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Quantum transport in open spin chains

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After reviewing the general mathematical framework for describing dynamics of open quantum systems, we focus on quantum Markovian processes. We recall two main approaches for deriving Markovian master equation within the weak-coupling limit, namely “local” and “global” approaches.

After highlighting the results of investigations for comparing the virtues and weaknesses of each approach, we focus on transport properties of a spin chain when either approach is used to describe the dynamics. More specifically we use these two approaches for describing the dynamics of a spin chain with XX Hamiltonian in an external field when the two ends of the spin chain are coupled to two thermal baths at different temperatures. This enables us to compare the predictions of each approach for transport properties of the open spin chain. In the global approach non-local effects of local baths are observed in the spin continuity equation as sink/source terms. These non-local features are missed in the local approach. Furthermore, we see that the asymptotic transport properties of the chain in the local approach can not be derived from the asymptotic properties of the global approach when interaction between spins in the chain tends to zero. We finish the discussion by discussing how varying Hamiltonian parameters leads to having negative transition frequencies and as a result the asymptotic spin and heat flows exhibit discontinuities.

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