Lower mimit to entropy production of a fault-tolerant measurement-free bit-flip quantum memory.

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Quantum computation needs quantum error correction (QEC), to protect the logical state against the noise that appears in the qubits. To better understand what would be the fundamental limits of the energy consumption of a quantum computer, it is interesting to understand how much irreversible QEC will be [1].
In this work we analyse the thermodynamic cost of a fault tolerant measurement free bit-flip QEC memory. Through this study we show that whereas perfect measurement-free QEC could be made thermodynamically reversible[2], QEC with noisy gates and noisy environment necessarily products entropy because of correlations of first order in the noise between the qubits to protect, and the ancillary qubits.

References

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[2] Landi, G.T., de Oliveira, A.L.F., Buksman, E., 2020. Thermodynamic analysis of quantum error correcting engines. Phys. Rev. A 101, 042106. https://doi.org/10.1103/PhysRevA.101.042106