Review of results

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1 Introduction

In 1983, Pendry derived a bound on the flow of information, which reads

$$\dot{I}^2 \leq \frac{\pi}{3\hbar \ln^2 2}\dot{E}. \tag{1}$$

This result is derived using classical statistical mechanics [1]. This classical framework, however, neglects the effects of genuine quantum mechanical phenomena, such as quantum correlations. We show that this classical inequality is violated when in a system with quantum correlations.

Consider a chain of qubits in the Heisenberg-XY model. Restricting their interaction to their nearest neighbors allows us to draw a comparison to Pendry's original derivation with fermions using Jordan-Wigner transform, mapping a chain of spin-1/2 qubits to a chain of spinless fermions. The information flow is then the time derivative of

In particular, we have the Hamiltonian of this system as

$$H = \sum_i \sigma_i^z + \sum_k \frac{J_k}{2}(\sigma_k^x \sigma_{k+1}^x + \sigma_k^y \sigma_{k+1}^y) \tag{2}$$

with

$$J_k = \frac{\lambda}{2}\sqrt{k \cdot (N-k)}. \tag{3}$$

[2]

> Since energy is conserved the flow into this segment equals the flow out and therefore energy flow is conserved as is the particle flow. However, the entropy flow is not conserved but can only increase monotonically until thermal equilibrium is established.

References

[1] J B Pendry. “Quantum limits to the flow of information and entropy”. In: *Journal of Physics A: Mathematical and General* 16.10 (July 1983), pp. 2161–2171.

[2] Kaonan Micadei et al. “Reversing the direction of heat flow using quantum correlations”. In: *Nature Communications* 10 (June 2019), p. 2456.