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Nonlinear Equations for Finite-Amplitude Wave Propagation in Fiber-Reinforced Hyperelastic Media

Various composite materials, including biological tissues, are modeled as nonlinear elastic materials reinforced with elastic fibers. We consider the full set of dynamic equations for finite deformations of incompressible hyperelastic solids reinforced by a single fiber family. Using finite-amplitude wave propagation ansätze compatible with the incompressibility condition, we derive the corresponding nonlinear and linear wave equations. Properties of these equations, including point symmetries, are studied. Exact time-dependent solutions are derived in several physical situations, including the evolution of pre-strained configurations and traveling waves.