Stage M2 : Acoustoelasticity of membranes

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PhD thesis after: Yes (ANR funds)

Context: For about twenty years, the wave physics community has discovered the immense potential of architected materials to offer unusual properties: metamaterials. However, their fabrication remains complex and requires meticulous work. In contrast, some manufacturing techniques that produce less periodic media, such as foams, are simpler to implement and could serve as a promising alternative (Figure 1). Inspired by their astonishing acoustic properties [1], we have identified that these properties arise from the presence of tensioned membranes. Our goal is to explore the dynamics of these 'membrane materials' in order to develop easily fabricated metamaterials for acoustic and vibrational damping, with potential applications in mechanobiology.

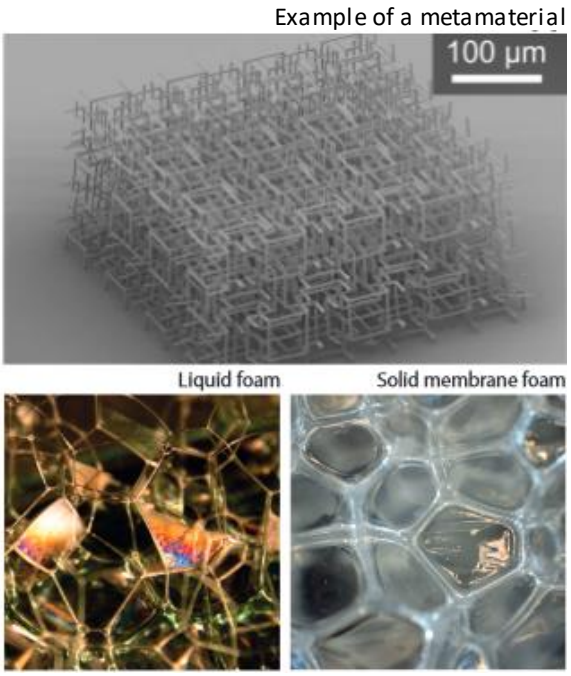

Figure 1. Example of a metamaterial and foams.

Objectives: The main objective of this internship is to focus on the dynamics of membranes in model systems. This involves comparing the behavior of liquid and elastic membranes, each governed by distinct physical principles. Elastic membranes, influenced by the Young's modulus of the material and the bending moment, differ significantly from liquid membranes, where vibrational modes are solely dictated by surface tension. Through rigorous experimentation and theoretical modeling, we aim to develop a unified framework for these two types of membranes. We also seek to understand the role of membrane tension, particularly in the case of liquid membranes that maintain their tension through fluid influx. Finally, our investigation will extend to exploring the complex interactions between membranes and surrounding fluids. By systematically addressing these aspects, the internship will provide a deep understanding of membrane dynamics, paving the way for significant advancements in acoustic applications within the broader context of the ANR MEMBRANE project.

[1] F. Elias, J. Crassous, B. D. Caroline Derec, W. Drenckhan, C. Gay, V. Leroy, C. Noûs, J. Pierre, and A. Saint-Jalmes, "The acoustics of liquid foams," Current Opinion in Colloid & Interface Science, vol. 50, p. 101 391 (2021).