NANOSCIENCE COLLOQUIUM

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Energy fluctuations and Maxwell's demon in nano-scale systems

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Energy fluctuations 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 $k_B T$ ln(2) per operation is extracted from thermal bath [3].

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[1] O.-P. Saira, Y. Yoon, T. Tanttu, M. Möttönen, D. V. Averin, and J. P. Pekola, Test of Jarzynski and Crooks fluctuation relations in an electronic system, Phys. Rev. Lett. **109**, 180601 (2012).

[2] J. V. Koski, T. Sagawa, O.-P. Saira, Y. Yoon, A. Kutvonen, P. Solinas, M. Möttönen, T. Ala-Nissila, and J. P. Pekola, Distribution of entropy production in nonequilibrium single-electron tunneling, arXiv:1303.6405, Nature Physics (2013).

[3] Jonne V. Koski, Ville F. Maisi, Jukka P. Pekola, and Dmitri V. Averin, Experimental realization of a Szilard engine with a single electron, arXiv:1402.5907

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Host: Heiner Linke (Solid State Physics)

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