Q 2 Quantengase I

Zeit: Montag 11:10–12:55 Raum: HVI

Q 2.1 Mo 11:10 HVI

Complex scaling approach to the decay of Bose-Einstein condensates — •Peter Schlagheck and Tobias Paul — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg

The mean-field dynamics of a Bose-Einstein condensate is studied in presence of a microscopic trapping potential from which the condensate can escape via tunneling through finite barriers. We show that the method of complex scaling can be used to obtain a quantitative description of this decay process. A real-time propagation approach that is applied to the complex-scaled Gross-Pitaevskii equation allows to calculate the chemical potentials and lifetimes of the metastably trapped Bose-Einstein condensate. The method is applied to a one-dimensional harmonic confinement potential combined with a Gaussian envelope, for which we compute the lowest symmetric and antisymmetric quasibound states of the condensate. A comparison with alternative approaches using absorbing boundary conditions as well as complex absorbing potentials shows good agreement.

Q 2.2 Mo 11:25 HVI

Exact tunnelling rates for the nonlinear Wannier-Stark problem — •Sandro Wimberger — CNR-INFM and Dipartimento di Fisica E. Fermi, Universita degli Studi di Pisa, Largo Pontecorvo 3, I-56127 Pisa

We present a method to numerically compute exact tunnelling rates for a Bose-Einstein condensate which is described by the nonlinear Gross-Pitaevskii equation. Our method is based on a sophisticated real-time integration of the complex-scaled Gross-Pitaevskii equation, and it is capable of finding the stationary eigenvalues for the Wannier-Stark problem. We show that even weak nonlinearities have significant effects in the vicinity of very sensitive resonant tunnelling peaks, which occur in the rates as a function of the Stark field amplitude. The mean-field interaction induces a broadening and a shift of the peaks, and the latter is explained by analytic perturbation theory. Our results are confronted with a recent experimental proposal to measure the quantum transport processes around the resonant tunnelling peaks, see S. Wimberger et al., preprint cond-mat/0506357.

Q 2.3 Mo 11:40 HVI

Theory of superradiant Rayleigh scattering from Bose-Einstein condensates — •Oliver Zobay and Georgios M. Nikolopoulos — Institut für Angewandte Physik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

We study superradiant scattering off Bose-Einstein condensates by solving the semiclassical Maxwell-Schrödinger equations describing the coupled dynamics of matter-wave and optical fields [1]. Taking the spatial dependence of these fields along the condensate axis into account, we are able to reproduce and explain many of the characteristic features observed in the experiments [2,3], such as the shape of momentum side-mode distributions for forward and backward scattering, the spatial asymmetry between forward and backward side modes, and the depletion of the condensate center observed for forward scattering.

[1] O. Zobay and G. M. Nikolopoulos, Phys. Rev. A **72**, 041604(R) (2005).
[2] S. Inouye, A. P. Chikkatur, D. M. Stamper-Kurn, J. Stenger, D. E. Pritchard, and W. Ketterle, Science **285**, 571 (1999).
[3] D. Schneble, Y. Torii, M. Boyd, E. W. Streed, D. E. Pritchard, and W. Ketterle, Science **300**, 475 (2003).

Q 2.4 Mo 11:55 HVI

Non-Abelian Atom Optics — •Andreas Jacob and Luis Santos — Institut für Theoretische Physik 3, Universität Stuttgart

We analyze the possibility to observe non-Abelian effects in the Atom Optics of cold atoms in optical lattices. After proposing realistic experimental schemes for the implementation of non-Abelian physics, we analyze the expansion of a Bose gas under non-Abelian conditions, showing the appearance of interference fringes. Additionally, we analyze non-Abelian Atom interferometers, and the effects of interactions in these arrangements.

Q 2.5 Mo 12:10 HVI

Spinor dynamics in Fock space — •Reinhold Walser, Lev Plimak, Carsten Weiss, and Wolfgang P. Schleich — Abteilung Quantenphysik, Universität Ulm, Germany

Well isolated trapped multi-component Bose gases represent an ideal environment to investigate exact many-body dynamics of simple spin systems [1-4]. In the present contribution, we will discuss static and dynamic aspects of quantum systems where only few quantized modes need to be considered. On one hand, the discrete nature of the Fock representation leads to highly efficient numerical algorithms, but on the other hand, it also leads to very intuitive description in terms of many-body potentials and effective masses.

[1] W. Zhang, D. L. Zhou, M.-S. Chang, M. S. Chapman, and L. You Phys. Rev. A, **72**, 013602 (2005)
[2] J. Kronjäger *et al.*, cond-mat/0509083, to be published Phys. Rev. A, (2005)
[3] L. Santos and T. Pfau, cond-mat/0510634 (2005)
[4] L. Plimak, C. Weiß, R. Walser and W.P. Schleich, Opt. Comm. submitted (2005)

Q 2.6 Mo 12:25 HVI

Dynamics of an ultracold quantum gas far from equilibrium — •Thomas Gasenzer, Jürgen Berges, Michael Schmidt, and Marcos Seco — Institut für Theoretische Physik, Philosophenweg 16, 69120 Heidelberg

A full quantum many-body theoretical study of the equilibration process of an ultracold Bose gas, initially in a state far away from equilibrium, is presented. In more and more experimental situations, ultracold atomic Bose and Fermi gases are driven far away from a thermal equilibrium state. Magnetic and optical Feshbach resonances as well as sophisticated trapping techniques play an important role in this progress. Precise measurements of the ensuing dynamics have become possible which have the potential for important impact in various areas of physics. The far-from equilibrium configurations of particular interest are those where quantum fluctuations become important which are not taken into account in mean-field theory. An approach to beyond-mean-field quantum many-body theory on the basis of Green-function techniques is presented. This allows to describe both the short and long-time evolution of a gas far from equilibrium. The dynamical many-body theory remains applicable at long times, where thermal equilibrium is approached. This is shown for the example of a weakly interacting one-dimensional Bose gas. The method allows to distinguish quantum and classical aspects of the dynamical evolution.

Q 2.7 Mo 12:40 HVI

Bose Gas in Disorder Potential With Arbitrary Correlation — •Patrick Navez[1], Axel Pelster[2], and Robert Graham[2] — [1]Labo Vaste-Stoffysica en Magnetisme, Katholieke Universiteit Leuven, Celestijnlaan 200 D, B-3001 Heverlee, Belgium — [2]Fachbereich Physik, Universität Duisburg-Essen, Universitätsstraße 5, 45117 Essen, Germany

We consider a dilute, weakly interacting Bose gas moving in a Gaussian distributed frozen disorder potential $V(\mathbf{x})$. Depending on the disorder correlation function $\overline{V(\mathbf{x}_1)V(\mathbf{x}_2)} = R(\mathbf{x}_1 - \mathbf{x}_2)$, this model describes superfluid helium in porous media or cold atoms trapped by magnetic fields along wires with current irregularities. In our approach we interpret the underlying zero temperature Gross-Pitaevskii equation as a spatial Langevin equation and calculate disorder ensemble averages from it. The resulting condensate and superfluid densities are determined as a function of the disorder correlation length.