Information to energy conversion with electronic Maxwell's demons

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Abstract

As it has become possible to measure systems at microscopic level, experimental realization of a Maxwell's demon has become accessible. One of the platforms for such experiments is based on single electron structures, where Coulomb blockade ensures that the charge on a small metallic island is defined and measured at the level of a single electron. This setup provides a two-state system with a controllable energy separation.

Here, we show an experimental realization of a Maxwell's demon in form of a single electron box, operated as a Szilard's engine. By measuring which of the initially degenerate charge states is occupied, we convert on average up to 75% of the fundamental kT ln(2) heat into work by appropriate feedback [1]. We also show that our experimental setup follows the Sagawa-Ueda relation for mutual information [2, 3]. Finally, we have built an autonomous Maxwell's demon based on the mutual interaction of two capacitively coupled single electron devices. One of the devices has the role of the Demon, extracting information about electron tunneling in the second device (in the role of the System), and applies feedback to cool down that device [4]. Indeed we measure a temperature drop in the System as a sign of entropy decrease, while we observe how the Demon heats up due to the thermodynamic cost of extracting information.

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