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**How does an isolated quantum system relax?**[1]

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One of the biggest challenges in probing non-equilibrium dynamics of many-body quantum systems is that there is no general approach to characterize the resulting quantum states. Interference experiments give access to the phase of the order parameter. The full distribution functions of the interference amplitude, and the full phase correlation functions allow us to study the relaxation dynamics in one-dimensional quantum systems. Starting form a coherently split 1d quantum gas, the initial coherence slowly decays. Due to the approximate conserved quantities in our nearly integrable system, this relaxation leads to a pre-thermalized state [1], which is characterized by thermal like distribution functions but exhibits an effective temperature much lower than the kinetic temperature of the initial system. A detailed study of the correlation functions reveals that these thermal-like properties emerge locally in their final form and propagate through the system in a light-cone-like evolution [2]. Furthermore we demonstrate that the pre- thermalized state is connected to a Generalized Gibbs Ensemble and show the pathways for further relaxation towards thermal equilibrium.

[1] M. Gring et al., Science **337,** 1318 (2012);
[2] T. Langen et al. Nature Physics **9**, 640-643 (2013).

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[2]Work done in collaboration with Tim Langen.