Laboratoire Lumière-Matière et Interfaces

Master2 Internship Proposal

Optical levitation of particles' array: toward nanothermodynamics and quantum interactions

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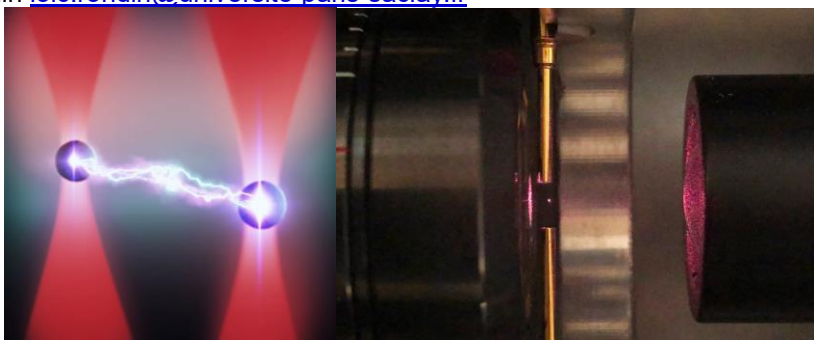

(left) Artist view of the levitation of two coupled particles (src: npg group). (right) A 70 nm nanoparticle trapped in vacuum (bright red spot) by a highly focused laser through an objective (on the left).

Optical levitation of particles in vacuum, offering excellent isolation from the environment, is a unique platform for the study of fundamental interactions [1], thermodynamics of nano-systems [2], or quantum physics at macro scales [3].
In that context, the opportunity to scale this system is particularly attractive to extend the capability of the system, by providing a unique opportunity to observe quantum entanglement between massive particles, to study anomalous energy flux at the nanoscale, or extend the sensibility of weakly interacting particles (WIMPS) detectors.
The proposed internship aimed at developing a system to **optically levitate multiple particles**. This system will be based on the **optical tweezer** setup we developed in the lab over the last few years. The objective of the internship will then be to trap two particles and characterize their interactions, both optical and electrostatics. These interactions will then be used to study energy exchange between the coupled particles.
The developed setup will serve as a basis to study anomalous energy flux at the nanoscale and quantum interaction between levitated massive particles.

The candidate should have a strong interest in experimental physics and know at least one of the topics: nano-optics and photonics, atomic physics, stochastic physics. An interest in instrumentation is a plus.
This internship can be followed by a PhD thesis

Références :
[1] Moore and Geraci. "Searching for New Physics Using Optically Levitated Sensors." Quant. Sci. Tech. 6, no. 1 (2021)
[2] Raynal et al. "Shortcuts to Equilibrium with a Levitated Particle in the Underdamped Regime." *PRL* 131, 087101 (2023)

[3] Levitating' nanoparticles could push the limits of quantum entanglement *doi: https://doi.org/10.1038/d41586-022-02322-6*