CPP 32: Colloid Dynamics

Time: Thursday 11:15–12:30 Location: C 264

CPP 32.1 Thu 11:15 C 264

Directed motion of colloidal particles by external magnetic fields — •Christian Kreidler, Larysa Baraban, Ina Seuffert, Paul Leiderer, and Artur Erbe — Universität Konstanz. FB Physik, Germany

Directed motion of microscopic particles can be used in many biological systems to transport molecules in a controlled way. Existing techniques, e.g. laser tweezers, work well under certain conditions. Here we demonstrate a concept of micro engines, which is based on the usage of asymmetrically catalytic colloidal particles. A chemical reaction is used to generate movement of the magnetic particles in suspension. Specially designed magnetic properties of colloids help to achieve their directed motion on the long time scale. The strength of the external magnetic field influences the velocity of the particles. Increasing its amplitude we can change the direction of the motion from antiparallel to parallel to the magnetic field. In principle, the technique can work even without direct optical access to the system. We present the time dependence of the mean square displacement for these particles as a proof of our concept. Further experiments concentrate on binding biological material to the moving particles in order to demonstrate the ability of the particles to serve as "transporters" for molecules.

CPP 32.2 Thu 11:30 C 264

Persistent correlations of constrained colloidal motion — •Jonas A. Kraus[1], Thomas Franosch[1], Sylvia Jeney[2], Branimir Lukić[2], and László Forró[2] — [1]Arnold Sommerfeld Center for Theoretical Physics and Center for NanoScience (CeNS), Department of Physics, Ludwig-Maximilians-Universität München, Theresienstrasse 37, D-80333 München, Germany — [2]Institut de Physique de la Matierère Complexe, Ecole Polytechnique Fédérale de Lausanne (EPFL), CH-1015 Lausanne, Switzerland

The dynamic behavior of a single colloidal particle in water confined by an optical trap and a plane surface is investigated at time scales where the inertia of the surrounding fluid plays a significant role. First, we quantify the influence of the confinement created by the harmonic potential of the optical trap on the particle's velocity autocorrelation (VACF). In particular, we observe a regime of anti-correlation which cannot be explained by the harmonic restoring force and the particle's inertia alone. For intermediates times unconstrained bulk behavior is recovered and we give first direct experimental evidence for the celebrated power-law long-time tails.

Second, the particle is brought close to a surface and we observe how the subtle interplay of surface confinement and hydrodynamic backflow changes the decay of the particle's VACF from a slow $t^{-3/2}$ to a much faster power-law $t^{-5/2}$. We compare our data to a recently developed theory by Felderhof [1] which we have extended by a harmonic trapping force.

[1] B.U. Felderhof, J. Phys. Chem. B 109, 21406 (2005).

CPP 32.3 Thu 11:45 C 264

Critical dynamics of ballistic and Brownian particles in a heterogeneous environment — •Felix Höfling, Tobias Munk, Erwin Frey, and Thomas Franosch — Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNS), Department of Physics, Ludwig-Maximilians-Universität München, Theresienstraße 37, 80333 München

Transport of tagged ions, macromolecules, or nanoparticles in heterogeneous environments is strongly hindered by the presence of a variety of differently sized components. Three major transport phenomena are observed: normal diffusion, immobilization or localization, and anomalous transport. It will be shown that all aspects may be unified into the concept of transport in a disordered, heterogeneous medium with a percolation transition [1].

We have investigated Lorentz models with ballistic and Brownian tracer particles by means of large-scale computer simulations. It is demonstrated that in the immediate vicinity of the localization transition, universality holds at large time scales. The scaling function describing the crossover from anomalous transport to diffusive motion is found to vary extremely slowly and spans at least 5 decades in time. To extract the scaling function, one has to allow for the universal corrections to scaling. Our findings suggest that apparent power laws with varying exponents generically occur and dominate experimentally accessible time windows as soon as the heterogeneities cover a decade in length scale.

[1] Höfling, Franosch & Frey, Phys. Rev. Lett. 96, 165901 (2006)

CPP 32.4 Thu 12:00 C 264

Dumbbell diffusion in a spatially periodic potential — •Jochen Bammert and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, D-95440 Bayreuth

We present a numerical investigation of the Brownian motion and diffusion of a dumbbell in a two-dimensional periodic potential. Its dynamics is described by a Langevin model including the hydrodynamic interaction. With increasing values of the amplitude of the potential we find along the modulated spatial directions a reduction of the diffusion and a reduction of hydrodynamic interaction effects on the dumbbell mobility. For modulation amplitudes in the range of the thermal energy the dumbbell diffusion exhibits a pronounced local maximum at a wavelength of about 3/2 of the dumbbell extension. This is especially emphasized for stiff springs connecting the two beads.

CPP 32.5 Thu 12:15 C 264

The dynamics of several small rotating dumbbells in a fluid — •Steffen Schreiber and Walter Zimmermann — Lehrstuhl Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

Dumbbells in a fluid carrying a magnetic moment may be set in rotation by an external rotating magnetic field. The hydrodynamic interaction between two or three rotating dumbbells causes a motion of the centers of mass of the dumbbells, which follow circular trajectories. The period of the circular motion of the centers of mass depends on the rotation frequency of the external magnetic flield. Transitions of three and more hydrodynamically interacting dumbbells to more complex dynamics are explored.