# ***INTERNSHIP PROPOSAL***

*(One page maximum)*

Laboratory name: SPEC, CEA Saclay
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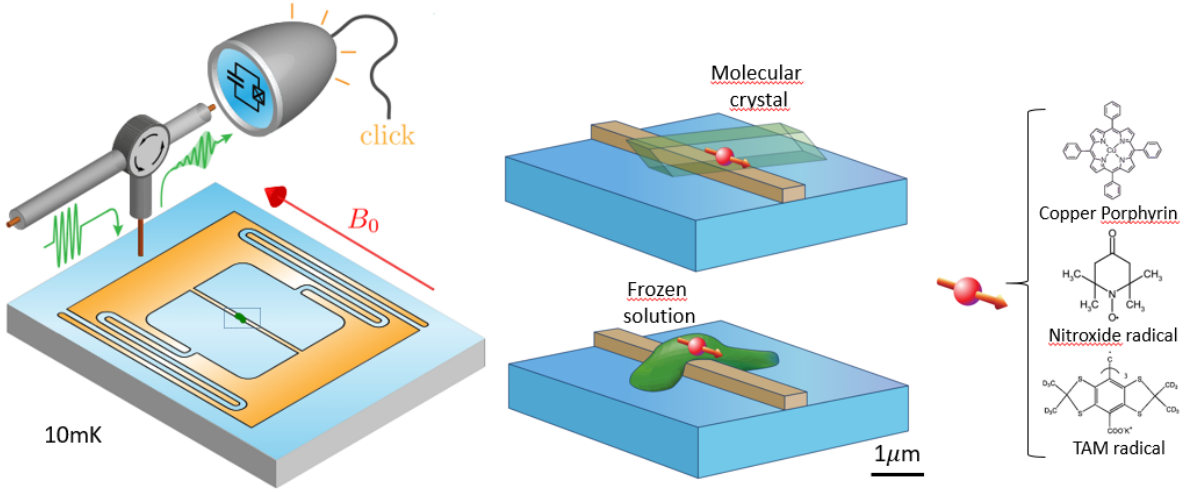
Internship location: CEA Saclay
Thesis possibility after internship: YES/~~NO~~
Funding: YES/~~NO~~ If YES, which type of funding: ANR

**Single-molecule magnetic resonance spectroscopy**

Magnetic resonance spectroscopy studies matter by probing the resonant frequencies and couplings of paramagnetic nuclei and unpaired electrons. It is a cornerstone of modern science, with numerous applications in condensed-matter physics, materials science, chemistry, biology, and medical imaging. A key drawback is its low sensitivity. Conventional spectrometers need large numbers of identical objects to detect a signal. This is an issue for systems with inhomogeneous properties, since their ensemble linewidth is often much larger than the linewidth of the individual objects, which limits spectral resolution.

In our laboratory, we have recently developed a unique method to perform magnetic resonance spectroscopy studies on individual objects. We detect individual electronic paramagnetic centers at 10mK by counting the fluorescence microwave photons emitted when they are excited and relax radiatively to the ground state [1], using a single-microwave-photon detector based on a superconducting transmon qubit [2,3,4]. So far, single-spin sensitivity was reached with individual $Er^{3+}$ ions in a single crystal [3,4]. We now want to extend the method, from this model system, to a large variety of individual paramagnetic centers, and particularly to individual paramagnetic molecules. This requires improving the setup sensitivity and developing suitable deposition methods (molecular crystals or frozen solutions, see Figure). Experimental techniques include cleanroom work, low-temperature microwave measurements in dilution refrigerators, single-spin magnetic resonance spectroscopy. The student will team up with a PhD and postdoc.


[1] A. Bienfait et al., Nature 531, 74 (2016)
[2] E. Albertinale et al., Nature 600, 434 (2021)
[3] Z. Wang et al., Nature 619, 276 (2023)
[4] J. Travesedo, arxiv (2024)


Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

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