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.

2 The model

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

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

This ensures a predictable periodic behaviour of the chain. This can be made apparent by considering the local magnetization $\langle \sigma_k^z \rangle$ of the qubits. Figure 1 shows the time evolution of the quibts' magnetization.[1]

[1] We choose λ to be 1. It was shown in [2] that at time $t = \pi/\lambda$, perfect state transfer is achieved

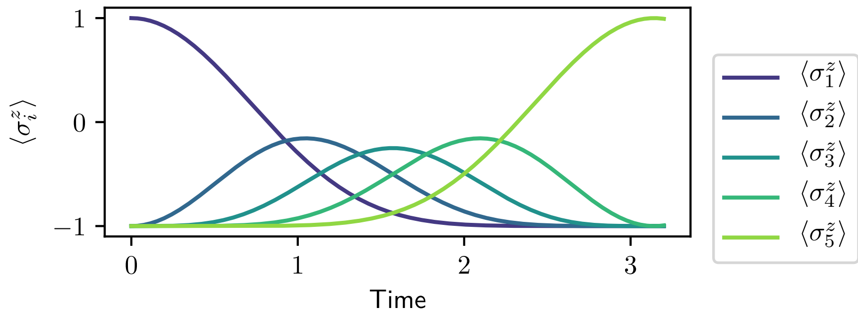

Figure 1: Time evolution of the individual magnetizations $\langle\sigma_i^z\rangle$ for the system with Hamiltonian defined as in equation (2). Qubit $i = 1$ is prepared in the excited state at time $t = 0$. Qubits $i > 1$ are prepared in the ground state at time $t = 0$.

3 Quantum correlations

In a work by Micadei et al., it was shown that certain quantum correlations *invert* the flow of energy [3]. Heat flows not from hot to cold, but from cold to hot. **??** shows the chain with inital correlations at positions 1 and 2 of the chain.

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] Matthias Christandl et al. “Perfect State Transfer in Quantum Spin Networks”. In: *Physical Review Letters* 92.18 (May 2004).

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