Multiple topological states in nanophononic superlattice devices

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Topological interface states have been demonstrated for a wide range of excitations (photons, phonons, vibrations, polaritons). In particular, nanoacoustic interface states have been evidenced in superlattices working at acoustic frequencies in the tens to hundreds of GHz [1–3]. A scheme to generate interface states in one-dimensional nanoacoustic superlattices is based on the principle of band inversion, which can be achieved by concatenating two periodic lattices with inverted spatial mode symmetries around the bandgap [4]. Most realizations optimize the thickness ratio to reverse the symmetries to create an interface mode at a specific bandgap.
In this work, we present topological nanophononic interface states at high-order bandgaps in multilayered structures based on GaAs/AlAs. We achieve band inversion by modifying the internal unit cell structure of the two lattices [5]. We extend the principle of band inversion to create an interface state at the second or higher-order bandgaps (see Fig.1). By carefully choosing the appropriate material thickness ratio of the two concatenated nanoacoustic superlattices we demonstrate that we can engineer interface states at the nth bandgap. We can design versatile topological devices where nanoacoustic interface states are simultaneously created in a broad frequency range. In addition, we can generate interface states in hybrid structures by combining two superlattices presenting bandgaps of different orders centered around the same frequency.

References

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Figures

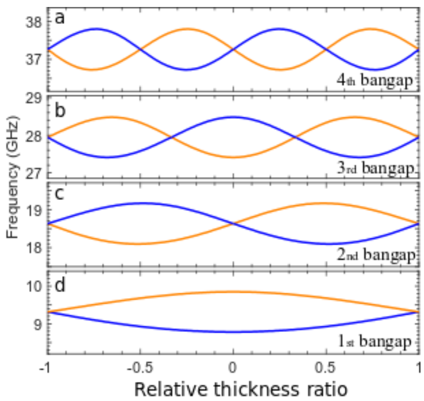

Figure 1: Band inversion of the acoustic bandgap. The mode symmetries are indicated with orange (symmetric) and blue (anti-symmetric) lines.