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Elastic metamaterials and effective medium theory
YING WU, Division of Mathematical and Computer Sciences and Engineering, King Abudllah University of Science and Technology, YUN LAI, Department of Physics, Soochow University, China, PING SHENG, Department of Physics and William Mong Institute of Nano Science and Technology, Hong Kong University of Science and Technology, ZHAO-QING ZHANG, Department of Physics and William Mong Institute of Nano Science and Technology, Hong Kong University of Science and Technology — The unusual properties of a metamaterial are induced by the resonance in its building blocks. We derived an effective medium theory for elastic metamaterials in two dimensions, which is capable of predicting the wave propagation behavior inside the metamaterial near resonances of the building-block. It reveals the connection between resonances and negativities in effective medium parameters. Based on the EMT, we design two types of elastic metamaterials consisting of different resonance structures in their building blocks that can exhibit multiple negative dispersion bands with special characteristics. One is able to produce negative shear modulus and negative mass density simultaneously over a frequency regime, and the other is super-anisotropic. All of these unusual properties are demonstrated by multiple-scattering theory or finite element simulations.

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