Q 38 Quantengase IV

Zeit: Mittwoch 10:40–12:55 Raum: HVI

Q 38.1 Mi 10:40 HVI

Excitation spectrum of an expanding BEC in 1D — •Antonio Negretti[1,2] and Carsten Henkel[3] — [1]Dipartimento di Fisica, Universit\'a di Trento, Italy — [2]ECT*, Villazzano, Italy — [3]Institut f\"ur Physik, Universit\"at Potsdam, Germany

We discuss the expansion of a Bose-Einstein condensate in a quasi-one-dimensional waveguide. The initial state is defined by a harmonic confinement, and the cloud expands along one direction after the aspect ratio of the confinement is suddenly changed. We compute for each time the excitation spectrum of the cloud and find that among the lowest modes, complex eigenfrequencies occur when the atom-atom interactions are sufficiently strong. This is interpreted in terms of a disruption of phase coherence due to a differential expansion velocity that exceeds the local speed of sound. A comparison to recent experiments with BECs expanding in 1D speckle potentials is made [1–3].

\Zitat{1}{Cl\'ement, Varon, Hugbart, Retter, Bouyer, Sanchez-Palencia, Gangardt, Shlyapnikov, Aspect: Phys. Rev. Lett. 95 (2005) 170409} \Zitat{2}{Fort, Fallani, Guarrera, Lye, Modugno, Wiersma, Inguscio: Phys. Rev. Lett. 95 (2005) 170410} \Zitat{3}{Schulte, Drenkelforth, Kruse, Ertmer, Arlt, Sacha, Zakrzewski, Lewenstein: Phys. Rev. Lett. 95 (2005) 170411}

Q 38.2 Mi 10:55 HVI

Collective resonance scattering from trapped BEC — •Michael Grupp, Gerrit Nandi, Reinhold Walser, and Wolfgang P. Schleich — Abteilung Quantenphysik, Universität Ulm

Two-particle Feshbach resonances have gained tremendous importance in degenerate gases, as it becomes possible to actively control the mutual interaction between particles.

Moreover, in this contribution we consider Feshbach resonances as a collective phenomenon in a mesoscopic or even macroscopic BEC. We examined the collective scattering of a superfluid droplet impinging on a two-component BEC trapped by two finite-depth external potentials. Quasi-bound excitations embedded in the scattering continuum yield collective Feshbach resonances of the BEC. For weak perturbations we have computed the transmission spectrum by the linear response theory introduced by Bogoliubov.

[1] M. Grupp, G. Nandi, R. Walser, W. P. Schleich, cond-mat/0510734
[2] U. Poulsen, K. Mølmer, Phys. Rev. A **67**, 13610(2003)
[3] J. Brand, I. Häring, J. Rost, Phys. Rev. Lett. **91**, 070403(2003)

Q 38.3 Mi 11:10 HVI

Optische Gitter für bosonische und fermionische Quantengase — •Tim Rom[1,2], Thorsten Best[1], Ulrich Schneider[1], Dries van Oosten[1] und Immanuel Bloch[1] — [1]Institut für Physik, Universität Mainz, 55099 Mainz — [2]Department für Physik, LMU München, 80799 München

Ultrakalte Quantengase in optischen Gittern haben in den letzten Jahren einen neuen experimentellen Zugang zu einer Vielzahl von Fragestellungen aus der Quantenoptik, der Quanteninformationsverarbeitung, der Vielteilchenphysik stark korrelierter Systeme und aus der Festkörperphysik eröffnet. Mit Hinblick auf die Festkörperphysik besteht ein großes Interesse, solche periodischen Lichtpotentiale nicht nur für bosonische, sondern auch fermionische Atome zu realisieren. Unter anderem können ultrakalte fermionische Atome in optischen Gittern, aufgrund der Vielzahl experimentell einstellbarer Parameter, als ein perfektes Modellsystem des Festkörpers – als ¨Quantensimulator¨ – eingesetzt werden. In unserer Gruppe wird ein optisches Gitter für entartete Quantengase von ^{87}Rb und ^{40}K aufgebaut. Es wird über den aktuellen Stand des Experimentes und erste Ergebnisse berichtet.

Q 38.4 Mi 11:25 HVI

Nonlinear Transport of Bose-Einstein Condensates Through Waveguides with Disorder — •Tobias Paul[1], Nicolas Pavloff[1], Patricio Leboeuf[2], Klaus Richter[2], and Peter Schlagheck[1] — [1]Institut für Theoretische Physik, Universität Regensburg — [2]Laboratoire de Physique Théorique et Modèles Statistiques, Université Paris Sud, Orsay

The coherent flow of a Bose-Einstein condensate in a disordered magnetic waveguide is investigated. We present analytical and numerical studies of realistic transport processes in quasi one-dimensional disorder potentials that are created on atom chips. We find that a repulsive interaction between the condensate atoms induces different transport regimes. For weak interactions we observe a stationary flow which shows typical signatures of localization; in this regime the transmission decreases exponentially with the length of the disorder region [1]. We identify a critical value for the interaction beyond which the system exhibits a transition towards a time-depedent flow with an algebraic decay of the time-averaged transmission. A comparison to a full three-dimensional simulation of the transport process through the disordered waveguide is finally presented.
[1] T.Paul, P.Leboeuf, N.Pavloff, K.Richter, P.Schlagheck, cond-mat 0509446 (2005), accepted for publication in Phys. Rev. A

Q 38.5 Mi 11:40 HVI

Mean-Field Approach to the Superfluid-Bose Glass Transition — •Matthias Timmer[1], Patrick Navez[2], Axel Pelster[1], and Robert Graham[1] — [1]Fachbereich Physik, Universität Duisburg-Essen, Universitätsstraße 5, 45117 Essen, Germany — [2]Labo Vaste-Stoffysica en Magnetisme, Katholieke Universiteit Leuven, Celestijnlaan 200 D, B-3001 Heverlee, Belgium

We describe a dilute, weakly interacting Bose gas in presence of a strong δ-correlated disorder potential, thus improving the perturbational approach of Ref. [1]. To this end, we treat the disorder with the replica method and derive a Hartree-Fock-Bogoliubov mean-field theory which generalizes the Hartree-Fock theory recently developed in Ref. [2]. The resulting condensate and superfluid density depend on the strengths of the disorder and the two-particle interaction. In particular, we focus on the location of a quantum phase transition between a superfluid and a Bose glass phase at zero temperature for a finite value of the disorder strength.

[1] K. Huang and H.F. Meng, Phys. Rev. Lett. **69**, 644 (1992).
[2] R. Graham and A. Pelster, `cond-mat/0508306`.

Q 38.6 Mi 11:55 HVI

Quantenentartete Fermi-Bose Mischung aus ^{87}Rb und ^{40}K in optischen Gittern — •Christian Ospelkaus, Silke Ospelkaus-Schwarzer, Manuel Succo, Oliver Wille, Leif Humbert, Philipp Ernst, Klaus Sengstock und Kai Bongs — Insitut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

Mischungen aus verdünnten fermionischen und bosonischen Atomen in optischen Gittern stellen Modellsysteme für festkörperphysikalische Fragestellungen dar, an denen u.a. theoretische Modelle von Hochtemperatursupraleitung getestet werden können. Wir stellen den am Institut für Laserphysik in Hamburg realisierten Aufbau zum Studium quantenentarteter Mischungen von ^{40}K und ^{87}Rb in dreidimensionalen optischen Gittern vor. Als Lichtquelle für das Gitter dient ein Yb:YAG Scheibenlaser bei 1.03 μm, der bis auf 20 kHz auf einen Referenzresonator stabilisiert ist. Wir haben ein Bose-Einstein-Kondensat in ein 3D optisches Gitter geladen und stellen Messungen der Bandstruktur zur Charakterisierung der Gittertiefe vor. In einer zweidimensionalen Gitterkonfiguration wurde eine quantentartete Mischung in das Gitter geladen; bei hohen Dichten beobachten wir u.a. Heizeffekte im Gitter. Der aktuelle Stand des Experiments wird diskutiert.

Q 38.7 Mi 12:10 HVI

Feshbach molecules from an atomic Mott insulator — •Niels Syassen, Thomas Volz, Dominik Bauer, Eberhard Hansis, Stephan Dürr, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany

Feshbach molecules from bosonic atomic species have proven to be very unstable with respect to inelastic collisions [1]. As a result, the typical lifetime observed for a cloud of ultracold $^{87}Rb_2$ molecules stored in an optical dipole trap is limited to a few milliseconds.
Here, we report on the observation of long-lived Feshbach molecules in an optical lattice. A BEC of ^{87}Rb atoms is loaded into the lowest Bloch band of a 3D optical lattice operated at a wavelength of 830 nm. By ramping up the lattice depth, the atomic gas enters the Mott insulator regime. A magnetic-field ramp through the Feshbach resonance at 1007 G creates molecules [2]. Lattice sites initially occupied with more than 2 atoms experience fast inelastic collisional losses. The observed lifetime of the remaining molecules is ~ 100 ms, which is much longer than for a pure molecular sample in an optical dipole trap. Similar results have recently

been reported in Ref. [3]. The increased lifetime is an important step on the route to a BEC of molecules in the vibrational ground state [4].

[1] T. Mukaiyama et al., Phys. Rev. Lett. 92, 180402 (2004)
[2] S. Dürr et al., Phys. Rev. Lett. 92, 020406 (2004)
[3] G. Thalhammer et al., cond-mat/0510755
[4] D. Jaksch et al., Phys. Rev. Lett. 89, 040402 (2002)

Q 38.8 Mi 12:25 HVI

BEC under microgravity — •Gerrit Nandi, Endre Kajari, Reinhold Walser, and Wolfgang P. Schleich — Abteilung Quantenphysik, Universität Ulm, Germany

Targeting the long term goal of studying Bose-Einstein condensates (BECs) on a space platform, several groups currently focus on the implementation of a BEC experiment at the ZARM drop tower in Bremen, as well as the theoretical description of a BEC under microgravity [1],[2].

In this contribution, we theoretically study the free evolution of the full three dimensional Gross-Pitaevskii equation of a freely falling BEC. Moreover, a BEC with two internal states can be used as a coherent matter-wave interferometer [3]. We outline the prospects of corresponding experiments in the drop tower.

[1] A. Vogel et al., Conference proceedings "Quantum Mechanics for Space", Paris (2005)
[2] J. F. Dobson, Phys. Rev. Lett. **73**, 2244 (1994).
[3] M. Kasevich and S. Chu, Appl. Phys. B **B 54**, 321 (1992).

Q 38.9 Mi 12:40 HVI

Mean-field expansion in Bose-Einstein condensates with finite-range interactions — •Michael Uhlmann[1], Ralf Schützhold[1], Yan Xu[1], and Uwe R. Fischer[2] — [1]Institut für Theoretische Physik, Technische Universität Dresden, D-01062 Dresden — [2]Eberhard-Karls-Universität Tübingen, Institut für Theoretische Physik, Auf der Morgenstelle 14, D-72076 Tübingen

We present a formal derivation of the mean-field expansion for dilute Bose-Einstein condensates with two-particle interaction potential which are weak and finite-range, but otherwise arbitrary. The expansion allows for a controlled investigation of the impact of the microscopic interaction details (e.g., the scaling behaviour) on the mean-field approach and the induced higher-order corrections beyond the s-wave scattering approximation. As an example, we calculate the quantum depletion in the presence of dipole-dipole interactions (in addition to the usual contact potential).