A positive tensor network approach to simulating open quantum systems

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Open quantum systems play an important role in quantum optics and condensed-matter physics, in order to study phenomena like transport properties, the interplay between Hamiltonian and decoherent dynamics, as well as the formation of topological order induced by dissipation. In this context we introduce a versatile numerically tool that allows for the simulation of one-dimensional open quantum systems while ensuring positivity of the operators in every step of the algorithm. At the heart of the construction are matrix product density operators (MPDO) capturing purifications of mixed states, for which we suggest a stable and efficient scheme of manipulation preserving the form of the tensors and keeping both bond and Kraus dimensions fixed. To exemplify the functioning of the approach, we study both stationary states and transient dissipative behaviour, for systems of coupled cavities and transport problems in dissipative quantum many-body systems.