Q 64: Poster Quantengase

Zeit: Donnerstag 16:30–18:30 Raum: Poster C

Q 64.1 Do 16:30 Poster C

A BEC Setup for Rydberg Excitation — •Björn Butscher, Rolf Heidemann, Vera Bendkowsky, Ulrich Raitzsch, Helmar Bender, Robert Löw, and Tilman Pfau — Universität Stuttgart, 5. Physikalisches Institut,

We present our versatile experimental setup which allows us to excite Rubidium atoms to Rydberg states in thermal clouds as well as in Bose-Einstein condesates produced in a Ioffe-Pritchard-type magnetic trap. The setup is equipped with additional tools to control the internal and external atomic degrees of freedom in a large parameter space.

For the two photon excitation into Rydberg state we employ a diode laser setup which is stabilized to a combined two photon linewidth below 1.5 MHz. Besides a radio frequency setup to perform evaporative cooling, we use an ultra stable microwave source at 6.8 GHz for cooling purposes as well as to control the atomic density distribution. Additionally, we installed eight electric field-plates inside the vacuum chamber close to the trapped atoms, allowing to apply complex electric field distributions to the atoms. This can be utilized to generate spatially dependent Stark shifts or to field ionize Rydberg atoms state selectively. The emerging ions and electrons can be detected simultaneously by two micro-channel plates.

We also present our experimental results on collective coherent Rydberg excitation in a thermal cloud as well as first measurements on Rydberg excitation in a BEC.

Q 64.2 Do 16:30 Poster C

All roads lead to Rome – even for trapped quasi-1D bosons — •Michael Eckart, Reinhold Walser, and Wolfgang Schleich — Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany

In this contribution we use an extended mean-field theory to calculate the correlation functions up to third order of a homogeneous as well as a trapped quasi-1D gas of bosons at zero and finite temperature. The relevance of our results arises from the fact that experiments in quasi-1D geometries are presently conducted [1, 2, 3] and the theoretical analysis of the transition from the weakly correlated Gross-Pitaevskii regime to the strongly correlated Tonks-Girardeau regime is pursued by many groups [4, 5].

With our results we are also able to study the limits of an extended mean-field theory and give a clear indication where it has to be replaced by a different approach. In addition to this we also present a comparison of our full extended mean-field theory with an exact as well as an approximate solution in the homogeneous case and numerical results for the exact behavior of few-boson systems in a trapped quasi-1D geometry [6].

[1] M. Greiner *et al.*, Nature **415**, 39 (2002)
[2] D. Hellweg *et al.*, Phys. Rev. Lett. **91**, 010406 (2003)
[3] T. Kinoshita *et al.*, Phys. Rev. Lett. **95**, 190406 (2005)
[4] K.V. Kheruntsyan *et al.*, Phys. Rev. A **71**, 053615 (2005)
[5] G.E. Astrakharchik *et al.*, J. Phys. B **39**, S1 (2006)
[6] S. Zöllner *et al.*, Phys. Rev. A **74**, 053612 (2006)

Q 64.3 Do 16:30 Poster C

Nonequilibrium dynamics of an ultracold lattice Bose gas — •Thomas Gasenzer[1] and Kristan Temme[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]School of Physics & Astronomy, University of Leeds, Leeds LS2 9JT, United Kingdom

The dynamical evolution of a Bose-Einstein condensate trapped in a one-dimensional lattice potential is investigated theoretically in the framework of the Bose-Hubbard model. The emphasis is set on the far-from-equilibrium evolution in a case where the gas is strongly interacting. This is realized by an appropriate choice of the parameters in the Hamiltonian, and by starting with an initial state, where one lattice well contains a Bose-Einstein condensate while all other wells are empty. Oscillations of the condensate as well as non-condensate fractions of the gas between the different sites of the lattice are found to be damped as a consequence of the collisional interactions between the atoms. Functional integral techniques involving self-consistently determined mean fields as well as two-point correlation functions are used to derive the two-particle-irreducible (2PI) effective action. The action is expanded in inverse powers of the number of field components $\mathcal{N}$, and the dynamic equations are derived from it to next-to-leading order in this expansion. This approach reaches considerably beyond the Hartree-Fock-Bogoliubov mean-field theory, and its results are compared to the exact quantum dynamics obtained from the solution of the Schrödinger equation for small atom numbers.

Q 64.4 Do 16:30 Poster C

Measurements of scattering lengths in ultracold lithium rubidium mixtures — •Benjamin Deh, Carsten Marzok, Philippe W. Courteille, and Claus Zimmermann — Physikalisches Institut, Universität Tübingen, Auf der Morgenstelle 14, D-72076

The physics of ultracold mixtures has received enormous interest in recent times. Fascinating experiments, such as simulation of a solid state like system and the formation of ultracold dimers are conceivable. The mixture of lithium and rubidium is especially interesting due to its high mass difference. We cooled both the Fermi–Bose mixture, ^{6}Li and ^{87}Rb, and the bose–bose mixture, ^{7}Li and ^{87}Rb, to ultracold temperatures. Furthermore, we were able to measure the triplet scattering lengths of these systems. The current status of the experiment will be described.

Q 64.5 Do 16:30 Poster C

A Platform for Experiments with Multiple-Species Mixtures of Quantum-Degenerate Gases — •Matthias Taglieber, Arne-Christian Voigt, Wolfgang Wieser, Christoph Eigenwillig, Takatoshi Aoki, Theodor W. Hänsch, and Kai Dieckmann — MPI for Quantum Optics, Hans-Kopfermann-Str. 1, D-85748 Garching and LMU Munich, Schellingstr. 4/III, D-80799 Munich

Spin mixtures of quantum-degenerate fermionic gases exhibit long lifetimes in the strongly-interacting regime near a Feshbach resonance. This has opened the door for numerous key experiments like the creation of Fermi-Fermi molecules, the realization of molecular BEC, and the observation of a pairing gap and of superfluidity in a fermionic gas in the BEC-BCS cross-over region near a Feshbach resonance.

We have set up an apparatus for the generation of a two-species mixture of quantum-degenerate Fermi gases. This additional degree of freedom bears the prospect for the realization of superfluid phases with inhomogeneous order parameter, of long-range pairing due to an induced attractive interaction, and of stable, dipolar Fermi-Fermi molecules. Our production scheme for quantum-degenerate fermionic ^6Li and ^{40}K and bosonic ^{87}Rb gases is based on loading of a multiple-species magneto-optical trap with lithium from a Zeeman slower and potassium and rubidium from vapor dispensers. The atoms are then magnetically trapped and transferred from the MOT chamber to a UHV chamber, where the fermions are sympathetically cooled by rubidium. We present details of our setup and show the latest experimental results.

Q 64.6 Do 16:30 Poster C

Towards ultracold quantum gas mixtures of Rb and Cs atoms — •Andrea Prantner[1], Almar Dankmar Lange[1], Karl Pilch[1], Hanns-Christoph Nägerl[1], and Rudolf Grimm[1,2] — [1]Institut für Experimentalphysik, Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Austria

We report on our experimental effort to produce heteronuclear mixtures of Rb and Cs atoms for the realization of double-species condensates and for the formation of ultracold heteronuclear molecules. The central part of our experimental setup is a glass cell which provides optimum optical access and allows rapid magnetic field switching. We have implemented a double-species Zeeman slower to simultaneously trap Rb and Cs in a magneto-optical trap. Currently we are implementing a high-power crossed beam dipole trap in order to search for interspecies Feshbach resonances and by this to determine the interspecies collision properties. Our next step will then be to produce a double condensate and to investigate double-condensate dynamics. A double condensate is also a good starting point for efficient formation of RbCs Feshbach molecules followed by the creation of an ultracold ensemble of molecules in the ro-vibrational ground state.

Q 64.7 Do 16:30 Poster C

Precision measurements of collective oscillations in the

BEC-BCS crossover regime — •Alexander Altmeyer[1], Stefan Riedl[1,2], Christoph Kohstall[1], Matthew J. Wright[1], Edmundo R. Sanchez[1], Johannes Hecker Denschlag[1], and Rudolf Grimm[1,2] — [1]Institut für Experimentalphysik, Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften

Experiments with ultracold fermionic atoms in the vicinity of a magnetic Feshbach resonance recently entered the crossover regime between Bose-Einstein condensation (BEC) and Bardeen-Cooper-Schrieffer superfluidity (BCS). The long lifetime of pairs of two fermionic atoms makes such a system ideal for experimental studies. We present precision experiments of collective oscillations and provide detailed quantitative insights into this BEC-BCS crossover regime[1]. At any point in the crossover regime the equation of state and the density dependence of the chemical potential of the system can be determined by measuring the normalized frequencies of compression modes. Our measurements are in agreement with a quantum Monte Carlo simulation including hydrodynamic theory in the local density approximation and rule out simple mean-field BCS approaches.

[1] A.Altmeyer *et. al.*, arXiv.org/abs/cond-mat/0611285, 2006, accepted for publication in PRL.

Q 64.8 Do 16:30 Poster C

Perturbative corrections to the numerical truncated Wigner representation — •Bettina Berg, Lev Plimak, and Wolfgang P. Schleich — Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany

We investigate perturbative corrections to the truncated Wigner representation for nonlinear bosons interacting via a quartic potential. Our scheme includes the third-order-noise correction to the "Langevin"equation in the phase space. Unlike the method developed recently by Polkovnikov [1], our approach allows for corrections to multi-time averages, giving access to spectra and similar characteristics of the quantum system. We present the results for the nonlinear oscillator and for two nonlinear oscillators coupled by a Josephson junction.

[1] Anatoli Polkovnikov, *Quantum corrections to the dynamics of interacting bosons: Beyond the truncated Wigner approximation*, Phys. Rev. A 68, 053604 (2003).

Q 64.9 Do 16:30 Poster C

Bloch-Oscillations of Atoms in Optical Multi-Photon Lattices — Tobias Salger[1], •Sebastian Kling[1], Carsten Geckeler[1,2], Gunnar Ritt[2], and Martin Weitz[1,2] — [1]Institut für Angewandte Physik der Universität Bonn, Wegelerstr. 8, 53115 Bonn — [2]Physikalisches Institut der Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen

We report on experiments studying quantum transport of atoms in periodic potentials of variable spatial periodicity. Besides ordinary standing wave lattices with $\lambda/2$ spatial periodicity, we studied four-photon lattices with $\lambda/4$ spatial periodicity. Such multiphoton lattices are realized using the dispersion of higher order Raman transitions. The spatial structure of both lattices can be investigated by diffraction of an atomic Bose-Einstein condensate off the periodic potential. In subsequent experiments, we studied Bloch oscillation in accelerated $\lambda/2$ and $\lambda/4$ spatial periodic lattices. The Bloch oscillation frequency is directly related to the spatial periodicity of the corresponding lattice potential. Of special interest were determinations of the effective atom mass, which at comparable lattice depth for the multiphoton-lattice near the band edge reaches its smallest absolute values.

Q 64.10 Do 16:30 Poster C

Generation and investigation of filled solitons in spinor BEC — •Simon Stellmer, Jochen Kronjäger, Christoph Becker, Parvis Soltan-Panahi, Kai Bongs, and Klaus Sengstock — Institut für Laserphysik, Uni Hamburg, Germany

We discuss a scheme to generate filled solitons in a multi-component BEC. Phase-imprinting on one component and a simultaneous transfer between hyperfine-states using a Raman-laser system creates so-called filled solitons. This will be achieved by the use of two spatial light modulators (SLM). We present several options for the manipulation of quantum gases by nearly arbitrary light patterns in intensity, phase, and time resolution. These can be addressed with these systems by a conventional computer. The SLMs, as well as the detection system, have been tested with sufficient precision. Future investigation will focus on the dynamics of a single soliton as well as the interaction of several solitons.

Q 64.11 Do 16:30 Poster C

Interacting Rubidium and Caesium Atoms — •Shincy John, Michael Haas, Vanessa Leung, Lars Steffens, Claudia Weber, Daniel Frese, Dietmar Haubrich, Arno Rauschenbeutel, and Dieter Meschede — Institut für Angewandte Physik, Universität Bonn, Wegelerstr. 8, 53115 Bonn

In our experimental set up we simultaneously store Rubidium and Caesium in a magnetic trap. We use species-selective microwave cooling on the Rubidium groundstate hyperfine transition. Caesium is sympathetically cooled via elastic collisions with Rubidium. We are thus able to cool down the mixture to temperatures below 1 μK. Below 4 μK we observe strong losses of Caesium.
Analysing the dynamics of sympathetic cooling we are able to estimate a lower limit for the Rubidium-Caesium s-wave scattering length.

Q 64.12 Do 16:30 Poster C

A Scanning Electron Microscope for Ultracold Atoms — •Peter Würtz, Daniel Reitz, Nils Hommerstad, Tatjana Gericke, and Herwig Ott — Institut für Physik, Universtität Mainz; 55099 Mainz, Germany

We present our experimental apparatus that we are setting up in order to detect single atoms with high spatial resolution in ultracold quantum gases. For this purpose we have implemented a scanning electron microscope in a standard BEC apparatus. In our main chamber we achieve a vacuum level of 1×10^{-10} mbar. With help of a movable test target which is installed inside the chamber we have demonstrated a spatial resolution of $50\,nm$ for a beam current of $10\,nA$ and a beam energy of $6\,keV$. The atoms are collected in a 3D MOT and successfully transferred in a single beam CO_2 dipole trap. We are currently preparing the system for evaporative cooling and perform first tests of the ion detectors.

Q 64.13 Do 16:30 Poster C

Solitary Excitations in Suprafluid Quantum Gases from the Viewpoint of the Kuramoto Model — •Stefan R. Arnold, Reinhold Walser, and Wolfgang P. Schleich — Institut für Quantenphysik, Universität Ulm, Germany

We examine the stability of solitons in superfluid quantum gases by means of the Kuramoto model [1,2]. This popular model of statistical physics describes the synchronization of classical oscillators with different eigen frequencies and a non-linear coupling. For example, this is experienced in every day life by the sudden synchronization of applause in a concert hall. When the coupling strength is increased beyond a critical value, a phase transition occurs.

In this presentation we will study an analogous situation by considering the time dependent excitations of the soliton [3,4] in a harmonic trap as the non-linearly coupled oscillator modes. By including quadratic corrections beyond the standard linear response calculations we can formulate a Kuramoto-like situation where different Bogoliubov modes exhibit a phase dependent coupling.

[1] U. Parlitz, A. Pikovsky, M. Rosenblum, and J. Kurths, Physik Journal **5**, 33–40 (2006)
[2] S. H. Strogatz, Physica D **143**, 1–20 (2000)
[3] S. Burger *et al.*, Phys. Rev. Lett. **83**, 5198–5201 (1999)
[4] J. Denschlag *et al.*, Science **287**, 97–100 (2000)

Q 64.14 Do 16:30 Poster C

Quantum Dynamical vs. Boltzmann description of an equilibrating Ultracold Bose Gas — •Alexander Branschädel and Thomas Gasenzer — Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg

A dynamical many-body theory is presented which systematically extends beyond mean-field and perturbative quantum-field theoretical procedures. It allows us to study the dynamics of strongly interacting quantum-degenerate atomic gases. The non-perturbative approximation scheme is based on a systematic expansion of the two-particle irreducible effective action in powers of the inverse number of field components. This yields dynamic equations which contain direct scattering, memory and "off-shell" effects that are not captured by the Gross-Pitaevskii equation and go far beyond Quantum Boltzmann type descriptions. We apply the theory to a homogeneous ultracold Bose gas in one spatial dimension. Considering the time evolution of an initial state far from equilibrium we show that it quickly evolves to a non-equilibrium quasistationary state and discuss the possibility to attribute an effective temperature to it. The approach to thermal equilibrium is found to be extremely slow. We compare in detail the predictions of the full quantum dynamical theory to that of a kinetic, i.e. Quantum Boltzmann description of the equilibration.

Q 64.15 Do 16:30 Poster C

Transport Properties in a Mott-like State of Molecules — •Niels Syassen, Dominik M. Bauer, Matthias Lettner, Daniel Dietze, Thomas Volz, Stephan Dürr, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, 85748 Garching, Germany

In Ref. [1] we prepared a Mott-like quantum state of molecules. This state has exactly one molecule at each site of an optical lattice. We now study the transport properties in this state. The tunneling amplitude for a molecule J_m can bring two molecules to the same site. If this happens, then the molecules can collide inelastically, leading to loss of both molecules from the sample. This loss occurs with a rate coefficient Γ which is typically much faster than $J_m/\hbar$. The fast on-site loss leads to a suppression of tunneling. Loss from the initial state effectively occurs with a rate $\Gamma_{\text{eff}} \propto J_m^2/\Gamma$. This prediction agrees with our experimental results measured at different lattice depths. It shows that a fast on-site loss rate Γ can suppress tunneling in the Mott-like state, much like a strong on-site repulsion suppresses tunneling in a usual Mott insulator.

[1] T. Volz et al. *Nature Physics* **2**, 692–695 (2006).

Q 64.16 Do 16:30 Poster C

Einzelatomdetektor auf einem Chip — •David Komma, Alexander Stibor, Sebastian Kraft, Andreas Günther, József Fortágh und Claus Zimmermann — Physikalisches Institut der Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen

In bisherigen Experimenten in magnetischen Mikrofallen werden überwiegend atomare Wolken mit großen Atomzahlen manipuliert, welche durch Absorptionsabbildung nachgewiesen werden können. Die Manipulation einzelner Atome erfordert jedoch die Entwicklung neuartiger Detektionsmethoden.

Wir präsentieren einen Einzelatomdetektor, der auf der zustands- und ortsselektiven Photoionisation von Atomen und dem anschließenden Nachweis der Ionen durch ein Channeltron beruht. Wir stellen den experimentellen Aufbau und die Ergebnisse zur Photoionisation von Atomen an der Chipoberfläche vor. Die Effizienz des Detektors bestimmen wir durch Korrelationsmessungen.

Q 64.17 Do 16:30 Poster C

Theory of spinor Bose-Einstein condensates: ground state and coherent dynamics — •Frank Deuretzbacher[1], Kai Bongs[2], Klaus Sengstock[2], and Daniela Pfannkuche[1] — [1]I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstr. 9, 20355 Hamburg, Germany — [2]Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

We study the dynamics of F = 1 and F = 2 spinor Bose-Einstein condensates following the experiments of Kronjäger *et al.* [1]. The evolution of these systems is commonly described by a coupled set of mean-field equations. We apply the single-mode approximation and afterwards diagonalize the Hamiltonian exactly in spin space [2,3]. In this approximation the Hamilton matrix has a band structure allowing the description of condensates with large particle numbers. We compare our results with mean-field simulations.

Furthermore, we study ground state properties of few (up to 5) strongly interacting spinor bosons. In this regime the *complete* Hamiltonian is diagonalized exactly and many properties, such as the energy spectrum, the densities, the momentum distribution, and the correlation function show an interesting new behavior.

[1] J. Kronjäger *et al.*, Phys. Rev. A **72**, 063619 (2005).
[2] C. K. Law, H. Pu, and N. P. Bigelow, Phys. Rev. Lett. **81**, 5257 (1998).
[3] L.I. Plimak, C. Weiß, R. Walser, and W. P. Schleich, Opt. Comm. **264**, 311 (2006).

Q 64.18 Do 16:30 Poster C

A new generation all-optical Cesium BEC — •Manfred Mark, Gabriel Rojas-Kopeinig, Anton Flir, Elmar Haller, Mattias Gustavsson, and Hanns-Christoph Nägerl — Institut für Experimentalphysik, Universität Innsbruck, Austria

We report on producing a BEC with Cs atoms in a new generation setup. The condensate with 10^5 atoms is formed every 8 sec in a glass cell apparatus with maximum optical access and fast magnetic field control.

A BEC of Cs atoms with tunable s-wave scattering length and several Feshbach resonances at low magnetic fields represents an ideal starting point for experiments in which the interaction properties are to be tuned and for the production of ultracold molecules.

After optical pre-cooling we load 10^7 atoms at a temperature of 1 μK into a large-volume crossed optical dipole trap generated by a high power fiber laser. To reach degeneracy the atoms are transferred to a focused crossed "dimple" trap where the density is high enough to allow for efficient evaporation.

Here we report on our progress with setting up an atom interferometer in the non-interacting limit to determine the fine structure constant α via a measurement of the photon recoil frequency* without perturbing mean-field shifts.

* *S. Gupta et al., Phys. Rev. Lett.* **89** *140401 (2002)*

Q 64.19 Do 16:30 Poster C

Towards an atom laser by all-optical means for Atom Interferometry — •Maic Zaiser, Waldemar Herr, Christian Schubert, Tobias Müller, Michael Gilowski, Thijs Wendrich, Wolfgang Ertmer, and Ernst Maria Rasel — Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover

We present the current status of our all-optical ATom LASer (ATLAS), an experiment aiming at Bose-Einstein-Condensation (BEC) in a dilute atomic gas of ^{87}Rb by all-optical means. The project is motivated by the ultra-low temperatures feasible in a BEC which may improve the accuracy of matter wave interferometers for precision measurements. Optical dipole traps make a fast production of BEC possible allowing for a high repetition rate in an interferometer. Dipole traps also allow for the trapping of all m_F-substates, especially $m_F = 0$, being intrinsically very insensitive to magnetic noise.

The atomic source consists of a two-stage design, where a three dimensional magneto-optical trap (3D-MOT) is loaded by a 2D-MOT. We present the experimental setup consisting of a specially designed and very compact vacuum chamber and a compact laser system for atom cooling employing modular integrated and fiber-based optics allowing for a high stability of the system. We will also give a characterization of our 2D- and 3D-MOT. In the future we will investigate the suitability of a high power Thulium fiber laser at 2 μm wavelength for trapping and evaporatively cooling atoms to quantum degeneracy. This work is part of the project FINAQS funded by the European Union. (www.finaqs.uni-hannover.de)

Q 64.20 Do 16:30 Poster C

Localisation and delocalisation of ultracold bosonic atoms in finite optical lattices — •Dirk-Sören Lühmann[1], Kai Bongs[2], Klaus Sengstock[2], and Daniela Pfannkuche[1] — [1]Institut für Theoretische Physik, Universität Hamburg, Jungiusstr. 9, 20355 Hamburg, Germany — [2]Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

By tuning the potential of optical lattices from shallow to deep, repulsively interacting bosonic atoms can undergo a quantum phase transition from a superfluid phase to a Mott insulator. The transition was predicted theoretically using the Bose-Hubbard modell [1] and was recently observed experimentally [2]. We have focused on finite quasi one-dimensional lattices which can be treated with great accuracy by exact diagonalisation of the full Hamiltonian in a multiple band eigenbasis. Surprisingly, lattices with few sites show already a very similar behaviour as known macroscopically. The transition from delocalisation to localisation is reflected in the momentum distribution as well as in the energy spectrum and was proved using spatial correlation functions. In deep lattices with non-integer filling factors a precursor of a Bose glass can be observed. Beside the formation of a lowest (gapped) many-particle band the momentum distribution and correlation functions were explored.

[1] D. Jaksch et al., Phys. Rev. Let. **81**, 3108 (1998)
[2] M. Greiner et al., Nature **415**, 39 (2002)

Q 64.21 Do 16:30 Poster C

Transport of an ultracold gas of atoms into an ultrahigh-finesse optical cavity — •Ferdinand Brennecke, Tobias Donner, Stephan Ritter, Anton Öttl, Thomas Bourdel, Michael Köhl, and Tilman Esslinger — Institut für Quantenelektronik , ETH Zürich, 8093 Zürich, Schweiz

The combination of Bose-Einstein condensation and cavity quantum electrodynamics in the strong coupling regime opens the possibility to study the interaction of matter fields with a single light field mode in a highly controllable way. Here we report on the first step toward this goal which consists in the controlled transport of an ultracold gas of ^{87}Rb atoms into the mode of a Fabry-Perot type optical resonator of ultrahigh finesse. Our starting point is a Bose-Einstein condensate of about 10^6 atoms trapped in a magnetic trap located 36 mm above the cavity. We load the atoms into a vertically aligned optical standing wave potential which can be moved with a micrometer resolution by detuning the frequency difference of the two counter-propagating laser beams. Ending up with an ultracold cloud of about 5×10^5 atoms in a crossed beam optical dipole trap intersecting the resonator mode, we reach the regime of very strong coupling in cavity quantum electrodynamics characterized by a cooperativity parameter larger than 10^6. By optically pumping this coupled atom-cavity system and analyzing the resulting cavity-light spectrum we study cavity enhanced Rayleigh scattering off the atoms and the excitation properties of the system.

Q 64.22 Do 16:30 Poster C

Ultrakalte bosonische und fermionische Quantengase in optischen Gittern — •Sebastian Will, Thorsten Best, Tim Rom, Ulrich Schneider, Lucia Hackermüller, Dries van Oosten, Martin Zwierlein und Immanuel Bloch — Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany

Ultrakalte bosonische und fermionische Quantengase in optischen Gittern erlauben die kontrollierte Simulation fundamentaler Systeme der Festkörperphysik. In unserem experimentellen Aufbau können bosonisches ^{87}Rb und fermionisches ^{40}K bis zur Quantenentartung gekühlt werden. Der externe Einschluss der Atome in einer gekreuzten Dipolfalle und ein blauverstimmtes, dreidimensionales optisches Gitter erlauben eine außergewöhnliche Flexibilität in der Wahl der Potentialeigenschaften. Darüber hinaus können in dieser Konfiguration verschiedenste interne atomare Zustände präpariert und gespeichert werden. Damit ist eine große Bandbreite von Experimenten mit Fermi-Fermi- und Bose-Fermi-Gemischen möglich.

Mit unserem System konnte erstmals das “antibunching” neutraler fermionischer Atome in Rauschkorrelationen beobachtet werden. Daraus lassen sich Rückschlüsse auf die Struktur des fermionischen Bandisolators im optischen Gitter ziehen. Es war uns möglich, die Bildung und Auflösung dieses Zustands unter Änderung des externen Einschlusses zu untersuchen.

Zudem stellen wir erste Ergebnisse zu RbK-Gemischen im optischen Gitter vor und gehen dabei auf die Verteilung der Atome auf die Gitterplätze ein.

Q 64.23 Do 16:30 Poster C

Bose-Einstein Condensates in superconducting Nb microtraps — •Daniel Cano, Brian Kasch, Matthias Kemmler, Michael Gierling, Dieter Kölle, Reinhold Kleiner, Claus Zimmermann, and József Fortágh — Physikalisches Institut der Universität Tübingen

This poster shows technical and theoretical aspects of a new experiment that aims to realize Bose-Einstein condensation (BEC) in superconducting microtraps.

A cloud of 87-Rb atoms will be evaporatively cooled in a magnetic trap until a BEC is formed. Subsequently, the condensate will be transferred by means of optical tweezers into a magnetic micro-trap generated on a Niobium chip at 4,2 K.

Magnetic fields in the vicinity of superconducting surfaces have been simulated. Inhomogeneous current densities within the superconductor have been calculated using an energy-minimization procedure that relies on the London equations.

Superconducting chips have been produced by means of optical lithography and a lift-off technique. Different magnetic-field configurations as well as possible trap geometries are depicted. The measured electronic properties of the fabricated chips are shown together with the current stage of the experiment.

Q 64.24 Do 16:30 Poster C

Quantum fluctuations in the time-dependent BCS-BEC crossover — •Bernhard M. Breid and James R. Anglin — Technische Universität Kaiserslautern, Fachbereich Physik, D-67653 Kaiserslautern

We present current work on a path integral approach to the time-dependent BCS-BEC crossover. In order to describe the creation of a molecular BEC out of cold fermionic atoms by a slow Feshbach sweep, we treat the molecules by means of a coherent state path integral formalism. Within the path integral, the molecules can be seen as a classical background field for the fermions. However, the dynamics of the fermionic atoms is calculated using multiple timescale analysis, assuming that the Feshbach sweep is adiabatically slow and that the resonance is narrow compared to the Fermi energy. By solving the fermionic part of the time evolution first, a coherent state path integral for the molecular part remains. Using this as a starting point, we want to analyze the behaviour of the correlation length and the quantum fluctuations in the frame of an adiabatic dynamics. To reach this goal we start with the analytically solveable toy model of just two fermions forming one boson which we treat by the formalism described above. We expect that we can then generalize this method to the many-body problem.

Q 64.25 Do 16:30 Poster C

Time Evolution of a Tonks Gas in Disorder — Birger Horstmann[1,2], •Tommaso Roscilde[1], and Ignacio Cirac[1] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, 85748 Garching, Germany — [2]Institut für Theoretische Physik, Friedrich-Schiller-Universität, Max-Wien-Platz 1, 07743 Jena, Germany

Waves propagating in static disorder can become localized in a finite region of space, even for energies for which classical motion is not bounded, a phenomenon known as Anderson localization. There have been proposals and experimental attempts to observe Anderson localization in Bose-Einstein Condensates and optical lattices. In these experiments, where disorder was introduced by using laser speckles, non-classical localization by coherent backscattering could not be achieved due to the large length scale of the disorder.

We analyse a system of cold atoms in an optical lattice in presence of disorder created by the interaction with a different immobile/frozen species of atoms. Two distinguishable species of atoms in optical lattices can be realized by addressing two different internal states of the atoms. The atoms are prepared in a Tonks Gas, i.e. a one dimensional system of hard core bosons, that has been realized in experiment and can easily be treated numerically.

We find that an initially localized wavepaket remains localized during time evolution for any value of the interaction strength between the two species and that the quasi-condensation in a Tonks Gas without disorder disappears in the presence of disorder.

Q 64.26 Do 16:30 Poster C

Quantum transport of matter waves in optical speckle potentials — •Robert Kuhn[1], Christian Miniatura[2], Dominique Delande[3], Olivier Sigwarth[1], and Cord Müller[1] — [1]Universität Bayreuth — [2]Institut Non-Lineaire de Nice — [3]Laboratoire Kastler Brossel, Paris

We study quantum transport properties of ultracold atoms propagating in a disordered optical potential. Within the framework of a microscopic diagrammatic perturbation theory we derive a general expression for the disorder-averaged probability density of the expanding atomic cloud for any initial phase space distribution. We calculate weak localization corrections to the diffusion constant and determine the threshold to the Anderson localized regime.

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Collective Excitations in a Trapped Bose-Einstein Condensate with Weak Quenched Disorder — •Giovanni Falco, Axel Pelster, and Robert Graham — Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

We study how the collective mode frequencies of a condensate in a harmonic trap are shifted by the presence of additional weak quenched disorder. To this end we apply the Huang-Meng theory [1] to an inhomogeneous condensate in the Thomas-Fermi approximation. This approach describes how local condensates in the minima of the disorder potential interfere with the superfluid properties of the condensate. The consequences for the hydrodynamic equations are worked out in detail. We find that the negative shifts of the collective frequencies for the monopole and the dipole mode decrease rapidly with increasing correlation length of the disorder potential, at least if we assume that its the spatial correlation function is a Gaussian. Thus, our theory makes it possible to experimentally test the predictions of the Huang-Meng theory.

[1] K. Huang and H.F. Meng, Phys. Rev. Lett. **69**, 644 (1992)

Q 64.28 Do 16:30 Poster C

A Fermion mixture of ultracold ^{6}Li and ^{40}K — •Antje Ludewig, Tobias Tiecke, Sebastian Kraft, Steve Gensemer, and Jook Walraven — Van der Waals-Zeeman-Instituut, Universiteit van

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We report on our progress in the construction of a new apparatus for the simultaneous cooling of the Fermionic alkali isotopes ^{6}Li and ^{40}K. Our goal is to cool the mixture to degeneracy and search for novel pairing mechanisms involving Fermions of different masses.

We have constructed, for the first time, a 2D-MOT source of Li atoms directly loaded from a thermal vapor, thereby circumventing the need for a Zeeman slower. The 2D-MOT is loaded from a Li oven and as a source for K, a second 2D-MOT is loaded from ^{40}K-enriched thermal vapor.

The cold beams of both species are then loaded via differential pumping sections into a dual MOT in the main chamber. From there the cold atoms are transferred into a magnetic trap, where they can be cooled by forced microwave evaporation. After this cooling the atoms will be loaded into a dipole trap.

For the ^{40}K we have already achieved magnetic trapping and evaporation.

Q 64.29 Do 16:30 Poster C

Ultracold Atomic Gases in 1D Lattices: A combined Bloch- and Wannier Approach — •Ilona Tuerschmann, Felix Schmitt, Markus Hild, and Robert Roth — Institut fuer Kernphysik, Technische Universitaet Darmstadt

We compare different methods to describe the correlated regime of ultracold quantum gases in 1D optical lattices. Primarily we use an exact diagonalization technique which is limited to moderate system sizes. In order to reduce the dimension of the Hilbert space we apply a physically motivated basis truncation scheme. Alternativly we accomplish pertubation theory. For the single particle basis we employ Bloch functions to describe the system in the superfluid regime. In combination with the Wannier-Basis approach for the strongly interacting regime this yields to a consistent description over the full phase diagram.