Physics of surface vibrational resonators: Pillared phononic crystals and metamaterials

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In this presentation, I will talk about the recent progress in pillared phononic crystals/metamaterials for topological states, energy harvesting, vibration reduction, et al. In the first part, we studied phononic crystal plates with pillars (regarded as mass-spring systems) deposited on a thin plate in honeycomb lattice. A double Dirac cone can be formed originating from the zone-folding effect of the band structures. A bandgap can be opened from the double Dirac cone when Kekulé distortion is applied to the lattice which contributes to a topological bound state. Robust energy harvesting against various perturbations is realized by attaching a piezoelectric patch at the center of the bound state. We further use neural network method to inverse design the opened bandgaps for realizing topological edge states. We also use the reinforcement learning to achieve the maximum bandgap width for beam’s longitudinal wave and predict the topological phases of bands. In the second part, we designed pillared seismic metamaterials consisting of pillars on a ground. With graded design, a wide Rayleigh wave attenuation frequency band is achieved. When introduce viscosity into the substrate, the attenuating effect will be significantly enhanced.

Reference
Dr. Yabin Jin currently is the Eastern Scholar Professor at Tongji University, China. He received two PhD degrees, from Tongji University, China and University of Lille, France in March 2017. He joined Tongji University in September 2018 after holding a postdoc position at the University of Bordeaux, France from April 2017 to August 2018. He leads a research group with 10 members studying elastic wave-structure interactions, mechanical metamaterials with multifunctional integration, and machine learning based inverse design. He published 28 papers as the first or corresponding author in well-known international journals including *Reports on Progress in Physics, Nature Communications, Physical Review B/Applied, Nanophotonics, Extreme Mechanics Letters, Mechanical Systems and Signal Processing*. He was an invited professor of the University of Lille in 2020, and was awarded Seal of Excellence by the European Commission (2018), Tongji Innovation Award (2018), Hundred Young Talents by Tongji University (2018), Pujiang Talent by Shanghai Government (2019), 1st Prize of Outstanding Young Scholar by the Shanghai Society of Theoretical and Applied Mechanics (2020).