DEPARTEMENT MICRO NANO SCIENCES ET SYSTEMES
VINCENT LAUDE, PHD, HAB.
Tél. +33 (0)3 63 08 24 52
vincent.laude@femto-st.fr

Topological phononic crystals

Master 2 internship proposal in wave physics, 5/6 months from March 2022

Context

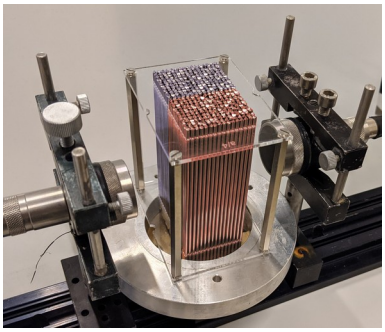
Topological phononics is blooming nowadays. The topic combines the concepts of artificial crystals for acoustic waves with group theory and topology. Of special interest is the creation of phononic crystal waveguides with desirable properties such as single-mode operation, symmetry-protection, and immunity against backscattering by defects. The internship work would include steps of theory (wave physics, topology of band structures), numerical simulation (finite elements for acoustic and elastic waves), and the achievement of demonstration experiments with underwater acoustic waves. Recent achievements by the group have been to valley Hall phononic crystals, extending the concept to dispersive waves and to square and rectangular lattices [1,2,3].

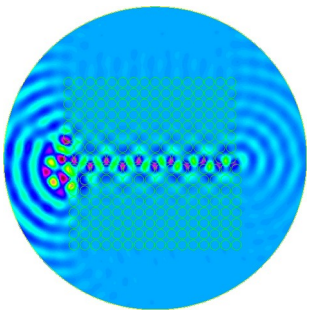
Of particular interest is the further investigation of the symmetries of phononic crystal waveguides. Backscattering immunity, a concept derived from topological insulators, indeed originates from symmetry protection in valley-Hall and quantum Hall phononic crystal waveguides. This desirable property, however, results from a topological transition at a Dirac point, leading to the opening of an initially closed band gap and hence to a limited available bandwidth compared to wide band gap but topologically trivial crystals. It is proposed to explore other possibilities that could lead to the appearance of wide-bandwidth, single-mode, and symmetry-protected guided waves.

1. Laforge et al. Observation of topological gravity-capillary waves in a water wave crystal. New Journal of Physics **21**, 083031 (2019).
2. Makwana et al. Experimental observations of topologically guided water waves within non-hexagonal structures. Applied Physics Letters **116**, 131603 (2021).
3. Laforge et al. Acoustic topological circuitry in square and rectangular phononic crystals. Physical Review Applied **15**, 054056 (2021).

Work plan

The internship will be devoted to implementing phononic crystal waveguides including an internal glide symmetry. Experiments will be performed using ultrasonic waves in water. Waveguide samples will be built by the intern from perforated alignment plates, obtained by laser drilling of Plexiglas. Various samples will be conceived and tested under the supervision of a third-year PhD student and his advisors. The ultimate goal is to produce publishable quality results and ideally to draft a scientific publication by the end of the internship.





Supervision

This master internship will take place in the MN2S department of FEMTO-ST institute in Besançon and will be supervised by Dr. Vincent Laude (vincent.laude@ubfc.fr), research director at CNRS, to which applications should be sent. The candidate profile would be in physics, waves, or instrumentation. Interest in fundamental physics and applied mathematics is expected. The candidate can send a CV, a cover letter motivating the application, and the transcript of grades for the last two years by email. The search for a candidate will continue until a suitable application is accepted.

Homepage: https://members.femto-st.fr/vincent-laude/

Group website: https://teams.femto-st.fr//phononics-microscopy/en