Internship (+ funded PhD)

OPEN POSITION

Quantum Circuit Group

ENS Lyon, France

SPIN SCANNING PROBE USING QUANTUM MICROWAVES

Electron paramagnetic resonance (EPR) is a powerful spectroscopy method which allows to identify spins and paramagnetic species and quantify their interactions with their environment. Because of the weak spin-microwave coupling, conventional EPR spectroscopy has a low sensitivity which limits its use to samples of macroscopic size. Recent experiments demonstrated that superconducting quantum circuits have the potential to drastically enhance the spin detection sensitivity down to the detection of single spins within a 1 um volume probe [1-3] using properties unique to quantum mechanics. However, these demonstrations have so far been done using well-known model spin systems and in restrictive conditions: very narrow spin and detector linewidths, extremely low microwave losses, and low static magnetic fields, implanted spin species. The internship project will center on developing and building a scanning probe allowing to perform EPR spectroscopy and imaging on a nearby surface with a resolution of a few spins.

The gain in absolute and concentration sensitivity will be based on earlier developments [1-2] using quantum circuits techniques, in particular high quality factor small mode volumes superconducting resonators and quantum-limited amplifiers. The intern will focus on designing and fabricating a scanning probe on which the detection circuit will lie to probe species lying within 100 nm -1 um of the tip. The internship will thus center on microwave design, nanofabrication, as well as building the instrumentation necessary to operate in a high vacuum low temperature environment. A successful implementation of this probe will enable to detect spurious paramagnetic species lying at the surface of superconducting circuits in order to improve their performance, but also from other solid-state devices, such as organic semiconductors, or chemical or biological entities, in a later PhD project (funded by the ERC project INDIGO).

The internship will take place in the Quantum circuits group at ENS de Lyon, which is an expert in quantum circuit technologies for quantum sensing and quantum information processing. A background in solid-state or quantum physics is highly desired. Any experience in the following fields will be appreciated: scanning probe instrumentation, pulsed microwave measurements, nanofabrication, low-temperature measurements, microwave instrumentation and design.

If you like experimental physics, want to enjoy living in one of the world food capitals and its nearby outdoors attractions, don't hesitate to reach out! Enquiries should be sent to Audrey Bienfait (audrey.bienfait@ens-lyon.fr).

[1] A. Bienfait et al., Nature Nanotechnology, 11, 253–257 (2016)

[2] V. Ranjan et al., Applied Physics Letters 116 (18), 184002 (2020)

[3] Z. Wang et al., Nature, 619, 2023