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Nonlinear elastic waves in solids: Deriving simplicity from complexity MAHMOUD I. HUSSEIN, ROMIK KHAJEHTOURIAN, University of Colorado Boulder — The introduction of nonlinearities to the dynamics of a homogeneous elastic medium alters the underlying wave dispersion characteristics. In this work, we present an exact formulation for the treatment of geometric nonlinearity in one-dimensional elastic wave propagation in a rod, considering both a thin rod where the thickness is small compared to the wavelength and a thick rod where lateral inertia is accounted for. Our derivation starts with the implementation of Hamilton's principle and terminates with an expression for the finite-strain dispersion relation in closed form. We explore the effect of wave amplitude on the derived dispersion relation and compare with results obtained by direct time-domain simulations followed by Fourier transformations. While often dispersion is attributed to only linear mechanisms, here we show that an otherwise linearly nondispersive elastic solid may exhibit dispersion solely due to the presence of a nonlinearity. This work provides insights into the fundamentals of nonlinear wave propagation in solids, which represents one of the agents of wave chaos in complex systems.

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