PhD in Physics and Nanotechnology

Non-Reciprocal Magnonic Architectures: Towards a micron size Circulator

Context: Non-reciprocal microwave components such as circulators, isolators, and phase shifters are crucial tools in both today's communication systems and future quantum computers. The ability to inhibit signal flow in one direction while allowing it in the reverse direction plays a decisive role in either protecting microwave devices from reflections, isolating the transmitter from the receiver in radar architecture, or shielding qubits from their environment. These non-reciprocal functionalities rely almost entirely on the gyrotropic nature of the magnetization dynamics. However, the current magnetic field-based components in-use tend to be relatively large, off-chip, limited in number, and costly to assemble. These issues have recently triggered intensive efforts from various fields of research to develop miniaturized non-reciprocal technologies compatible with integrated circuit technology (ICT). Among all the potential solutions for this challenge, the emerging field of magnonics[1], which focuses on the implementation of elementary magnetic excitations called magnons, is well engaged in the hunt with several recent demonstrations of non-reciprocal properties[2]. The International Collaborative Research Project ANR/FWF "*MagFunc*", which constitutes a French-Austrian partnership between the Institut Mines Telecom Atlantique (IMTA), the Institut de Physique et Chimie des Matériaux de Strasbourg (IPCMS), and the University of Vienna, explores novel non-reciprocal magnon phenomena in 2D and 3D hybrid architectures at the nanoscale for the development of non-reciprocal microwave devices and sensors.

Description of work: The PhD candidate at IMTA will be involved in the development and the characterization of a micron-size magnonic circulator prototype operating in a broadband of the microwave spectrum. The PhD candidate will explore in a first step various curvilinear paths for the spin wave propagation from lithographied micro-magnet and/or the Oersted field of current strips. In a second step, she/he will incorporate the most suitable factors of non-reciprocity along those circular path in order to elaborate the magnonic circulator. The scope of this work encompass finite element simulations, nanofabrication of devices using a state of the art facility at IPCMS, and also the microwave characterization of the devices via vector network analyzer. The candidate will play an active role in developing the new magnonic lab at IMT-Atlantique. She/He will also be part of a top-tier research consortium and getting hands-on experience with challenges of meeting research milestones and deliverables, presenting advances in international conferences and writing scientific articles.

Profile of the candidate: The ideal candidate should have a Master degree in physics with a strong background in Solid-State Physics. In addition, the advertised position would suit a candidate with a clear interest for experimental research in magnetism and microwave. A solid knowledge of English, strong interpersonal skills and communication skills, self-motivation and the ability to work as part of a team are necessary.

Interested candidates are encouraged to submit their CV and motivation letter to Vincent Vlaminck at *vincent.vlaminck@imt-atlantique.fr*.

Provisional start of the PhD contract in January 2021.

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[1] *Opportunities and challenges for spintronics in the microelectronic industry*, B. Dieny, Nature Electronics **vol. 3**, pages 446–459(2020)
[2] *Excitation of unidirectional exchange spin waves by a nanoscale magnetic grating*, J. Chen et Al., Phys. Rev. B **100**, 104427 (2019)

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