DY 8: Superfluidity and Bose Einstein Condensation

Time: Monday 17:00–18:30 Location: MA 001

DY 8.1 Mon 17:00 MA 001

Systematic Semiclassical Approximations for Harmonically Trapped Ideal Bose Gases — •Ben Klünder, Axel Pelster, and Robert Graham — Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

Based on the field-theoretic effective action approach, we systematically generalize the usual semiclassical approximation in such a way that its range of applicability is essentially extended. With this we can calculate analytically thermodynamic properties of harmonically confined non-interacting Bose gases in the grand-canonical ensemble also for small particle numbers. Furthermore, it becomes now possible to determine the critical temperature as well as the temperature dependence of heat capacity and condensate fraction in low-dimensional traps, where the standard semiclassical approximation is not applicable.

DY 8.2 Mon 17:15 MA 001

Phase diagram for interacting Bose gases — •Michael Männel[1], Klaus Morawetz[1,2], and Michael Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany

From the many-body T-matrix we obtain the condition for a medium-dependent bound state in a Bose gas with contact interaction. This condition, i.e. the phase diagram, is derived from the medium-dependent scattering length and scattering phase as well as from the pole of the T-matrix. Also the binding energy is calculated. By separating the Bose pole from the distribution function the influence of a Bose condensate is measured too.

DY 8.3 Mon 17:30 MA 001

Functional renormalization group analysis of the interacting Bose gas in the symmetry broken phase — •Andreas Sinner, Nils Hasselmann, and Peter Kopietz — Institut für Theoretische Physik, Universität Frankfurt, Max-von-Laue Str.1, 60438 Frankfurt

We investigate the small frequency and momentum structure of the weakly interacting Bose gas in $1 \leq D \leq 3$ within a functional renormalization group approach. Using a variant of the local potential approximation, the $U(1)$ symmetry is automatically obeyed and our approach allows to go beyond the Bogoliubov theory in a consistent manner. The flow equations are derived within a derivative approximation of the effective action up to second order in spatial and temporal variables and investigated numerically. We present further an approach which goes beyond the derivative approximation of the functional renormalization group. It allows to calculate corrections to the Bogoliubov spectrum and to investigate the damping of quasiparticles also at finite momenta.

DY 8.4 Mon 17:45 MA 001

Green's Function Approach to the Bose-Hubbard Model for Finite Temperatures — Henrik Enoksen[1], •Alexander Hoffmann[2], Matthias Ohliger[3], and Axel Pelster[4] — [1]Department of Physics, Norwegian University of Science and Technology, N-7491 Trondheim, Norway — [2]Arnold Sommerfeld Center for Theoretical Physics, Theresienstr. 37, Department Physik, Universität München, 80333 München, Germany — [3]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [4]Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

The Green's function for bosons in an optical lattice is determined in the Mott phase within a finite-temperature hopping expansion up to the second order in the tunnel matrix element. This allows us to reconstruct in a qualitative way the time-of-flight absorption pictures, which are taken after the optical lattice is switched off. Furthermore, investigating the divergence of the Green's function, we can locate the boundary between the superfluid and the Mott phase for finite temperatures. Whereas the first-order calculation reproduces the seminal mean-field result, the second order goes beyond and shifts the phase boundary in the immediate vicinity of the critical parameters determined by Monte-Carlo simulations of the Bose-Hubbard model.

DY 8.5 Mon 18:00 MA 001

The chemical potential for the inhomogeneous electron liquid in terms of its kinetic and potential parts with special consideration of the surface potential step and BCS-BEC crossover — •Klaus Morawetz[1,2], Norman H. March[3,4,5], and Richard H. Squire[6] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden, Germany — [3]Department of Physics, University of Antwerp, Belgium — [4]Oxford University, Oxford, England — [5]Abdus Salam International Centre for Theoretical Physics, Trieste, Italy — [6]Department of Chemistry, West Virginia University, Montgomery, WV25136, USA

The chemical potential μ of a many-body system is valuable since it carries fingerprints of phase changes. Here, we summarize results for μ for a three-dimensional electron liquid in terms of average kinetic and potential energies per particle. The difference between μ and the energy per particle is found to be exactly the electrostatic potential step at the surface. We also present calculations for an integrable one-dimensional many-body system with delta function interactions, exhibiting a BCS-BEC crossover. It is shown that in the BCS regime the chemical potential can be expressed solely in terms of the ground-state energy per particle. A brief discussion is also included of the strong coupling BEC limit.
Physics Letters A, In Press,
http://dx.doi.org/10.1016/j.physleta.2007.10.025

DY 8.6 Mon 18:15 MA 001

Functional renormalization group approach to the Anderson impurity model: partial bosonization in two competing channels — •Jose Juan Ramos Cardenas and Peter Kopietz — Institut für Theoretische Physik, Universität Frankfurt, Germany

We take into account the dominant singularities in two competing interaction channels of strongly interacting Fermi systems via a generalization of the collective field functional renormalization group approach developed by Schütz, Bartosch and Kopietz [Phys. Rev. B **72**, 035107 (2005)]. Our method is based on the introduction of two independent bosonic Hubbard-Stratonovich fields describing competing collective fluctuations of the underlying Fermi system. As an application, we study the Anderson impurity model where the interference between the spin-singlet particle-hole and particle-particle channels is essential to correctly describe the strong-coupling crossover to the Fermi-liquid regime at energy scales below the Kondo temperature.