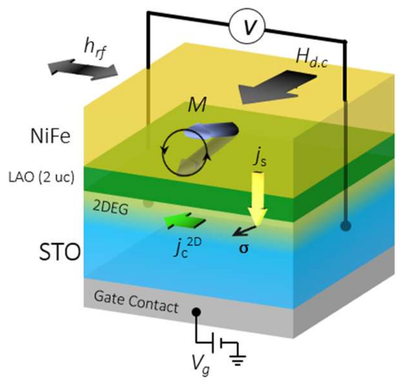
Laboratoire Albert Fert – CNRS, Thales, Université Paris-Saclay

Post-doctoral Fellowship

Spin-charge and orbit-charge conversion at Rashba interfaces

BACKGROUND AND OBJECTIVES. The current technology based on CMOS devices is getting close to its limits, both in terms of scaling and power needs, and new concepts based on entirely different physics principles are required[1]. Devices able to provide such a paradigm shift in information processing include the MESO (magnetoelectric spin-orbit) transistor proposed by INTEL[2] and the FESO (ferroelectric spin-orbit) transistor, proposed by the Laboratoire Albert Fert and Spintec[3]. Unlike conventional transistors that operate on charge, MESO and FESO operates on spin and ferroelectricity, which endows them with an ultralow power consumption. The output unit of MESO and FESO harnesses spin-charge conversion and requires systems able to achieve this conversion with a very high efficiency and high electrical resistance. 2D systems such as van der Waals materials, oxide Rashba 2D electron gases (2DEGs), Rashba interfaces and surface states of topological insulators have potential to meet this goal. In addition, just as spin currents can be interconverted into charge currents, it was recently realized that a similar operation could be realized between currents carrying not spin but orbital angular momentum (orbital currents), and charge currents. Orbital current to charge current conversion is predicted to be of much higher magnitude than conventional spin-charge conversion and has a large potential for beyond CMOS technologies. Yet, the search for systems with efficient orbit-charge conversion is just beginning, although theory predicts a very high efficiency for oxide 2DEGs[4].



PROJECT. The proposed project aims to assess the spin-charge and orbit-charge conversion efficiency of various systems (oxide 2DEGs, Rashba interfaces, etc) using spin-pumping from ferromagnetic resonance (SP-FMR). The samples will be patterned to perform broadband FMR with coplanar waveguides and measure the transverse charge current produced at resonance. Systematic measurements, e.g. as a function of the magnetic field angle, will be performed and the data carefully analyzed to isolate the spin-charge and/or orbit-charge conversion signals and quantify the conversion efficiency. The objective will be to achieve large output signals at room temperature.

ACTIVITIES. For this project, the candidate will perform the following activities:

- Growth of heterostructures using sputtering.
- Magnetometry and magnetotransport characterization of the heterostructures
- Device fabrication using UV lithography
- Ferromagnetic resonance and spin-pumping experiments
- Data analysis and modeling
- Report and paper writing

EXPECTED COMPETENCES. The candidate is expected to have the following competences:

- Magnetism and spintronics (required)
- Ferromagnetic resonance and magnetization dynamics (required)
- Optical and/or electron beam lithography (required)
- Growth experience in sputtering (recommended)
- Python and/or Labview programming (recommended)
- Excellent organization and scientific writing skills (required)
- Good communication skills (recommended)

WORK ENVIRONMENT. The project will be performed at the **Laboratoire Albert Fert** located in Palaiseau on the Université Paris-Saclay campus. The Laboratoire Albert Fert is the cradle of spintronics, with the discovery of giant magnetoresistance in 1988 for which its Scientific Director, Prof. A. Fert, received the Nobel Prize in Physics in 2007.

ADDITIONAL INFORMATION. 2993-3431 € gross monthly with benefits, based on experience (offer is for 1 year, renewable). The position is to be filled as soon as possible.

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1. Manipatruni, S. *et al.* Nature Physics 14, 338 (2018).
2. Manipatruni, S. *et al.* Nature 565, 35 (2019).
3. Noël, P. *et al.* Nature 580, 483 (2020).
4. Johansson, A. *et al.* Phys. Rev. Research 3, 013275 (2021).