Q 1: Quantengase: Bosonen 1

Time: Monday 10:30–12:45 Location: V53.01

Q 1.1 Mon 10:30 V53.01

Dissipative effects in a cloud of ultracold atoms — •Ralf Labouvie, Andreas Vogler, Felix Stubenrauch, Vera Guarrera, Giovanni Barontini, and Herwig Ott — TU Kaiserslautern, Deutschland

This talk addresses the experimental investigation of dissipative effects in a cloud of ultracold atoms.

In our experiment, we use a focussed electron-beam to locally remove atoms from the system. The possibility to modify the electron-beam current and width allows us to control the strength of the dissipation. We investigate the behaviour of the quantum system under different dissipative conditions and temperatures.

Q 1.2 Mon 10:45 V53.01

Shear Viscosity in Ultracold Bose Gases in 1/N-Expansion — •Roman Hennig, Thomas Gasenzer, and Jan M. Pawlowski — Institute for theoretical Physics, Heidelberg University

We investigate shear viscosity in ultracold bosonic gases, using field theoretical methods. This can be done by means of a Kubo-relation, which relates the hydrodynamic behaviour of a fluid in linear response to correlation functions of field operators. For shear viscosity we have to calculate the correlation function of the stress tensor, which involves 4-point correlation functions. To this end we apply the 1/N expansion, which is a non-perturbative resummation technique classifying diagrams according to their power in the inverse number of field components (1/N).

Q 1.3 Mon 11:00 V53.01

Non-equilibrium dynamics of domain walls in a two-component Bose gas — •Markus Karl[1,2], Boris Nowak[1,2], and Thomas Gasenzer[1,2] — [1]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

The miscibility-immiscibility phase transition in an ultracold binary Bose gas, in one and two spatial dimensions, is simulated using coupled classical field equations in a statistical approach. The dynamics of the transition depends on the time-dependence of the coupling between the two components. Particularly, a dynamical formation of domains can be induced by rapid quenches. Therefore the setup allows to study the non-equilibrium time-evolution of the domain structures. A focus is set on the influence of the domains on the single particle excitation spectrum, which is discussed in the context of turbulent scaling properties known from the single-component Bose gases.

Q 1.4 Mon 11:15 V53.01

Solitonic states far from equilibrium — Maximilian Schmidt[1,2], •Boris Nowak[1,2], Denes Sexty[1,2], and Thomas Gasenzer[1,2] — [1]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

Far from equilibrium dynamics of an ultracold Bose gas, in one spatial dimension, is analysed with respect to topological excitations and compared to turbulent phenomena in two and three dimensions. A special focus is set on the single particle momentum distribution, which can be described within a statistical soliton model. The results give insight into the structure of (quasi-)stationary states of an ultracold Bose gas away from equilibrium.

Q 1.5 Mon 11:30 V53.01

Cool quantum gases "going ballistic": quantum-dynamics in micro-gravity — •R. Walser, R. Nolte, and M. Schneider — Institute for Applied Physics, TU Darmstadt, Germany

Optical imaging of matter-waves after releasing them from confining traps is the standard method to analyze the properties of the matter-wave in the expanded form. This gives access to the structure of the matter-wave within the optical resolution limit. In Earth-bound laboratories this expansion is usually limited by the height of the vacuum system, when the free falling atoms hit the bottom of the chamber. In the current micro-gravity experiments of the QUANTUS collaboration at ZARM [1], this limitation is lifted as the container is co-propagating ($\approx$ 100 m). The ballistic expansion is limited by much lesser constraints giving raise to macroscopic condensates, visible by the naked eye (2mm).

In this presentation, we will discuss theoretical aspects of modeling the release of a trapped quantum gas [2] with time-dependent Hartree-Fock Bogoliubov [3] equations and simulations in the hydrodynamical regime within the Wigner approximation.

[1] T. van Zoest, *et al.*, Science **328**, 1540, (2010).
[2] G. Nandi, R. Walser, E. Kajari and W. P. Schleich, Phys. Rev. A, **76**, 63617 (2007).
[3] R. Walser, J. Williams, J. Cooper and M. Holland, Phys. Rev. A, **59**, 3878 (1999).
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Q 1.6 Mon 11:45 V53.01

Optimized dye-filled microcavity setup to observe Bose-Einstein condensation of photons — •Tobias Damm, David Dung, Julian Schmitt, Jan Klaers, Frank Vewinger, and Martin Weitz — Institute for Applied Physics (IAP), University of Bonn

In earlier works we realised a Bose-Einstein Condensate (BEC) of Photons in a dye-filled optical microcavity. A photon number conserving thermalisation process is achieved by multiple absorption and emission processes of dye-molecules. The cavity itself provides a confining potential that leads to a non-trivial ground state and a nonvanishing photon mass, making the system formally equivalent to a two-dimensional gas of trapped, massive bosons. The photon occupation of the transversal cavity modes follows a room temperature thermal distribution above the cavity cut-off. Increasing the mean photon density inside the cavity by enhancing the pump power above a critical value leads to Bose-Einstein condensation of photons into the transversal ground mode.
Here we report on the development of a newly designed dye-filled optical microcavity system. In this mechanically closed new setup, an improved control of the dye flow is achieved. Further, an enhanced optical access is provided and a new technique for active cavity length stabilisation is implemented. These improvements of the experimental setup promise to be useful e.g. in planned measurements of the statistics of the photon Bose-Einstein condensate.

Q 1.7 Mon 12:00 V53.01

Thermalization of a two-dimensional photon gas in a polymeric host matrix — •Julian Schmitt, Jan Klärs, Tobias Damm, David Dung, Frank Vewinger, and Martin Weitz — Institut für Angewandte Physik, Universität Bonn, Wegelerstraße 8, D-53115 Bonn

We investigate thermodynamic properties of a two-dimensional photon gas confined by a polymer-filled optical microcavity. A thermally equilibrated state of the photon gas is achieved by radiative coupling of the photons to a heat bath, that is composed of dye molecules at room temperature. Differently from previous measurements with liquid dye solutions, the presented experimental scheme incorporates dye molecules implemented in polymeric host matrices. Prior examinations of thermalized bosons in solid state systems gave rise to reports on intriguing effects, such as the formation of quasi-condensates of exciton-polaritons. In contrast to this, the here discussed experiments are carried out far below the strong-coupling regime in a system with large decoherence. In a proof-of-principle experiment a thermalization of photons in the applied polymer substance is observed. Furthermore, we report on fluorescence characteristics of dye molecules embedded in polymers, and discuss the applicability of a Kennard-Stepanov theory in this context. The described solid state scheme demonstrates a first step towards technical applications. In the future, dye-based solid state systems hold promise for the realization of single-mode light sources in thermal equilibrium, as well as the solar energy concentrators.

Q 1.8 Mon 12:15 V53.01

Nonthermal fixed points, vortex statistics and superfluid turbulence — •Boris Nowak[1,2], Jan Schole[1,2], Denes Sexty[1,2], and Thomas Gasenzer[1,2] — [1]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

Turbulent dynamics of an ultracold Bose gas, in two and three spatial dimensions, is analysed by means of statistical simulations using the classical field equation. A special focus is set on the infrared regime of large-scale excitations following universal power-law distributions distinctly different from those of commonly known weak wave-turbulence phenomena. The infrared power laws can be understood from the statistics of vortex excitations as well as from an analytic field-theoretic approach based on the 2PI effective action. The results shed light on fundamental aspects of superfluid turbulence and have strong potential implications for related phenomena, e.g., in early-universe inflation or quark-gluon plasma dynamics.

Q 1.9 Mon 12:30 V53.01

Complex Potential Well as a Primordial Model for a Dissipative Bose-Einstein Condensate — •Max Lewandowski[1] and Axel Pelster[2] — [1]Institut für Physik und Astronomie, Universität Potsdam, Germany — [2]Hanse-Wissenschaftskolleg, Delmenhorst, Germany

An electron beam focussed on a Bose-Einstein condensate represents a paradigmatic system to systematically study the delicate interplay between dissipation and quantum coherence in a quantitive way [1]. As a primordial model we neglect any two-particle interaction and consider a one-dimensional Schrödinger equation with a constant nested complex potential well. Its real part mimics the trapping, whereas an imaginary part restricted to the center describes the particle loss. We derive the quantization condition for the stationary states and determine numerically both the complex energy eigenvalues and eigenfunctions. In the limit of large dissipation we find that the eigenfunctions have the tendency to extremize the loss of particles, i.e. the particle density is limited to either the inner or the outer dissipation region.

[1] T. Gericke, P. Würtz, D. Reitz, T. Langen, and H. Ott, Nature Physics **4**, 949 (2008).