

Influence functional of many-body systems: temporal entanglement and matrix-product state representation

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Despite recent experimental and theoretical progress, predicting local dynamics of out of equilibrium many-body systems remains a challenge of computational physics. While in thermalizing systems information about the initial state is quickly forgotten locally, it remains encoded in nonlocal correlations of the entire quantum state. The complexity of the time evolved quantum state severely limits traditional numerical approaches based on the global wavefunction. To circumvent this difficulty we view local dynamics as evolution of a small subsystem subjected to a dissipative quantum bath which represents the rest of the system. This way any spatial correlations which do not contribute to local dynamics do not need to be considered. The action of a quantum bath can be described by the Influence Matrix, a discrete version of the celebrated Feynman-Vernon influence functional. For one dimensional geometries, it is possible to iteratively construct the Influence Matrix corresponding to a longer chain from that of a shorter chain. Instead of spatial entanglement, this method is limited by temporal entanglement. We found several parameter regimes where temporal entanglement is low, even in thermalizing system, where spatial entanglement is high and traditional methods are unfeasible.

[1] Sonner, Michael, Alessio Lerose, and Dmitry A. Abanin, "Influence functional of many-body systems: temporal entanglement and matrix-product state representation", arXiv preprint arXiv:2103.13741 (2021).