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# Nonlinear harmonic generation in mechanical metamaterials

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## Abstract

Elastic wave propagation and control in solid materials and structures play a crucial role in the development of devices and technologies across various fields, including vibration control, damage detection, medical ultrasound imaging, and information processing. Mechanical metamaterials, composed of artificial microstructures, have garnered significant attention due to their remarkable capabilities in elastic wave manipulation. Nonlinear harmonic generation is a fundamental dynamic process and an essential mechanism for wave energy transfer in the frequency domain. However, studies on nonlinear harmonic wave propagation in mechanical metamaterials remain scarce. In this work, we systematically investigate nonlinear harmonic generation, propagation, enhancement, and control in mechanical metamaterials. Our findings reveal anomalous dispersion in a metamaterial exhibiting coupled translational and rotational motion, which can induce localized nonlinear harmonic generation. We also explore the influence of pre-strain on nonlinear harmonic generation, demonstrating significant tunability. Additionally, we propose tailoring the geometric asymmetry of the structure to enable both longitudinal and flexural second harmonic generation. This research offers new insights for the development of advanced elastic wave devices.

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