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Granular assemblies: a sandbox of nonlinear physics phenomena

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Granular materials play a major role in our daily lives and are vital to the function of a diverse array of industries, from agriculture to mining to pharmaceutical manufacturing. Understanding the dynamics of granular media is of fundamental importance to the study of matter in general, and beyond being intimately connected to a variety of natural geophysical phenomena, knowledge of the behaviour of these systems has many potential implications to industry. For example, granular systems are useful in applications related to shock absorption and vibration reduction primarily because they are capable of dissipating mechanical energy through inelastic collisions and friction between the grains. As energy is transferred between grains they deform slightly, and the contact potential arising from the elastic deformation of grains is given by the nonlinear Hertz law. The discrete nature of these systems in combination with the nonlinear contact interaction between grains leads to complex collective behaviour, providing a sandbox of interesting physics phenomena. Investigating granular chains gives insight into this complex behaviour, and also provides the stepping stone required to comprehend the dynamic behaviour of higher-dimensional analogues. Our work focuses on the dynamics and statistical mechanics of granular chains and, in particular, on how these systems can be exploited to locally trap vibrational energy. Using particle dynamics simulations, we investigate how solitary wave propagation in these systems is affected by material properties, and how introducing inertial mismatches affects the reflection of solitary waves at boundaries. We also look into how material properties affect energy localization and equipartitioning processes in these systems.

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