Entanglement prethermalization in one-dimensional Bose gases

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A well-isolated system often shows relaxation to a quasi-stationary state before reaching thermal equilibrium. Such a prethermalization has attracted considerable interest recently in association with closely related fundamental problems of relaxation and thermalization of isolated quantum systems. Motivated by the recent experiment in ultracold atoms, we study the dynamics of a one-dimensional Bose gas which is split into two subsystems, and find that individual subsystems relax to Gibbs states, yet the entire system does not due to quantum entanglement. In other words, each individual subsystem subsequently relaxes to a stationary state which can be well described by the canonical ensemble at an effective temperature, whereas the stationary state of the total system cannot be described by the canonical ensemble at any temperature due to quantum entanglement between the subsystems.
In this work, we analyze the phenomenon of entanglement prethermalization in one-dimensional Bose gas. Firstly, we consider the relaxation dynamics of the Tomonaga-Luttinger model split into the two subsystems. We find the above mentioned phenomenology of entanglement prethermalization in this model. The steady state is described by the generalized Gibbs ensemble with non-local conserved quantities associated with both subsystems.
Secondly, we discuss entanglement prethermalization in the Lieb-Liniger model and find that entanglement prethermalization occurs for small numbers of particles[1]. Entanglement prehtermalization in the Lieb-Liniger model is originated from the combination of the time-reversal symmetry and the translational symmetry.

[1] E. Kaminishi, T. Mori, T. N. Ikeda and M. Ueda, Nature Physics, 11, 1050 (2015).