DY 31: Statistical Physics far from Equilibrium

Time: Friday 10:15–13:00 Location: H38

Topical Talk DY 31.1 Fri 10:15 H38

Real-time transport and dynamics in strongly interacting one-dimensional systems — •Fabian Heidrich-Meisner — LMU Munich, Germany

The question of ballistic and diffusive dynamics in one-dimensional systems has a long history, both for classical and quantum systems. In the quantum case, there exist several examples such as heat transport in Heisenberg chains where integrability renders transport anomalous giving rise to ballistic behavior even at finite temperatures. While most studies have focussed on the linear response regime [1], in this talk, I will address similar questions for systems driven out of equilibrium. Using the time-dependent DMRG technique, a particular set-up is used, namely the expansion of wave-packets in either a zero [2] or finite background density [3]. The former is relevant for transport experiments on bulk materials such as low-dimensional quantum magnets whereas the latter can be directly studied with ultracold atoms in optical lattices. I will argue that this set-up allows us to identify ballistic and diffusive time regimes, depending on model parameters and initial conditions [3]. The models under scrutiny comprise spin chains and the 1D Hubbard model as well as perturbations around these two integrable limits. I shall further emphasize emergent non-equilibrium phenomena and discuss the behavior of the entanglement entropy [2].

[1] Heidrich-Meisner et al., EPJ Spec. Topics 151, 135 (2007)
[2] Heidrich-Meisner et al., Phys. Rev. A 80, 041603(R) (2009)
[3] Langer et al., Phys. Rev. B 79, 214409 (2009)

DY 31.2 Fri 10:45 H38

Generalized Clausius inequality for non-quasistatic quantum processes — •Sebastian Deffner and Eric Lutz — Universität Augsburg, D-86135 Augsburg, Germany

We sharpen the Clausius inequality for the irreversible entropy production of a quantum system arbitrarily far from equilibrium by introducing a positive, process dependent lower bound. We express the latter in terms of the Bures distance, a quantum information theoretic measure of distinguishability, between the nonequilibrium and the corresponding equilibrium density operators of the system. As an illustration, we evaluate the entropy production and the Bures distance for an analytically solvable model, namely the time-dependent harmonic oscillator.

DY 31.3 Fri 11:00 H38

Revealing deviations from the fluctuation theorem — •Aljoscha Hahn[1] and Holger Then[2] — [1]Institut für theoretische Physik, Technische Universität Berlin, 10623 Berlin, Germany — [2]Institut für Physik, Carl von Ossietzky Universität, 26111 Oldenburg, Germany

Together with the Jarzynski relation, Crook's Fluctuation Theorem (CFT) is one of the main new theoretical results of statistical physics of irreversible processes, relating the probability of work necessary to realize a certain nonequilibrium process with that of the time-reversed process. Although it is in principle possible to test the CFT experimentally by measuring an amount of of work-values in either direction, the "verification" of the CFT becomes quite hard if the process is far from equilibrium, and the interpretation of the experiments with respect to the CFT using standard arguments (e.g. based on histograms) may remain suspicious.

Within the talk, we present a new and precise tool for testing the CFT on a given amount of experimental data which is strongly related to free-energy calculation. As key features, the method tells us simultaneously whether the amount of data collected is sufficient to make a statement on the CFT at all and whether the hypotheses that the CFT holds has to be rejected. On the other hand, if we a priori know that the CFT holds, which can be the case e.g. in computer experiments, the method can be used to detect systematic errors of the experimental setup.

DY 31.4 Fri 11:15 H38

Suppression of thermally activated escape by heating — •Sebastian Getfert and Peter Reimann — Universität Bielefeld, Fakultät für Physik, 33615 Bielefeld, Germany

The problem of thermally activated escape over a potential barrier is solved by means of path integrals for one-dimensional reaction dynamics with very general time-dependences. For a suitably chosen, but still quite simple static potential landscape, the net escape rate may be substantially reduced by temporally increasing the temperature above its unperturbed, constant level [1].

[1] S. Getfert and P. Reimann, Phys. Rev. E 80, 030101(R) (2009)

DY 31.5 Fri 11:30 H38

Anisotropic Phase Transition in a two-dimensional Ising model with friction — •Sebastian Angst, Alfed Hucht, and Dietrich E. Wolf — Fakultät für Physik, Universität Duisburg-Essen, D-47057 Duisburg

Magnetic friction is a field of raising interests. Magiera et al. [1] modeled a moving tip above a substrate consisting of Heisenberg spins. Magnetic friction in an Ising model has recently been introduced by Kadau et al.[2], and Hucht [3] investigated thermodynamic properties of this system.

Here two layers of Ising spins, displaced by one lattice constant, are moved relative to each other along an axis. Due to the directed motion the correlations behave differently in direction parallel and perpendicular to the motion. Using Monte Carlo methods it is shown, that the system becomes strongly anisotropic and thus the correlation length diverges with different exponents when reaching criticality. For infinite velocity we determine the correlation length exponents and demonstrate, that the system behaves mean field-like.

[1] M.P. Magiera et al., EPL 87, 26002 (2009)
[2] D. Kadau et al., Phys. Rev. Lett. 101, 137205 (2008)
[3] A. Hucht, Phys. Rev. E 80 (in press), arXiv:0909.0533

DY 31.6 Fri 11:45 H38

Interfacial tension in a fluid-gas coexistence of wet granular matter — •Klaus Röller and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

We report on simulations of fluid-gas coexistence in agitated wet granular matter [1,2]. Event-driven molecular dynamics type simulations were performed in three dimensions to study the dependence of the excess energy of the fluid-gas interface ('surface tension') upon the external driving. The surface tension was determined by applying a time-constant but spatially periodic shear force in the direction normal to the interface, and measuring the corresponding elongation of the initially flat interface [3]. The knowledge of the surface tension was then used to estimate an effective granular viscosity using a deterministic version of the Edwards-Wilkinson equation. An initial sinusoidally elongated configuration of the fluid interface was therefore dynamically relaxing back to its (flat) stationary state with minimal interfacial area. We found that both the surface tension and the granular viscosity are decreasing as the driving energy [2] of the external drive is increased. This result can be viewed as the non-equilibrium analogue to the known dependence of these two physical quantities to temperature in equilibrium statistical physics.

[1] S. Herminghaus Advances in Physics **5**4, 221 (2005)
[2] A. Fingerle, et al., New J. Phys. **1**0, 053020 (2008)
[3] K. Roeller, et al., Chaos **1**9, 041106 (2009)

DY 31.7 Fri 12:00 H38

Molecular dynamics simulation of excitation and relaxation kinetics of ionic subsystem in swift heavy ion's track — •Vladimir Lipp[1] and Alexander Volkov[2] — [1]Fachbereich Physik, Universität Kaiserslautern, Erwin-Schrödinger-Straße, D-67663 Kaiserslautern, Germany — [2]Russian Research Centre Kurchatov Institute, Kurchatov Sq. 1, Moscow, 123182, Russia

Computer simulation of solid argon was performed to check the validity of the classical temperature diffusion approach for short-time kinetics in swift heavy ions (SHI) tracks. Cylindrical symmetry of the SHI track was assumed. The excitation was propagating from the center to surroundings of the system. The time which the system needs to reach local equilibrium was estimated by analyzing entropy behavior and by the comparison of local kinetic temperature and configuration temperature [1] at certain distances from the center of the SHI track. In addition, spatial-temporal propagation of the excitation was compared with that predicted by classical parabolic heat conduction equation.

[1] Powles, J. G., Rickayzen, G. and Heyes, D. M.(2005)'Temperatures: old, new and middle aged', Molecular, Physics,103:10,1361-1373.

DY 31.8 Fri 12:15 H38

Dynamic crack propagation of icosahedral quasicrystals — •Tian You Fan — Department of Physics, Beijing Institute of Technology

Based on the Landau-Anderson symmetry-breaking princple on condensed matter, theory of elasticity of quasicrystals is developed, in which the two elementary excitations–phonon and phason play a central role. Elasticity and other mechanical behaviour of quasicrystals are connected close to the defects, among them dislocations and cracks are observed. The study of dynamic crack propagation is interesting in particular. The present work uses the elato-/hydro-dynamic model of quasicrystals and discusses the response of crack to the impact force and the crack fast propagation of icosahedral Al-Pd-Mn quasicrystals, the comparison of the results to those of decagonal Al-Ni-Co quasicrystals is given. The results show the effects of phason and phason-phonon coupling to the resonse and propagation, the effects are more important than that in static cases.

Invited Talk DY 31.9 Fri 12:30 H38

Noise controlled transport in constrained geometries — •Fabio Marchesoni — Dipartimento di Fisica, Universita' di Camerino, I-62032 Camerino, Italy

Diffusive transport of particles or, more generally, small objects, is a ubiquitous feature of physical and chemical reaction systems [1]. In configurations containing confining walls or constrictions, transport is controlled both by the fluctuation statistics of the jittering objects and the phase space available to their dynamics. Consequently, the study of transport at the macro- and nanoscales must address both Brownian motion and entropic effects [2].

We report on recent advances in the theoretical and numerical investigation of stochastic transport occurring either in microsized geometries of varying cross sections or in narrow channels wherein the diffusing particles are hindered from passing each other (single-file diffusion). For particles undergoing biased diffusion in static suspension media enclosed by confining geometries, transport exhibits intriguing features such as 1) a decrease in nonlinear mobility with increasing temperature and 2) a broad excess peak of the effective diffusion above the free diffusion limit [1]. If, in addition, the suspension medium is subjected to external, time-dependent forcing, rectification of the diffusing Brownian particles sets on, at times with anomalous negative mobility.

[1] P. Hänggi and F. Marchesoni, Rev. Mod. Phys. 81, 387 (2009)

[2] P. S. Burada, P Hänggi, F.Marchesoni, G.Schmid, P. Talkner, ChemPhysChem 10, 45 (2009)