Technische Universität München

Laboratoire d'Acoustique Le Mans Université · CNRS · UMR 6613

# Design of finite-size acoustic metasurfaces with a combination of Machine Learning and Reduced Order Models

A three years joint PhD position between Le Mans University and the Technical University of München is open in the field of metamaterials and Machine Learning. Secondments to Phononic Vibes an industrial partner, are planned during the PhD.

**Expected starting date:** October 1st 2024
**Application Deadline:** June 1st 2024
**Salary:** Gross Salary of 2812 € (about 2250 € net) + Mobility allowance: 600 € gross + Family allowance depending of the status: 660 € gross
**Working hours:** 35h per week
**Working time:** 100% on the project

**Project:**
This doctoral project is part of a larger, multidisciplinary and international project VAMOR: "Vibro-Acoustic Model Order Reduction" (Grant agreement no. 101119903) funded under the Marie-Skłodowska-Curie Actions Doctoral Networks within the Horizon Europe Program of the European Union.

VAMOR contributes to a more sustainable and quieter future for Europe. Noise pollution has arisen as one of the key factors towards the degradation of the quality of life in European societies. Adding noise treatments commonly leads to an increase in mass and/or volume usage, harming the sustainability of the respective products, e.g. leading to heavier vehicles. To avoid such solutions and striving for the sustainability and optimal acoustic behavior of products, vibro-acoustic design needs to be pushed earlier in their design phase. Additionally, product sustainability can be also enhanced by exploiting the information included in sound waves emitted during their operation, detecting potential malfunctions. In that context, efficient physics-based sound modeling is a key enabler towards not only optimized and sustainable acoustic profiles through efficient design procedures, but also affordable so-called digital twins that monitor product performance in real time. To this end, the overarching goal of VAMOR is to provide high level scientific and transferable skills training on a new generation of efficient vibro-acoustic modeling techniques, so-called model order reduction (MOR) strategies, to a group of high achieving, competent doctoral candidates to promote a quieter and more sustainable environment.

VAMOR brings together a remarkable consortium, which combines research leading academic institutions - KU Leuven, Technische Universitaet Munchen (TUM), Technical University of Denmark (DTU), Kungliga Tekniska Hoegskolan (KTH), Université du Mans (also named Le Mans University), Conservatoire National des Arts et Metiers (CNAM) - with a constantly innovating, wide variety of industrial partners

working on software, material, testing, design and sound enhancement (Siemens Industry Software NV, Müller BBM, Trèves, Phononic Vibes, Saint-Gobain Ecophon, Tyréns, Purifi ApS). By deploying such an inter-sectorial, multi-disciplinary consortium, VAMOR guarantees the creation of a coordinated research environment to develop and exploit novel tools for the efficient simulation of noise and vibration and promote sustainability and acoustic comfort of products

**Your tasks:**
As doctoral candidate within this project you will work on the numerical modeling, design, manufacturing, and experimental validation of poroelastic materials. To do this :

- You investigate different modeling and model reduction strategies
- You investigate potential optimization strategies
- You design and measure prototypes to validate the models
- You identify the ideal solution for specific problems.

**Profile:**
If you recognize yourself in the story below, then you have the profile that fits the project and the research group:

- I have a master degree in acoustic, physics, mechanical engineering or mathematics, and performed above average in comparison to my peers.
- I am not already in possession of a doctoral degree. I am proficient in written and spoken English. I have not had residence or not had main activities (work, studies, etc.) in France (mainland and outermost regions and territories) for more than 12 months in the last 3 years immediately before the planned recruitment date. During my courses or prior professional activities, I have gathered some experience with at least one of the following: principles of acoustics, numerical modeling techniques, or experimental methods in acoustics. I have a profound interest for these topics. As a researcher I perform research in a structured and scientifically sound manner. I read technical papers, understand the nuances between different theories and implement and improve methodologies myself. In frequent reporting, varying between weekly to monthly, I show the results that I have obtained and I give a well-founded interpretation of those results. I iterate on my work and my approach based on the feedback of my supervisors which steer the direction of my research. It is important for me to work as an active team member and I am eager to share my results to in-spire and being inspired by my colleagues. During my PhD, I want to grow towards following up the project that I am involved in and representing the research group on project meetings and conferences. I see these events as an occasion to disseminate my work to an audience of international experts and

research colleagues, and to learn about the larger context of my research and the research project.

**Offer:**

The aim of this PhD research is to optimize acoustic metasurfaces of finite size using machine learning algorithms. While simple mass-spring systems or C-shaped resonators are well suited to the study of basic principles, more complex unit cells are required for broadband and low-frequency sound and vibration attenuation/absorption. Although the periodicity of the structure implies infinite structures at least in one planar dimension, this is not the case for practical applications, as edges induce a considerable effect. To effectively manage the increased computational effort associated with calculating the response of the finite-dimensional structure many times over, the DC will undertake MOR approaches in combination with machine learning strategies to result in high-performance numerical models that can be used in an optimization scheme. The aim of this research is to incorporate MOR techniques into machine learning-based optimization for the simultaneous design of a host structure and a customized metasurface for automotive applications. Experimental validation (absorption coefficient in an impedance tube - attenuation in an alpha cabin) of the designed structure (poroelastic core with optimized internal resonator) will be carried out to validate the approach.

**For further information** about the position please contact

For Le Mans University : Olivier Dazel (Main contact) , Mathieu Gaborit, Jean-Philippe Groby

For TU München: Steffen Marburg or Johannes Schmid

**We look forward** to receiving your online application including a letter of motivation, CV, diplomas with transcripts and contact details of two referees. The PhD candidate will be selected in two stages: application file evaluation and at least 2 interviews.

Applications must be made online via the Le Mans University recruitment portal (https://theses.doctorat-bretagneloire.fr/sis/campagne-2024/design-of-finite-size-acoustic-metasurfa/++add++Candidate#autotoc-item-autotoc-1). The application form is in french or English (click on **Switch to English** to fill the form in english). Note that instructions and dates in the first menu are for French government PhD scholarship and do not concern applicants to MSCA DC.

Please also send your application to Olivier.dazel@univ-lemans.fr