Elastic wavepackets crossing a space-time interface

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Abstract

Time-varying media play a prominent role in current wave physics research, offering rich opportunities for wave manipulation, particularly in the realm of metamaterials. The integration of time as a modulation variable significantly expands the scope of potential applications. The space-time interface serves as an elementary building block for such manipulations, and a comprehensive understanding of wave interactions with such an interface is critical. This work presents experimental observations on guided elastic waves in soft strips. The velocities of flexural modes are directly linked to initial prestress, and we introduce an experimental setup capable of modulating these velocities through sudden uniaxial stress application. Our findings reveal that induced deformations propagate within the strip as step functions, causing not only deformation but also consistent translational motion at a constant speed. The potential of this deformation front as a space-time interface is revealed through its characterization. The interaction of flexural waves with this interface are then studied and significant changes in frequency and wavenumber are measured. Notably, we investigate the case of a supersonic interface, which offer interesting observations regarding wave control. In the future, the manipulation of waves through one or more space-time interfaces shows potential for inducing effects such as freezing, significant frequency conversions, and nonlinear modulations. This study is a crucial step in understanding space-time soft metamaterials and offers insights into diverse phenomena, drawing analogies with astrophysical phenomena and metric signature changes.

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