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Quantum thermal machine regimes in the transverse-field Ising model

Wednesday 4 September 2024 17:00 (2 hours)

We identify and interpret the possible quantum thermal machine regimes with a transverse-field Ising model as the working substance. In general, understanding the emergence of such regimes in a many-body quantum system is challenging due to the dependence on the many energy levels in the system. By considering infinitesimal work strokes, we can understand the operation from equilibrium properties of the system. We find that infinitesimal work strokes enable both heat engine and accelerator operation, with efficiencies and boundaries of operation described by macroscopic properties of the system, in particular net transverse magnetization and energy. At low temperatures, the regimes of operation and performance can be understood from quasiparticles in the system, while at high temperatures an expansion of the free energy in powers of inverse temperature describes the operation. The understanding generalises to larger work strokes when the temperature difference between the hot and cold reservoirs is sufficiently large. For hot and cold reservoirs close in temperature, a sufficiently large work stroke can enable refrigerator and heater regimes. Our results and method of analysis will prove useful in understanding the possible regimes of operation of quantum many-body thermal machines more generally.

References

Short bio (50 words) or link to website

I am a third-year PhD student specializing in quantum thermodynamics, with a keen interest in quantum many-body physics. My research explores the intersection of thermodynamics and quantum mechanics, particularly focusing on the behavior of complex quantum systems.

Relevant publications (optional)

Career stage

Student

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