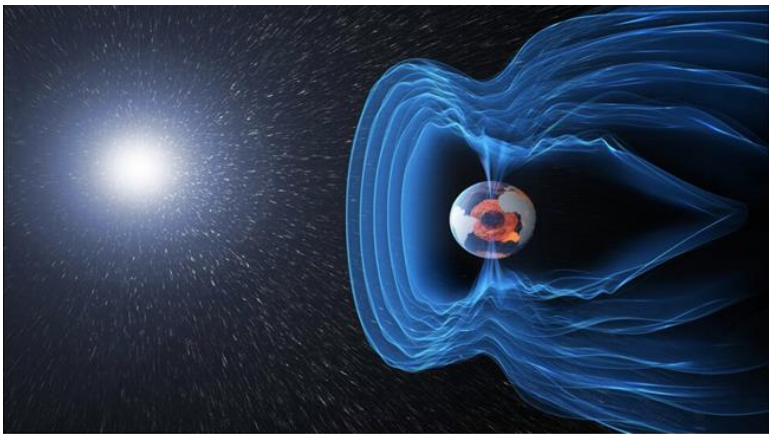
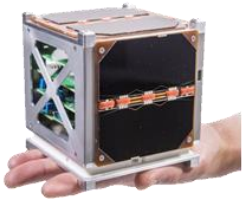
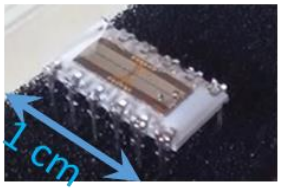
Recruiting a post-doctoral researcher in the development of a miniature, ultra-sensitive magnetic field sensor for space exploration







Context: The magnetic field is essential for understanding our solar system and the Earth's geomagnetism, as well as for studying solar eruptions and their impact on the Earth and our technological infrastructures. All space missions designed for the exploration of the solar system or the monitoring of our space environment carry magnetometers, which have excellent resolution but are very heavy and cumbersome. As a result, they are not suited to the new miniature satellites (Cubesat) that are about to revolutionize space exploration. This is the reason why the Centre National d'Etudes Spatiales (CNES, the French space agency) is supporting the development of new sensors for measuring magnetic fields in space.

In this context, Spintec and the Laboratoire de Physique et Chimie de l'Environnement et de l'Espace (LPC2E, Orléans) work together in a long-standing partnership to develop a single miniature sensor with a reduction in mass of a factor of 10 to 20 and with a as good or better detectivity. The sensor we propose combines a magnetic tunnel junction as the sensor's sensitive element, a flux concentrator to amplify the field to be measured and a modulation technique to reduce sensor noise. Finally, a feedback loop ensures linearity and immunity to thermal drift.

The magnetic tunnel junction and the flux concentrators are already optimized [1] and the next step is to implement the modulation technique in order to reduce further the noise of the sensor and to reach the required detectivity of ~ 0.1 - 1 pT/sqrt(Hz).

Position: The post-doc project will focus on the development of the modulation using a magnetic field chopping technique. Two innovative paths will be explored. (i) The first solution is to develop an electrically controllable magnetic “short-circuit” in the flux concentrator's air-gap that would trap the field lines; this magnetic switch would be opened and closed at high frequency to chop the field. Such switch would be made of a combination of a piezoelectric and a magnetostrictive material to electrically tune the susceptibility of the magnetic switch. (ii) The second solution is the use of a micro-electromechanical system (MEMS): the junction will be placed on a vibrating beam that moves in and out of the flux concentrator's air gap. These chopping methods will be developed in collaboration with teams from IEMN in Lille and C2N in Saclay.

The MTJs, deposited and patterned at Spintec, will be available for the studies of the modulation. Fabrication process and characterizations will be performed at Spintec (magnetic, magnetotransport, standard noise measurement) and at LPC2E (advanced noise measurements and modulation tests), with possible stays at IEMN and C2N.

The candidate must hold a Ph.D. in physics, with a good knowledge in magnetism, spintronics and an experience on artificial multiferroics or MEMS. A previous experience in clean room will be highly appreciated. The successful candidate will join the « Magnetic sensor» team of Spintec and the LPC2E lab. The contract duration is 18 months (with possible extension).

[1] S. Manceau et al. “Large amplification of the sensitivity of symmetric-response magnetic tunnel junctions with a high gain flux concentrator” Appl. Phys. Lett. 123, 082405 (2023)

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