Q 1: Quantengase (gemeinsam mit A)

Zeit: Montag 10:30–12:45 Raum: 6J

Q 1.1 Mo 10:30 6J

Interference of one-dimensional quasi-condensates — •Sebastian Hofferberth[1], Igor Lesanovsky[2], Stephanie Manz[1], Thorsten Schumm[1], and Jörg Schmiedmayer[1] — [1]Atominstitut der Österreichischen Universitäten, TU-Wien, Stadionallee 2, A-1020 Vienna, Austria — [2]Universität Innsbruck, Institute for Quantum Optics and Quantum Information, A-6020 Innsbruck, Austria

Phase fluctuations play an important role in one-dimensional systems, preventing true long range phase order even at zero temperature. We study the thermal phase fluctuations in a one-dimensional Bose gas by coherently splitting a single quasi-condensate and observing interference between the two resulting matter wave packets.

Our interferometer scheme is based on radio-frequency induced adiabatic potentials implemented on an atom chip, which allows us to prepare two quasi-condensates with a defined macroscopic relative phase [1] . The phase fluctuations lead to an intrinsic dephasing over time, which can be extracted from the observed interference patterns [2].

We study the dependence of the dephasing time on the density in the quasi-condensates and the trap parameters. Additionally we investigate how a finite tunnel-coupling between the two systems affects the dynamics of the relative phase.

[1] S. Hofferberth, I. Lesanovsky, B. Fischer, J. Verdu and J. Schmiedmayer, Nature Phys. 2, 710 (2006) [2] V. Gritsev, E. Altman, E. Demler and A. Polkovnikov, Nature Phys. 2, 705 (2006)

Q 1.2 Mo 10:45 6J

Comparing Contact and Dipolar Interactions in a Bose-Einstein Condensate — •Axel Griesmaier, Jürgen Stuhler, Tobias Koch, Marco Fattori, Stefano Giovanazzi, and Tilman Pfau — 5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany

We have measured the relative strength ε_{dd} of the magnetic dipole-dipole interaction compared with the contact interaction [1] in a dipolar chromium Bose-Einstein condensate [2]. We analyze the asymptotic velocities of expansion of the condensate with different orientations of the atomic magnetic moments. By comparing the experimental results with numerical solutions of the hydrodynamic equations for dipolar condensates, we obtain $\varepsilon_{dd} = 0.159 \pm 0.034$. We use this result to determine the s-wave scattering length $a = (5.08 \pm 1.06)\ 10^{-9}$m= $(96\pm20)\ a_0$ of ^{52}Cr. This is fully consistent with our previous measurements on the basis of Feshbach resonances [3] and therefore confirms the validity of the theoretical approach used to describe the dipolar Bose-Einstein condensate.

[1] A. Griesmaier *et al.*, Phys. Rev. Lett. in press (2006).
[2] A. Griesmaier *et al.*, Phys. Rev. Lett. **9**4, 160401 (2005).
[3] J. Werner *et al.*, Phys. Rev. Lett. **9**4, 183201 (2005).

Q 1.3 Mo 11:00 6J

Critical behavior of a trapped interacting Bose gas — •Tobias Donner, Stephan Ritter, Thomas Bourdel, Ferdinand Brennecke, Anton Öttl, Michael Köhl, and Tilman Esslinger — Institut für Quantenelektronik, ETH Zürich, 8093 Zürich, Schweiz

In the vicinity of a phase transition minute variations in the controlling parameters can dramatically change the properties of a system. Using a trapped Bose gas we have entered the critical regime of Bose-Einstein condensation and gained access to its beyond mean-field physics. This regime is characterized by fluctuations extending far beyond the thermal de Broglie wavelength: The length scale over which the system behaves coherently diverges, which is directly reflected in the shape of the spatial first order correlation function.

Using matter-wave interference we measure the correlation length of these fluctuations as a function of temperature. We study the divergence of the correlation length of the order parameter as the temperature approaches the critical point and determine its critical exponent for a trapped, weakly interacting Bose gas to be $\nu = 0.67 \pm 0.13$.

Q 1.4 Mo 11:15 6J

Antibunching in einem atomaren Fermigas — •Tim Rom, Thorsten Best, Dries van Oosten, Ulrich Schneider, Simon Fölling, Belen Paredes und Immanuel Bloch — Insitut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany

Entartete Quantengase in optischen Gittern könnten die Realisierung von Quantenphasen, wie zum Beispiel Antiferromagnet und Supersolid, erlauben. Zum Nachweis solcher Ordnungszustände könnten Dichtekorrelationen entscheidend beitragen. Wir berichten über die Messung von Korrelationen im Schrotrauschen eines Fermigases. Dabei konnten wir erstmals antibunching an neutralen Atomen beobachten. In unserem Experiment kühlen wir fermionische Kalium-Atome in einer optischen Falle zur Quantenentartung. Die Atome werden in ein dreidimensionales optisches Gitter geladen, wo sie bei entsprechender Wahl der Gitterparameter einen Bandisolator bilden. Die Absorptionsbilder der Atomwolke nach hinreichender Expansionszeit enthalten in ihrem Schrotrauschen die Information über den ursprünglichen Ordnungszustand, die wir durch Korrelationsanalyse sichtbar machen. Wir zeigen, wie sich daraus unter anderem die Temperatur des Fermigases rekonstruieren lässt.

Q 1.5 Mo 11:30 6J

Scissors Mode of a Strongly Interacting Fermi gas — •Stefan Riedl[1], Alexander Altmeyer[1], Christoph Kohstall[1], Matthew Wright[1], Johannes Hecker Denschlag[1], and Rudolf Grimm[1,2] — [1]Inst. of Experimental Physics and Center for Quantum Physics, Univ. Innsbruck, 6020 Innsbruck, Austria — [2]Inst. for Quantum Optics and Quantum Information, Acad. of Science, 6020 Innsbruck, Austria

A powerful method to investigate ultracold strongly interacting fermionic quantum gases is the study of collective excitation modes of the gas. Their behavior reveals the different regimes the gas can enter depending on the coupling between the Fermions. Here the scissors mode plays an important role since the qualitative behavior of the mode is different in a collisionless and hydrodynamic gas, respectively. Together with the low damping of the mode this allowed us to study the hydrodynamic to collisionless transition of the gas as a function of temperature. To distinguish between superfluid and collisional hydrodynamics we investigate the scissors mode in a slowly rotating trap, where the dynamic behavior of a superfluid is different compared to a normal gas.

Q 1.6 Mo 11:45 6J

Coherent Control of the Superfluid-to-Mott-Insulator Transition — •Andre Eckardt and Martin Holthaus — Institut für Physik, Carl von Ossietzky Universität, 26111 Oldenburg

We demonstrate that the transition from a superfluid to a Mott-insulator in the Bose-Hubbard-Modell can be controlled coherently by an oscillating force through an effective renormalization of the tunneling matrix element [1]. The mechanism involves adiabatic following of Floquet-states in combination with diabatic passing of tiny avoided crossings in the quasienergy spectrum that indicate interaction-induced resonant coupling to excited states. Deviations from this ideal dynamics result in a loss of coherence, i.e., heating of the system. We investigate conditions for a controlled time-evolution with respect to frequency, amplitude and switching time of the drive, and discuss a possible scenario for the limit of large lattices. The estimation of experimentally accessible parameters suggests that both the regime of coherent control and its limits can be observed with ultracold atoms in optical lattices.

[1] A. Eckardt, C. Weiss, and M. Holthaus, *Superluid-Insulator Transition in a Periodically Driven Optical Lattice*, Phys. Rev. Lett. 95, 260404 (2005)

Q 1.7 Mo 12:00 6J

Superradiant Rayleigh Scattering and Collective Atomic Recoil Lasing with ultracold atoms in a ring-cavity — •Sebastian Slama, Gordon Krenz, Simone Bux, Claus Zimmermann, and Philippe Courteille — Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany

We present experiments with ultracold and Bose-Einstein condensed atoms in an optical high-finesse ring cavity. This represents the first realization of BEC inside an optical resonator.

We load ultracold ^{87}Rb atoms into a ring cavity and subsequently pump one of the cavity modes. Scattering of pump light from the atoms leads to the sudden build-up of a probe light field in the non-pumped mode. The characteristic feature is the emission of a sequence of light pulses, typical for Collective Atomic Recoil Lasing (CARL)[1]. By changing the finesse of the cavity we are able to reach a regime in which Superradiant Rayleigh Scattering (SRyS) occurs[2]. This is the first observation of cavity-enhanced SRyS. We are able to observe SRyS for temperatures as high as several tens of μK. This demontrates clearly that SRyS does not rely on quantum statistical effects, but on the cooperative behaviour of the atoms.

[1] R. Bonifacio and L. De Salvo, Appl. Phys. B 60, S233 (1995).
[2] S.Inouye et al., Science 285, 571 (1999).

Q 1.8 Mo 12:15 6J

Spindomänen in F=2 87Rb Spinor-Kondensaten — •Jochen Kronjäger, Christoph Becker, Parvis Soltan-Panahi, Simon Stellmer, Kai Bongs und Klaus Sengstock — Institut für Laser-Physik, Luruper Chaussee 149 Geb. 69, 22761 Hamburg

Neue experimentelle und theoretische Untersuchungen von 87Rb Spinorkondensaten haben das grundlegende Verständnis der kohärenten Spindynamik in diesem System weit vorangebracht [1-3]. Dabei hat sich der Fokus von der semiklassischen Dynamik homogener Systeme hin zu räumlichen Effekten verschoben, die aufgrund verschiedener Mechanismen auftreten können und zu beobachtbarer Strukturbildung führen.

Spindomänen wurden bereits beobachtet in ferromagntischem F=1 87Rb [4], wo sie spontan aufgrund einer dynamischen Instabilität [5,6] auftreten. Dagegen handelt es sich bei F=2 87Rb um ein System mit antiferromagnetischem Grundzustand. Wir haben die Bildung von Spindomänen in nahezu isotroper und extrem elongierter Fallengeometrie untersucht und beobachten Strukturen auf verschiedenen charakteristischen räumlichen Skalen.

[1] M.-S. Chang et al., Nature Physics 8, 152 (2006)
[2] J. Kronjäger et al., Phys. Rev. A 72, 063619 (2005)
[3] J. Kronjäger et al., Phys. Rev. Lett. 97, 110404 (2006)
[4] L. E. Sadler at al., Nature 443, 312 (2006)
[5] W. Zhang et al., Phys. Rev. Lett. 95, 180403 (2005)
[6] J. Mur-Petit, Phys. Rev. A 73, 013629 (2006)

Q 1.9 Mo 12:30 6J

Coupling a Bose-Einstein condensate to a nanomechanical resonator — •Stephan Camerer[1], David Hunger[1], Daniel König[3], Jörg Kotthaus[3], Theodor Hänsch[1], Jakob Reichel[2], and Philipp Treutlein[1] — [1]MPQ und LMU München, Deutschland — [2]LKB, ENS Paris, France — [3]LMU München, Deutschland

The experimental fusion between quantum optics and solid-state physics is a rapidly developing and auspicious field of research. Due to the capability to control atom clouds near surfaces, atom chips are particularly well suited to provide an experimental interface between a quantum optical and a condensed matter system.

Our experiment aims at studying the interaction between small Bose-Einstein condensates (BECs) and a nanomechanical resonator on an atom chip. The coupling is mediated by a single domain magnetic island located on the resonator tip. The oscillation of the thermally driven resonator is transduced by the magnetic island into an oscillating magnetic field at the location of the BEC. On resonance, the field oscillations cause spin-flip transitions of the trapped atoms: the BEC serves as quantum probe for the mechanical motion of the resonator. For high mechanical quality factors, coherent interactions between the BEC and the resonator can be studied.

The core of our experiment is a chip which combines gold wires for a magnetic trap, free-standing nanomechanical structures and single-domain ferromagnets. It is fabricated using various lithographic, deposition and etching techniques. In the talk, the current status of the experiment is reported.