Design of interface states using canonical phononic waveguides

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Abstract

We propose a novel and rigorous method to predict the presence of localized modes at the interface between two dissimilar two-phases quasiperiodc phononic waveguides. The condition for the presence of an interface state between two one-dimensional structures, requiring that the sum of the surface impedances of the two waveguides that
make up the system is zero and previously introduced for electromagnetice waves (1), is here applied to study mechanical localized modes. We show that, for systems composed of two quasiperiodic rods which elementary cell possesses particular layouts corresponding to a periodic frequency spectrum, the so-called *canonical* configurations (2), it is possible to determine exactly all the gaps of the spectrum where this condition is satisfied. The variation of the impedance inside each band gap is analyzed through the method of the universal toroidal manifold, recently introduced by the authors to describe the dynamical properties of this class of structures (3).
In terms of prediction, the results obtained are identical to those derived by calculating the Zak phase of the bulk bands for both the waveguides composing the system (4). Considering two specific
combinations of finite canonical rods and analyzing the associated reflection coefficients, we obtain exact equations to determine the frequency of the interface state. Our approach provides new insight
to design and optimize systems where interface modes appear inside a prescribed gap avoiding the challenging numerical calculations normally required to estimate topological invariants such as the
Zak phase.

References

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