# Q 36: Quantum Gases: Bosons V

Time: Wednesday 11:00–12:30 Location: P/H2

Q 36.1 Wed 11:00 P/H2

**Generalized Gibbs Ensemble and Prethermalization** — •Sebastian Erne[1,2,4], Thomas Gasenzer[1,2,3], and Jörg Schmiedmayer[4] — [1]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany — [3]Kirchhoff-Institut für Physik, INF 227, 69120 Heidelberg, Germany — [4]Vienna Center for Quantum Science and Technology (VCQ), Atominstitut, TU Wien, Vienna, Austria

In integrable systems non-trivial constants of motion in general prevent thermalization. The fundamental principle of entropy maximization under these constraints leads to the Generalized Gibbs ensemble (GGE). If a perturbative expansion leads to an effective integrable description, the system may be critically slowed down at a prethermalized state, connected to the corresponding GGE. In highlight of recent experiments, we consider two linearly coupled one-dimensional quasicondensates and explicitly calculate the GGE and time-evolution of the system following a quench in the linear coupling. Finite-size systems, even in the harmonic approximation, experience drastic changes dependent on the trap geometries and on position dependent squeezing and allow for a direct observation of the GGE. Understanding these systems is essential in the study of complete thermalization, where higher-order corrections are no longer negligible. The excellent experimental accessibility and controlability of the system allows to examine fundamental principles of statistical mechanics.

Q 36.2 Wed 11:15 P/H2

**Correlated energy transfer between two ultracold atomic species** — •Sven Krönke[1], Johannes Knörzer[1], and Peter Schmelcher[1,2] — [1]Centre for Optical Quantumtechnologies, University of Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, University of Hamburg, Germany

We study a single atom as an open quantum system, which is initially prepared in a coherent state of low energy and oscillates in a one-dimensional harmonic trap through an interacting ensemble of $N_A$ bosons, held in a displaced trap [1]. The non-equilibrium quantum dynamics of the total system is simulated by means of an *ab-initio* method, giving us access to all properties of the open system and its finite environment. In this talk, we focus on unravelling the interplay of energy exchange and correlations between the subsystems, which are coupled in such a spatio-temporally localized manner. We show that an inter-species interaction-induced level splitting accelerates the energy transfer between the atomic species for larger $N_A$, which becomes less complete at the same time. System-environment correlations prove to be significant except for times when the excess energy distribution among the subsystems is highly imbalanced. These correlations result in incoherent energy transfer processes, which accelerate the early energy donation of the single atom. By analyzing correlations between intra-subsystem excitations, certain energy transfer channels are shown to be (dis-)favored depending on the instantaneous direction of transfer.

[1] S. Krönke, J. Knörzer and P. Schmelcher. arXiv:1410.8676.

Q 36.3 Wed 11:30 P/H2

**Driven-dissipative ideal Bose gases: Fragmented, excited-state and ground-state condensation** — •Daniel Vorberg[1,2], Roland Ketzmerick[1,2], and André Eckardt[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden — [2]Institut für Theoretische Physik, Technische Universität Dresden

We consider non-equilibrium steady states of driven-dissipative bosonic quantum systems. Here Bose condensation, defined by a macroscopic eigenvalue of the single-particle density matrix, can occur not only into the ground-state but also into excited states or even into multiple states (fragmented condensation). This has been observed, for example, in exciton-polariton systems, subjected to pumping and loss. We present a theory giving a unified description of all of these different types of Bose condensation in driven-dissipative ideal gases. In particular, we identify different limiting cases where, despite the non-equilibrium character, ground-state condensation occurs. We apply our theory to exciton-polariton systems and find good agreement with experiment.

Q 36.4 Wed 11:45 P/H2

**New scaling relation for far-from-equilibrium Bose gases and Kolmogorov scaling** — Thomas Gasenzer, •Steven Mathey, and Jan M. Pawlowski — ITP, Heidelberg, Germany

Classical hydrodynamic turbulence is related to super-fluid turbulence by means of the density and phase decomposition of the Bose gas wave function. Steady-state, scale-invariant, classical turbulence is invariant under Galilei transformations. This results in a well-known scaling relation for two-point correlation functions. Relating this to super-fluid turbulence, a new scaling relation emerges for far-from-equilibrium quantum gases at a non-thermal fixed point. Combined with strong wave turbulence, this is shown to lead to a kinetic energy spectrum with the Kolmogorov 5/3 exponent and an anomalous correction.

Q 36.5 Wed 12:00 P/H2

**Strong-wave-turbulence character of non-thermal fixed points in Bose gases** — •Isara Chantesana[1,2,3], Asier Piniero Orioli[1], Jürgen Berges[1], and Thomas Gasenzer[1,2,3] — [1]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Germany — [2]Kirchhoff Institute for Physics, INF 227, 69120 Heidelberg, Germany — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

Far-from equilibrium dynamics of a dilute Bose gas is studied by means of the two-particle irreducible effective action formalism. We investigate the properties of non-thermal fixed points predicted previously, which are related to non-perturbative strong wave turbulence solutions of the many-body dynamic equations. While they can be formulated in the framework of scaling theory, these fixed points are closely connected with strong non-linear excitations of the gas, including those of (quasi-)topological nature. They are readily accessible to experiment while their relevance reaches far beyond the closer realm of cold gases. A recent analysis of the infrared renormalisation of vertices is of strong interest for the further development of a non-perturbative renormalisation-group description of non-thermal fixed points.

Q 36.6 Wed 12:15 P/H2

**Universal self-similar dynamics of relativistic and non-relativistic field theories near non-thermal fixed points** — •Asier Piñeiro Orioli[1], Kirill Boguslavskii[1], and Jürgen Berges[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Germany — [2]ExtreMe Matter Institute EMMI, Planckstraße 1, 64291 Darmstadt, Germany

The dynamics of quantum fields far from equilibrium play an important role in systems ranging from early universe cosmology and relativistic heavy-ion collisions to ultra cold quantum gases. Strikingly, universal features emerge during the respective thermalisation processes. This universality is based on the existence of non-thermal fixed points, which are attractor solutions characterised by turbulence and self-similar time evolution. In this talk we will show that the (massless) relativistic and the non-relativistic (Gross-Pitaevskii) scalar field theory belong to the same universality class in the infrared. We compute the scaling exponents and scaling functions in this non-perturbative regime in two ways: first by performing classical statistical lattice simulations and second by using the resummed 2PI $1/N$ expansion to NLO.