# Physikalisches Kolloquium — Physics Colloquium

**Einladung** — **Invitation**

# Monday, 16 June 2025

**Lecture Hall N24/H13, at 16:15 hrs**

**Coffee and cookies will be served in front of the lecture hall from 16:00 hrs**

## Spin-Mechanics with Nitrogen-Vacancy Centers


**Prof. Dr. Gabriel Hétet**

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https://www.phys.ens.fr/fr/article/cours-de-gabriel-hetet


Controlling the motion of trapped macroscopic particles in the quantum regime has been the subject of intense research in recent decades. Especially noteworthy is the recent milestone of achieving ground state cooling for a trapped particle [1]. However, the generation of purely non Gaussian states such as the first phonon Fock state or Schrödinger cat states, is required for further quantum control as well as for realizing quantum interference. One approach is to transfer the quantumness of a well-controlled two-level system to the mechanical degree of freedom, which can be realized by coupling the motion of crystals with embedded spins using magnetic fields.

The coherence time of the spin system stands as a critical factor for this application in particular for the preservation of Schrödinger cat states, which is still a significant challenge in the field of levitodynamics.

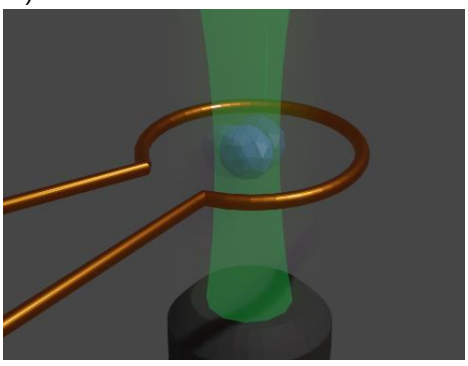
We will show our progress towards this goal using electronic spins of NV centers in diamonds in Paul traps [2] as well as attached to a cantilever [4]. We will also show recent results on Nuclear Magnetic Resonance (NMR) within a levitating micro-diamond. There, we employ the nuclear spins of nitrogen-14 atoms, offering coherence times up to hundreds of microseconds. This represents the longest coherence time recorded for a controlled two-level system in a levitated particle, surpassing the previously measured coherence time in electronic spins by three orders of magnitude [2,3].


[1] U. Delic, M. Reisenbauer, K. Dare, D. Grass, V. Vuletic, N. Kiesel, and M. Aspelmeyer, Cooling of a levitated nanoparticle to the motional quantum ground state, Science 367, 892 (2020).

[2] T. Delord and et al., Spin-cooling of the motion of a trapped diamond, Nature 580, 56 (2020).

[3] J. Voisin, T. Copie, A. Durand, M. Perdriat and G. Hétet, Nuclear magnetic resonance with a levitating micro-particle, to appear PRL 133 (21) 213602 (2024).

[4] Perdriat M., Durand A., Voisin J. L. Chambard, G. Hétet, Spin dependent Force from an NV center ensemble on a microlever ArXiv 2410.18762 (2024)

Host: Prof. Benjamin Stickler, Institute of Complexe Quantum Systems

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