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Acoustic metamaterials and phonic crystals

Foreword

Phononic crystals and acoustic metamaterials are artificial materials whose constituents are specifically designed and/or organized to lead to unusual properties of acoustic and vibrational waves. In phononic crystals, the structuration is periodic and the control of wave dispersion is obtained through Bragg scattering when the wavelength is comparable to the spatial period of the lattice. A matrix containing a periodic arrangement of inclusions that scatter the wave is a classic example of a phononic crystal. Acoustic metamaterials include local resonators in order to obtain unusual wave dispersion characteristics associated with effective dynamic mass density and bulk modulus at the vicinity of the resonance frequency. Wavelengths significantly larger than the resonator's dimension can be affected if the resonator is engineered to be sufficiently soft.

Phononic crystals and acoustic metamaterials constitute nowadays a very active research topic that feeds from different scientific and engineering communities and fields: phonon and condensed matter physics, dynamics of composite materials and structures, photonic crystals and electromagnetic resonant metamaterials, etc.

This thematic issue gathers nine papers covering the current trends in phononic crystals and acoustic metamaterials research.

Acoustic isolation, absorption and transmission constitute an engineering area that could benefit greatly from material structuration and local resonances to reach perfect impedance matching. Four papers of this issue are related to this topic sometimes described by the term "metasurface". Agnès Maurel et al. analyze the transmission of sound waves through a hard layer with periodic subwavelength slits and propose an extension of homogenization theory. On a similar geometry with oblique slits, Andrew N. Norris and Xiaoshi Su examine the consequences of symmetry breaking on the "extraordinary acoustic transmission". Min Yang et al. consider sound absorption from thin subwavelength membranes supporting rigid platelets with different backward boundary conditions. Pierre Méresse et al. study coatings including resonant inclusions used to reduce acoustic radiation or reflection from hull in marine systems. Propagation in a resonant acoustic metamaterial is addressed by Navid Nemati et al., who apply the nonlocal theory of sound propagation to a porous medium in the form of an array of Helmholtz resonators.

Four papers of the issue report recent developments on phononic crystals. Reconfigurability and tunability of these crystals is a major concern, which is addressed in two papers: Marshall Schaeffer and Massimo Ruzzene describe how dynamic reconfiguration of magneto-elastic lattices is controlled by magnetization, Anton A. Kutsenko et al. analyze the modifications of the dispersion spectrum of a one-dimensional piezoelectric phononic crystal with periodical electrical boundary conditions connected with variable negative capacitances. Spatial filtering is another feature of phononic crystals used by Mathieu Chekroun et al. to demonstrate theoretically and experimentally that directional radiation of water waves can be obtained with a crystal of surface-piercing cylinders. The final paper by Pierre Deymier et al. revisits the properties of rotational waves propagating in a one-dimensional discrete block-spring chain within Dirac's formalism.

As guest editors, we would like to thank the editorial staff for their assistance and the editor in chief, Jean-Baptiste Leblond, for his encouragement. We also express special thanks to the authors and reviewers. We hope that this issue will lead to further contributions to the journal on this topic.

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