# Experimental rectification of entropy production by a Maxwell's demon in a quantum system

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Maxwell's demon explores the role of information in physical processes. Employing information about microscopic degrees of freedom, this "intelligent observer" is capable of compensating entropy production (or extracting work), apparently challenging the second law of thermodynamics. In a modern standpoint, it is regarded as a feedback control mechanism and the limits of thermodynamics are recast incorporating information-to-energy conversion.

Theoretical endeavours to incorporate information into thermodynamics acquire a pragmatic applicability within the recent technological progress, where information just started to be manipulated at the micro- and nanoscale. A modern framework for these endeavours has been provided by explicitly taking into account the change, introduced in the statistical description of the system, due to the assessment of its microscopic information. This outlines an illuminating paradigm for Maxwell's demon, where the information-to-energy conversion is governed by fluctuation theorems, which hold for small systems arbitrarily far from equilibrium.

We derive a trade-off relation between information-theoretic quantities empowering the design of an efficient Maxwell's demon in a quantum system. Supported by this trade-off relation and employing Nuclear Magnetic Resonance (NMR) techniques. The demon is experimentally implemented as a spin-1/2 quantum memory that acquires information, and employs it to control the dynamics of another spin-1/2 system, through a natural interaction. Noise and imperfections in this protocol are investigated by the assessment of its effectiveness. This realisation provides experimental evidence that the irreversibility in a nonequilibrium dynamics can be mitigated by assessing microscopic information and applying a feed-forward strategy at the quantum scale [1,2].

[1] P. A. Camati, J. P. S. Peterson, T. B. Batalhao, K. Micadei, A. M. Souza, R. S. Sarthour, I. S. Oliveira, and R. M. Serra, Experimental Rectification of Entropy Production by Maxwell's Demon in a Quantum System, Phys. Rev. Lett. 117, 240502 (2016).

[2] J. Goold, Maxwell's Demon Meets Nonequilibrium Quantum Thermodynamics, Physics 9, 136 (2016).