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Reconstructing quantum states from local data MILAN HOLZAEPFEL, Institut fuer Theoretische Physik, Universitaet Ulm, Germany, MARCUS CRAMER, Institut fuer Theoretische Physik, Leibniz Universitaet Hannover, Germany, NILANJANA DATTA, Statistical Laboratory, Centre for Mathematical Sciences, University of Cambridge, UK, MARTIN PLENIO, Institut fuer Theoretische Physik, Universitaet Ulm, Ulm, Germany — Quantum spin chains are systems of extreme complexity, in the sense that the number of parameters that fully characterize the state of a quantum spin chain grows exponentially with the number of spins. Yet, physically relevant subsets of all quantum states can be well-approximated by a small number of parameters using well-known methods such as Matrix Product States (MPS). The structure of such states can guarantee reconstruction of the state from the measurement of a small number of simple observables, merely growing linearly with the number of spins.
We compare two classes of quantum states which admit efficient reconstruction from incomplete, local information: States which have vanishing conditional mutual information, and the recently introduced class of states with non-decreasing operator Schmidt rank under partial traces which includes generic Matrix Product Operators (MPO). It is well-known that Rényi entropies can be used to characterize the bond dimension of a pure MPS, i.e. the number of parameters required to describe the state. For mixed MPOs, no similar relation is known. Our comparison provides a first relation between the mutual information and the bond dimension of an MPO representation of a mixed state.

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