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Nonlinear Sonic Vacua

Alexander Vakakis[1*]

Abstract
We will present recent results on a special class of dynamical systems designated as nonlinear sonic vacua. These systems are non-linearizable, and have zero speed of sound (in the sense of classical acoustics). Accordingly, their dynamics and acoustics are highly degenerate and tunable with energy, enabling new and highly complex nonlinear phenomena. Two examples of sonic vacua will be discussed. The first is un-compressed ordered granular media, which, depending on their local state, behave either as strongly nonlinear and non-smooth dynamical systems (in the absence of strong local compression), or as almost linear coupled oscillators (under strong local compression, e.g., in the primary fronts of propagating solitary pulses) [1,2]. The second example concerns a spring-mass lattice in the plane. In the small energy limit this seemingly simple system is 'transformed' by geometric nonlinearity to a nonlinear sonic vacuum with surprising properties, such as strong nonlocality (despite of only next-neighbor interactions in the lattice!), orthogonal nonlinear normal modes, and accelerating propagating fronts [3,4]. Interesting applications of nonlinear sonic vacua will be discussed, including intense energy cascading from low-to-high frequencies and long-to-short wavelengths, resembling "mechanical turbulence". We will discuss the implications of these findings on the design of dynamical systems for predictive passive energy management.

Keywords
Nonlinear, sonic vacuum

[1] Mechanical Science and Engineering, University of Illinois, Urbana, USA
* **Corresponding author:** avakakis@illinois.edu

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