Institut Néel, Grenoble
Fully funded Ph.D./postdoc position

Topic: Metallic and Oxide Materials for Orbitronics

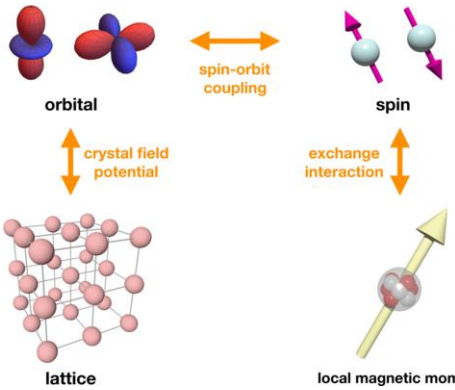
Keywords: orbitronics, magnetic oxides, magnetization dynamics

Context: Fundamental research in spin electronics has provided major contributions to our everyday technologies, among which hard disk drives or magnetic random-access memory chips. The latest generation of magnetic devices for memory applications features an electrical manipulation of the magnetization in nm-thin nanomagnets by spin–orbit torques. Whereas a widely acknowledged interpretation of spin–orbit torques has been established over the past decades, based on the spin character of electrons only, recent research has given hints of a previously unsuspected, yet likely dominant contribution from orbital flows and orbital polarization [1]. Many previous results in the field are thereby questioned, opening a bright avenue for new discoveries and pushing further the technological prospects of spintronics. In particular, the mutual coupling between the spin and orbital degrees of freedom in out-of-equilibrium conditions drives new research questions of great fundamental interest. The scientific community is still looking for a consensus on the mechanisms of orbital phenomena in current-induced torques and magnetization dynamics, yet the groundbreaking nature of orbital transport in spintronics, validated experimentally, already promises low-power information technology without the requirement of using any rare materials in the design of magnetic circuits.

Project summary: This position is opened in the frame of a collaborative project funded by the French government on orbital electronics named OXIMOR, as part of the PEPR "SPIN": https://www.pepr-spin.fr/; https://www.pepr-spin.fr/en/projet/oximor-2/. Our team investigates the generation of spin and orbital electronic currents for spin–orbit torques in solid-state devices made of light metals, metallic ferromagnets and/or magnetic insulators [2-4]. In the electrical excitation of magnetization dynamics by torques, the different channels related to spin dynamics and orbital dynamics need to be disentangled, which we want to accomplish by experiments involving magnetic transport measurements and microwave spectroscopy of magnetization dynamics [5]. The Ph.D./postdoc will focus on the electronic measurement of metallic and magnetic oxide heterostructures subjected to microwaves, and will image the displacement of magnetic textures by currents, to quantify their efficiency in the generation of orbital currents and torques. The Ph.D./postdoc will actively participate to the collective dynamics of the national project OXIMOR together with our partner labs specialized in theory, materials and devices, in order to further understand the physics involved in orbitronics phenomena. Our approach will rely on the realization of new measurement procedures combining several kinds of electronic and microwave instrumentation.

Methods: Magneto-transport in patterned devices, magneto-optical Kerr effect microscopy under currents, broadband ferromagnetic resonance spectroscopies, spin–orbital pumping.

Available facilities: Institut Néel (as well as SPINTEC, CEA with who we actively collaborate) house their respective state-of-the-art cleanroom facilities with complementary or mirrored nanofabrication equipment. Our research group has privileged access to dc and rf magnetron sputtering equipment for deposition of metals and oxides, maintained by NEEL staff. Our team hosts state-of-the-art setups for the imaging of magnetic textures, under ultrashort magnetic field pulses, as well as under current-induced motion, based on pulsers and magneto-optical Kerr effect microscopy.



Schematic of how the lattice, orbital polarization, spin polarization and magnetization interact with each other to generate spin–orbital torques. [Phys. Rev. Res. 2, 033401 (2020)]

International dimension: Grenoble hosts a very international and active scientific community, with around 100 Ph.D. students graduating in Physics every year and around as many postdoctoral researchers hired each year.

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Possible collaboration and networking: The OXIMOR project will enable numerous opportunities for collaboration and scientific exchanges with our partners at CINaM (CNRS, Marseille), Laboratoire Albert Fert (CNRS, Palaiseau), SPINTEC (CEA, Grenoble), Institut Jean Lamour (Université de Lorraine), CEMES (CNRS, Toulouse), and IPCMS (CNRS, Strasbourg). Our team is also part of several networks in spintronics, forming a strong and cohesive community of researchers in both France and Europe. These different collaborations offer solid theoretical support and an adequate environment to fertilize ideas and further develop the offsprings of this investigation.

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Required qualifications and skills:

- Ph.D. applicants: A Master's degree awarded at the latest by the starting date is demanded, and an excellent academic record is mandatory.
- Postdoctoral applicants: A Ph.D. degree awarded at the latest by the starting date is demanded, and an excellent Ph.D. thesis work is mandatory.

Applicants should have a degree in Physics, good practical and coding skills, a commitment to teamwork and scientific communication, and the will to pursue work involving experiments, material science, and solid-state magnetism physics. This position requires a strong motivation to actively learn and refine a wide set of experimental techniques (nanofabrication, microwave electronics, magnetic microscopy), and a taste for solving technical challenges.

Funding:

- Ph.D. applicants: The doctoral contract with CNRS offers a gross salary of 2200€ minimum per month. The duration of the position is fixed to 3 years.
- Postdoctoral applicants: The duration of the position is fixed to 2 years, gross salary between 2991,58 € and 3417,33 € per month, based on experience and according to CNRS regulations.

Starting date: Flexible, contact us.

Application procedure: Candidates should apply to this position by emailing the two contacts listed below with a brief message specifying their background, attaching an academic CV and a cover letter, and providing at least 2 contacts for reference. The closing date for applications is fixed to September 15th, 2025. Applicants shortlisted for an interview will be informed via an email containing further details.

Selection criteria: The following criteria will be evaluated during the selection process:
- the academic merit of the candidates and their ability to conduct research, as demonstrated in their previous Master/Ph.D. thesis works or equivalent;
- their motivation to pursue a Ph.D. degree / a postdoc;
- their background and expertise in relation to the proposed thesis project;
- their demonstration of having the required skills

Contacts:
William Legrand (william.legrand@neel.cnrs.fr), Stefania Pizzini (stefania.pizzini@neel.cnrs.fr)

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[3] Ding, S., Kang, M.-G., Legrand, W. & Gambardella, P. Orbital Torque in Rare-Earth Transition-Metal Ferrimagnets. *Phys. Rev. Lett.* **132**, 236702 (2024).
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[5] Wang, H. et al., Orbital Pumping in Ferrimagnetic Insulators. *Phys. Rev. Lett.* **134**, 126701 (2025).