PhD Research Proposal Form
China Scholarship Council (CSC) - ENS Group

FIELD: Chemistry (Physical chemistry)
(eg: Mathematics, Physics, Sociology, ….)

Thesis subject title: Fast field cycling methods at the service of dissolution dynamic nuclear polarization and magnetic resonance at zero field

Name of the French doctoral school: Ecole Doctorale de Chimie de Lyon – ED 206

Name of the Research team: Hyperpolarized magnetic resonance laboratory (HMRlab)
Website: www.hmrlab.eu/

Name of the Supervisor: Sami Jannin
Email: sami.jannin@ens-lyon.fr

Lab Language: English and French

Research Proposal Abstract: The resolution and sensitivity of nuclear magnetic resonance (NMR) is constantly improving thanks to the ever increasing available magnetic field strength of modern superconducting magnets. However, the high resolution spectrometers currently operating at highest magnetic fields have the obvious disadvantage of being very expensive (more than 10 million euros). Dissolution dynamic nuclear polarization [1] (*d*DNP) is an alternative method to boost the sensitivity of liquid state NMR without relying on super high magnetic fields. Providing signal enhancements of up to 4 orders of magnitude, it opens new perspectives for both NMR and magnetic resonance imaging (MRI). [2] Another exotic NMR modality is the detection of nuclear spins at zero- and ultra low-fields (ZULF). [3] In this case, it is not the spin-field interaction (or Zeeman interaction) which dictates the outcome of the experiment but rather the mutual interaction between nuclear spins (or J-coupling). The field of ZULF NMR is rapidly growing and allows more and more applications in particular when coupled to hyperpolarization techniques. [3] Our team is a pioneer is the combination of *d*DNP with ZULF NMR. [4] We plan to develop a fast field cycling device [5] based on a benchtop spectrometer that will serve the purposes of our *d*DNP and ZULF experiments as well as their combination. This device will be useful for a number of applications such as the measurement of relaxation as a function of magnetic field strength (relaxometry), [5] the study of diffusion in porous media for hyperpolarization [6] and ZULF spectroscopy. We search candidates with interests in multidisciplinary research at the interface of spectroscopy, chemistry and hardware development, both for the development and the use of this device.

References:

1. Ardenkjær-Larsen, J. H. *et al. Proc. Natl. Acad. Sci. U. S. A.* **100**, 10158–10163 (2003).
2. Jannin, S., Dumez, J.-N. N., Giraudeau, P. & Kurzbach, D. *J. Magn. Reson.* **305**, 41–50 (2019).
3. Blanchard, J. W. & Budker, D. *eMagRes* **5**, 1395–1410 (2016).
4. Barskiy, D. A. *et al. Nat. Commun.* **10**, 1–9 (2019).
5. Zhukov, I. V. *et al. Phys. Chem. Chem. Phys.* **20**, 12396–12405 (2018).

6. Cavaillès, M. *et al. Angew. Chemie - Int. Ed.* **57**, 7453–7457 (2018).

Type of PhD:

1.Full PhD - Regular PhD (leading to a single French diploma)
2. Visiting PhD (for students enrolled at a Chinese institution who will be invited to a French institution to carry out a mobility period)