INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Ondes et Matière d'Aquitaine (LOMA)
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Internship location:
Bat A4N, Université de Bordeaux, 351 Cours de la Libération, 33405 TALENCE

Thesis possibility after internship: YES
Funding: NO (proposal submitted) If YES, which type of funding:

Probing Short-Time Brownian Motion in 3D with Optical Traps

Optical trapping was first demonstrated in 1970 through the discovery of radiation pressure forces on dielectric spheres, in the pioneering experiments of A. Ashkin (Nobel Prize 2018). Extended to cold atoms in the 1990s, optical forces became a powerful tool to probe matter at the nanoscale.
Brownian motion, first observed in the early 19th century, has fascinated scientists ever since. Measuring instantaneous velocity is a major challenge, as it depends critically on the temporal sampling rate: while x(t) is continuous but not differentiable, Einstein argued it could never be measured. This was achieved in liquids and gases with an optically trapped particle (Rice University, Texas), with 10 pm spatial and 5 ns temporal resolution, revealing the diffusive-to-ballistic transition (mean square displacement scaling as t then t^2).
At LOMA, we built a unique optical trapping setup combining balanced detection, high-speed acquisition, and an ultra-stable laser, and observed the ballistic regime in water, measuring particle velocity and its autocorrelation along x(t). We recently obtained a proof of concept for simultaneous x(t) and y(t) tracking by CMOS camera under white light, run alongside the photodiode x(t) channel for parameter-free calibration. Our system reaches state-of-the-art sensitivity, with noise levels down to 10^{-15} m/√Hz.

We are now seeking a Master 2 student to join this experiment, with opportunities to: (i) set up Köhler-type white-light illumination, (ii) build a y(t) channel with balanced photodiodes identical to the existing x(t) channel, (iii) develop a new axial z(t) channel using backscattering homodyne interferometry, (iv) longer term (PhD project): explore Brownian motion near rigid then soft boundaries to extract the effective mass m*.

The student will join a stimulating, multidisciplinary environment at LOMA, working close-ly with the EMetBrown group (Thomas Salez, Yacine Amarouchene), NOG group (Julien Burgin, Yann Louyer) and LOMA staff (Théo Guillaume).

Applicants should have a strong interest in experimental physics applied to fundamental prob-lems. Background knowledge in optics, nanoscience, nonlinear physics, or statistical physics will be highly valuable. Programming experience (Python or Matlab) is welcome.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: YES
Quantum Physics: NO Theoretical Physics: NO