



Wave manipulation in metamaterials with nonlinear resonators

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This talk explores 1D and 2D metamaterials featuring a periodic arrangement of highly tunable infinite-dimensional resonators, such as cantilevers with tip masses and spider-web membranes. These resonator-embedded metamaterials exhibit distinctive dispersion characteristics, including the emergence of single and multiple band gaps. The sensitivity of these band gaps to key design parameters is examined. By harnessing tailored geometric and material nonlinearities, the resonators significantly enhance band gap behavior. Using a perturbation approach, we compute nonlinear wave frequencies and waveforms both near and away from internal resonances, showcasing remarkable nonlinear tunability -an essential attribute for advanced applications.

To validate our theoretical predictions, we experimentally test various 3D-printed metamaterial samples using 3D laser scanning vibrometry. The results reveal fascinating wave propagation properties and confirm the enhanced performance driven by nonlinear effects.

Biosketch of Walter Lacarbonara

Walter Lacarbonara is a Professor of Nonlinear Dynamics at Sapienza University and Director of the Sapienza Center for Dynamics. During his graduate education he was awarded a MS in Structural Engineering (Sapienza University) and a MS in Engineering Mechanics (Virginia Tech, USA), and a PhD in Structural Engineering (Sapienza/Virginia Tech). His research interests cover nonlinear structural dynamics; metamaterials and nanostructured composites; asymptotic techniques; nonlinear control of vibrations; experimental nonlinear dynamics; dynamic stability of structures. He is Editor-in-Chief of Nonlinear Dynamics, former Associate Editor for ASME Journal of Applied Mechanics, Journal of Vibration and Acoustics, Journal of Sound and Vibration. He served as Chair of the ASME Technical Committee on Multibody System and Nonlinear Dynamics, General co-Chair and technical program co-Chair of the ASME 2015 (Boston, USA) and 2013 (Portland, USA) IDETC Conferences. He has organized over 10 international symposia/conference sessions and, very recently, the 1st, 2nd, 3rd, 4th, and 5th International Nonlinear Dynamics Conferences

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His research is supported by national and international sources (EOARD/AFOSR, NSF, European Commission, Italian Ministry of Science and Education). He has published about 300 papers and conference proceedings, 7 international patents (EU/USA/China), 30 book chapters, 12 co-edited Springer books and a single-authored book (Nonlinear Structural Mechanics, Springer, NY, <https://link.springer.com/book/10.1007/978-1-4419-1276-3>) for which he received the 2013 Texty Award nomination by Springer US.