DY 18: Brownian motion and transport II

Time: Tuesday 16:45–18:15 Location: H3

DY 18.1 Tue 16:45 H3

Lévy diffusion in thermal equilibrium — •Eric Lutz — Institut für Physik, Universität Augsburg, 86135 Augsburg

We show how anomalous Lévy diffusion can occur for systems coupled to a thermal bath of harmonic oscillators. The fluctuation-dissipation relation is satisfied and leads both to a natural truncation of the process and to an algebraically slow relaxation to thermal equilibrium.

DY 18.2 Tue 17:00 H3

Electrical resistance of disordered one-dimensional quantum conductors — •Christophe Deroulers — Institut für Theoretische Physik, Köln, Deutschland

In some (quasi-)one-dimensional quantum conductors (nanowires, anisotropic crystals, ...), it is observed that the electrical resistance R behaves, in some temperature range, as a power of the temperature T. Some results do not coincide with the well-known predictions of Kane and Fisher for a Luttinger liquid with a few weak impurities, and we study if these results could be due to disorder (many strong impurities in the wire). In our model, the wire is randomly cut in a chain of weakly-coupled "quantum dots" between which electrons hop. Because of competition betweenn tunneling and activation, and because of some interesting statistical effects, R behaves at low temperatures like $\exp(1/\sqrt{T})$ and, at higher temperatures, like a complicated function that may look like a power-law over one or two decades, as in experiments. We show, based on numerical simulations, that these two regimes are also distinguished by the repartition of current in the network of resistances equivalent to one wire, and that the statistical distribution of $\ln R$ is non-trivial and is given, for some temperatures, by an extreme value statistics (Gumbel law).

DY 18.3 Tue 17:15 H3

Anomalous Diffusion on Fractals — •Janett Prehl, Do Hoang Ngoc Anh, Peter Blaudeck, and Karl Heinz Hoffmann — Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz

Diffusion in porous materials shows anomalous behavior over certain length scales. As an appropriate model we apply Sierpinski carpets with finite iteration depth [1]. Modeling anomalous diffusion usually random walks on regular fractals are used. We study disordered fractals in an attempt to capture the random nature of disordered material by randomly mixing different Sierpinski carpet generators [2]. Besides we consider biased diffusion of charge particles with external field applied on fractal pattern. In order to analyze the diffusive process on such structures we utilize different methods to determine important quantities as e.g. the random walk dimension d_{w}. We find that this exponent d_{w} shows a strong dependence on the mixture composition and on the structural features of the carpets analyzed.

[1] S. Tarafdar, et al., *Physica A*, **292**, 1 (2001)
[2] D. Anh, et al., *Europhys. Lett.*, **70**, 109 (2005)

DY 18.4 Tue 17:30 H3

Hydrodynamic properties of fractal aggregates — •Rainer Bedrich and Roland Ketzmerick — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

For aggregates with a fractal-like structure, e.g. pyrogenic silica, it is important to relate their translational and rotational diffusion coefficients to their geometrical properties. We present a new algorithm, that allows for generating aggregates with any desired fractal dimension between $d_f = 1$ (chains) and $d_f = 3$ (spheres). Hydrodynamic properties are determined by a multipole expansion of the flow velocity at low Reynolds number [1]. We introduce hydrodynamic dimensions in analogy to the fractal dimension and obtain a universal relation between these dimensions for fractal aggregates. Aggregates from standard algorithms, like DLA, are in agreement with this relation.

[1] A. V. Filippov, J. Colloid Interface Sci. **229**, 184 (2000)

DY 18.5 Tue 17:45 H3

Exact solution for the diffusion coefficient of nonlinear Brownian motion — •Benjamin Lindner — Max-Planck-Institut, Dresden, Germany

A quadrature formula for the diffusion coefficient of a Brownian particle with nonlinear velocity dependent friction and diffusion coefficients is derived for the one-dimensional case. The result is discussed for three different systems: (1) an equilibrium system with nonlinear friction function; (2) a model of relativistic Brownian motion; (3) a phenomenological model of biological motion (active Brownian motion).

DY 18.6 Tue 18:00 H3

Hydrogen recombination on interstellar dust: A first-passage problem with disorder — •Ingo Lohmar and Joachim Krug — Institute for Theoretical Physics, University of Cologne, Germany

Hydrogen recombination on the surface of interstellar dust grains is both a crucial ingredient in the complex astrochemistry of gas clouds and a prime example for the effect of a confined geometry on diffusion-mediated reactions. We have studied this problem theoretically: based on the first-passage problem of two diffusing (and desorbing) random walkers on the surface, we formulate a consistent revised definition of the *sweeping rate* of a single atom, which allows us to introduce the spatial aspects of the problem to standard master or rate equation treatments. For simple (spherical and homogeneous) grains, the effect on the recombination efficiency can be calculated exactly and is appreciable compared to previous approximations [1].

The astrophysical puzzle in this context is that H_2 recombination still occurs efficiently at temperatures higher than predicted by the theory. The commonly accepted reason is the complex surface structure of the dust grains, which leads to a spatially inhomogeneous binding strength for reactants. While numerical simulations routinely confirm this explanation, analytical results for such first-passage problems in truly *disordered* environments are rare and limited to certain classes of systems. Our aim is to improve the theory in this respect, both for fundamental reasons as well as in view of the applicability to astrophysics.

[1] I. Lohmar, J. Krug, Month. Not. R. Astron. Soc. **370**, 1025 (2006)