Q 12: Quantengase (Unordnung)

Zeit: Montag 16:30–18:30 Raum: 6J

Q 12.1 Mo 16:30 6J

Disorder Induced Shift of Condensation Temperature for Dilute Trapped Bose Gases — •Matthias Timmer, Axel Pelster, and Robert Graham — Fachbereich Physik, Universität Duisburg-Essen. Lotharstraße 1, 47048 Duisburg, Germany

We determine the leading shift of the Bose-Einstein condensation temperature for an ultracold dilute atomic gas in a harmonic trap due to weak disorder by treating both a Gaussian and a Lorentzian spatial correlation for the quenched disorder potential. Increasing the correlation length from values much smaller than the geometric mean of the trap scale and the mean particle distance to much larger values leads first to an increase of the positive shift to a maximum at this critical length scale and then to a decrease.

Q 12.2 Mo 16:45 6J

Mean-Field Phase Diagram of Disordered Bosons in a Lattice at Non-Zero Temperature — Konstantin Krutitsky, •Axel Pelster, and Robert Graham — Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

Bosons in a periodic lattice with on-site disorder at low but non-zero temperature are considered within a mean-field theory [1]. The criteria used for the definition of the superfluid, Mott insulator and Bose glass are analysed. Since the compressibility does never vanish at non-zero temperature, it cannot be used as a general criterion. We show that the phases are unambiguously distinguished by the superfluid density and the density of states of the low-energy exitations. The phase diagram of the system is calculated. It is shown that even a tiny temperature leads to a significant shift of the boundary between the Bose glass and superfluid.

[1] K.V. Krutitsky, A.Pelster, and R.Graham, New J.Phys. **8**, 187 (2006)

Q 12.3 Mo 17:00 6J

Thermodynamics of a Bose-Einstein Condensate with Weak Disorder — •Giovanni Falco, Axel Pelster, and Robert Graham — Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

We determine the thermodynamic properties of a homogeneous superfluid dilute Bose gas in presence of weak quenched disorder. To this end we extend the Bogoliubov theory of Huang and Meng [1] to finite temperatures by applying both the Popov and the many-body T-Matrix approach. Within a high-temperature approximation we derive self-consistent equations for the temperature dependence of both the condensate density and the s-wave scattering length which generalize the theory of Ref. [2]. Their solution allows to calculate how the temperatures T_c and T_s, which characterize the onset of Bose-Einstein condensation and superfluidity, respectively, depend on the strengths of disorder and contact interaction.

[1] K. Huang and H.F. Meng, Phys. Rev. Lett. **69**, 644 (1992)

[2] A.V. Lopatin and V.M. Vinokur, Phys. Rev. Lett. **88**, 235503 (2002)

Q 12.4 Mo 17:15 6J

Bogoliubov excitations in 2D disordered Bose-Einstein condensates — •Christopher Gaul and Cord Müller — Universität Bayreuth

We consider a 2D–Bose–Einstein–Condensate in a disordered potential. In a first step we calculate the condensate density for different types of disorder using the Gross–Pitaevskii equation. In a second step we determine the disorder–broadened dispersion relation for elementary excitations using diagrammatic perturbation theory and calculate relevant transport coefficients.

Q 12.5 Mo 17:30 6J

Bose-Einstein Condensates in Disordered Lattice Potentials — •Sascha Drenkelforth, Thomas Schulte, Georg Kleine Büning, Wolfgang Ertmer, and Jan Arlt — Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover

Optical lattices are excellent tools to probe the nature of quantum degenerate Bose gases and serve as an ideal testing ground for theories originating in condensed matter physics. The addition of small pseudorandom potentials can disturb ideal lattice configurations and allows for the introduction of disorder in the experimental system. Depending on the experimental parameters this disorder is predicted to lead to the formation of new phases in the strongly interacting and the weakly interacting case. In the weakly interacting regime an observation of non-trivial localization effects and a full analysis including the interplay of interactions and localization in the system is still outstanding.

We will report on the realization of a disordered lattice and discuss the effect of the nonlinear interactions and the shape of the disorder potential in detail. The investigation of transport phenomena is of particular relevance for the understanding of disordered potentials in the solid state case. We have therefore addressed the use of Bloch oscillations as a probe of the disorder in our system. We will present our theoretical results on these Bloch oscillations in disordered optical lattice potentials

Q 12.6 Mo 17:45 6J

Transport of Bose-Einstein condensates through two-dimensional disorder potentials — •Michael Hartung, Klaus Richter, and Peter Schlagheck — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany

The rapid progress in the experimental techniques for Bose-Einstein condensates permits detailed studies of mesoscopic transport dynamics of interacting matter waves with rather high accuracy and high flexibility in the control of parameters. We particularly focus on the transport of a Bose-Einstein condensate through a two-dimensional disorder potential. To this end we developed, in analogy with our previous study on one-dimensional condensate transport [1], a two-dimensional numerical method to simulate the time-dependent propagation process within the mean-field approximation of the condensate. We discuss the influence of the repulsive atom-atom interaction on the transport process of the condensate, and focus here in particular on the phenomena of coherent backscattering and weak localization.

[1] T. Paul, P. Leboeuf, N. Pavloff, K. Richter, and P. Schlagheck Phys. Rev. A **72**, 063621 (2005)

Q 12.7 Mo 18:00 6J

From superfluidity to Anderson-localization in quasi 1d Bose-Einstein condensates. — •Tobias Paul, Patricio Leboeuf, and Nicolas Pavloff — Laboratoire de Physique Théorique et Modèles Statistiques, Universite Paris Sud, Batiment 100, F-91405 Orsay Cedex

The interplay between particle-particle interactions and disorder-induced interference effects is a challenging aspect of condensed matter physics, which is due to the advent of coherent atom manipulation nowadays revisited in guided Bose-Einstein condensates [1,2]. In this contribution we present a new, global analysis of the coherent condensate flow through a disordered region. We show that a variation of the condensate velocity v with respect to the disordered potential induces different regimes of quantum transport. We demonstrate the existence of three different regimes: At velocities v small compared to the sound velocity c the flow shows superfluid behaviour, whereas a domain of time dependent flow is reached when v becomes comparable to c. For velocities considerably larger then the sound velocity again a stationary regime is found. In this domain, depending of the extent of the disordered region, the system enters an Anderson localized phase.

[1] D. Clement *et al.* Phys. Rev. Lett. **95**, 170409 (2005)

[2] T. Schulte *et al.* Phys. Rev. Lett. **95**, 170411 (2005)

Q 12.8 Mo 18:15 6J

Anderson localization in guided beams of Bose condensed atoms — •Tobias Paul[1], Patricio Leboeuf[1], Peter Schlagheck[2], and Nicolas Pavloff[1] — [1]Laboratoire de Physique Théorique et Modèles Statistiques, Universite Paris Sud, Batiment 100, F-91405 Orsay Cedex — [2]Institut für Theoretische Physik, Universität Regensburg, D–93040 Regensburg

Recently the influence of atom-atom interactions on the phenomenon of Anderson localization has been investigated by a series of experimental [1] and theoretical studies [2,3] on BEC systems. Following up these works, the objective of this contribution is to demonstrate that the scenario of Anderson localization is preserved in a quasi 1D coherent beam of weakly interacting Bose condensed atoms. For that purpose we study the coherent flow of a condensate through a disordered potential formed by a series of uncorrelated delta scatterers. This particular disorder model allows an analytical treatment within which we recover the well known picture of Anderson localization, with a rescaled localization length in the presence of a weak atom-atom interaction. Complementary numerical computations indicate that this behaviour is generic and does not depend on the specific structure of the disordered potential.

[1] D. Clement *et al.* Phys. Rev. Lett. **95**, 170409 (2005)
[2] B. Damski *et al.* Phys. Rev. Lett. **91**, 080403 (2003)
[3] T.Paul, *et al.* Phys. Rev. A **72**, 063621 (2005)