Q 5: Quantengase (Bose-Einstein-Kondensation)

Zeit: Montag 14:00–16:00 Raum: 6J

Gruppenbericht Q 5.1 Mo 14:00 6J

Coherence in two dimensional Bose gases — •Peter Krüger, Zoran Hadzibabic, Marc Cheneau, Baptiste Battelier, Patrick Rath, and Jean Dalibard — Laboratoire Kastler Brossel, Ecole Normale Superieure, Paris, France

Dimensionality can drastically affect the properties of cold degenerate quantum gases. In three dimensions bosonic clouds can form Bose-Einstein condensates in which full phase coherence, i.e. true long range order, extends over the entire system. This is no longer true in reduced dimensions. Two dimensional systems are special as correlations in a quasi-ordered phase decay only algebraicly and not exponentially, so that order phenomena such as superfluidity can persist.

We implement a two dimensional bosonic system with Rb-87 atoms confined in a combined magnetic and optical potential and study coherence properties by a matter wave heterodyning technique. Interference experiments between two uncoupled flat clouds allow us to study phase correlations and the superfluid to normal phase crossover known as the Berizinskii Kosterlitz Thouless crossover.

Q 5.2 Mo 14:30 6J

On the detectability of quantum radiation in Bose-Einstein condensates — •Ralf Schuetzhold — Institut für Theoretische Physik, Technische Universität Dresden, D-01062 Dresden, Germany

Based on doubly detuned Raman transitions between (meta) stable atomic or molecular states and recently developed atom counting techniques, a detection scheme for sound waves in dilute Bose-Einstein condensates is proposed whose accuracy might reach down to the level of a few or even single phonons. This scheme could open up a new range of applications including the experimental observation of quantum radiation phenomena such as the Hawking effect in sonic black-hole analogues or the acoustic analogue of cosmological particle creation.

Q 5.3 Mo 14:45 6J

From Many-Body Interaction to Nonlinearity — •Niklas Teichmann[1], Christoph Weiss[2], and Martin Holthaus[1] — [1]Institut für Physik - Carl von Ossietzky Universität - D-2611 Oldenburg - Germany — [2]Laboratoire Kastler Brossel - École normale supérieure - 24 rue Lhomond - F-75231 Paris Cedex 05 - France

A model system is introduced, which allows one to study the N-particle dynamics of an externally forced Bose-Einstein condensate at zero temperature numerically for reasonably large N, and gives rise to mean-field dynamics which can be either regular or chaotic. The correspondence between the evolution of the N-particle system, governed by the linear many-body Schrödinger equation, and the mean-field dynamics described by the nonlinear Gross-Pitaevskii equation is illustrated by various examples. This correspondence is strongly sensitive to whether or not the mean-field dynamics are chaotic.

Q 5.4 Mo 15:00 6J

Noise-induced phase transitions — •María Eckholt[1], Juan José García-Ripoll[1,2], and Ignacio Cirac[1] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching (Germany) — [2]Dpto. de Física Teórica I, Facultad de CC. Físicas, Universidad Complutense, Ciudad Universitaria s/n, 28040 Madrid (Spain)

We study the quantum phase transition of ultracold bosonic atoms in the presence of a noisy environment. The study comprehends different analytical and numerical techniques to estimate the phases of the atoms.

Q 5.5 Mo 15:15 6J

Quantum vs. Classical Dynamics of an Ultracold Bose Gas — •Thomas Gasenzer[1] and Jürgen Berges[2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstrasse 9, 64289 Darmstadt

Dynamics of an ultracold gas far from thermal equilibrium is studied with special focus on the quantum vs. the classical statistical aspects of the many-body time evolution. Knowledge about the differences between quantum and classical statistical dynamics is of particular interest for experimental and theoretical efforts to identify effects of quantum fluctuations. The employed functional-integral approach, which involves the two-particle irreducible (2PI) effective action, allows in a particularly transparent way to distinguish between the time evolution of correlation functions in the classical and quantum cases, respectively. It is shown that these cases only differ in the interaction vertices appearing in the phase factor in the generating functional. The differences in the dynamic equations beyond the purely classical Hartree-Fock-Bogoliubov mean-field theory are derived in next-to-leading order of the 2PI $1/\mathcal{N}$ approximation.

Q 5.6 Mo 15:30 6J

Transport of Bose-Einstein condensates beyond the Gross-Pitaevskii approach — •Thomas Ernst[1], Michael Hartung[1], Tobias Paul[2], and Peter Schlagheck[1] — [1]Institut für Theoretische Physik, Universität Regensburg — [2]Laboratoire de Physique Théorique et Modèles Statistiques, Université Paris Sud, Orsay

We study the transport of Bose-Einstein condensates through scattering potentials in quasi one-dimensional waveguides. While our previous works used the Gross-Pitaevskii equation to calculate this process, we employ an approach which goes beyond this mean field theory and which is able to take into account excitations of the condensate as well as its depletion rate. This approach is based on a cumulant expansion [1], where we use a truncation scheme that is formally valid for weak interactions and a large number of atoms. We apply it to the scattering problem of a propagating BEC on a double barrier potential, where resonant transmission of the condensate takes place via the population of dynamically unstable scattering states. Our results confirm the validity of previous calculations of these processes based on the Gross-Pitaevskii equation [2].

[1] T. Köhler and K. Burnett, Phys. Rev. A **65**, 033601 (2002)
[2] T. Paul, K. Richter and P. Schlagheck, Phys. Rev. Lett. **94**, 020404 (2005)

Q 5.7 Mo 15:45 6J

The many-particle mean-field correspondence for a BEC in quantum phase space — •Friederike Trimborn, Dirk Witthaut, and Hans Jürgen Korsch — FB Physik, TU Kaiserslautern, 67663 Kaiserslautern

In many cases the dynamics of a BEC is well described by a single macroscopic wave function following the Gross-Pitaevskii equation (GPE). However, the GPE takes into account only expectation values and neglects quantum fluctuations which are especially important for quantum phase transitions as the superfluid to Mott insulator transition which is therefore considered not to be explicable within mean-field theory. We will present a new approach representing many-particle quantum states by a classical phase space ensemble following a generalized GPE. This method provides an excellent tool to analyze the mean-field – many particle correspondence. Several examples will be given (e.g. the superfluid to Mott insulator transition).