Universal dynamics far from equilibrium

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Quenched or continuously driven quantum systems can show universal dynamics near non-thermal fixed points, generically in the form of scaling behaviour in space and time [1-3]. Systems where such fixed points can be realized range from post-inflationary evolution of the early universe to low-energy dynamics in cold gases. Effective field theories hold promise to describe the non-perturbative infrared dynamics by allowing to identify the relevant degrees of freedom [1,4,5]. The status of different examples and their relevance to near-linear quasiparticle dynamics as well as to the strongly non-linear dynamics of solitary waves and topological defects will be discussed [4-6].

[1] C.-M. Schmied, A. N. Mikheev, T. Gasenzer, Non-thermal fixed points: Universal dynamics far from equilibrium, Proc. Julian Schwinger Centennial Conf. and Workshop, Singapore, 2018, arXiv:1810.08143 [cond-mat.quant-gas]

[2] M. Prüfer, P. Kunkel, H. Strobel, S. Lannig, D. Linnemann, C.-M. Schmied, J. Berges, T. Gasenzer, M.K. Oberthaler, Observation of universal dynamics in a spinor Bose gas far from equilibrium, Nature 563, 217 (2018).

[3] S. Erne, R. Bücker, T. Gasenzer, J. Berges and J. Schmiedmayer, Universal dynamics in an isolated one-dimensional Bose gas far from equilibrium, Nature 563, 225 (2018).

[4] A. N. Mikheev, C.-M. Schmied, T. Gasenzer, Low-energy effective theory of non-thermal fixed points in a multicomponent Bose gas, Phys. Rev. A 99, 063622 (2019); arXiv:1807.10228 [cond-mat.quant-gas]

[5] P. Heinen, C.-M. Schmied, A.N. Mikheev, T. Gasenzer, Universal scaling dynamics of the quenched sine-Gordon system, unpublished (2020).

[6] P. Wittmer, C.-M. Schmied, T. Gasenzer, C. Ewerz, Vortex motion quantifies strong dissipation in a holographic superfluid, arXiv: 2011.12968 [hep-th] (2020).