INTERNSHIP PROPOSAL

Laboratory name: LPEM
CNRS identification code: UMR 8213
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Internship location: ESPCI

Thesis possibility after internship: NO
Funding: YES If YES, which type of funding: ANR

Electromagnetic simulations for near field GHz spectrometer

The advances of circuit quantum electrodynamic (cQED) have enabled tremendous progress both in the field of quantum computing and quantum sensors. It is now possible with such circuits to detect accurately single photons in various range of frequencies, potentially giving access to microscopic excitations in condensed matter systems.

However, the current tools are usually lacking spatiality and sensitivity. In that regard, in the lab we are pursuing an endeavour to combine cQED methodology [1] with the latest development in scanning probe techniques[2]. The idea would be to develop a scanning nano-antenna to get access to single photon processes at the heart of condensed matter systems with nanometer resolution.

The goal of this internship is to explore numerically different geometries of nano-antennas and optimise the electromagnetic coupling with its environment at the relevant frequencies. A first part of the internship will consist in designing and simulating this nano-antenna with HFSS ANSYS. If time permits, you will be able to start the fabrication process by making tips and on-chip antennas by state of the art lithography techniques. You will also participate in the rest of the lab activities and discussion around the project.

The results of this intersnhip will directly impact the design of future nanoantennas. It requires creativity, rigor and a good understanding of classical electromagnetism.

References:

[1] Wang, Z., *et al.* Single-electron spin resonance detection by microwave photon counting. *Nature* **619**, 276–281 (2023). https://doi.org/10.1038 https://arxiv.org/pdf/2301.02653.pdf
[2] Halbertal, D., *et al.* Nanoscale thermal imaging of dissipation in quantum systems. *Nature* **539**, 407–410 (2016). https://doi.org/10.1038/nature19843 https://arxiv.org/abs/1609.01487

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

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