Scientific Area	Molecular quantum materials
Topic title	Heterospin molecular systems for two-qubit gates
Main host institution	Institut de Chimie https://institut-chimie.unistra.fr/
Supervisor/institution	Athanassios K. Boudalis, CNRS Director of Research https://pomam.chimie.unistra.fr/
Co-Supervisor/institution	Andrea Hofmann / University of Basel https://physik.unibas.ch/en/persons/andrea-hofmann/
Mentor[1]/institution	TBC
Secondment institution	TBC

Topic description

The construction of quantum circuits entails several requirements, one among which is the possibility to implement a universal set of quantum gates. It had been shown that this can be achieved using single-qubit rotations plus a two-qubit gate, such as the CNOT gate. While significant effort has been invested in the former, the latter has only lately began to be addressed in the research of molecular quantum materials. Molecular heterospin systems based on metals and/or organic radicals have been considered alonmg these lines, using Electron Paramagnetic Resonance (EPR) as the method of implementing panipulations.
In this project, we will use tailor-made molecular architectures to construct weakly-interacting heterospin systems, whose individual spins can be independently addressed to implement a CNOT gate operation. Our main objective is to design experimental protocols based on pulse EPR to demonstrate suchoperations. These protocols will be designed on the basis of optimal control theories, harnessing the potential of shaped microwave pulses to manipulate spins in the desired manner.

Recommended applicant's profile

This is a project ideally suited for a PhD applicant highly motivated in the area of physical chemistry, willing to work on the interface between of synthetic chemistry and EPR spectroscopy. The student will benefit from the strong knowledge base of the host group in synthetic chemistry (coordination and organic) and pulse EPR spectroscopy and will develop new molecules and will refine pulse EPR protocols already developed within the group. Secondments to collaborating labs will be carried out for the student to gain further knowledge in specific domains like quantum tomography using EPR. The applicant should have a good background in organic synthesis. A good understanding of magnetic resonance theory will be favourably considered.

[1] Mentor: The primary role of the mentors will be to identify and facilitate specific training objectives, advise on any problems faced by the DC, including career matters with an external perspective and provide mediation in the case of disputes.

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