Band structures and transmission properties of acoustic waves in phononic lattices

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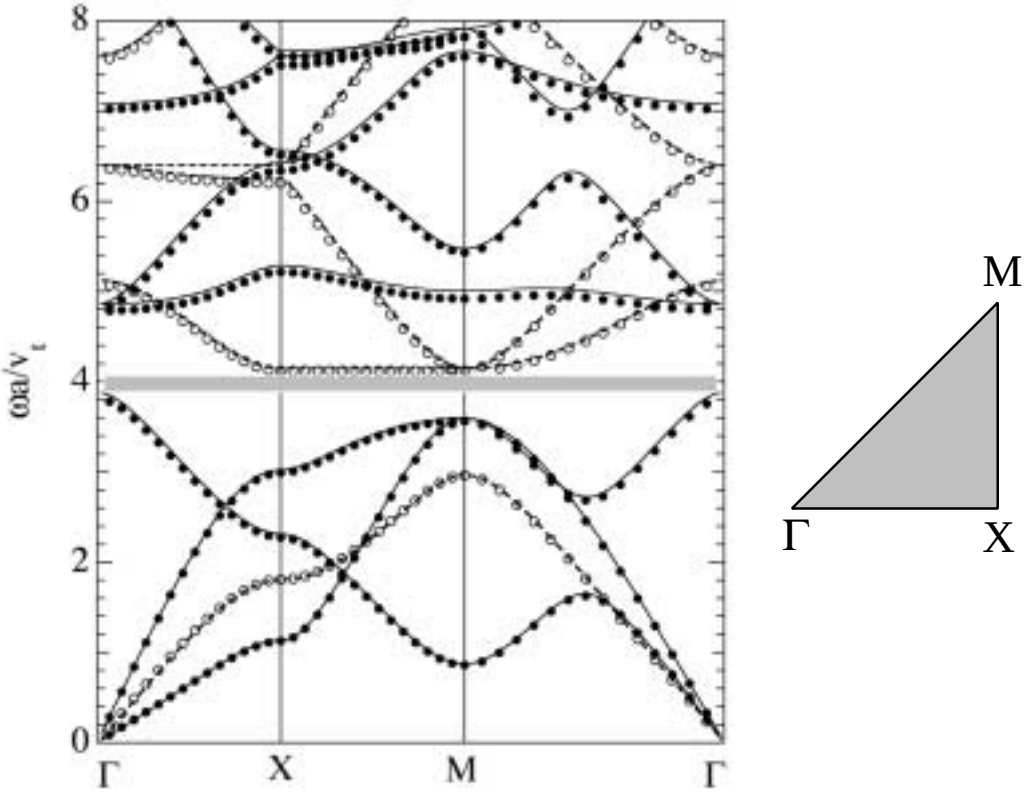
The finite-difference time-domain (FDTD) method is applied to the calculation of dispersion relations of acoustic waves in two-dimensional (2D) phononic lattices, i.e., periodic solid-solid, solid-liquid, and solid-vacuum composites, for which the conventional plane-wave-expansion (PWE) method fails or converges very slowly. Numerical examples are developed for 2D structures with polyethylene, mercury, and vacuum cylinders forming a square lattice in an aluminum matrix. Also with the FDTD method we study the transmission properties of acoustic waves through a finite one- and two-dimensional phononic lattices. The implication of the calculated dispersion relations and transmission characteristics for ultrasound transmission experiments is discussed.



FDTD result for the dispersion relations of the coupled longitudinal and transverse modes (dots) and the single transverse mode (open circles) in a 2D square lattice consisting of vacuum circular cylinders in an Al substrate with filling fraction f=0.55. (v_t=3.1km/s is the transverse sound velocity in Al and a is the lattice spacing.) Also plotted by the solid and dashed lines are the PWE calculations for the coupled and single modes, respectively. The hatched region shows the complete gap for three acoustic modes.