Observation of topologically protected helical edge states in an elastic waveguide

M. Miniaci[a,b], R.K. Pal[b], B. Morvan[a] et M. Ruzzene[b]
[a]Normandie Univ, UNIHAVRE, CNRS, LOMC, 75 rue Bellot, 76600 Le Havre, France
[b]Schools of Aerospace Engineering and Mechanical Engineering, Georgia Institute of Technology, North Ave NW, Atlanta, GA 30332, USA
marco.miniaci@gmail.com

The investigation of topologically protected waves in classical media has opened unique opportunities to achieve exotic properties like one-way phonon transport, protection from backscattering and immunity to imperfections. While a number of experimental observations in acoustic and electromagnetic domains has appeared so far, their observation in elastic solids has so far been elusive due to the presence of both shear and longitudinal modes and their modal conversion at interfaces and free surfaces.
Here we report the experimental observation of topologically protected helical edge waves in an elastic plate patterned according to a Kagome lattice with an accidental degeneracy of two Dirac cones induced by drilling blind holes through the waveguide thickness. The careful breaking of symmetries couples the corresponding elastic modes which effectively emulates spin orbital coupling in the quantum spin Hall effect.
The experimental full wavefield reconstruction by means of a scanning laser Doppler vibrometer clearly provides the demonstration of topological robustness and the ability to guide waves along channels with sharp corners in elastic structures. The results may open up new avenues in the fields where vibrations play a crucial role, such as civil engineering, energy harvesting and the aerospace industry, opening avenues for the practical realization of compact, passive and cost-effective elastic topological waveguides.