Energy fluctuations and Maxwell's demon in electronic circuits

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Energy fluctuations and relaxation play an important role in small systems. The distribution of entropy production and the work performed under non-equilibrium conditions are governed by fluctuation relations; the second law of thermodynamics applies only for averages over long times or many experiments. Several systems, including molecules, micro-particles and nano-electronic circuits, demonstrate the same physics in this respect and they are currently under intensive experimental interest. We apply the concepts of such stochastic thermodynamics to a single-electron box, and present experiments at sub-kelvin temperatures on various fluctuation relations in it [1,2]. Single-electron circuits provide a basic set-up for realizing a Maxwell's Demon, where information can be converted into energy; here the information is collected by a detector with single-electron sensitivity. Recently we have performed an experiment on a Maxwell's Demon where heat (and work) of order kBT ln(2) per operation is extracted from thermal bath [3]. Generalized fluctuation relations incorporating the mutual information yield a quantitative account of the experimental observations [4]. Finally I present our work on fast thermometry towards calorimetry of dissipation down to single quantum level.

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