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Acoustic wave propagation in granular systems

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We present numerical simulations of acoustic wave propagation in granular systems consisting of particles interacting with the three-dimensional Hertz-Mindlin force law. The response to a short mechanical excitation on one side of the system is found to be a propagating coherent wavefront followed by random oscillations made of multiply scattered waves. We find that the coherent wavefront is insensitive to details of the packing: force chains do not play an important role in determining this wavefront. The coherent wave has a well defined velocity, which is roughly compatible with the predictions of macroscopic elasticity, and its amplitude and width depend as a power law on distance. As there is at present no theory for the broadening and decay of the coherent wave, we numerically and analytically study pulse-propagation in a one-dimensional chain of identical elastic balls. The results for the broadening and decay exponents of this system differ significantly from those of the disordered packings. We briefly discuss the eigenmodes of the system and effects of damping are investigated as well.