GREMAN
matériaux microélectronique
acoustique nanotechnologies

université de TOURS

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES CENTRE VAL DE LOIRE

cnrs

Internship Engineer / M2 Research

Experimental study of space-time modulation induced by Helmholtz resonators reconfigurable by acoustic radiation pressure

Keywords

Ultrasound - Acoustic radiation pressure - Space-time modulation - Metamaterials - Experiments

Context

By directing an ultrasonic field towards a water-air interface, it is possible to create a local deformation, as illustrated in Figure 1. This deformation results from the acoustic radiation pressure (ARP). At the GREMAN laboratory, an experimental set-up has been developed to characterize this ARP-induced deformation. A finite element numerical model was also developed. By comparing experimental and numerical results, it was demonstrated that it was possible to predict the spatio-temporal characteristics of this deformation [1-2]. Based on this effect, it is possible to control the resonance properties of a meta-resonator by modifying the cavity volume. The potential of this study has already been confirmed by the numerical model but remains to be validated by experimental results. This internship proposes to build on the experimental and numerical resources already developed, in collaboration with IEMN laboratory skills, to study and create new tunable and time-dependent structures [3-5].

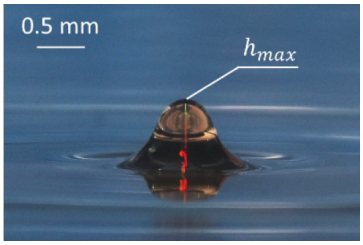

Fig.1: *Example of a water-air interface deformed by an acoustic wave*

Proposed work

For this internship**, the scientific objective** is to develop and study a system consisting, initially, of a resonator coupled to a waveguide. Once this characterization has been completed, a multi-resonator system will be considered. By applying a gradient of temporal and spatial properties along an acoustic waveguide, part of the incident wave's energy can be converted into new frequency components [6-7]. The main tasks for this internship are:

- Time-dynamic study of the PRA-induced deformation in a resonator;
- Optimizing deformation dynamics by optimizing resonator geometry;
- Study the effect induced by a reconfigurable resonator via a classic "Kundt tube" system: the reflection coefficient of such a resonator will be studied (in amplitude and phase);
- Frequency study of the modulation induced by this resonator and the equivalent electrical system;
- Extension to a multi-resonator system: implementation and study of system limits.

[1] F. Sisombat, *et al.*, Journal of Applied Physics 132, 174901 (2022)
[2] F. Sisombat, *et al.*, Sci Rep 13, 14703 (2023).
[3] S. Tessier Brothelande, *et al.*, Applied Physics Letters 123, 201701 (2023)
[4] J. Palacios, *et al.*, The Journal of the Acoustical Society of America 151, 3669 (2022)
[5] C. Croënne, *et al.*, J. Appl. Phys. 126, 145108 (2019)
[6] Z. Chen, *et al.*, Science advances, 7(45), eabj1198. (2021).
[7] J. Li, *et al.,* Physical Review B, 99(14), 144311. (2019).

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Candidate profile

3rd year engineering or Master student. Knowledge of ultrasonic acoustics, particularly experimental, will be appreciated.

Location

The internship will mainly take place at the GREMAN laboratory (UMR CNRS 7347) at INSA Centre Val de Loire (Blois). Some travel will be required to the IEMN laboratory in Lille.
http://greman.univ-tours.fr/
https://www.iemn.fr/

Salary

Approximately €3700.00 for a 6-month internship.

Period & Duration

Minimum 4-month internship in 2025, starting date depending on candidate.

Supervision & Contact

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