université de BORDEAUX

LOMA UMR5798 Laboratoire Ondes et Matière d'Aquitaine

Master 2 Internship

Title: Singular acoustics: mechanical effects and its consequences on sound and matter

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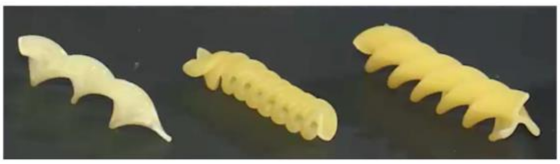
PhD funding : This internship can be follow up with a PhD

Project

Phases singularities represent a common feature to any scalar wave whatever its nature. They represent generic events in wave physics prone to appear in usual observations conditions as three planes waves are enough to construct them. In our laboratory, we develop experimental techniques to generate them for sound waves, in particular from 3D printed objects and we are interested in their mechanical effects on matter as a result of sound-matter interaction. This led us to the study of spinning of macroscopic objects in fluids [1] or at air-water interface [2], and also to the twisting of matter with the demonstration of torsional pendulum driven by the orbital angular momentum carried by acoustic vortex generation [3]. Indeed, as a phase singularity is imprinted on an initially smooth propagating pressure field, an acoustic vortex is born and leaves a mechanical fingerprint to matter in the form of a torque exerted on it. Therefore, according to angular momentum conservation principles, sound-matter angular momentum transfer allows us to rotate or twist matter with acoustic waves, in a contactless manner.

Here, we will experimentally explore non-intuitive sound-matter interaction geometries leading to nonzero acoustic torque contributions lying in the transverse plane with respect to the propagation direction rather than pointing along it as reported so far [1-3]. This will be done by direct and simple means, using suitably designed 3D printed objects placed in the course of an ultrasonic vortex propagating in the air. The mechanical effects of sound on matter will be studied from a dual point a view: that of matter and that of the sound itself.



$\ell = +1$ $\ell = +2$ $\ell = +3$

Noodle images illustrating helical-shaped wavefronts analog to those of vortices of sound, light or elementary particle wavefunction.

[1] A. Anhauser, R. Wunenburger, and E. Brasselet, *Acoustic rotational manipulation using orbital angular momentum transfer*, Physical Review Letters 109, 034301 (2012).

[2] B. Sanchez-Padilla, L. Jonusauskas, M. Malinauskas, R. Wunenburger, and E. Brasselet, *Direct mechanical detection and measurement of wave-matter orbital angular momentum transfer by non-dissipative vortex mode conversion*, Physical Review Letters 123, 244301 (2019).

[3] B. Sanchez-Padilla and E. Brasselet, *Torsional mechanical oscillator driven by the orbital angular momentum of sound*, Physical Review Applied 13, 064069 (2020)