LNCMI-Grenoble

Nuclear Magnetic Resonance instrumentation and methods for high magnetic fields (36 T) and high frequencies (1.5 GHz)

Master 1/2 extendable to PhD within the same research subject

Summary

In Nuclear Magnetic Resonance (NMR) magnetic field dependent phenomena attract considerable interest. In this context paramagnetic relaxation enhancement (PRE) is of particular importance, as it alters the image contrast in magnetic resonance imaging (MRI). LNCMI currently explores PRE up to 32.9 T / 1.4 GHz using novel PRE agents. The proposed internship offers design studies for NMR probes or the development of advanced NMR concepts.

Detailed subject

Paramagnetic relaxation enhancement (PRE) in NMR has become an important subject for magnetic resonance imaging (MRI) in medicine and in material science. PRE reveals properties below the spatial resolution of MRI by tuning the image contrast. It is achieved by additional, paramagnetic relaxation induced by a contrast agent that influences the NMR relaxation rates. Following the common trend in materials research, the available static magnetic fields in MRI are continuously increasing. Thus, the field dependence of PRE up to highest magnetic fields becomes highly relevant.

LNCMI Grenoble runs a PRE project in collaboration with an NMR group at KIT Karlsruhe (Germany) [1,2]. Amongst others the project comprises the development of a tailored ultra-high field NMR platform up to 36 T and 1.5 GHz, which is the context of the proposed internship. Depending on the interest and the skills of the candidate the following topics are proposed:
(i) Design studies for NMR probes operating from 1 - 2 GHz using Comsol simulation tools and model setups.
(ii) Exploration of real-time correction methods for compensation of magnetic field fluctuations.
(iii) Development of advanced methods for treatment of experimental NMR data using Matlab.
Tentatively, participation in a high field experiment is possible during the internship.

Publications linked to the theme

[1] J.R. Machado et al.: Nuclear Magnetic Resonance Relaxivities: Investigations of Ultrahigh-Spin Lanthanide Clusters from 10 MHz to 1.4 GHz, ChemPhysChem, 15, 3608 (2014).
[2] G. Guthausen et al.: Characterisation and application of ultra-high spin clusters as magnetic resonance relaxation agents, Dalton Trans., 44, 5032 (2015).

Background and skills expected :

Motivation to work in an experimental laboratory on an international project. Experimental skills in scientific instrumentation, electronics, NMR, Matlab programming or simulation by Comsol will be an advantage.

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