

# Aerospace Seminar

## Professor Mostafa Nouh



### Dynamics of Periodic Media: Understanding the Evolution of Band Gaps in Finite Phononic Materials

Thursday, March 8, 2018 | Onizuka | 10:00 A.M.

The ability of mechanical structures to realize a wide array of functionalities is limited by the non-tunable and largely isotropic properties of its constituent materials. As a consequence, research in artificially architected materials has rapidly emerged. Specifically, there has been a spurt of activity addressing the use of Phononic Materials (PMs) which are synthetically formed by spatially arranging materials of different acoustic/elastic properties in a periodic pattern. The ability of PMs to provide solutions to challenging vibroacoustic challenges stems from their ability to manipulate incident waves across different length and time scales culminating in band gaps, or frequency ranges within which wave propagations are not permitted. Band gaps in PMs take place by virtue of different mechanisms, including Bragg scattering and local resonances in acoustic metamaterials. Owing to such unique dispersion attributes, the use of PMs opens up new avenues in vibration mitigation, wave cloaking, acoustic guidance, and refraction, to name a few. This talk focuses on the dynamics of finite periodic media in an attempt to understand, and further exploit, band gap phenomena in PMs. Despite their prediction in theoretically infinite systems, band gaps materialize in finite realizations of the phononic unit cells as demonstrated numerically and backed up by experimental evidence. The previous implies the presence of a set of adaptations in the dynamics of such systems, as they morph from homogenous to phononic materials, which explain the band gap formation at the finite level. Through a rigorous mathematical scheme, we show the morphing of the PM's pole-zero characteristics in the frequency domain as Bragg and resonance band gaps evolve and become noticeable. The analysis provides a unique interpretation of band gaps at the nexus of wave physics and systems theory and, as will be shown, bridges the gap between both in the limiting case. Finally, we briefly show a couple of examples on how such understanding changes the paradigm of informed phononic material design, enabling this class of periodic materials to reach its full, yet hidden, theoretical potential.



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