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”Cavity” quantum thermodynamics: Autonomous Maxwell's demon

Quantum thermodynamics follows the approach of classical thermodynamics to study the energy exchange during the interaction of quantum systems. It defines the quantum counterparts of heat, work, and entropy, and it provides equations that constrain the variation of these quantities. The Maxwell's demon *Gedankenexperiment* portrays a tiny being that uses the information on individual molecules of a gas to rectify thermal fluctuations without work expenditure, thus, violating the Second law of thermodynamics. In the present work, we implemented experimentally an autonomous Maxwell's demon with a single circular Rydberg atom and a single mode of a superconducting microwave cavity. We treat two levels of the atom as a qubit, which resonantly exchanges energy with the cavity. We prepare the qubit and the cavity in thermal states at different temperatures and we let them exchange a photon by means of an adiabatic passage. Transferring the atoms from the low-energy level to an additional off-resonant level is equivalent to a sneaky demon preventing the low-energy qubits from interacting with the cavity, therefore, extracting heat out of thermal fluctuations. The obtained results can be explained by applying a generalized version of the second law, which takes into account the information exchange between the qubit and the demon.

Field

Quantum thermodynamics in cavity QED with circular Rydberg atoms

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