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Phononic crystals in the diffraction regime

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Phononic crystals are periodic composite materials exhibiting amazing wave propagation properties. In many works, complete band gaps are being looked for, i.e. the materials constituting the phononic crystal and its lattice arrangement are chosen such that propagation for all waves within a prescribed frequency range is forbidden. In other studies, the phononic crystal is considered a metamaterial, the anisotropic spatial dispersion of which can be tuned, and in which negative refraction can even be observed under certain circumstances. Such effects are usually considered in the sub-diffraction regime, i.e. below some critical onset frequency. In this work, we specifically examine phononic crystals in the diffraction regime. Indeed, the boundaries of a finite size phononic crystal embedded in a host propagation medium can be viewed as diffraction gratings, as we show. We will specifically consider two cases: two-dimensional phononic crystals composed of steel rods in water, and two-dimensional phononic crystals for surface acoustic waves achieved by etching cylindrical holes in a solid substrate.