Realization of a quantum Maxwell demon using superconducting circuits

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Abstract

Since the introduction of Maxwell's demon in 1867, many physicists like Szilard, Landauer, Bennett and Feynman have questioned the thermodynamics of systems with an internal memory, which has lead to the advent of thermodynamics of information. Recent experiments at Tokyo University (2010), ENS Lyon (2012) and Aalto University (2013) have enabled to test some of its fundamental predictions in the classical domain. Here, we present an experimental realization of a quantum version of the Maxwell's demon using superconducting circuits. The thermal energy of a system (superconducting qubit) is used to extract energy towards a detector thanks to the knowledge acquired by a demon (a superconducting cavity) on the system. Thanks to the high level of controllability of superconducting circuits, we have experimental access to the flows of entropy, heat and work in all parts of the experiment. Moreover the transition between accurate or inaccurate information extracted by the demon and the role of quantum coherence on this particular implementation are investigated. These provide an ideal testing ground for the theories of quantum thermodynamics, and will help clarify the definition and interplay of entropy, information, heat and work in quantum mechanics.

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