Spin-mechanics with trapped diamonds

Speaker: **Gabriel Hétet**

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Date and time: **Friday March 19th, at 15:15**

Place: <https://epfl.zoom.us/j/89778378177>

Abstract: Observing and controlling macroscopic quantum systems has long been a driving force in research on quantum physics. To this end, many groups are investigating platforms for coupling the motion of levitating particles to the spin of individual atoms at the quantum level. I will show that the angular degrees of freedom of diamonds in a Paul trap and coupled to embedded Nitrogen-Vacancy (NV) centers offer bright prospects towards this purpose.

I will present our experimental progress towards these goals. First, I will show our demonstration of coherent manipulations of the spin of NV centers [1] and of the spin-dependent torque and spin- cooling of the angular motion of diamonds levitating in a Paul trap [2]. I will also discuss more recent efforts towards using dipolar interactions between NV centers to control the angular motion of diamonds [3] as well as the use of NV centers to make a diamond behave as diamagnet under magnetic field above a critical value (≈ 0.1T, see Figure 1). I will show how the resulting magnetization enables magneto-optical alignment of the diamond main axes along the magnetic field [4].

[1] T. Delord, P. Huillery, L. Schwab, L. Nicolas, L. Lecordier, and G. Hétet, **Phys. Rev. Lett.** 121, 053602 (2018).

[2] T. Delord, P. Huillery, L. Nicolas, and G. Hétet, **Nature** 580, 56 (2020).

[3] C. Pellet-Mary, P. Huillery, M. Perdriat, and G. Hétet, arXiv e-prints arXiv:2103.00836 (2021), 2103.00836.

[4] M. Perdriat, P. Huillery, C. Pellet-Mary, and G. Hétet, arXiv e-prints arXiv:2102.13637 (2021), 2102.13637.

Gabriel Hétet is assistant professor at the Physics Laborator of Ecole Normale Supérieure in Paris. He obtained his PhD from the Australian National University in Canberra under the supervision of P. K. Lam and H-A Bachor in 2008, where he worked on optical squeezing and quantum memories with Rubidium atoms. His postdoc journey took him successively to Innsbruck (working on QED in with trapped ions in Rainer Blatt’s group), to Toulouse (project on quantum chaos in the motion of BECs) and finally to Paris-Orsay (studying individual NV centers in diamond with Vincent Jacques and Jean-François Roch), before becoming permanent research and group leader at ENS, where is pioneering a new approach toward quantum coherent spin-mechanic coupling in levitated nanodiamonds.