Passive Energy Management in Dynamics and Acoustics Through Strong Nonlinearity, Asymmetry and Internal Scale Hierarchy

We explore a new concept for passive energy management of dynamical and acoustical systems based on the synergy of intentional strong local nonlinearity, asymmetry, and internal scale hierarchy. Central to this concept is the inducement of irreversible nonlinear energy transfers from large-to-small scales that break non-reciprocity in controlled and predictable ways. Then, broadband or narrowband input energy is either directed in preferential paths/modes, dissipated locally/globally, or harvested at *a priori* designated sites in the system through predictable design. These non-reciprocal energy transfers mimic analogous energy cascades that occur often in Nature (e.g., in turbulent flows or granular media), and, as such benefit from the well-known robust and enhanced dissipative features exhibited by these natural phenomena. Our approach dictates advanced theoretical modeling and analysis, but also nonlinear system identification and reduced-order modeling to characterize the experimental realizations that validate the theoretical predictions. In a particular application, we'll discuss new approaches for designing, analyzing, characterizing and experimentally testing non-reciprocal lattice materials incorporating multiple internal hierarchical scales. The aim is to translate these materials to new technologies and acoustic devices that exploit and showcase acoustic non-reciprocity.

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