DY 24 Brownian Motion and Kinetic Theory I

Time: Tuesday 14:30–16:15 Room: HÜL 186

DY 24.1 Tue 14:30 HÜL 186

Balancing between source and target - a novel kind of fractional Fokker-Planck operator — •Vitaly Belik, Dirk Brockmann, and Theo Geisel — MPI für Dynamik und Selbstorganisation, Göttingen

Based on the recently introduced concept of topological superdiffusion we introduce a novel kind of fractional Fokker-Planck operator for random motion in inhomogeneous environments which incorporates the relative impact of the source and target location of an underlying random walk. We show that the dynamics in weak inhomogeneities exhibits distinct regimes of attenuation and enhancement. The operator can be constructed in two ways: with non-normalized Boltzmann-like probability density (a), which corresponds to some common physical systems, such as hetero-polymers, and normalized one (b), which naturally arises in population dynamical systems. We show that in the limit of ordinary diffusion an increase in the target influence slows down the process in either case. Sursprignly, a superdiffusive process may either be slowed down or enhanced with increasing target influence, in contrast with the common belief that external quenched disorder generally attenuates dispersion. As our theory obeys ordinary Gibbs-Boltzmann thermodynamics we believe that it will facilitate the understanding of a number of anomalous transport phenomena in fields such as intracellular transport and dispersal phenomena in ecological systems.

DY 24.2 Tue 14:45 HÜL 186

Diffusion in disordered fractals — •Janett Balg, Do Hoang Ngoc Anh, Karl Heinz Hoffmann, Steffen Seeger, and Sujata Tarafdar — Institut für Physik, Technische Universität Chemnitz - D-09107 Chemnitz, Germany

Diffusion in disordered media shows anomalous behavior for certain length scales. In order to model anomalous diffusion random-walks on regular fractals were usually used. Here we study disordered fractals in an attempt to capture the random nature of the disordered material by randomly mixing different Sierpinski carpet gernerators. In particular, we investigate the diffusion on the resulting fractals by random-walk simulations and exact enumeration. We find that the random-walk exponent d_w shows a strong dependence on the mixture composition. Beyond that we consider the influence of external fields on the movement of the diffusing particles.

DY 24.3 Tue 15:00 HÜL 186

Dissipative spin ratchets — •Dario Bercioux, Milena Grifoni, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, Germany

Spin ratchets [1] are a novel class of ratchet systems [2] based on the spin inversion asymmetry induced by spin-orbit interaction in confined structures. For such systems, it has been shown that it is possible to generate, under the influence of an unbiased driving force, a net spin current different from zero without additional charge current.

In this contribution we present results with respect to the influence of an external environment coupled with the spin ratchet. We approximate the spin ratchet with an effective two-band tight-binding Hamiltonian in presence of spin-orbit interaction. The environment is represented by a bath of harmonic excitations bilinearly coupled to the particle position [3]. All the calculations are done in the framework of the real-time path integral technique [3].

[1] A. Pfund, D. Bercioux, and K. Richter in preparation.
[2] P. Reimann, Phys. Rep. **361**, 57 (2002).
[3] U. Weiss, *Quantum dissipative systems*, World Scientific, 2001

DY 24.4 Tue 15:15 HÜL 186

Effective Approximations of First Passage Time Distributions of Non-Markovian Processes — •Tatjana Verechtchaguina, Igor M. Sokolov, and Lutz Schimansky-Geier — Institut für Physik, Humboildt Universität zu Berlin, 12489 Berlin

Motivated by the dynamics of resonant neurons we discuss the properties of the first passage time (FPT) densities for nonmarkovian differentiable random processes. We start from an exact expression for the FPT density in terms of an infinite series of integrals over joint densities of level crossings, and consider different approximations based on truncation or on approximate summation of this series. Thus, the first few terms of the series give good approximations for the FPT density on short times. For rapidly decaying correlations the decoupling approximations perform well in the whole time domain.

As an example we consider resonate-and-fire neurons representing stochastic underdamped or moderately damped harmonic oscillators driven by white Gaussian or by Ornstein-Uhlenbeck noise. We show, that approximations reproduce all qualitative different structures of the FPT densities: from monomodal to multimodal densities with decaying peaks. The approximations work for the systems of whatever dimension and are especially effective for the processes with narrow spectral density, exactly when markovian approximations fail.

DY 24.5 Tue 15:30 HÜL 186

Entropic transport in symmetric tubes — •Poornachandra S. Burada, Gerhard Schmid, and Peter Hänggi — Institut für Physik, Universität Augsburg

We study the transport of biased Brownian particles in symmetric tubes in two and three dimensions with periodically varying cross-section. Bottlenecks which produce entropic barriers hinder the motion of the particles and exhibit peculiar characteristics in the transport behavior which are different from that taking place in systems with energy barriers [1]. The constrained dynamics is responsible for an existence of a scaling regime for the particle current and the diffusion coefficient in terms of the ratio between the work done to the particles and thermal energy. Our findings, genuine of the entropic nature of the barriers, can be used in the control of transport through quasi-one dimensional structures, such as pores, ion channels and zeolites, in which irregularities of the boundaries may induce entropic effects. The kinetic description of the dynamic quantities have been developed within an analytic approach [2] and corroborated by simulations.

[1] P. Reimann, C. Van den Broeck, H. Linke, P. Hänggi, J.M. Rubi, and A. Pérez-Madrid *Phys. Rev. Lett.* **87**, 010602 (2001).
[2] D. Reguera and J.M. Rubi, *Phys. Rev. E* **64**, 061106 (2001).

DY 24.6 Tue 15:45 HÜL 186

High-efficiency Deterministic Josephson Vortex Ratchet — •Edward Goldobin[1], Markus Beck[1], Manfred Neuhaus[2], Michael Siegel[2], Reinhold Kleiner[1], and Dieter Koelle[1] — [1]Universität Tübingen, Physikalisches Institut - Experimentalphysik II, Auf der Morgenstelle 14, D-72076, Tübingen, Germany — [2]Universität Karlsruhe, Institut für Mikro- und Nanoelektronische Systeme, Hertzstraße 16, 76187 Karlsruhe, Germany

We investigate experimentally a Josephson vortex ratchet — a fluxon in an asymmetric periodic potential driven by a deterministic force with zero time average. The highly asymmetric periodic potential is created in an underdamped annular long Josephson junction by means of a current injector providing an average velocity of the ac driven fluxon of up to 91% of the Swihart velocity. We measured the ratchet effect for driving forces with different spectral content. For monochromatic high-frequency drive the rectified voltage becomes quantized. At high driving frequencies we also observe chaos, sub-harmonic dynamics and voltage reversal due to the inertial mass of a fluxon.

[1] Phys. Rev. Lett. **95**, 090603 (2005).

DY 24.7 Tue 16:00 HÜL 186

Localization Transition of the 3D Lorentz Model and Continuum Percolation — •Thomas Franosch[1,2], Felix Höfling[1], and Erwin Frey[2] — [1]Hahn-Meitner-Institut, Abteilung Theorie, Glienicker St. 100, D-14109 Berlin — [2]Arnold Sommerfeld Center and CeNS, Department of Physics, Ludwig-Maximilians-Universität München, Theresienstrasse 37, D-80333 München

The Lorentz model has served as a paradigm for transport in disordered media. It describes a structureless test particle moving in a random array of identical obstacles which interact with the test particle via a hard-sphere repulsion. At high densities, the model exhibits a localization transition, i. e., above a critical density, the test particle is always trapped by the obstacles.

It has been a longstanding open question whether the dynamics close to the critical density can be mapped to the transport properties of continuum percolation ("Swiss cheese model"). The fractal nature of the void space between the overlapping spheres in the Lorentz model suggested to use a description in terms of an equivalent random resistor network model.

We present extensive Molecular Dynamics simulations and provide the first unambiguous evidence for an intimate connection between the Lorentz model and continuum percolation [1]. In particular, we show the validity of a generalized dynamic scaling theory employing two divergent length scales, and discuss corrections to scaling. The non-Gaussian parameter is predicted to diverge close to the transition.

[1] F. Höfling, T. Franosch, and E. Frey, `cond-mat/0510442`.