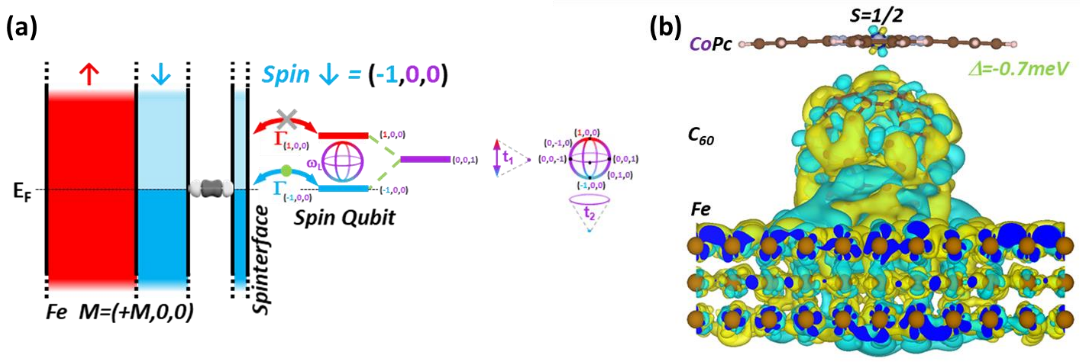
INTERNSHIP PROPOSAL

Lab name: Institut de Physique et Chimie des Matériaux de Strasbourg (IPCMS; UMR 7504)
Internship director' surname: Bowen e-mail: bowen@unistra.fr Tel: 03 88 10 68 88
Web page: https://www.ipcms.fr/en/equipe/molecular-quantum-spintronics-2/

Internship location: Strasbourg, France Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ED 182

Quantum Spintronic Qubit: first experiments



Many hardware platforms exist to implement qubit operations for quantum technologies, but these platforms, although conceptually elegant, do not offer a straightforward path toward consumer applications in terms of energy/resource usage (#QEI)[1]. To address this challenge, **we propose a new platform: the quantum spintronic qubit device**. It contains an atomic paramagnetic atom that electronically interacts with a simple ferromagnetic metal across a fully spin-polarized interface ('spinterface', see panel a). Thanks to its solid-state implementation, this qubit paradigm offers many advantages: large/built-in magnetic field, spintronic initialization/manipulation/readout of the qubit (panel a), potential for room-temperature operation[2,3], built-in entanglement[4].

Beyond first successes in the areas of quantum information[5,6] and energy harvesting[2,3], we propose as a Masters 2 project to further mature this platform by continuing promising magnetotransport experiments across a CoPc-borne qubit embedded into a molecular spintronic nanojunction. The project's samples will be grown and processed into nanojunctions by Jan 2026, and the M2 candidate will oversee the measurements in close interactions with the research team.

This initial M2 work can segue into an experimental PhD to evaluate the relevant time scales of the qubit's spintronic operation. The M2 candidate will acquire skills on how to intuitively construct experimental measurement protocols based on scientific knowledge and experimental data-driven intuition. In a possible PhD program, this research track offers solid training for academic/industrial career opportunities: UHV growth/characterization , clean-room, magnetotransport measurements, thinking outside the box.

References

1.Auffèves, A. Quantum Technologies Need a Quantum Energy Initiative. PRX Quantum 3, 020101 (2022).

2.Katcko, K. et al. Spin-driven electrical power generation at room temperature. Communications Physics 2, 116 (2019).

3.Chowrira, B. et al. Quantum Advantage in a Molecular Spintronic Engine that Harvests Thermal Fluctuation Energy, Adv. Mater. 34, 2206688 (2022).

4.Arnesen, M. C., Bose, S. & Vedral, V. Natural Thermal and Magnetic Entanglement in the 1D Heisenberg Model. Phys. Rev. Lett. 87, 017901 (2001).

5.Lamblin, M. & et al. Encoding information onto the charge and spin state of a paramagnetic atomic cluster using MgO tunnelling spintronics. arXiv:2308.16592.

6.Katcko, K. et al. Encoding Information on the Excited State of a Molecular Spin Chain. Advanced Functional Materials 2009467 (2021)

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