



Saclay, September 15th 2021

Hyperpolarization of alkali metals and noble gases at high magnetic field

Increasing the sensitivity of NMR is of paramount importance for applications e.g. in chemistry, biology, medicine, and material sciences. The nuclear spin polarization at Boltzmann equilibrium even in the highest available magnetic fields is only on the order of 10^{-4} - 10^{-5} . It may be significantly increased to values close to unity thanks to hyperpolarization techniques. Spin-Exchange Optical Pumping (SEOP), where polarized laser light induces electronic spin polarization of an alkali metal, is used to boost by several orders of magnitude the nuclear polarization of noble gases such as xenon or krypton. Whereas SEOP has been deeply studied at low magnetic fields, the whole hyperpolarization process is not yet established above 0.5 T, where a new physics is expected to appear and there may be decisive advantages for applications. Exploring the physics of high-field SEOP is at the center of this project which is funded by an ANR grant (HELPING project ANR-20-CE30-0021).

The laboratory has a long experience of SEOP of noble gases at low magnetic field. Usually, the hyperpolarized noble gas is produced in the batch mode via home-built setups, and transferred to samples for further analysis in high field spectrometers. The laboratory owns 11.7 T narrow bore high-field spectrometers. Recently a 7 T superwide bore MR imager/spectrometer (BRUKER 2-channel NEO console) was purchased. This leaves open the possibility of inserting the pumping cell and various optics elements inside the cavity.

In this context, a 1-year postdoctoral position is available at CEA in Saclay (France, 25 km SW from Paris). This position is renewable for one year. The post-doctoral fellow will mainly be involved in experiments concerning understanding and optimization of hyperpolarization of alkali vapors and noble gases at high magnetic fields. Detection of the polarization will be made either optically or using magnetic resonance, or both. The candidate should have good skills in atomic physics and have a good knowledge of instrumentation while being dexterous. An experience in NMR would be greatly appreciated.

The position can start from March 2022. The monthly salary is ca. 3800 € (before tax). Interested candidates should send a CV and two recommendation letters to gaspard.huber@cea.fr and patrick.berthault@cea.fr.

References

- 1) E. Mari, P. Berthault, “ ^{129}Xe NMR-based sensors: biological applications and recent methods”, *Analyst* 142 (2017) 3298-3308
- 2) P. Berthault, G. Huber, H. Desvaux, “Biosensing using laser-polarized xenon NMR/MRI”, *Progress in NMR Spectroscopy*, 55 (2009) 35-60
- 3) C. Chauvin, L. Liagre, C. Boutin, E. Mari, E. Léonce, G. Carret, B. Coltrinari, P. Berthault, “Spin-Exchange Optical Pumping in a Van”, *Review of Scientific Instruments* 87 (2016) 016105, DOI: 10.1063/1.4940928

Université Paris-Saclay, CEA, CNRS, NIMBE (UMR 3685)
Nanosciences and Innovation for Materials, Biomedicine and Energy
UMR CEA-CNRS 3685
CEA Saclay - PC n°9
91191 Gif-sur-Yvette Cedex
Tél. : G. Huber +33 (0)1 69 08 64 82 ; P. Berthault +33 (0)1 69 08 42 45
gaspard.huber@cea.fr , patrick.berthault@cea.fr - iramis.cea.fr/nimbe/lisdrm/index.php