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## Abstract

In this work, we investigate the resonant properties of finite-sized membrane-mass-type elastic metamaterial thin plates. We find that the effective bending stiffness of such metamaterial thin plates can be controlled independently by the out-of-plane rotational resonances, so as to vary from positive to negative values, and even approach infinity. The effective bending stiffness can be retrieved by using resonant frequency analysis for metamaterial plates with different sizes. Since the effective mass density and bending stiffness are both configurable, the resonant frequencies of the elastic metamaterial thin plate can be engineered efficiently. In a special example, we have enhanced the rotational mode by increasing the moment of inertia, and realized simultaneously negative bending stiffness and mass density, which leads to a band of negative group velocity. Our work demonstrates an efficient approach for manipulating flexural waves in elastic metamaterial thin plates.

## Figures used in the abstract

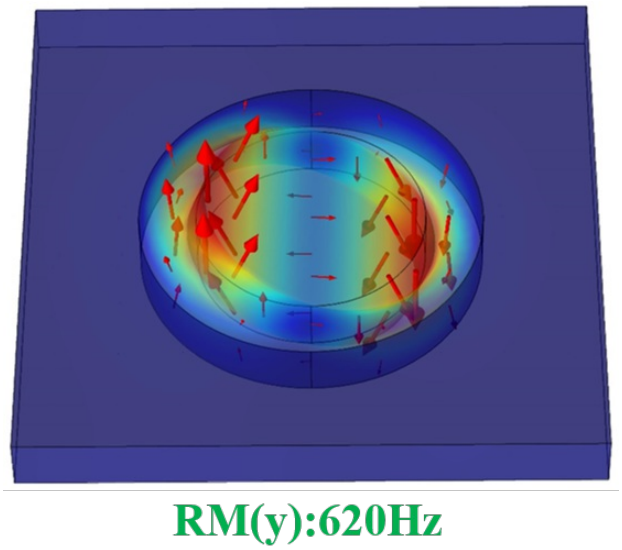


**Figure 1**: 波沿X方向传播，Γ点上转动模的场图。