Waveguides and sources for topological phononics

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In the quest to realize topological phononic waveguides, we have simulated Quantum Valley Hall waveguides structures using COMSOL building on a recent realization of a mechanical gap at 6.5 GHz [1]. Currently, we are targeting a gap also centred in the GHz range which would sustain an isolated non-trivial topological phononic mode (see simulations in figure 1).

Samples have been designed and recently fabricated in SOI wafers and Brillouin light scattering experiments are in progress. Since the main objective is to integrate these waveguides in a phononic circuit, we have tested concepts of phonon excitation and detection [2] showing that coherent acoustic phonon generation can be achieved using an optomechanical interface [3] (see figure 2). For validation in the low GHz range, an independent test using Laser Doppler Vibrometry is being developed which will allow a comprehensive characterization of out-of-plane acoustic waves.

References

[1] O. Florez et al., Nat. Nanotech., 17 (2022) 947-951
[2] R. C. Ng et al., Nanoscale, 37 (2022) 13428-13451
[3] G. Madiot et al, arXiv, 2206.06913 (2022)

Figures

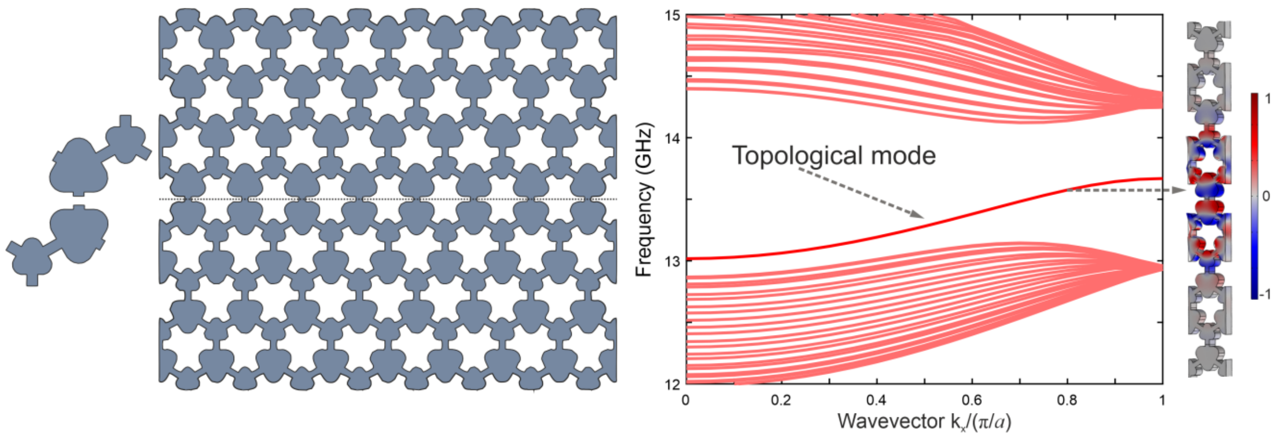

Figure 1: Waveguide modes simulation. Left: Geometry of the topological crystal based on the valley Hall approach. Right: Phononic dispersion relation showing the isolated topological mode inside the gap.

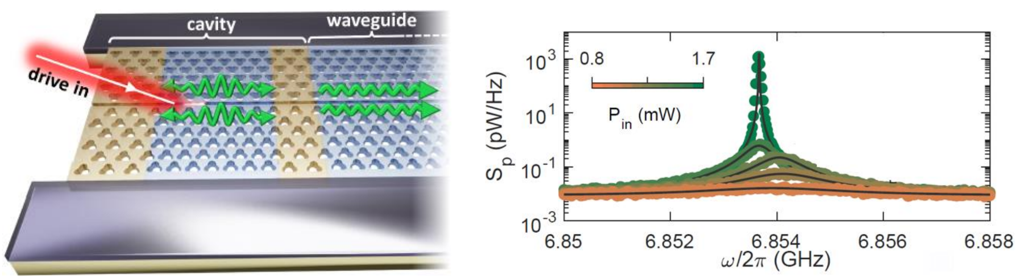

Figure 2: A phonon source. Left: Optomechanical device based on a phononic crystal design. Right: phonon emission of a coherent phonon flow near 7 GHz [3]