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Slow edge acoustic waves in phononic monolayer granular membranes

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The edge states of elastic waves in semi-infinite honeycomb monolayer granular membranes with armchair and zigzag boundaries are investigated. The two-dimensional monolayer granular membranes under consideration [1] are composed of periodically ordered spherical particles, arranged in a honeycomb lattice. Considering the translational and rotational degrees of freedom of the grains, normal, shear and bending couplings are activated for in-plane particle motions and shear, bending and torsional couplings for out-of-plane motion. The dispersion curves of edge states are analyzed in detail. The edge modes, at frequencies that are higher than the bulk modes, are found in the armchair edge configuration. We also study the existence of slow elastic edge modes propagating due to finite bending or torsional rigidities. The observation of nearly flat associated branches in the phonon spectra indicates that the propagation of wave is extremely slow due to the weak bending and torsional intergrain interactions. These studies on acoustic edge waves in discrete elastic membranes is a necessary step towards their applications for wave control through the introduction of the topological or unidirectional edge states for example.