PhD position at IM2NP
(AMU CNRS, Marseille)

Institut Matériaux Microélectronique
Nanosciences de Provence

Subject's title: Advancing Instrumentation for Conventional Electron Spin Resonance in the Realm of Quantum Technologies.

Keywords : electron spin resonance – quantum technologies – high-Tc superconducting resonator – microwave instrumentation

Subject description:
Electron Spin Resonance (ESR) is a powerful spectroscopic technique used to study the magnetic properties of materials with unpaired electrons. The resulting spectrum provides valuable information about the local environment of unpaired electrons, such as their number, spin state, and interactions with neighboring atoms. ESR finds diverse applications in fields like chemistry, physics, biology, and more specifically in quantum information. Quantum technologies represent a transformative frontier leveraging the principles of quantum mechanics for revolutionary applications. Expectations and implications are enormous, but so are the technological hurdles. Superconducting quantum circuits (SQC), one of the leading hardware candidates for quantum computing, have also emerged as powerful tools in the realm of quantum metrology and sensing. By leveraging its high sensitivity, at the quantum limit, these circuits enable highly precise measurements for a variety of applications, including magnetic spectroscopy.

A key element, shared by both the SQC and ESR fields is a microwave resonator. Recently, by merging SQC with ESR, sensitivity breakthroughs, down to single-spin detection, have been achieved by using millikelvin temperature and long coherence superconducting resonator. However, it still lacks the necessary versatility for the broad range of uses of conventional ESR as it only operates at milli-Kelvin temperature and using a well-chosen spin sample.

Our approach will be to build a homemade ESR spectrometer based on resonators made of higher critical temperatures superconductors, thus allowing to improve spin sensitivity without sacrificing too much on temperature versatility. The associated microwave circuitry and electronics will also be developed in order to be able to probe the time-resolved quantum dynamics of diverse spin samples. This PhD project has a strong experimental and instrumental component.

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Research group : The Magnetism (MAG) group at IM2NP focuses on investigating unique magnetic properties in condensed matter through an integrated approach involving instrumentation, experimentation, and theory. Our expertise lies in electron spin resonance (ESR) studies of paramagnetic, ferromagnetic, and antiferromagnetic materials. Our research spans both fundamental science, exploring low-dimensional strongly correlated magnets (e.g., spin chains, frustration, spin liquids), or quantum information processing (quantum coherence of electron spin in solids), and applied science, examining materials with potential applications in spintronics (ferromagnetic, multiferroic). More information on https://www.im2np.fr/fr/equipe-magnetisme-mag

Funding : Amidex
Starting date : 01/10/2024

Application deadline : 01/06/2024
Candidate profile : The candidate must hold a Master degree in physics, nanoscience, or an equivalent, by the summer 2024. He/she should have a solid background in experimental condensed matter and quantum physics and be strongly motivated in instrumental development. Skills in Python coding would also be appreciated.

Selection process : Applications, in English, should be sent to sylvain.bertaina@im2np.fr and remy.dassonneville@im2np.fr. It includes a CV (specifying the English level), a cover letter, transcripts and ranking of Master degree, and contact information for at least two references.