INSTITUT DE SCIENCE ET D'INGENIERIE SUPRAMOLECULAIRES
CENTRE EUROPEEN DE SCIENCES QUANTIQUES

MINI-SYMPOSIUM

Thermodynamics of fluctuating systems

14:30 - Sabine H.L. Klapp – Institute for Theoretical Physics, TU Berlin

Colloids under time-delayed feedback

15:10 - Paulo A. Maia Neto – Institute of Physics, UFRJ, Rio de Janeiro

Applications of optical tweezers with vortex beams

Break

16:10 - Yann Louyer – LOMA, Université de Bordeaux

Giant diffusion of nanomechanical rotors in a tilted washboard potential

16:50 - Loïc Rondin – LuMIn, Université Paris-Saclay

Out-of-equilibrium dynamics control of an optically levitated particle

Wednesday December 13th, 2023 - 14 h 30
ISIS - Campus Esplanade

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Sabine H.L. KLAPP: Colloids under time-delayed feedback.

Abstract: Within the last years, feedback (closed-loop) control of fluctuating systems, such as colloids in a thermal bath, has become a focus of growing interest. In this talk I will discuss recent theoretical results for colloids subject to feedback with time delay. After discussing general thermodynamic aspects, I will move to the specific case of repulsive, nonlinear feedback. Already for single particles we find that, in dependence of the delay time and feedback strength, repulsive feedback can generate persistent motion. I will then discuss simulation results for the collective behavior of many particles interacting via a repulsive (WCA) potential, each being subject to time-delayed repulsive feedback. Intriguingly, one observes a state with spontaneous, large scale alignment of the velocity vectors.

Paulo A. Maia Neto: Applications of optical tweezers with vortex beams

Abstract: We use an optical tweezer based on a tightly-focused vortex laser beam as a platform for the investigation of paradigmatic models of stochastic thermodynamics involving non-equilibrium steady states, bistability, and cyclic symmetry breaking. As a second application, we present proposals of enantioselective optical manipulation, sorting and characterization of individual chiral particles which are based on a theoretical model for the optical force and torque on chiral microspheres trapped by a tightly-focused vortex beam.

Yann Louyer: Giant diffusion of nanomechanical rotors in a tilted washboard potential

Abstract: We present an experimental realization of a biased optical periodic potential in the low friction limit. The noise-induced bistability between locked (torsional) and running (spinning) states in the rotational motion of a nanodumbbell is driven by an elliptically polarized light beam tilting the angular potential. By varying the gas pressure around the point of maximum intermittency, the rotational effective diffusion coefficient increases by more than 3 orders of magnitude over free space diffusion. These experimental results agree with a simple two-state model that is derived from the Langevin equation through using timescale separation. Our work provides a new experimental platform to study the weak thermal noise limit for diffusion in this system.

Loïc Rondin: Out-of-equilibrium dynamics control of an optically levitated particle

Abstract: The opportunity to finely control the coupling between a nanoparticle and its environment offers exciting perspectives, from developing ultrasensitive force sensors to macroscopic quantum physics tests through studying thermodynamics at the nanoscale [1]. Over the last decade, such control has been demonstrated using optical levitation of nanoparticles in vacuum. After introducing the principle of optical tweezers and their application to levitation, I will discuss our recent results on controlling levitated nanoparticles dynamics and shaping their trapping potential. I will demonstrate how this control can be used to address out-of-equilibrium thermodynamics [2] and discuss perspectives toward the generation of advanced quantum states of the particle motion.

[1] Gonzalez-Ballestero, C., Aspelmeyer, M., Novotny, L., Quidant, R. & Romero-Isart, O. Levitodynamics: Levitation and control of microscopic objects in vacuum. Science 374, eabg3027
[2] Raynal, D. et al. Shortcuts to Equilibrium with a Levitated Particle in the Underdamped Regime. Phys. Rev. Lett. 131, 087101 (2023)