Entanglement growth from squeezing on the matrix product state manifold

Sebastian Leontica
Andrew G. Green

London Centre for Nanotechnology, University College London, Gordon St., London WC1H 0AH, United Kingdom

sebastian.leontica.22@ucl.ac.uk

Finding suitable characterizations of quantum chaos is a major challenge in many-body physics, with a central difficulty posed by the linearity of the Schrödinger equation. A possible solution for recovering non-linearity is to project the dynamics onto some variational manifold. The classical chaos induced via this procedure may be used as a signature of quantum chaos in the full Hilbert space. Here, we demonstrate analytically a previously heuristic connection between the Lyapunov spectrum from projection onto the matrix product state (MPS) manifold and the growth of entanglement. This growth occurs by squeezing a localized distribution on the variational manifold. The process qualitatively resembles the Cardy-Calabrese picture [1], where local perturbations to a moving MPS reference are interpreted as bosonic quasi-particles. Taking careful account of the number of distinct channels for these processes recovers the connection to the Lyapunov spectrum. Our results rigorously establish the physical significance of the projected Lyapunov spectrum, suggesting it as an alternative method of characterizing chaos in quantum many-body systems, one that is manifestly connected to classical chaos.

References

[1] P. Calabrese and J. Cardy, Journal of Physics A: Mathematical and Theoretical **42,** 504005 (2009).

Figures

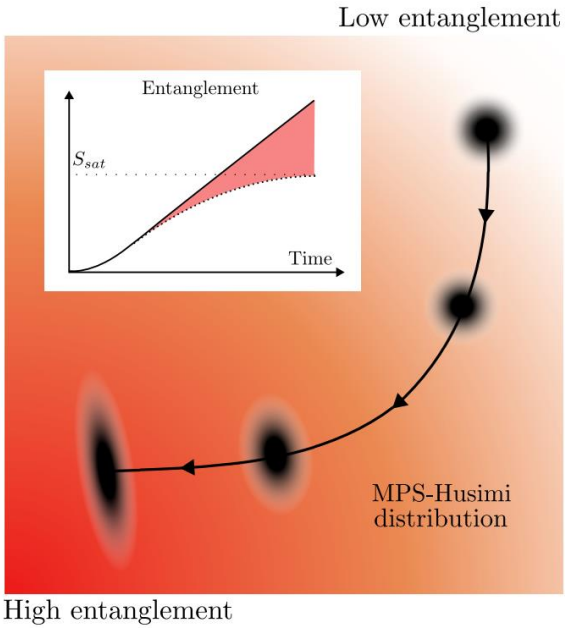

Figure 1: Schematic representation of the entropy growth due to squeezing. The quantum state starts in a low entanglement corner of the MPS manifold and evolves via the time-dependent variational principle (TDVP) towards higher entanglement areas. When saturation is reached, excess entanglement is captured as a squeezing of the MPS-Husimi distribution (light-red contribution in the inset).