BIOPHAB, optical tweezers for single molecule manipulations

CONTACT
herve.guillou
@neel.cnrs.fr

LABORATORIES: NEEL, INAC

PRINCIPAL INVESTIGATORS : Hervé Guillou, Jochen Fick, Yannick Sonnefraud

Nanoscale systems are of great interest because of their peculiar physical properties generated by their low size. However, this size makes their manipulation and study challenging. Two strategies have been developed: either these systems are studied statistically and their properties are ensemble averaged, or they are studied individually. Optical trapping is in that case very convenient because it allows simultaneous manipulation and observation. It is the method of choice if spectroscopic properties need to be measured.

We started the development of an instrument able to trap micro or nanoparticles. The instrument is based on the RAMM system from ASI that offers a modular platform for microscopy. We use a laser diode @790 nm to generate the trapping beam. It is expended by using Newton telescopes to fill the back aperture of the objective lens (Olympus 60X Water NA1.2). The high numerical aperture insures a strong focusing of the laser beam and thus high trapping forces. We trapped micron sized polystyrene beads. The trapping force was calibrated by recording the backscattered laser beam with a high speed sCMOS camera (Andor). The fluctuations of the positions were analyzed by a homemade software in order to calibrate the trap stiffness (Fig. 1). To achieve the development of the instrument, the software, the trap symmetry and the bandwidth need to be improved. For that purpose we will interact with groups who are expert in nanomechanical systems and develop similar detection setup.

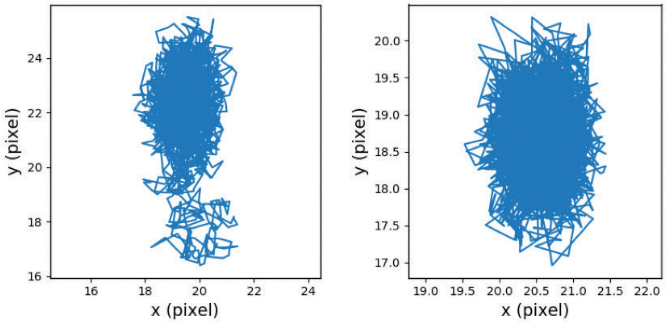

Figure 1 Brownian motion of a trapped particle for low and high trap stiffness.

About 30 students in Master 2 Nano and Complex Matter and Living Matter were invited for a hand-on experience on optical trapping (Fig. 2).

The instrument is now ready to be applied to specific studies. We expect to use it to investigate the force-extension curves of DNA origami with Didier Gasparutto: the information obtained in such experiment is intimately related to the free energy landscape of the system. The experimental setup will also be used to study the fluctuation theorem for self-assembled nanostructures in an open system. In collaboration with Cecile Delacour we will use the highly focused laser beam to cut and reverse engineer neuron networks using photo-ablation: we want to identify the minimal amount of links needed to achieve robust information transmission and processing.

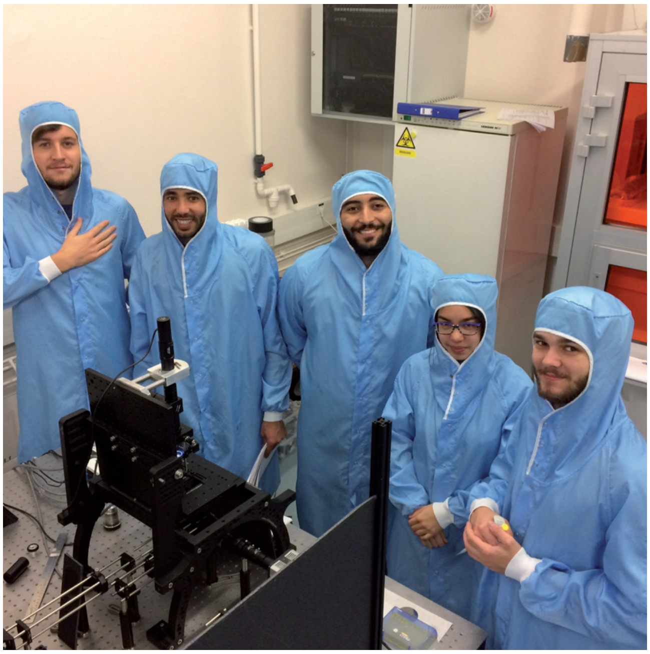

Figure 2 : Students from the master Complex Matter, Living Matter studying optical trapping.

OUTCOMES

Dissemination: give access to state of the art experimental setup to M2 students.