DY 51 Einstein Symposium Brownian Motion, Diffusion and Beyond (SYBM) – Contributed Talks II

Zeit: Mittwoch 10:15–13:15 Raum: TU H2032

DY 51.1 Mi 10:15 TU H2032

Rate theory of the stick-slip motion of an AFM tip in friction force microscopy experiments — •Mykhaylo Evstigneev and Peter Reimann — Universität Bielefeld, Universitätsstraße 25, 33615 Bielefeld

During the stick-slip motion of an AFM tip contacting with a uniformly moving atomically clean surface, the force developed in the cantilever spring performs random sawtooth-like oscillations resulting from the thermally activated transitions of the tip from one surface site to the next. Using escape rate theory, the probability distribution of forces is calculated numerically to deduce the time-average lateral force as a function of pulling velocity. A much simpler analytic transcendental equation for the average force is proposed and its approximate solution is obtained. The high accuracy of this analytic approximation is demonstrated via comparison with the numerical results. The analogous force-velocity relations existing in the literature are shown to be the limiting cases of low and high cantilever spring constants of our formula.

DY 51.2 Mi 10:30 TU H2032

Jarzynski's relation: When is the work distribution a Gaussian? — •Thomas Speck and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart

Jarzynski's relation constrains the distribution of dissipated work spent in externally driven non-equilibrium processes like the mechanical stretching of biopolymers. Using this constraint, free energy differences can be extracted from non-equilibrium data. If the work distribution is a Gaussian, its mean and variance are related. We prove constructively that for slow driving this distribution is always Gaussian even for an underlying non-linear Langevin equation of motion [1]. For a linear Langevin equation, this distribution remains Gaussian even at fast driving. For this case, we determine its mean (and variance) as given by a non-local integral kernel [2]. This general result is illustrated for stretching Rouse polymers.

[1] T. Speck and U. Seifert, Phys. Rev. E, in press.
[2] T. Speck and U. Seifert, Eur. Phys. J. B, submitted.

DY 51.3 Mi 10:45 TU H2032

Experimental Verification of the Fluctuation Theorem for a Chemical Rate Equation — •Sebastian Schuler, Carsten Tietz, Thomas Speck, Udo Seifert, and Jörg Wrachtrup — Institute of Physics, University of Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart

A non-linear fluctuation theorem for systems described by chemical master equations driven out of equilibrium is experimentally verified. In [1] starting out from Jarzynski's relation the fluctuation theorem is derived for transitions between n states. For experimental verification an optical 2-level system was used.

Defect centres in diamond can be switched from a fluorescent to a non-fluorescent state by illumination with red light (680 nm). By appliance of green light (514 nm) the system is switched back to its fluorescent state. Altering the intensity of the used wavelength changes the transition rates between bright and dark state.

While the system is driven out of equilibrium by introducing a time dependant transition rate the effect on the fluorescence is measured.

[1] U. Seifert J. Phys. A **37**, L517 (2004)

DY 51.4 Mi 11:00 TU H2032

The transition from Brownian to active Brownian motion — •Andreas W. Liehr[1,2], Hendrik U. Bödeker[2], Svetlana V. Gurevich[2], and Hans-Georg Purwins[2] — [1]Material Research Center Freiburg, Stefan-Meier-Str. 21, D-79104 Freiburg i. Br., Germany — [2]University of Münster, Institute of Applied Physics, Corrensstr. 2/4, 48149 Münster, Germany

In this talk we present recent results on Brownian and active Brownian motion in complex systems. On the example of self-organized current filaments in semiconductor-gas-discharge systems we discuss the detection of these different types of motion by means of stochastic time series analysis [1]. Furthermore, we report the transition from Brownian to active Brownian motion due to a change of system parameters. The theoretical discussion of this effect is carried out on basis of a qualitative reaction-diffusion model, which leads to the classification of the observed transition as supercritical drift-bifurcation [2,3].

[1] Liehr, A. W. ; Bödeker, H. U. ; Röttger, M. C. ; Frank, T. D. ; Friedrich, R. ; Purwins, H.-G.: Drift Bifurcation Detection for Dissipative Solitons. In: *New Journal of Physics* 5 (2003), Nr. 89, S. 1–9
[2] Bödeker, H. ; Röttger, M. C. ; Liehr, A. W. ; Frank, T. ; Friedrich, R. ; Purwins, H.-G.: Noise-covered drift bifurcation of dissipative solitons in a planar gas-discharge system. In: *Physical Review E* 67 (2003), Nr. 056220
[3] Gurevich, S. V. ; Bödeker, H. U. ; Moskalenko, A. S. ; Liehr, A. W. ; Purwins, H.-G.: Drift bifurcation of dissipative solitons due to a change of shape: experiment and theory. In: *Physica D* 199 (2004), Nr. 1–2, S. 115–128

DY 51.5 Mi 11:15 TU H2032

Why Hopping a Zig-zag Course — •Udo Erdmann[1], Niko Komin[1], Lutz Schimansky-Geier[1], Igor M. Sokolov[1] und Frank Moss[2] — [1]Humboldt-Universität zu Berlin, Instiut für Physik — [2]Center for Neurodynamics, University of Missouri at St. Louis

We investigate self-moving particles which prefer to hop with a certain turning angle equally distributed to the right or left. We assume this turning angle distribution to be given by a double Gaussian distributions. Based on the model of active Brownian particles and using the Green-Kubo formula we calculate the diffusion coefficient in dependence on the mean and the dispersion of the turning angles. It is shown that bounded distribution of food in patches will be optimally consumed by the objects if the hop preferable with a given angle and not straight forwardly

DY 51.6 Mi 11:30 TU H2032

Oscillating first passage time densities of strongly non-Markovian random processes. — •Tatiana Verechtchaguina, Igor M. Sokolov, and Lutz Schimansky-Geier — Institute for Physics, Humboldt University of Berlin, Newton Str. 15, 12489 Berlin

The first passage time (FPT) densities in many noise-driven dynamical systems do not resemble monomodal distribution with an exponential tail typical for Markovian systems. An example are interspike interval densities in resonant neurons driven by intrinsic noise and (or) external signal. The problem of finding ISI density can be reformulated as the first passage time problem for a non-Markovian random process with reset to a prescribed initial state after crossing a fixed barrier value.

As a mathematical example we consider a strongly underdamped harmonic oscillator driven with white Gaussian or colored harmonic noise. Using the general expression for the FPT density through multiple level-crossing densities of a stationary random process and truncating the corresponding integral series one obtains a good approximation for short and intermediate times which works especially well for processes with narrow spectral density, i.e. when the Markovian approaches fail, and reproduces very well quite a few first peaks of FPT densities.

DY 51.7 Mi 11:45 TU H2032

A paradox of non-Markovian dynamic disorder — •Igor Goychuk — Institut für Physik, Universität Augsburg, Germany

Rate processes with fluctuating rates are ubiquitous in nature. For example, a nonadiabatic donor-acceptor electron transfer (ET) in some proteins can be strongly influenced by the conformational jump dynamics between two macroconformations of the electron-transferring protein possessing two very different ET rates. The conformational dynamics will introduce a sort of stochastic time-dependence into the ET rates. This situation is known under the label of dynamic disorder. If the rate fluctuations are very fast on the time-scale of electron transfer, i.e. the mean residence times spent in the protein macroconformations are much less than the inverse of corresponding ET rates, a self-averaging occurs and the ET kinetics is described by the averaged ET rate. This is the fast fluctuation limit. In the opposite limit of quasi-static disorder, the averaged transfer kinetics is described by a weighted average of the two exponentials with the ET rates reflecting temporally "frozen"conformations. This picture is well established in the case of Markovian dynamic disorder which is characterized by the exponential distributions of the conformational residence times. I will show that the influence of non-Markovian dynamic disorder characterized by a broad distribution of the residence times can be highly nontrivial. A fast fluctuation limit, in accordance with the Markovian criteria, may surprisingly reveal a quasi-static rate distribution in the averaged dynamics. A clear-cut resolution of this ap-

parent paradox will be provided and its practical consequences will be discussed.

DY 51.8 Mi 12:00 TU H2032

AC-assisted DC-energy transport in spatially extended system: soliton ratchet — •Denysov Sergey — MPIPKS, Dresden

We study the directed energy diffusion in homogeneous spatially extended systems in the presence of an external AC-field. We showh that there are two channel for energy transport: heat current through the system and current due to nonhomogeneous energy exchange withe the AC-field.

DY 51.9 Mi 12:15 TU H2032

Brownian motors: current fluctuations and rectification efficiency — •Lukasz Machura[1,2], Marcin Kostur[1], Peter Hänggi[1], Peter Talkner[1], and Jerzy Łuczka[2] — [1]Theoretical Physics I, Institute of Physics, Augsburg University — [2]Department of Theoretical Physics, Institute of Physics, Silesian University, Poland

The quantity of foremost interest in the context of transport in Brownian motors is the mean velocity of the particle. Here, we address instead the fluctuations of the current, an often neglected aspect of the directed transport. These have a vital influence on the efficiency of rectifying noise [1]. Typically, we find that the asymptotic, time- and noise-averaged transport velocities are small, possessing rather broad velocity fluctuations. This implies a corresponding poor performance for the rectification power. For tailored profiles of the ratchet potential, however, and appropriate drive parameters, we can identify a drastic enhancement of the rectification efficiency [1].

[1] L. Machura, M. Kostur, P. Talklner, J. Łuczka and P. Hänggi, Phys. Rev. E **70** xxxxxx (2004); preprint cond-mat/0409314

DY 51.10 Mi 12:30 TU H2032

Phase diffusion in periodically driven systems — •Tobias Prager and Lutz Schimansky-Geier — Institut fuer Physik, HU Berlin, Newtonstr. 15, 12489 Berlin

We consider two differnt periodically driven two state models, a Markovian model for bistable dynamics and a non Markovian model for excitable dynamics. For these models we propose a theory to calculate the phase velocity and the effective phase diffusion coefficient. These quantities can be calculated analytically for the Markovian model with dichotomic driving. The non Markovian model can only be solved numerically, showing a complex behaviour with different frequency locking modes.

DY 51.11 Mi 12:45 TU H2032

Partially asymmetric exclusion models with quenched disorder — •Ludger Santen[1], Róbert Juhász[1], and Ferenc Iglói[2] — [1]Fachrichtung Theoretische Physik, Universität des Saarlandes, 66041 Saarbrücken — [2]Research Institute for Solid State Physics and Optics, H-1525 Budapest, P.O. Box 49, Hungary

We consider the one-dimensional partially asymmetric exclusion process with random hopping rates, in which a fraction of particles (or sites) have a preferential jumping direction against the global drift. In this case the accumulated distance traveled by the particles, x, scales with the time, t, as $x \sim t^{1/z}$, with a dynamical exponent $z > 0$. Using extreme value statistics and an asymptotically exact strong disorder renormalization group method we exactly calculate, z_{pr}, for particlewise (pt) disorder, which is argued to be related as, $z_{st} = z_{pr}/2$, for sitewise (st) disorder. In the symmetric with zero mean drift the particle diffusion is ultra-slow, logarithmic in time.

DY 51.12 Mi 13:00 TU H2032

From Sub- to Superthreshold Oscillations in Ensembles of Globally Coupled Excitable Systems — •Xaver Sailer[1], Michael Zaks[1], Alexander Neimann[2] und Lutz Schimansky-Geier[1] — [1]Institut fuer Physik, Newtonstrasse 15, 10119 Berlin — [2]Institute of Physics and Astronomy, Ohio University, Athens, Ohio

We investigate a globally coupled ensemble of excitable FitzHugh-Nagumo systems subject to Gaussian white noise. In a certain parameter regime we find for increasing noise intensity a transition from a stable fixed point to global oscillations. The transition is complex and we find different regimes exhibiting small amplitude oscillations, period doubling, chaos, and intermittent and non-intermittent spiking. We derive the dynamical system of the ensembles moment dynamics in the Gaussian approximation and calculate the Hopf bifurcation condition analytically.