COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
UNIVERSITY OF MICHIGAN

ME Department Seminar

The Search for Edge States (Boundary Modes) in Mechanical Metamaterials

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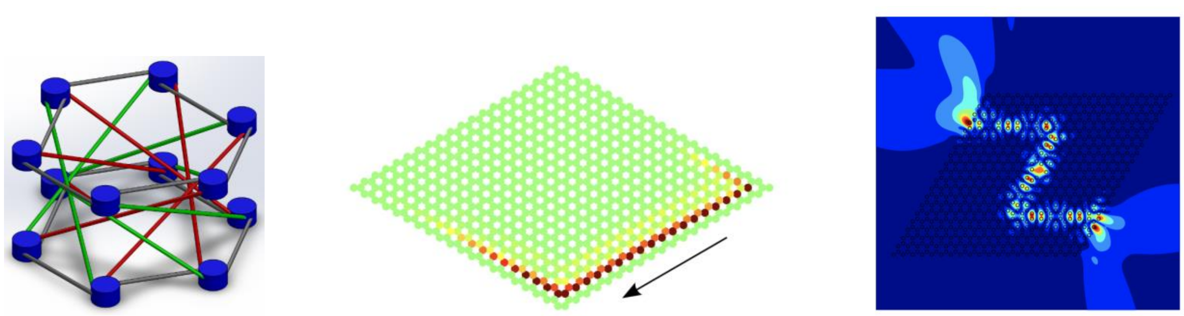
Abstract

Recent breakthroughs in condensed matter physics are opening new directions in band engineering and wave manipulation. Specifically, challenging the notions of reciprocity, time-reversal symmetry and sensitivity to defects in wave propagation may disrupt ways in which mechanical metamaterials are designed and employed, and may enable totally new functionalities. Non-reciprocity and topologically protected wave propagation will have profound implications on how stimuli and information are transmitted within materials, or how energy can be guided and steered so that its effects may be controlled or mitigated.

The presentation will introduce basic concepts that are based on the analysis of dispersion and its topology, and that govern the onset of localized, interface wave modes. Specifically, spring-mass systems, lattices, and plates with internal resonators will be presented as part of a framework which seeks for mechanical lattices that exhibit one-way, edge- bound, defect-immune, non-reciprocal wave motion. Helical edge waves are shown to be found within lattices that are composed of a set of disks connected through linear springs. Discrete one and two-dimensional spring mass lattices are investigated that support *nontrivial* bandgaps associated with backscattering suppressed edge waves. Finally, results are shown for a continuous plate with resonators which supports wave motion confined along the interface between two-media characterized by identical dispersion properties, yet different topological invariants.



(a) (b) (c)

Figure: Unit cell of a bilayer hexagonal lattice (a) featuring helical edge states shown in (b). Plate domain with an interface and traveling edge mode (c).

Bio

Massimo Ruzzene is the Pratt and Whitney Professor of Aerospace and Mechanical Engineering at Georgia Tech. He is author of 2 books, 135 journal papers and about 180 conference papers, and has participated to projects funded by the AFOSR, ARO, ONR, NASA, US Army, US Navy, DARPA, and NSF, as well as numerous companies. His work focuses on solid mechanics, structural dynamics and wave propagation with application to structural health monitoring, metamaterials, and vibration & noise control. M. Ruzzene is a Fellow of ASME, an Associate Fellow of AIAA, and a member of AHS, and ASA.