AKB 24 Brownian Motion and Fluctuation Theorems

Time: Thursday 17:15–18:00 Room: ZEU 255

AKB 24.1 Thu 17:15 ZEU 255

Observation of nondiffusive Brownian motion of an isolated particle — •Sylvia Jeney[1], Branimir Lukic[1], Christian Tischer[2], Andrzej Kulik[1], Laszlo Forro[1], and Ernst-Ludwig Florin[3] — [1]Institut de Physique de la Matière Complexe, Ecole Polytechnique Fédérale de Lausanne, CH-1015 Lausanne, Switzerland — [2]European Molecular Biology Laboratory, Meyerhofstrasse 1, D-69117 Heidelberg, Germany — [3]Center for Nonlinear Dynamics, University of Texas, Austin, Texas 78712, USA

The thermal position fluctuations of a single micron-sized sphere immersed in a fluid were recorded by optical trapping interferometry with nanometer spatial and microsecond temporal resolution. We find, in accord with the theory of Brownian motion including hydrodynamic memory effects, that the transition from the ballistic to the diffusive motion is delayed to significantly longer times than predicted by the standard Langevin equation. This delay is a consequence of the inertia of the fluid. On the shortest time scales investigated, the sphere*s inertia has a small, but measurable, effect. Furthermore, our study gives insight on the particle's behavior, when confined in a harmonic potential. Surprisingly the hydrodynamic memory effects coming from the inertia of the fluid and the harmonic potential act at the same time scale for the studied system.

AKB 24.2 Thu 17:30 ZEU 255

Fluctuation-Dissipation Relations for Non-Equilibrium Steady States — •Thomas Speck and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, Pfaffenwaldring 57/III, 70550 Stuttgart

In non-equilibrium, the fluctuation-dissipation theorem (FDT) relating the response function of an observable with its auto-correlation is violated. This violation has been studied intensely, especially in the context of aging systems and glasses, where it allows to define an effective temperature. In the case of colloidal systems, the heat permanently dissipated in order to maintain the violation of detailed balance has been identified as "housekeeping" heat [1,2]. As the crucial ingredient, this heat involves two aspects of the velocity, namely the actual velocity and the *local* mean velocity. Studying a paradigmatic single colloidal particle moving in a periodic potential, we discuss the close connection between the violation of the velocity FDT and the violation of detailed balance. We derive an explicit expression for this violation and illustrate our results with numerical simulations.

[1] T. Hatano and S. Sasa, Phys. Rev. Lett. **86**, 3463 (2001)
[2] T. Speck and U. Seifert, J. Phys. A: Math. Gen. **38**, L581 (2005)

AKB 24.3 Thu 17:45 ZEU 255

Short-time inertial response of viscoelastic fluids: observation of vortex propagation — •Maryam Atakhorrami[1], Gijsberta H. Koenderink[2], Daisuke Mizuno[1], Tanniemola Liverpool[3], Christoph F. Schmidt[1], and Frederick C. MacKintosh[1] — [1]Dept. Physics, Vrije Universiteit, Amsterdam, NL — [2]Division of Engineering and Applied Sciences, Harvard University, Cambridge, MA 02138, USA — [3]Department of Applied Mathematics, School of Mathematics, University of Leeds, Leeds, LS2 9JT, UK

We probe the response of viscous and viscoelastic fluids on micrometer and microsecond length and time scales using two optically trapped beads. In this way we resolve the flow field, which exhibits clear effects of fluid inertia. Specifically, we resolve the short time vortex flow and the corresponding motion of this vortex, which propagates diffusively for simple liquids. For viscoelastic fluids, this propagation is shown to be faster than diffusive and the displacement correlations reflect the frequency dependent shear modulus of the medium. The phenomenon is related to long-time tails in scattering experiments.