DY 16: Brownian motion and transport I

Time: Tuesday 14:30–16:30 Location: H3

DY 16.1 Tue 14:30 H3

Dispersionless transport in a washboard potential — •Igor Sokolov — Institut für physik, Humboldt Universität zu Berlin

Based on extensive numerical simulations of thermally agitated classical particles in a tilted washboard potential we have identified and characterized a transport regime that involves dispersionless motion of particles over several decades of time in appropriate parameter regimes. This remarkably coherent behavior requires the presence of thermal fluctuations, and is restricted to underdamped systems. The associated distribution of the particle positions moves at an essentially constant velocity and is far from Gaussian. This new regime is complementary to, and entirely different from, well-known nonlinear response and large dispersion regimes observed for other values of the external force. We provide a theoretical framework to estimate the times of onset and duration of dispersionless transport and the parameter regimes in which it occurs. A similar regime is also observed in numerical simulations in two dimensions with a tilted separable potential. Our results may be testable on the motion of molecules and clusters on surfaces as well as in Josephson junctions.

K. Lindenberg, J. M. Sancho, A. M. Lacasta, and I. M. Sokolov, Phys. Rev. Lett., in press.

DY 16.2 Tue 14:45 H3

Traffic phenomena in driven transport with internal states — •Tobias Reichenbach, Thomas Franosch, and Erwin Frey — Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNS), Department of Physics, Ludwig-Maximilians-Universität München, Theresienstrasse 37, D-80333 München

Traffic phenomena occur in biological contexts as well as in mesoscopic quantum systems. Molecular motors move along parallel one-dimensional filaments in cells, serving as biological engines. On the other hand, spintronic devices aim to exploit quantum effects, the spin of electrons, when passing these trough nanowires. Here, we present a generic model that underlies both situations [1]. Allowing particles in an exclusion process to possess internal states, the latter account for several parallel lanes as well as different spin states, where Pauli's exclusion principle is respected. Exploring the system's behavior, we find that it can be tuned by controlling the particle fluxes at the boundaries. In particular, a spontaneous polarization may occur at a certain spatial position and, upon changing the fluxes at the boundaries, be driven in or out of the system. We derive the shape of the density profiles as well as resulting phase diagrams analytically by a mean-field approximation and a continuum limit.

[1] T. Reichenbach, T. Franosch, E. Frey, Phys. Rev. Lett. 97, 050603 (2006)

DY 16.3 Tue 15:00 H3

Experimental characterization of a Brownian Motor based on Ferrofluids — •Jens Nawitzki and Achim Kittel — Institute of Physics, Energy and Semiconductor Research Laboratory, Carl von Ossietzky University of Oldenburg, 26111 Oldenburg, Germany

We characterize the dynamics of an experimental Brownian Motor. The Brownian Motor consists of a hollow plastic sphere filled with a ferrofluid. The orientation dynamics of the ferrofluids ferromagnetic particles ist strongly influenced by thermal fluctuations. The sphere is suspended on a thin filament in the center of two crossed pairs of Helmholtz coils. One of the pair forms a static magnetic field in x direction and the other on applies a time dependent magnetic field in y direction. The time dependent field consists of a harmonic oscillation with a higher harmonic of the basic frequency. The magnetic fields act as potential for the orientation of the ferromagnetic particles. Directed motion of the ferromagnetic particles manifests as a rotation around the z Axis. Through the viscous coupling of the particles with the ferrofluids carrier liquid and their combined effective action results in a macroscopic torque of the plastic sphere. We measure the torque by means of applying a countertorque to the sphere's suspension. The control parameters for the measurements are the amplitude, frequency and phase of the time dependent and the magnitude of the static magnetic field. The measurements are done with varying viscosities of the ferrofluid. We observe the dynamical behavior of the sphere under variation of the control parameters and compare the results with the theoretical expectations.

DY 16.4 Tue 15:15 H3

Anomalous response behavior of a Josephson junction — •David Speer, Ralf Eichhorn, and Peter Reimann — Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld

We predict unusual transport properties of a Josephson Junction in the form of average current and voltage of opposite sign. The effect survives in the presence of not too large (thermal) noise. Numerical simulations are complemented by intuitive explanations of the basic mechanism and analytical approximations.

DY 16.5 Tue 15:30 H3

contribution moved to Dy 16.8 (Tue, 16:15) — •XXX XXX —

DY 16.6 Tue 15:45 H3

Quasiperiodic ratchets with cold atoms — •Sergey Denisov — Institute of Physics, University of Augsburg, 86135 Augsburg, Germany

We investigate experimentally the route to quasiperiodicity in a driven ratchet for cold atoms, and examine the relationship between symmetries and transport while approaching the quasiperiodic limit.

Depending on the specific form of driving, quasiperiodicity results in the complete suppression of transport, or into the restoration of the symmetries which hold for a periodic driving.

DY 16.7 Tue 16:00 H3

Multifractal conductance fluctuations — •Angelo Facchini[1], Andrea Tomadin[2], and Sandro Wimberger[3] — [1]University of Siena, Center for the Study of Complex Systems, Via Tommaso Pendola37, I-53100 Siena — [2]Scuola Normale Superiore, Piazza dei Cavalieri 7, I-56126 Pisa. — [3]CNISM and Dipartimento di Fisica del Politecnico, C. Duca degli Abruzzi 24, I-10129 Torino.

To characterize complexity on many different scales a standard tool is offered by the multifractal analysis. Yet often used in the study of classical complex systems, there are not many results on the quantum level, which would show multifractality surviving the quantum coarse-graining. A multifractal scaling of eigenfunctions at phase-transitions is one of the few well-known "quantum" examples. In this contribution, we show that multifractality is found in a *single* and easily measurable observable which characterizes *global* quantum transport in a paradigmatic model of quantum chaos. More specifically, we predict a multifractal scaling of the survival probability of the opened δ-kicked rotor in the deep quantum regime. Our analysis intrinsically focuses on intermediate and large-scale correlations of the survival probability as the global transport signal [1], and it generalizes previous results predicting parametric monofractal fluctuations on small scales [2].

[1] A. Facchini, A. Tomadin, S. Wimberger, Physica A, doi:10.1016/j.physa.2006.10.012.

[2] A. Tomadin, R. Mannella, and S. Wimberger, J. Phys. A **39**, 2477 (2006).

DY 16.8 Tue 16:15 H3

Josephson vortex ratchet: experiment and simulations — •Edward Goldobin, Markus Beck, Reinhold Kleiner, and Dieter Koelle — Physikalisches Institut – Experimentalphysik II, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany

We investigate a Josephson vortex ratchet — a fluxon in an asymmetric periodic potential driven by a deterministic force with zero time average. Our recent experiments[1] show that the average velocity of the ac driven fluxon may reach 91% of the Swihart velocity. In this talk we describe our experiment and give some further insights on the fluxon dynamics in such a ratchet, obtained by numerical simulations. [1] Phys. Rev. Lett. **95**, 090603 (2005).