Q 47: Quantengase (Bosonen II / Fermionen)

Zeit: Donnerstag 16:30–18:45 Raum: 1A

Q 47.1 Do 16:30 1A

Mean-field description of a decaying BEC — •Astrid Niederle, Eva-Maria Greafe, Hans Jürgen Korsch, Friederike Trimborn, and Dirk Witthaut — TU Kaiserslautern, Germany

A quantum system with decay can be effectively described by a non-Hermitian Hamiltonian with complex energy eigenvalues, whose imaginary parts describe the decay rate. In this talk we focus on a non-Hermitian, two-mode Bose-Hubbard Hamiltonian, which serves as a model for a Bose-Einstein-condensate in a double-well potential with decay from one of the two wells. We discuss the dynamics of operators, which is governed by a generalized Heisenberg-equation. Taking expectation values of the operators, we obtain a mean-field approximation. The resulting dynamics described by a generalized nonlinear Bloch equation is mainly influenced by the (up to four) fixed points, which can be repulsive or attractive depending on the system parameters. The mean-field dynamics is compared with the full N-particle quantum evolution.

Q 47.2 Do 16:45 1A

Single atom detection on a magnetic microchip — •Helmar Bender[1], Andreas Günther[1], Alexander Stibor[1], Sebastian Kraft[2], József Fortágh[1], and Claus Zimmermann[1] — [1]Physikalisches Institut der Universität Tübingen, Auf der Morgenstelle 14, D-72076 — [2]van der Waals-Zeeman Instituut, Universiteit van Amsterdam, Valckenierstraat 65, 1018 XE Amsterdam, The Netherlands

The possibility to detect small amounts of atoms on a magnetic microchip opens the door to a variety of interesting fundamental experiments in the field of ultracold quantum gases. Standard absorption imaging requires a minimum number of several hundred atoms. Thus novel detection methods with single atom sensitivity are currently developed. Here, we present a single atom detector which is implemented in our magnetic microchip setup. The detection scheme is based on optical ionization of single atoms and subsequent counting of the ions in a channeltron. We discuss the characterization of the detector as well as our latest experimental data with ultracold atoms on a magnetic microchip.

Q 47.3 Do 17:00 1A

Dropping Bose-Einstein condensates over long times and large distances — •Endre Kajari, Stefan Arnold, Michael Eckart, Reinhold Walser, and Wolfgang P. Schleich for the QUANTUS-Collaboration — Institute of Quantum Physics, Universität Ulm, D-89069 Ulm

Ultracold quantum gases have the potential to extend the limits of matter-wave interferometry beyond current precision standards. In particular, the QUANTUS project [1] aims for the creation of a Bose-Einstein condensate at the drop tower facility at the "Center of Applied Space Technology and Microgravity" (ZARM) in Bremen. Such an experiment permits an unperturbed free fall of a condensate for up to 10 s. In this talk we present our theoretical contributions [2] and provide three-dimensional numerical simulations of the time dependent Gross-Pitaevskii equation, including explicit time dependent trapping frequencies. Our results are compared with the scaling approach given in [3,4].

[1] A. Vogel et al., Appl. Phys. B **84**, 664 (2006).
[2] G. Nandi et al., Phys. Rev. A (to be published 2007).
[3] Yu. Kagan et al., Phys. Rev. A. **54**, R1753 (1996).
[4] Y. Castin and R. Dum, Phys. Rev. Lett. **77**, 5315 (1996).

Q 47.4 Do 17:15 1A

Environment-induced dynamics in Bose-Einstein condensates — •Alexej Schelle[1,2], Andreas Buchleitner[2], Benoît Grémaud[1], and Dominique Delande[1] — [1]Laboratoire Kastler Brossel, 4, place Jussieu, F-75252 PARIS, cedex 05 — [2]Institute of Physics, Department for Quantum Optics and Statistics, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

We develop a master equation theory for general Bose-Einstein condensates. Starting from first principles, we find that the condensate's dynamics in the presence of the non-condensed component can be described by a Lindblad master equation, which accounts for all possible two-particle interaction processes. As a first application, we study the process of condensate formation in a 3-dimensional harmonic trap.

Q 47.5 Do 17:30 1A

Fermion- and Spin-Counting in Strongly Correlated Systems — •Sibylle Braungardt[1], Aditi Sen[1], Ujjwal Sen[1], Roy J. Glauber[2], and Maciej Lewenstein[1] — [1]ICFO - Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860 Castelldefels (Barcelona), Spain — [2]Lyman Laboratory, Physics Department, Harvard University, 02138 Cambridge, MA, U.S.A.

We apply the atom counting theory to strongly correlated Fermi systems and spin models, which can be realized with ultracold atoms. The counting distributions are typically sub-Poissonian and remain smooth at quantum phase transitions, but their moments exhibit critical behavior, and characterize quantum statistical properties of the system. Moreover, more detailed characterizations are obtained with experimentally feasible spatially resolved counting distributions.

Q 47.6 Do 17:45 1A

Interspecies Feshbach resonances and scattering properties of the ultracold Fermi-Fermi mixture ^{6}Li and ^{40}K — •Andreas Trenkwalder[1], Eric Wille[1,2], Frederik Spiegelhalder[1], Gabriel Kerner[1], Devang Naik[1], Gerhard Hendl[1], Florian Schreck[1], Rudolf Grimm[1,2], Tobias Tiecke[3], Jook Walraven[3], Servaas Kokkelmans[4], Eite Tiesinga[5], and Paul Julienne[5] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Austria — [2]Institut für Experimentalphysik und Forschungszentrum für Quantenphysik, Universität Innsbruck, Austria — [3]Van der Waals-Zeeman Institute of the University of Amsterdam, The Netherlands — [4]Eindhoven University of Technology, The Netherlands — [5]Joint Quantum Institute, National Institute of Standards and Technology and University of Maryland, Gaithersburg, USA

We present recent results on the observation of interspecies Feshbach resonances in the Fermi-Fermi mixture of ^{6}Li and ^{40}K. The mixture is stored in an optical dipole trap and is prepared in different combinations of spin states. At specific values of the magnetic field we observe enhanced atom loss which we can assign with the help of two theoretical models to *s*- or *p*-wave Feshbach resonances. The results from a simple model agree well with a full coupled channels analysis. The singlet and triplet scattering lengths are found to be 52.1(3) a_0 and 63.5(1) a_0 respectively. Our next step will be the formation of bosonic molecules at the identified Feshbach resonances leading towards the creation of a heteronuclear molecular BEC. Preprint: arXiv:0711.2916

Q 47.7 Do 18:00 1A

Dissipative dynamics of a rotating, strongly-interacting Fermi gas. — •Edmundo R. Sánchez Guajardo, Stefan Riedl, Christoph Kohstall, Alexander Altmeyer, Johannes Hecker Denschlag, and Rudi Grimm — Institut für Experimentalphysik, Technikerstrasse 25/4, A-6020 Innsbruck

We present our experiments on dissipative dynamics of a rotating ultracold gas of strongly interacting ^{6}Li atoms in a harmonic trap. In such a system both the superfluid core and the surrounding thermal gas are hydrodynamic, in contrast to weakly interacting BEC experiments where the thermal gas is collisionless. This leads to particularly long lifetimes of rotation of the thermal part, allowing for precise measurement of the angular momentum. We measure the lifetime of the angular momentum for different temperatures and trap anisotropies using collective oscillations. The measurements are in excellent agreement with the theoretical exponential decay previously predicted [Guéry-Odelin, 2000].

Q 47.8 Do 18:15 1A

Finite-Temperature Collective Dynamics of a strongly interacting Fermi Gas — •Christoph Kohstall[1], Stefan Riedl[1,2], Edmundo R. Sánchez Guajardo[1], Alexander Altmeyer[1,2], 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

Collective excitations are a powerful tool to investigate the dynamics of a strongly interacting fermionic quantum gas.

In a weakly interacting Bose gas hydrodynamic behavior coincides with superfluidity. According to BCS-theory superfluidity of fermions concurs with pairing. These two predictions are no more valid in the BEC-BCS crossover where interactions are strong; hydrodynamic behavior, superfluidity and pairing are established at different temperatures.

The focus of this talk is our experimental data on collective oscillations of an ultracold, strongly interacting gas of ^{6}Li atoms showing the transition from hydrodynamic to nearly collisionless behavior as a function of temperature. The results are in agreement with recent calculations that take into account Pauli blocking and pairing.

We find a novel feature of the scissors mode which might indicate the critical temperature for superfluidity.

In addition, radiofrequency spectra reveal the existence of atom pairs up to a temperature where the gas behaves nearly collisionless.

Q 47.9 Do 18:30 1A

Dynamics of a trapped spinor Fermi gas — Nils Bornemann, •Philipp Hyllus, and Luis Santos — Institut für Theoretische Physik, Leibniz-Universität Hannover, Appelstr. 2, 30167 Hannover

We investigate the spin dynamics of an atomic Fermi gas with a spin of $f \geq \frac{3}{2}$ in a harmonic trap. Spin-changing collisions, which induce a population tranfer between different spin components, are largely suppressed in the presence of a sufficiently large magnetic field due to the quadratic Zeeman effect.

We derive the corresponding Master equation, and neglecting coherences, we simulate the equivalent rate equation for the populations including the supressing effects of the quadratic Zeeman effect, and the trap anharmonicity. We will show that the interplay between anharmonicity and quadratic Zeeman effect leads to a resonant enhancement of the spin-changing collisions as a function of the applied magnetic field. This effect should have clearly observable consequences especially for fermions in deep optical lattices, since for bosons under the same conditions the resonances would be absent.