INTERNSHIP PROPOSAL

Laboratory name: Mag4Health (startup company spin-off of CEA Grenoble)
CNRS identification code: -
Internship director'surname: Agustin PALACIOS-LALOY / Rudy ROMAIN
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Internship location: 37 rue Diderot, 38000 Grenoble
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: CIFRE

Study of the light-matter interaction in an optically pumped magnetometer for brain imaging

Mag4Health is a startup company that designs a new brain functional imaging machine which relies on the magnetic fields emitted by the brain activity to diagnose different kinds of neuronal diseases, like epilepsy, mild traumatic brain injury or Alzheimer.

Our imaging device is composed by an array of quantum sensors, namely optically pumped magnetometers based on a gas of helium-4 atoms brought to their metastable triplet state. The collective spin of such a gas is prepared and monitored by a laser beam. Atomic physics shows that in this setup it becomes possible to perform a vector measurement of the magnetic field with excellent levels of intrinsic noise [1,2] without any kind of cryogenic cooling.

We currently deploy these kind of sensors in the configuration which results from the works of CEA Leti [2], but we envision a new generation of higher performance sensors based on a set of unexpected results obtained these last months. The aim of this internship is to consolidate the understanding of these regimes. For that, the student will design and operate two optical benches : the first one aiming to characterize the sensitive element with Doppler-free spectroscopy, the second one aiming to study the different contributions to the magnetometer intrinsic noise (spin projection noise, photon noise and polarization noise of the probe beam, technical noises…) This work will be closely followed by two members of our team with an atomic physics background, and may also benefit from technical help of other crew members (in optics and electronics notably). The results will be patented and/or published.

We want to hire a student of Master 2, with an excellent level in Physics, and the will to work in a research subject which has a societal impact. He or she should have a solid background on light-matter interaction, some experience in experimental optics and data processing with a computer language, ideally python. A PhD will be proposed in the continuity of the subject.

[1] F. Beato et al., Phys. Rev. A **98**, 053431 (2018).
[2] W. Fourcault et al., Opt. Express **29**, 14467 (2021).

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:
Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO