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

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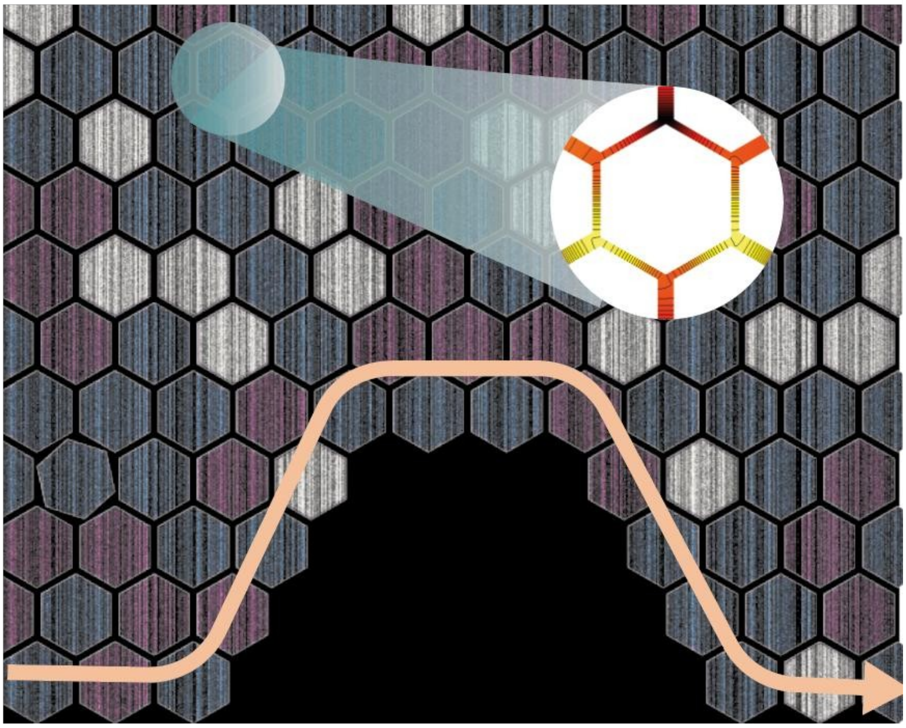
TopoAcoustics25 Workshop

19-21 March 2025, Le Mans



METAVISION
METAmaterials for VIbration and Sound reductION

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Time Schedule

	Wednesday, 19th	Thursday, 20th
10h00	Welcome Coffee	**Vittorio Peano**
10H30	**Pierre Deplace**	
11H00		Coffee break
11h30	Xinxin Guo	Magda Koukouraki
12h00	Clément Tauber	Antonin Coutant
12h30	Lunch	Lunch
14h00	**Muamer Kadic**	**Fabrice Mortessagne**
14h30		
15h00	Koijam Monika Devi	Vassos Achilleos
15h30	Aurelien Merkel	Severine Atis
16h00	Coffee break	Coffee break
16h30	Fotis Diakonos	Peter Schmelcher
17h00	TC Acoustic Materials of the EAA	
17h45		Guided visit of the old city
19h30	Dinner	

	Friday, 21st
9h15	YRAM
9h20	Jiahua Zhang
9h40	Alexander Kryuchkov
10h	Alara Karaman
10h20	Yves Pillot
10h40	Coffee break
11h00	Anis Maddi
11h20	Nicolas Herrera Leon
11h40	Noman Ahsan
12h00	Marco Ribera
12h20	Lunch
14h00	Su Ho Cheong
14h20	Juan-Pablo Escudero Lopez
14h40	Nadeen Ayyash
15h	Mathieu Maréchal
15h20	Coffee break
15h40	Line Mardini
16h00	Ioannis Stefanou
16h20	Closing and wrap-up

Practical information

Venue

4th floor of the IAM building - LAUM, UMR 6613 CNRS, Avenue Olvier Messiaen, 72085 Le Mans cedex 09.
From Le Mans train station or the city center, take the tramway towards the University and stop at Campus-Ribay. Signs will indicate the location of the workshop from this tram stop.

Dinner

Wednesday evening's dinner will be held at La Fabrique Brasserie pas banale, 16 Rue des 3 Sonnettes, 72100 Le Mans, located in the bottom part of the old-city, near the stop Éperon – Cité Plantagenet.

Guided Tour of the old city

Tour of the Plantagenet City, including St Julien's Cathedral (exterior), the Roman wall and the main streets of the historic quarters; duration approx. 1h30 to 2 hours. As the tour starts at 17h45, we suggest that you bring warm clothes and an umbrella, as we are not responsible for outside temperatures or rain.

Keynotes

Topological Wave Guiding: Stronger Than Chern

Pierre Delplace
CNRS, ENS de Lyon

Originally discovered in the quantum Hall effect, chiral edge states are, in fact, a remarkable manifestation of a Chern topological phase, whose experimental realizations extend beyond the realm of quantum matter. The robustness of these unidirectional modes against defects and imperfections makes them ideal candidates for the robust transport of information or energy. However, this robustness has its limits, set by the energy gap, which must remain large compared to the amplitude of perturbations. The situation is different for networks of circulators. These nonreciprocal media can develop not only a Chern topological phase but also another topological phase formally analogous to the so-called anomalous Floquet topological phases. Remarkably, these edge states persist under certain types of disorder, particularly structural disorder, beyond the threshold at which those of the Chern phase are destroyed.

Topological Mechanics

Muamer Kadic and Ji Qingxiang
Université Marie et Louis Pasteur

TBA

Tunneling in the Brillouin Zone: Theory of Backscattering in Valley Hall Edge Channels

Vittorio Peano, Tirth Shah, and Florian Marquardt
Max Planck Institute for the Science of Light

Many experiments have explored topological transport of elastic and acoustic vibrations. In the majority of these setups, time-reversal symmetry is preserved, and band structures are engineered by choosing appropriate geometries to produce topologically nontrivial band gaps near high-symmetry points. However, this approach leaves open the possibility of large quasimomentum backscattering, which could destroy topological protection. This paper introduces a comprehensive semiclassical theory of tunneling transitions in momentum space, specifically addressing backscattering in systems based on the valley Hall effect. We predict that, even for smooth domain walls, effective scattering centers appear at locations determined by the local slope of the wall and the energy. Our theory provides a quantitative analysis of the exponential suppression of the reflection amplitude as domain-wall smoothness increases.

Dynamical Transport Properties of Helical Topological Edge States in a Microwave Experiment

Fabrice Mortessagne
Université Nice Côte d'Azur

Topological insulators host edge states protected against disorder and scattering, with notable differences between chiral and helical modes. Chiral edge states, observed in quantum Hall and quantum anomalous Hall systems, emerge in time-reversal symmetry

(TRS)-broken media. In contrast, helical edge states, characteristic of the quantum spin Hall effect (QSHE), exist in TRS-preserving systems and support counter-propagating modes with opposite pseudospins. Although spatial properties of these modes have been widely studied, their dynamical transport characteristics remain largely unexplored. This study presents a microwave experiment emulating QSHE, enabling time-resolved observations of helical edge state propagation. Our measurements reveal robust, pseudospin-polarized transport that is immune to defects and propagates at velocities orders of magnitude lower than free-space waves, offering new insights into topological transport dynamics with implications for photonic and quantum information technologies.

Lossless Topological Edge Modes in Acoustic Systems

Xinxin Guo
CPAS Laboratory, ETH Zurich

This work demonstrates lossless topological edge states in active acoustic systems. In a one-dimensional lattice, we employ a feedback control approach on electroacoustic resonators to demonstrate nonlinear persistence of topological edge states. In a two-dimensional network, airflow is used to enable lossless propagation of topological edge modes through synchronization. Analytical derivations and simulations illustrate how external forcing generates a spinning acoustic field, which becomes a standing wave, locking wave propagation in a single direction.

Boundary Driven Topological Modes in Shallow Water Waves and Dirac Fluid

Clément Tauber[1], Pierre Delplace[2], Antoine Venaille[2], Gian Michele Graf[3], and Hansueli Jud[4]
[1]CEREMADE – Université Pairs Dauphine – PSL,[2]CNRS - ENS de Lyon, and [3]ETH Zürich, [4]Lab42

The bulk-edge correspondence is a fundamental concept in topological insulators, extensively used in the past thirty years to predict the number of protected edge modes at the boundary of topological materials. However, this correspondence has recently been found to break down in two distinct contexts: classical rotating shallow-water waves and quantum Dirac fluids of electrons. In both cases, the model has a bulk index, yet the number of edge modes depends on boundary conditions. Despite this, the edge modes remain protected in these systems, and their number can be tuned by adjusting boundary conditions. In this talk, we explain the failure of the bulk-edge correspondence in these models and discuss various boundary conditions that lead to these anomalous situations.

Topological Modes in Phononic Waveguide Interface

Koijam Monika Devi[1], Clivia M. Sotomayer Torres[2], Yann Pennec[1], and Bahram Djafari-Rouhani[1]
[1]Université de Lille, Institut d'Electronique, de Microélectonique et de Nanotechnologie, UMR CNRS 8520, and [2]INL International Iberian Nanotechnology Laboratory

Topological waveguide systems are crucial for controlling electromagnetic/elastic waves due to their unidirectionality, robustness, and backscattering-free propagation in the presence of defects. This study investigates different topological waveguide interfaces using a hypersonic phononic crystal structure, exhibiting Dirac gaps in the 13-14 GHz range. The results show that the behavior of topological edge modes depends on the waveguide interface configuration. This work could significantly impact the development of topological waveguides for low-loss phononic components.

Non-Hermitian Topology in Acoustic Su Schrieffer Heeger Chains

Aurélien Merkel, Tong Guo, Brice Vincent, and Badreddine Assouar
Institut Jean Lamour, Université de Lorraine

We investigate the Su Schrieffer Heeger model in a non-Hermitian context, incorporating onsite gain/loss and breaking reciprocity in wave propagation couplings. Through theoretical and numerical analysis, we study acoustic non-Hermitian Su Schrieffer Heeger chains in both cases. We identify three types of edge modes: (1) those originating from the topology of the unit cells, (2) cavity modes arising from local Parity symmetry at interfaces, and (3) edge modes from Parity-Time symmetric domain walls. Additionally, we explore the impact of phase non-reciprocity on the band structure and topology, demonstrating how it can trigger topological phase transitions and skin effects.

Edge States and Chiralization in a Continuous Optical Super-Lattice

Fotis Diakonos
Department of Physics, University of Athens

We investigate edge states in a finite optical lattice, focusing on the critical role of lattice boundaries in determining their energy spectrum. By introducing a boundary parametrization, we identify optimal parameter values that restore chiral symmetry. This optimization suppresses next-nearest-neighbor tunneling and enables the lattice to map to a finite SSH model. We also examine the topological nature of the resulting edge states.

Control of Water Waves Using Time-Varying Vertical Plates

Magdalini Koukouraki[1], Philippe Petitjeans[1], Agnès Maurel[2], and Vincent Pagneux[3]
[1]Laboratoire Physique et Mécanique des Milieux Hétérogènes (PMMH), [2]Institut Langevin, and [3]Laboratoire d'Acoustique de l'Université du Mans (LAUM), CNRS, Le Mans Université, France

This work investigates the propagation of water waves over time-varying topography using thin vertical plates as metamaterials. We begin by studying the scattering of a plane wave incident on a submerged vertical plate within a water channel, extracting scattering coefficients as a function of frequency and plate height. We observe harmonic generation experimentally when the plate height is time-dependent. The study is extended to a periodic array of plates, where we analytically and numerically explore the two-dimensional propagation of shallow water waves over a medium that switches from isotropic to anisotropic at a given time. The results shed light on the control of wave propagation using time-varying topography and its potential applications in wave manipulation.

Topological Waves in Acoustic Lattices with Chiral Symmetry

Antonin Coutant
Aix Marseille Univ., CNRS, Centrale Marseille, LMA UMR 7031, Marseille, France

This presentation explores the unique properties of acoustic networks when the lattice is bipartite and combined with various spatial symmetries. Acoustic networks, a class of metamaterials consisting of discrete lattices of acoustic waveguides, can exhibit topological phases when symmetries are appropriately combined. These phases give rise to edge waves or defect-localized modes with robust, exotic properties, governed by a topological invariant. Focusing on bilayered hexagonal lattices, the study demonstrates the appearance of specific defect modes that are topologically protected and show an eigenfrequency that remains unaffected by symmetry-preserving random perturbations. After providing a theoretical discussion of the properties of these topological defect modes, the presentation also covers the experimental implementation of these systems using modular networks of tubes.

Acoustic analogue of the Hatano-Nelson model

Anis Maddi, Yves Auregan, Guillaume Penelet, Vincent Pagneux, and Vassos Achilleos
Laboratoire d'Acoustique de l'Université du Mans (LAUM), UMR 6613, Institut d'Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France

In this work we use active acoustic elements to design an exact acoustic analogue of the Hatano-Nelson model which features asymmetric couplings between adjacent lattice sites. Our approach relies on a simple transfer matrix formulation and does not employ resonances, thus the mapping is broadband. Most importantly, the inherent losses our system allows us to probe the transition between a line segment spectrum for open boundary conditions (OBC) to a closed loop complex spectrum for a periodic lattice (PBC) avoiding instabilities. Our experiments further probe the inherent sensitivity of the system to boundary condition changes.

Internal Waves in Periodic Stratifications

Severine Atis[1] and Michel Fruchart[2]
[1]Pprime and [2]ESPCI

In the presence of gravity, fluids naturally stratify by density. The interplay between heat and salt diffusion in seawater can lead to periodic stratification profiles known as thermohaline staircases. Although observed in the ocean, their effects on internal gravity wave dynamics have remained unclear. We report experimental observations of band gaps for internal waves in a laboratory setup with periodic stratification. We find surface states with frequencies within the band gap, exponentially localized near interfaces and controlled by boundary conditions. These surface states are formally equivalent to those in one-dimensional topological insulators and photonic crystals. Our findings suggest that the presence of periodic stratifications in the ocean could significantly alter energy transport by internal waves.

Isospectrally Patterned Aperiodic Lattices

Peter Schmelcher
University of Hamburg

We design and explore patterned aperiodic lattices consisting of coupled isospectral cells, with varying properties across the lattice. Each resulting band consists of three distinct domains, with mobility edges marking transitions from localized to delocalized states. The characteristic localization length emerges from a competition between phase gradients and intercell coupling, providing insight into the localization mechanism. The proportion of localized versus delocalized eigenstates can be controlled by adjusting the gradient between lattice cells, offering new perspectives on isospectrally patterned aperiodic lattices.

Impact of Design Variations of Micro-Perforated Panels on Psychoacoustic Metrics

Jiahua Zhang[1], Laurent De Ryck[1], Jacques Cuenca[1], Lucas Van Belle[2], and Elke Deckers[2]
[1]Siemens Digital Industry Software and [2]Department of Mechanical Engineering, KU Leuven

Conventional and novel acoustic solutions such as micro-perforated panels (MPPs) and acoustic metamaterials not only affect noise levels but may also influence perceived sound quality. Gaining insights into the underlying mechanisms governing the relationship between the acoustic solution design parameters and human perception is crucial for designing acoustic (meta)materials with tailored psychoacoustic properties. This study investigates the interplay between the intrinsic physical properties of MPPs and their perceived sound quality. A global sensitivity analysis was conducted to quantify the impact of MPP design parameters (thickness, perforation rate, hole diameter, and air cavity depth) on psychoacoustic metrics such as loudness, sharpness, prominence ratio, and speech intelligibility index. The results reveal a non-linear relationship between MPP design and perceived sound quality, with sensitivity fluctuations depending on the acoustic stimulus. These findings highlight the importance of precise MPP design, particularly at higher frequencies, for achieving the desired sound quality.

Investigating Relationships Between Manufacturing Parameters, Geometrical Accuracy, and Vibrational Properties of Selective Laser Sintering PA-12 Beams

Alexander Kryuchkov[1], Michele Pavan[1], Claus Claeys[2], and Elke Deckers[2]
[1]Materialise NV and [2]Department of Mechanical Engineering, KU Leuven

Selective Laser Sintering (SLS) enables the production of complex structures, but ensuring their geometrical accuracy and material properties remains challenging. This study investigates the vibrational properties of PA-12 beams fabricated using SLS, focusing on the relationships between manufacturing parameters, geometrical accuracy, and natural frequencies. The research examines the spatial and thermal effects on part quality and uses dimensional measurements to predict the natural frequencies of cantilever beams. The results are compared with experimental data, obtained using a laser scanning vibrometer, to visualize the relationship between beam dimensions, resonant frequencies, and temperature of the printer bed.

Predicting the Impact of Injection Molding Process Parameters on the Vibroacoustic Performance of Manufactured Vibroacoustic Metamaterials

Alara Karaman[1], Lucas Van Belle[2], and Elke Deckers[1]
[1]Department of Mechanical Engineering, KU Leuven and [2]Flanders Make@KU Leuven

Vibroacoustic metamaterials (VAMMs) are lightweight yet efficient solutions for noise and vibration control. While additive manufacturing is commonly used for their production,

injection molding (IM) presents challenges for mass manufacturing and may affect VAMM performance. This study investigates how IM process parameters, such as injection and packing pressure, mold and melt temperature, and cooling and packing time, influence vibration attenuation in VAMMs. By analyzing their impact on resonator properties and predicted stop bands, the study uses iterative Bayesian frameworks to refine manufacturing processes and optimize VAMM performance for broadband vibration attenuation.

Accounting for Geometric Variability in the Response of Elastic Metamaterials

Yves Pillot, Régis Boukadia, Lucas Van Belle, Elke Deckers
Department of Mechanical Engineering, KU Leuven

This presentation addresses the effect of manufacturing variability on the performance of elastic metamaterials, particularly focusing on geometric changes. The study explores various case studies to assess the influence of geometric variability and its potential application to larger finite element models. The presentation highlights the importance of accounting for these variations to ensure the reliable performance of metamaterials in industrial applications.

A nonreciprocal and tunable active acoustic scatterer

Anis Maddi
Laboratoire d'Acoustique de l'Université du Mans (LAUM), UMR 6613, Institut d'Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France.

A loudspeaker placed inside a waveguide acts as a reciprocal scatterer for plane waves. However, reciprocity can be broken by using an electroacoustic feedback loop that feeds the loudspeaker a signal proportional to the pressure picked up from a microphone. This simple modification offers new possibilities for sound wave control. In this work, we investigate the scattering properties of a two-port consisting of two coupled active loudspeakers, each controlled by an amplifier. Experimentally, we demonstrate that by tuning the independent gain of the amplifiers, the system exhibits several exotic effects, including reflectionless configurations with transmission gain or unidirectional absorption, a directional amplifier with an isolation factor of 42 dB, and a CPA-Laser.

Modular Sonic Crystals for Urban Noise Mitigation: A Sustainable Approach with Porous Concrete and Resonant Structures

Nicolas Herrera Leon, Luis Godinho, Paulo Amado-Mendes
University of Coimbra

Sonic crystals have emerged as a promising alternative to traditional solid noise barriers, offering effective noise mitigation with enhanced design flexibility and aesthetic appeal. This study investigates the acoustic performance of noise barriers composed of porous concrete-covered scatterers and internal resonant structures, such as Helmholtz resonators, for urban traffic noise reduction. The porous concrete targets mid-to-high frequencies, while the Helmholtz resonators enhance low-frequency sound absorption. The scatterers are designed to meet urban aesthetic requirements. Numerical simulations and experimental evaluations reveal the complementary roles of the porous concrete and resonant structures, demonstrating significant noise attenuation across a wide frequency range.

Numerical and Experimental Analysis to Study Acoustic Performance of Phononic Crystals-Based Ventilated Noise Barriers

Noman Ahsan[1,2], Luca Sangiuliano[1], Luca D'Alessandro[1], Paulo Amado-Mendes[2], and Luís Manuel C. Godinho[2]
[1]Phononic Vibes SRL and [2]University of Coimbra

Phononic crystal-based noise barriers offer a promising solution for urban noise mitigation while maintaining ventilation. This study contributes to the state-of-the-art by employing finite element modeling and experimental methods to analyze sound transmission loss (STL) under idealized boundary conditions and in realistic settings. The research explores the acoustic behavior of phononic crystal barriers, optimizing lattice configuration, scatterer shape, and ventilation design. The experimental setup uses an Alpha cabin with a reverberation source to measure STL in practical conditions. The results demonstrate peak attenuation between 1 kHz and 2 kHz, providing an efficient solution for urban noise mitigation.

Advancing Sound Insulation in Building Acoustics Using Inertia Amplification Resonators

Marco Ribera[1], Luis Goidiho[1], and Bart Van Damme[2]
[1]University of Coimbra and [2]Empa

Improving sound insulation in building elements remains a critical challenge. This presentation explores an innovative approach using inertia amplification (IA) resonators to enhance sound insulation performance in lightweight building components. The study investigates the mass-air-mass resonance in double-leaf partitions and introduces IA resonators with increased dynamic mass and non-linear damping behavior. A comparative analysis highlights the potential of IA resonators for lightweight solutions, offering flexibility to control both resonance frequency and damping. Experimental impedance tube tests support the practical implementation of IA-based sound insulation systems.

Improved direct mapping of acoustic waveguides to lattice models

Su Ho Cheong, Georgios Theocharis, Vassos Achilleos, Olivier Richoux, Vincent Pagneux
Laboratoire d'Acoustique de l'Université du Mans (LAUM), UMR 6613, Institut d'Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France.

The propagation of acoustic waves in waveguides provides an effective testbed for studying topological insulators and their properties. Recent studies have demonstrated how waveguides can be used to model the one-dimensional (1D) Su-Schrieffer-Heeger (SSH) model. In these works, it has been shown that an acoustic waveguide can be directly mapped to a 1D SSH, which supports the presence of edge modes through chiral symmetry and where the geometry of the waveguide plays the role of inter and intra-site hopping’s. This 1D modelling approximates the 3D problem and it ignores near field effects at each change of cross-section of the waveguide. Here, by using an expression for the discontinuities at the cross-sections for the pressure and flux, which contains a so-called correction length, this improved discrete SSH model achieves a better alignment between the eigenfrequencies of the discrete SSH and those obtained from finite-element simulations. Furthermore, with the use of the improved discrete equations, it is possible to show that some robustness of the edge mode can be maintained.

Reciprocity Driven Omni-directional Absorption

Juan-Pablo Escudero Lopez, Jean-Philippe Groby, Vincent Pagneux
Laboratoire d'Acoustique de l'Université du Mans (LAUM), UMR 6613, Institut d'Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France

This study investigates the strong absorption of an incident acoustic plane wave by a rigidly backed lossy architectured layer composed of a periodic arrangement of inclined resistive wire meshes. Impedance matching is achieved when the incident wave's angle corresponds to the angle of inclination of the wiremesh, as well as its exact opposite angle, leveraging the reciprocity principle. The structure exhibits large absorption over a broad frequency band for medium inclination angles and almost omnidirectional large absorption over a subwavelength narrow frequency band for large inclination angles. This novel acoustic behavior provides a new perspective for designing omnidirectional subwavelength sound-absorbing devices.

Analysis of the Transmission Loss of a Metaporoelastic-Interface Coated Panel

Nadeen Ayyash[1,2], Francois Gautier[1], Adrien Pelat[1], Damien Lecoq[2], and Clément Lagarrigue[2]
[1]Laboratoire d'Acoustique de l'Université du Mans (LAUM), UMR 6613, Institut d'Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France and [2] Metacoustic

This study focuses on using elastic and locally resonant metamaterials to enhance the acoustic insulation properties of panels, particularly at low frequencies. The work investigates a configuration involving a very soft panel made of poroelastic material with cylindrical inclusions and a coated backing. The panel creates a low-frequency transmission dip due to the interaction between the elastic resonance mode of the skeleton and the rigid body mode of the inclusions. The study provides a minimal lumped element model, validated by finite element method comparisons, to explain the essential physical mechanisms involved in the design of such metamaterial panels.

Dispersion of guided waves in (meta)poroelastic layers

Mathieu Maréchal[1], Alan Geslain[1], Olivier Dazel[1], Vicent Romero-Garcìa[2], and Jean-Philippe Groby[1]
[1]Laboratoire d’Acoustique de l’Université du Mans (LAUM), UMR 6613, Institut d’Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France, and [2]Instituto Universitario de Matemática Pura y Aplicada (IUMPA), Universitat Politècnica de València, Spain.

Energy dissipation effects are used in the design of poroelastic-based layers to mitigate both acoustic and elastic energies. These materials are traditionally used for acoustic absorption, but their performance remains limited at low frequencies for homogeneous layers of small thickness. The different loss mechanisms involved have a major impact on the dispersion of surface waves propagating in these structures. The addition of periodic inclusions within the layer enables additional properties to be used, in order to optimize the absorption and acoustic insulation of these structures. However, their modal behavior remains generally unclear. The aim of this work is to develop numerical tools for calculating dispersion relationships in complex wave numbers and real frequencies for (meta)poroelastic layers. A first part is dedicated to the computation of dispersion relations in homogeneous multilayer dissipative structures using spectral collocation, and a second part focuses on poroelastic layers with embedded periodic inclusions, using finite elements.

Placement Optimization of Multimodal Resonators for Broadband Attenuation

Line Mardini[1,2], A. Bergamini[1], E. Deckers[2], C. Claeys[2], and B. Van Damme[1]
Empa[1], [2]Department of Mechanical Engineering, KU Leuven

This study optimizes the placement of multimodal resonators to achieve broadband vibration attenuation in host structures. By approximating the dynamics of complex-shaped resonators as mass-spring-damper systems using the linear prediction method, the optimal position of these resonators is determined to attenuate vibrations in a specific frequency range. The results are compared with those obtained from equivalent tuned mass dampers, providing insights into the efficiency of multimodal resonators for complex vibration control.

Acoustic response of periodically time modulated ultrathin resistive sheet

Ioannis Stefanou
Laboratoire d’Acoustique de l’Université du Mans (LAUM), UMR 6613, Institut d’Acoustique - Graduate School (IA-GS), CNRS, Le Mans Université, France.

Preliminary results will be presented on the acoustic scattering by an ultrathin resistive sheet, a purely resistive wire mesh, in the case where the resistance is periodically moduated in time. The potential influence of this wire mesh on the modes inside a cavity will be discussed as well.

List of participants

Vassos Achilleos, CNRS UMR 6613 – LAUM
Noman Ahsan, Phononic Vibes/University of Coimbra
Severine Atis, Pprime
Nadeen Ayyash, Metacoustic/LAUM
Eric Ballestero, LAUM
Torea Blanchard, Metacoustic
Su Ho Cheong, LAUM
Antonin Coutant, Laboratoire de Mécanique et d'Acoustique
Bérangère Delourme, LAGA, Université Sorbonne Paris Nord
Pierre Delplace, CNRS, ENS de Lyon
Fotios Diakonos, Department of Physics, University of Athens
Juan Pablo Escudero, CNRS UMR 6613 – LAUM
Daniele Giannini, KULeuven
Jean-Philippe Groby, CNRS UMR 6613 - LAUM
Xinxin Guo, CPAS Laboratory, ETH Zurich
Nicolas Herrera Leon, University of Coimbra
Ioannis Ioannou Sougleridis, LAUM
Muamer Kadic, Université Marie et Louis Pasteur
Alara Karaman, KULeuven
Magdalini Koukouraki, Laboratoire Physique et Mécanique des Milieux Hétérogènes
Alexander Kryuchkov, Materialise NV/KULeuven
Anis Maddi, LAUM
Line Mardini, EMPA/KULeuven
Mathieu Maréchal, LAUM
Yang Meng, LAUM
Monisha Muralidharan Menon, CNRS UMR 6613 - LAUM
Aurélien Merkel, Institut Jean Lamour, Université de Lorraine
Koijam Monika Devi, IEMN CNRS UMR8520
Fabrice Mortessagne, Université Nice Côte d'Azur
Nicolas Noiray, ETH Zürich
Vincent Pagneux, CNRS UMR 6613 - LAUM
Vittorio Peano, Max Planck Institute for the Science of Light
Yan Pennec, ULille IEMN
Yves Pillot, KULeuven
Marco Ribera, University of Coimbra
Peter Schmelcher, University of Hamburg
Ioannis Stefanou, LAUM
Clément Tauber, CEREMADE - Université Paris Dauphine - PSL
Georgios Theocharis, CNRS UMR 6613 – LAUM
Vincent Tournat, CNRS UMR 6613 – LAUM
Jiahua Zhang, Siemens Digital Industry Software
Joar Zhou Hagström, LAUM, Le Mans Université

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