Proposition de stage / Internship proposal + PhD Thesis

Date de la proposition : 14.10.2025

Responsable du stage / *internship supervisor*

Nom / *name*: **HAMADEH** Prénom/ *first name* : **Alexandre**

Tél : **01.70.27.03.96** Courriel / *mail*: **alexandre.hamadeh@universite-paris-saclay.fr**

Nom du Laboratoire / *laboratory name*: **Centre de Nanosciences et de Nanotechnologies (C2N)**

Etablissement / *institution* : **CNRS/UPSaclay** Code d'identification : UMR 9001

Site Internet / *web site*: **www.c2n.universite-paris-saclay.fr**

Adresse / *address:* **10 boulevard Thomas Gobert, 91120 Palaiseau**

Lieu du stage / *internship place*: **C2N, Palaiseau**

Titre du stage / *internship title*: Spin-to-sound: creating acoustic waves from magnetism

Résumé / *summary*

The increasing demand for faster, smaller, and more energy-efficient electronics is driving research into new physical principles for information processing. Our project, SAWSiX, explores a novel approach: using magnetic nanodevices to generate and detect sound waves, known as acoustic phonons. We are focusing on the fundamental interaction between a material's magnetic properties and its mechanical vibrations.

This internship offers an opportunity to contribute directly to the foundational stages of this project. You will be at the forefront of research exploring how to effectively **"turn spin into sound."** The main objective is to demonstrate that a specific device, a Spin Hall Nano-Oscillator (SHO), can generate high-frequency acoustic waves when driven by an electric current. To achieve this, the device will be built on a piezoelectric substrate (lithium niobate, LiNbO3), which couples its mechanical properties to the magnetic dynamics of the SHO.

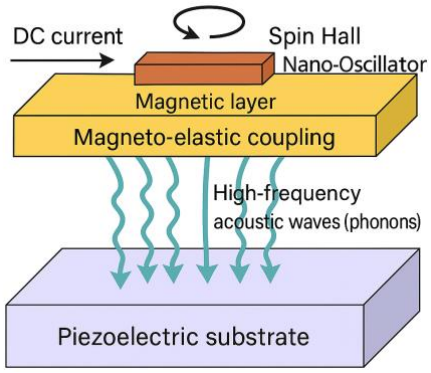

Figure: A DC current is injected into the Spin Hall Nano-Oscillator, causing its magnetic layer to oscillate. Through magneto-elastic coupling, these oscillations generate high-frequency acoustic waves (phonons) that travel into the piezoelectric substrate.

You will be involved in the key stages of the experiment. First, you'll learn how to build these devices in our specialized cleanroom and run electrical tests to get them working correctly. The final step will be to prove that your device is creating sound waves using our two key detection methods: Interdigital Transducers (IDTs) to measure the waves electrically, and our micro-Brillouin Light Scattering (µBLS) system to visually map the sound they produce. In addition to this hands-on work, you will have the opportunity to run numerical simulations to help model the device's behavior and compare your findings with theoretical predictions.

This internship provides comprehensive, hands-on experience in nanofabrication, high-frequency spintronics, and optical spectroscopy. Your results will be a direct contribution to demonstrating a new hybrid platform for controlled sound generation at the nanoscale, with potential applications in microwave signal processing and sensing technologies.

For further reading :

On SHOs : Z. Duan, et al., "Nanowire spin torque oscillator driven by spin orbit torques," *Nature Communications* 5, 5616 (2014).

On Magneto-elastic coupling at interfaces : S. Bhuktare, et al., "Gyrator based on magneto-elastic coupling at a ferromagnetic/piezoelectric interface," *Scientific Reports* 7, 840 (2017)

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Yes**

Si oui, financement de thèse envisagé ou acquis / *financial support for the PhD* **? ANR-SAWSIX (Funded)**

Financement acquis / *Secured funding*	***YES***	Nature du financement */Type of funding*	*ANR*
Financement demandé / *Requested funding*		Nature du financement */Type of funding*	