PhD Title:
Magnon beamforming at the nanoscale

IMT Atlantique : Campus ☒ **Brest** ☐ **Nantes** ☐ **Rennes**

Laboratory : Magnonics Lab - Dpt. MO, Lab-STICC

École doctorale : ☒ **SPIN** ☐ **3MG**

Funding: PEPR SPIN, project SWING

IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

AGENCE NATIONALE DE LA RECHERCHE ANR FRANCE 2030

Academic environment:

IMT Atlantique, internationally recognized for the quality of its research, is a leading general engineering school under the aegis of the Ministry of Industry and Digital Technology, ranked in the three main international rankings (THE, SHANGHAI, QS). Located on three campuses, Brest, Nantes and Rennes, IMT Atlantique aims to combine digital technology and energy to transform society and industry through training, research and innovation. It aims to be the leading French higher education and research institution in this field on an international scale. With 290 researchers and permanent lecturers, 1000 publications and 18 M€ of contracts, it supervises 2300 students each year and its training courses are based on cutting-edge research carried out within 6 joint research units: GEPEA, IRISA, LATIM, LABSTICC, LS2N and SUBATECH.

The proposed thesis is part of the research activities of the Magnonic team within the Microwave department. The scientific activities of this department are related to the propagation of electromagnetic waves, and concern mainly the modelling, design, construction and characterization of high-frequency signal processing devices, as well as original propagation media for their applications in various communications systems

Scientific Context:

The emerging field of magnonics focuses on the transport and processing of information by elementary magnetic excitations called spin waves (or their quanta magnons) [1]. A Travelling spin wave carries angular momentum without a net motion of charges; therefore, it appears as a potential building block for low-power data processing and computing [2]. Furthermore, magnons display unique properties of anisotropy, non-linearity, and non-reciprocity that are finely tunable in a broad range of the microwave spectrum. The peculiar wave nature of magnon constitutes of formidable ground for novel wave computing methods, such as spin wave logic, holographic memory, and neuromorphic computing, all of which are essentially interference based methods.

Expected contributions of the Thesis:

Along this global effort to explore the interferometric potential of magnons, we offer at IMT Atlantique in Brest (https://www.imt-atlantique.fr/en/research-innovation/phd) a PhD position starting in the fall 2024 to study the shaping and the manipulation of spin wave beams at the nanoscale. Recent advances inspired from the concepts of optics demonstrated the focusing or diffracting of spin wave beams in continuous film with properly designed microwave antennas [3,4]. In parallel, unidirectional transmission of micron-size spin waves beam was achieved very recently using the chiral coupling between the uniform resonance of NiFe nanowires and exchange spin waves in a thin YIG film [5]. In this project, we aim at combining both ideas, and explore configurations of magnetic nanostructures coupled to a continuous thin film that can create interference pattern readily adjustable.

Required skills:

We are looking for resourceful candidates with sharp written and oral communication skills that are used to carrying out technical tasks autonomously. Candidates must possess a Master in physics or in engineering prior to the start of the PhD. Preferences will be given to candidates demonstrating proficiency in object–oriented programming, combined with meticulous craftsmanship to handle delicate experiments.

References:

[1] A. Barman et al., “The 2021 Magnonics Roadmap” J. Phys.: Condens. Matter 33, 413001 (2021).

[2] A. V. Chumak et al., “Advances in Magnetics Roadmap on Spin-Wave Computing”, IEEE TRANSACTIONS ON MAGNETICS 58, 6(2022).

[3] N. Loayza, M. B. Jungfleisch, A. Hoffmann, M. Bailleul, and V. Vlaminck, “Fresnel diffraction of spin waves”, Phys. Rev. B 98, 144430 (2018).

[4] L Temdie, V Castel, V Vlaminck, MB Jungfleisch, R Bernard, H Majjad, ..., “Probing Spin Wave Diffraction Patterns of Curved Antennas”, Phys. Rev. Appl. 21 (1), 014032.

[4] L. Temdie, V. Castel, C. Dubs, G. Pradan, J. Solano, H. Majjad, Y. Henry, M. Bailleul, V. Vlaminck, “High Wave Vector Non-reciprocal spin Wave Beams”, AIP Advances 13, 025207 (2023)

Plan de travail – Work Plan:

The first part of the work entail designs and simulations aiming at identifying the most prominent assemblies of nanomagnets, and excitation geometries. The second part of the work will consist in nano-fabrication of devices, followed by their measurement to demonstrate the feasibility of a magnon interferometer. This project is funded by the collaborative PEPR SPIN program within the project SWING (“Spin waves for advanced signal processing”), which will involve frequent collaborations with major spintronic labs in France within a large collaborative program entitled PEPR SPIN.

Candidature – Application:

To apply for this position, please send a detailed application including a cover letter, an up-to date CV, transcripts of grades and reference letters addressed to Dr. Vincent Vlaminck at vincent.vlaminck@imt-atlantique.fr, before July 27th 2024.

Additional Information:

- Application deadline: 27/07/2024
- Start date: September 2024
- Contract duration: 36 months
- Location: Brest
- Contact(s): Vincent Vlaminck - vincent.vlaminck@imt-atlantique.fr