Third-order exceptional points and frozen modes in planar elastic laminates

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Abstract

Exceptional points (EPs) are degeneracies of two or more natural modes of open systems, which lead to unusual wave phenomena. Despite the robustness against imperfections of spatial EPs, they are less studied relative to temporal EPs, particularly in elastodynamics. However, elastic waves exhibit features not found in sound and light, which have proven useful for forming spatial EPs. Here, we harness these features to tune the coalescence of three eigenmodes in the Bloch spectrum of planar elastic laminates. We show that these third-order EPs give rise to axially frozen modes: anomalous transmitted waves with zero axial group velocity and finite transmittance. These modes, which were first reported in optics and required three-dimensional laminates, are achieved here in a planar setting thanks to elastodynamics tensorial structure, and expand the toolbox for elastic wave shaping.

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