Nonequilibrium quantum XX spin chain under multisite Lindblad baths

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Abstract

We present the study of nonequilibrium steady state (NESS) for a one-dimensional quantum XX spin chain, which can be mapped into a fermionic tight-binding model through the Jordan-Wigner transformation. To this end, we have modeled the interaction between the particles at the ends of the system and the heat/particle reservoirs, maintained at different temperatures or chemical potentials, by including Lindblad dissipators in the quantum master equation. The system-reservoir interaction is then generalized to an arbitrary number of particles at each end of the chain that are in contact with the reservoirs. An exact equation for the covariance matrix of fermionic operators has been obtained. From this procedure, we have analyzed the behavior of heat flux and particle flux through the system when the number of particles that are in contact with the reservoirs tends to the thermodynamic limit. In addition to numerical results for the covariance matrix equation, we have obtained analytical results using perturbation theory, in the limit in which the interaction between the particles in the chain is small. We have also obtained the Onsager reciprocity relations between heat flux and particle flux in this regime, from which we calculated the transport coefficients associated with the system.

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