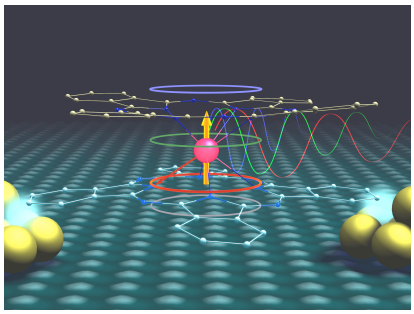
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2020-2021

Title: Molecular spin devices for quantum information processing

General Scope:



For some decades, significant efforts have been invested in quantum information research, with the promise to revolutionise the way information is stored and processed. The strength of quantum computing lies in the possibility of using a coherent superposition of states, and interference between them, which enables a class of algorithms that are not accessible to classical computers. To achieve the fabrication of quantum computers, the first step is to realise a quantum bit. It must be fully controllable and measurable, which requires a connection to the macroscopic world. In this context, solid state devices, which establish electrical connections to the qubit are of high interest. However, beyond the usual two-level encoding capacity of qubits, multilevel quantum systems (also known as qu*d*its with "*d*" being the number of available states) are a promising way to extend and increase the amount of information that can be stored in the same number of quantum objects. In this context, magnetic molecules possessing magnetic memory, better known as Single Molecule Magnets (SMMs), are a promising platform to create spin qudits. Towards this goal, the team combines the different disciplines of spintronics, molecular electronics, and quantum information processing. In particular, we fabricate, characterize and study molecular spin-transistor in order to manipulate[1] and read-out an individual spin[2] to perform quantum operations[3].

[1] S. Thiele, F. Balestro, R. Ballou, S. Klyatskaya, M. Ruben, W. Wernsdorfer, *Science* **2014.**
[2] R. Vincent, S. Klyatskaya, M. Ruben, W. Wernsdorfer, F. Balestro. *Nature* **2012**.
[3] C. Godfrin, R. Ballou, S. Klyatskaya, M. Ruben, W. Wernsdorfer, F. Balestro, *Phys. Rev. Lett.* **2018.**

Research topic and facilities available: Nano-devices addressing single molecular spins will be fabricated and characterized. The team has a strong experience in molecular magnetism, nanofabrication, ultra-low noise transport measurements, microwave electronics and cryogenic equipment. Single molecular units are embedded in scalable electronic circuits and individual spin read out will be performed. The key experiment will be the demonstration of two qubit gate to complete the set of universal gates for scalable architectures. The student will fabricate the samples using the clean room facilities of the Néel Institut. She/he will carry out the measurements of the device at very low temperature (20mK), in order to create, characterize and manipulate single spin using spin based molecular quantum dot.

Possible collaboration and networking: This multidisciplinary research field is based on years of collaborations with teams from different scientific and technical cultures (cleanroom, technicians, collaborations with chemists and theoreticians, ...), in the framework of European projects and different national and regional funding.

Possible extension as a PhD: Yes

Required skills: We are looking for a motivated student who is interested in experiments that are challenging from the experimental point of view.

Starting date: flexible

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