Universal dynamics near non-thermal fixed points

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Quantum many-body systems far from equilibrium show much richer characteristics than those in equilibrium. It remains, though, an unresolved question to date how in general quantum systems with many degrees of freedom can relax and approach final equilibrium states [1,2]. Symmetries give rise to the possibility for universal dynamics, showing up with the same properties in very different systems irrespective of their concrete building blocks and allowing a classification independent of the details of microscopic properties and initial conditions. Various manifestations of such scaling dynamics are being discussed for classical systems, among them turbulence, coarsening, and phase-ordering kinetics. Non-thermal fixed points have been proposed on the grounds of the Schwinger-Keldysh approach to non-equilibrium quantum field theory. These lead beyond standard equilibrium universality and are characterized by different anomalous scaling dimensions for statistical and spectral correlation functions [3]. In my lecture, I will give an introduction to predictions for non-thermal fixed points obtained from non-equilibrium quantum field theory and discuss various manifestations in ultracold and relativistic Bose systems within and beyond present-day analytical reach.

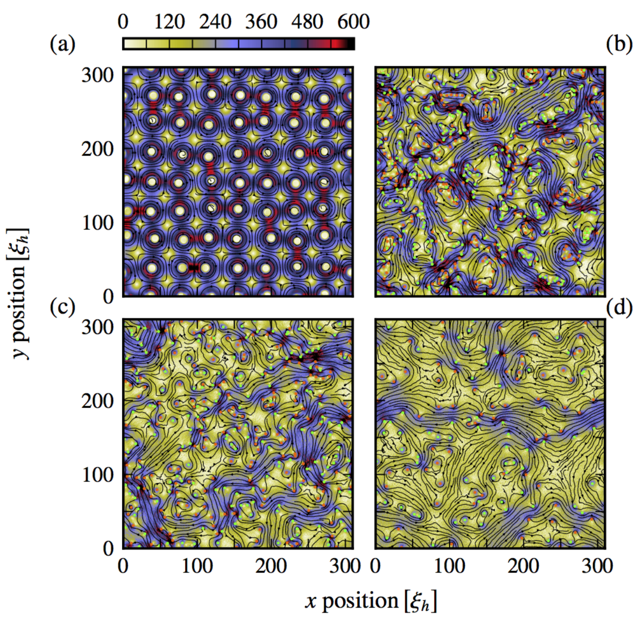

Figure 1: Strongly anomalous turbulent dynamics in the vicinity of a non-thermal fixed point in a two-dimensional superfluid Bose gas [4]. The flow pattern evolves from a far-from-equilibrium initial state containing unstable multiply charged vortices to a configuration reminiscent of classical fluid turbulence.

[1] T. Langen, T. Gasenzer, and J. Schmiedmayer, JSTAT 064009, 2016; `arXiv:1603.09385`.

[2] B. Nowak, S. Erne, M. Karl, J. Schole, D. Sexty, and T. Gasenzer, `arXiv:1302.1448`, in *Strongly Interacting Quantum Systems out of Equilibrium*, edited by T. Giamarchi, et al. (Oxford University Press, 2016).

[3] I. Chantesana, A. Pineiro Orioli, T. Gasenzer, `arXiv:1801.09490`.

[4] M. Karl and T. Gasenzer, New J. Phys. **19** 093014, 2017; `arXiv:1611.01163`.