Poster.V

Matter wave guiding through a photonic bandgap fiber — •Hannes Duncker, Lars Wacker, Patrick Windpassinger, and Klaus Sengstock — Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

In this contribution, we present a project where we intend to study light-matter interaction in an extremely one-dimensional geometry by loading ultracold atoms into a hollow core photonic bandgap (HCPBG) fiber. As a first step, we have been able to demonstrate guiding of cold, slow atoms through an 88 mm long piece of fiber [1]. The guiding potential is created by a far-off resonance dipole trap which propagates in the hollow core of the HCPBG fiber. By imaging the guided atoms' fluorescence signal, we are able to analyze the dynamics of the atoms inside the fiber in detail. The tight confinement of both atoms and light fields inside the fiber leads to an increased interaction probability which will allow us to study atom mediated photon-photon interaction in the future.

[1] S. Vorrath et al, NJP 12, 123015 (2010)

A 40.27 Thu 16:30 Poster.V

Non-linear and metastable dynamics of a Bose-Einstein condensate — •Holger Hauptmann[1], Sigmund Heller[1], Patrick Navez[1], Holger Kantz[2], and Walter Strunz[1] — [1]Technische Universität Dresden — [2]Max-Planck-Institut für Physik komplexer Systeme, Dresden

We examine the non-linear dynamics associated to the lowest breathing mode of a self-interacting repulsive Bose-Einstein condensate at zero temperature with the Gross-Pitaevskii equation in a three-dimensional harmonic trap under external time-periodic stretching and squeezing. This perturbation leads to collective excitations of this many-body system und we observe a resonance-like behavior. To understand this phenomenon qualitatively, we derive an approximative system of equations, which resembles equations of motion for a classical particle in an electromagnetic field and external potential. This analogy allows us to identify the resonance as emerging from a saddle point.

Furthermore we investigate the metastability of the relative motion between a Bose-Einstein condensate und its thermal cloud at finite temperature in a harmonic trap. Stirring the system at low frequencies leads to a rotation of the thermal cloud with a resting condensate. We are looking for the critical angular velocity between condensate and thermal cloud for which the system becomes unstable.

A 40.28 Thu 16:30 Poster.V

Cooling and trapping erbium atoms — •Patrizia Weiss, Florian Jessen, Claus Zimmermann, and József Fortágh — Physikalisches Institut der Universität Tübingen, Center for Collective Quantum Phenomena and their Applications

Erbium is a rare-earth element with a complex energy level structure, and a range of possible laser cooling transitions, including very strong and narrow transition lines. Erbium has a large magnetic moment of $7\mu_B$. This property makes it interesting for studying magnetic interactions between cold atoms and superconducting nanostructures.

We present our experimental progress towards cooling and trapping erbium and the current status of the setup, that is compatible with cooling nanostructures to cryogenic temperatures.

A 40.29 Thu 16:30 Poster.V

A new lattice setup for a three-component Fermi gas — •Johanna Bohn[1,2], Thomas Lompe[1,2], Martin Ries[1,2], Friedhelm Serwane[1,2], Juliana Stachurska[1,2], Andre Wenz[1,2], Gerhard Zürn[1,2], and Selim Jochim[1,2] — [1]Physikalisches Institut, Universität Heidelberg — [2]Max-Planck-Institut für Kernphysik, Heidelberg

Strongly interacting degenerate three-component Fermi gases promise to show interesting many-body physics. However, preparing such systems has so far been inhibited by large three-body loss rates which scale with the scattering length to the fourth power. On this poster we present progress towards the preparation of a three-component Fermi gas of Li-6 atoms in a two-dimensional optical lattice potential. This should allow to stabilize the three-component system by making use of the quantum-Zeno effect which suppresses three-body loss as described in [1]. We have cooled a gas of two-component ^{6}Li atoms to quantum degeneracy in an optical dipole trap and transferred atoms into the third state using a radio frequency signal. The next step is loading them into a two-dimensional light sheet onto which the two-dimensional lattice will be projected to produce a stable strongly interacting three-component Fermi gas.

[1] A. Kantian et al. PRL 103, 240401 (2009)

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Interaction quenches in a one-dimensional Bose gas — •Fedja Oručević[1], Anton Piccardo-Selg[1], Gal Aviv[1], Susanne Pielawa[2], Thomas Fernholz[1], and Peter Krüger[1] — [1]Midlands Ultracold Atom Research Centre, School of Physics and Astronomy, University of Nottingham, UK — [2]The Weizmann Institute of Science, Rehovot, Israel

Atom chips allow for almost arbitrary trapping geometries for atomic ensembles and are ideally suited for the investigation of low-dimensional ultracold quantum gases at the low temperatures.

We use such an atom chip to trap and prepare a one-dimensional quasi-condensed Bose gas. Its first order correlation function (g_1) decays algebraically slowly with distance, rather than exponentially like a non-degenerate thermal gas would. The exponent of this decay depends on the Luttinger parameter, i.e. the interaction strength in the system. The aim of our experiment is to address the question of what happens when the interaction strength in the gas is changed abruptly in a quench and how quickly the system adapts to the new Luttinger parameter. It is predicted that after some prethermalization time the gas will display correlations that would be expected for a more strongly interacting equilibrium gas. One can further ask whether or not or on which time scale full thermalization occurs. Answers to these questions can be obtained from determining phase correlations from interference patterns that form when one or two similar systems are released from the trap(s) after a varied time following the quench. The current progress of the experimental setup will be presented.

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Collisions of ultracold Rb_2 triplet molecules — •Markus Deiss, Björn Drews, Manuel Thoma, Benjamin Deissler, and Johannes Hecker Denschlag — Institut für Quantenmaterie, Universität Ulm, Albert-Einstein-Allee 45, 89081 Ulm, Germany

In recent years it has become possible to prepare ultracold and dense molecular samples in the rovibrational ground state which opens the door for novel experiments [1,2,3]. Here, we report on our current status concerning collisions between ultracold Rb_2 triplet molecules. Starting with a BEC of ^{87}Rb atoms, we use a magnetic Feshbach resonance at 1007.4G to produce a pure sample of molecules which are held in a 3D optical lattice and transferred to the rovibrational ground state by STIRAP. One question of interest is how quickly these triplet molecules relax into a singlet state.

[1] F. Lang et. al., Phys. Rev. Lett. **101**, 133005 (2008)
[2] J. G. Danzl et. al., Nature Physics **6**, 265 (2010)
[3] K.-K. Ni et. al., Science **322**, 231 (2008)

A 40.32 Thu 16:30 Poster.V

Phase control of optical lattice by the interferometer — •Amir Mohamamdi and Johannes Hecker Denschlag — Institut für Quantenmaterie, Universität Ulm, Albert-Einstein-Allee 45, 89081 Ulm, Germany

Optical lattices are used as a fundamental tool for investigating the physics of ultracold atoms [1]. Particularly interesting are superlattices, which are generated by the superposition of two lattices with different wavelengths. In a superlattice of period two, the relative height of the potential wells can be varied by controlling the relative phase of the two lattices. In this way, particles can be moved between lattice wells in a controlled way, making it possible to realize quantum information schemes or measure particle correlations [2]. We present a new scheme to stabilize the phase of a 1D optical lattice using an interferometric scheme. A Michelson interferometer is used to measure the relative phase of two counterpropagating laser beams. Using two AOMs, this phase can then be stabilized. We discuss our experimental results and compare with existing schemes.

References: [1] I. Bloch, nature physics, 1, 23, 2005.– [2] O. Romero-Isart and J. José Phys. Rev. A, 76, 052304 (2007).

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Conduction of ultracold Fermions through a mesoscopic channel — •Sebastian Krinner, Jakob Meineke, Jean-Philippe Brantut, David Stadler, and Tilman Esslinger — Institute for Quantum Electronics, ETH Zürich, 8093 Zürich, Switzerland

We present a conduction measurement of ultracold Fermions flowing through a quasi two-dimensional channel which is connected to two macroscopic atom reservoirs. A controlled imbalance of the atom number in the two reservoirs induces a current from one side to the other. We observe this current as a function of time and see a characteristic decay of the atom number imbalance to its equilibrium position. In addition we measure in-situ the density distribution in the channel for two different situations: a purely ballistic channel and a channel containing disorder. Eventhough the macroscopic atom current is the same, we observe a very different local behaviour of the atomic density in the channel and at the contacts.

A 40.34 Thu 16:30 Poster.V

Narrow-line magneto-optical trap for erbium: A simple approach for a complex atom — •Albert Frisch[1], Kiyotaka Aikawa[1], Michael Mark[1], Simon Baier[1], Rudolf Grimm[1,2], and Francesca Ferlaino[1] — [1]Institut für Experimentalphysik und Zentrum für Quantenphysik, Universität Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, 6020 Innsbruck, Austria

We report on the experimental realization of a robust and efficient magneto-optical trap (MOT) for erbium atoms, based on a weak cooling transition at 583 nm. The atomic beam is captured into the narrow-line MOT from a Zeeman slower operating on the strong optical transition at 401 nm. We observe up to $N = 3 \times 10^8$ atoms at a temperature of $T = 15\ \mu$K. This simple scheme provides better starting conditions for loading the dipole trap compared to approaches based on the strong cooling transition or on the combination of a strong and an ultra-narrow transition.

We demonstrate direct loading of the dipole trap from the narrow-line MOT without any additonal cooling stages. Finally we investigate collisional properties of ultracold dipolar erbium atoms.

Our cooling and trapping scheme simplifies the route towards quantum degneracy and thus we speculate it can be successfully applied to other atoms in the lanthanide series.