Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

Laboratory name: LPENS
CNRS identification code: UMR 8023
Internship director'surname: Gabriel Hétet
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Web page: https://www.lpens.ens.psl.eu/nano-optique/diamonds/?lang=en
Internship location: 24, rue Lhomond, 75005

Thesis possibility after internship: YES
Funding: NO

Spin-Mechanics with Levitating Diamonds

Experiments on trapping particles containing atoms with a spin degree of freedom have shown remarkable progress in recent years [1].

In our team, we have developed a micro-electrostatic trap for diamond particles containing defects whose spin can be coherently polarized and manipulated with microwaves (see fig. 1). These defects are molecular systems consisting in the association of a nitrogen atom and a vacancy (NV center). Thanks to a coupling mechanism of the spin of the NV centers in the diamond with the oscillation of the diamond in the trap, we have been able to demonstrate an efficient cooling mechanism of the angular motion of the latter [2].

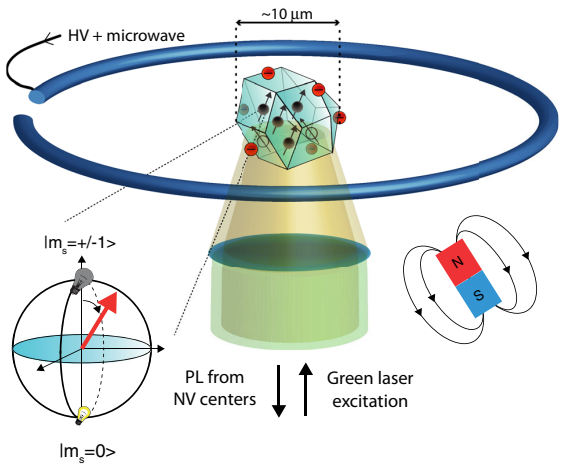

Figure 1 : Levitating diamond with embedded individual spins

It is in fact theoretically possible to control this motion until it is cooled to the ground state of the harmonic oscillator.
The objective of the internship (and later of the thesis) will be to levitate ultra-pure diamond particles and employ instead the coupling of the motion to **nuclear spins** to move towards this regime.

The perspectives offered by this type of experiments range from the detection of weak magnetic fields to the observation of quantum effects on macroscopic objects.

[1] Perdriat M. et al. " Spin-mechanics with NV centers and trapped particles" Micromachines (2021): https://www.mdpi.com/2072-666X/12/6/651
[2] Delord T. et al. "spin-cooling of the motion of a trapped diamond", Nature 580 (7801), 56-59

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