DY 23: Statistical physics far from thermal equilibrium

Time: Thursday 14:00–16:00 Location: HÜL 386

Invited Talk DY 23.1 Thu 14:00 HÜL 386

Work and Fluctuation Theorems for quantum systems — •Peter Talkner — Inst. fuer Physik, Universitaet Augsburg, Germany

For small systems classical work and fluctuation theorems have proved useful to extract thermodynamic information from nonequilibrium processes. Here, we focus on specific quantum aspects of work performed on a quantum system by an external force. This work is random due to the randomness of quantum mechanics and of the initial state. The statistics of work is completely determined by its characteristic function defined as Fourier transform of the corresponding probability. This characteristic function can be expressed in terms of a correlation function of exponentiated system's Hamiltonians at the two instants of times that mark the beginning and end of the force protocol [1]. For systems that initially stay in a canonical state Jarzynski's work theorem [1] and Tasaki-Crooks' fluctuation theorem [2] follow immediately. For a microcanonical initial state a Crooks type fluctuation theorem holds [3]. The dependence of the statistics of work on the force protocol and the initial state are exemplified for a driven harmonic oscillator [4]. Generalizations of fluctuation and work theorems to open systems[5] are mentioned. [1] P. Talkner, E. Lutz, and P. Hanggi, Phys. Rev. E 75, 050102(R) (2007). [2]P. Talkner, and P. Hanggi, J. Phys. A 49, F569 (2007). [3] P. Talkner, M. Morillo, and P. Hanggi,Phys. Rev. E 77, 051131 (2008). [4] P. Talkner, P.S. Burada, and P. Hanggi, Phys. Rev. E 78, 011115 (2008). [5] P. Talkner, M. Campisi, and P. Hanggi, J. Stat. Mech. Theor. Exp. in press; arXiv:0811.0973.

DY 23.2 Thu 14:30 HÜL 386

Transport beyond the Fermi liquid picture of quasiparticles — •Klaus Morawetz — Forschungszentrum Dresden-Rossendorf, PF 51 01 19, 01314 Dresden, Germany — International Center for Condensed Matter Physics, 70904-910, Brasília-DF, Brazil

Considering the microscopic correlations of particles in a more realistic way by taking into account the nonlocal and noninstant character of collisions leads to a nonlocal quantum kinetic theory. This theory is thermodynamically consistent. The balance equations contain besides the Landau quasiparticle parts also the parts of the correlated states which can be seen as molecules. It leads to the same mean-field fluctuations in the one-particle distribution as proposed by Boltzmann-Langevin pictures. The kinetic equation combines time derivatives with finite time stepping known from the logistic mapping. This continuous delay differential equation equation is a consequence of the microscopic delay time representing the dynamics of the deterministic chaotic system.

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K. Morawetz, CHAOS 13 (2003) 572

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DY 23.3 Thu 14:45 HÜL 386

Condensation in 1d systems with pair-factorized steady states — •Bartlomiej Waclaw[1], Julien Sopik[2], Hildegard Meyer-Ortmanns[2], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany — [2]School of Engineering and Science, Jacobs University, P. O. Box 750561, 28725 Bremen, Germany

Many models describing the transport of some conserved quantity have been proposed recently. The best known are the zero-range process and the asymmetric simple exclusion process. They are lattice models where particles jump between adjacent sites with given probability. Although they are far from equilibrium, they possess a steady state which takes a factorized form over the sites of an underlying lattice, which simplifies calculations. Recently, Evans et al. [1] have proposed a 1d model in which the steady state factorizes over N pairs of nodes: $\prod_i g(m_i, m_{i+1})$ where m_i is the number of particles at node i, and $g(m, n)$ is defined by the dynamics of the model. If $g(m, n)$ does not factorize, interactions between particles at neighboring nodes emerge. In this talk we examine how different choices of $g(m, n)$ influence static properties of the steady state. In particular we observe a condensation of particles above some critical density. The condensate can be either localized at a single node, or extended over $\sim N^{\alpha}$ nodes with $0 < \alpha < 1/2$, depending on the interaction strength. We calculate also the shape of the condensate and the distribution of particles.

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DY 23.4 Thu 15:00 HÜL 386

Lateral transport of interfacial fluctuations in driven lattice models — Thomas H. R. Smith[1], Oleg Vasilyev[2], •Anna Maciolek[2,3], and Matthias Schmidt[1,4] — [1]H.H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, United Kingdom — [2]Max-Planck-Institut für Metallforschung, Heisenbergstraße 3, D-70569 Stuttgart, Germany — [3]Institute of Physical Chemistry, Polish Academy of Sciences, Department III, Kasprzaka 44/52, PL-01-224 Warsaw, Poland — [4]Theoretische Physik II, Universität Bayreuth, Universitätsstraße 30, D-95440 Bayreuth, Germany

We investigate whether thermal fluctuations of the interface between coexisting phases can be coherently transported along the interface by the action of a suitably chosen external driving field. The Ising lattice gas is studied with kinetic Monte Carlo (MC) simulations using Kawasaki exchange dynamics. We apply a variety of different external fields, which may vary in space, in order to create a particle current in the direction parallel to the interface. Lateral motion of thermal capillary waves occurs only if the driving field is an odd function of the coordinate perpendicular to the averge interface plane. We argue that this interfacial transport is intimately related to a broken symmetry under space reflection and particle-hole inversion. The behaviour of the interfacial current in the Ising model, as well as results from MC simulations of a corresponding solid-on-solid model indicate that the effect is not advective but that it is induced by the motion solely of particles at the interface.

DY 23.5 Thu 15:15 HÜL 386

Quantum Jarzynski estimator for boundary switching processes — •Jens Teifel and Günter Mahler — Universität Stuttgart, 1. Institut für Theoretische Physik, Germany

We consider the Jarzynski relation for a single particle inside a one-dimensional quantum well. We compare two types of processes: i) changing the width of the well and thus the boundary conditions (BSP), ii) changing the width of a potential step inside a fixed quantum well (QBSP). The latter can approximate BSP to any desired accuracy. While BSP violates the Jarzynski relation, QBSP does not. Simulations of measurement series on QBSP reveal limits on the practical applicability of the Jarzynski estimator for the free energy change.

DY 23.6 Thu 15:30 HÜL 386

Fluctuation theorems in driven open quantum systems — Peter Talkner, •Michele Campisi, and Peter Hänggi — Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany

The statistics of the internal energy, the exchanged heat and the work of a quantum system that weakly couples to its environment is determined in terms of the energy changes of the system and the environment due to the action of a classical, external force on the system [1,2]. If the system and environment initially are in a canonical equilibrium, the work performed on the system is shown to satisfy the Tasaki-Crooks theorem [3] and the Jarzynski equality [4].

References

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[3] Talkner P and Hänggi P, *The Tasaki-Crooks quantum fuctuation theorem*, 2007 J. Phys. A: Math. Theor. **40** F569-F571

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DY 23.7 Thu 15:45 HÜL 386

Quantum fluctuation theorem in the strong damping limit — •Sebastian Deffner and Eric Lutz — University of Augsburg, Germany

We consider a driven quantum particle in the large friction limit. We derive a generalized Crooks type fluctuation theorem using the quantum Smoluchowski equation and identify a new type of entropy production of purely quantum origin.