Name: Eleonora Tubaldi

Title: Assistant Professor

Institution: Department of Mechanical Engineering, University of Maryland, College Park

Short Bio

Dr. Tubaldi is Assistant Professor in the Department of Mechanical Engineering at the University of Maryland, College Park. She received her Ph.D. degree at McGill University in Mechanical Engineering. Her research interests sit at the interface of nonlinear dynamics, fluid-structure interaction, and soft materials for applications in mechanical metamaterials, soft robotics, and reconfigurable structures. Recently, she has been awarded the 2024 ASME Henry Hess Early Career Publication Award, 2023 NSF CAREER Award, and the 2020 Haythornthwaite Young Investigator Award from the ASME Applied Mechanics Division.

Title of Talk

Unlocking Mechanical Instabilities for Intelligent Material Design

Abstract

Biological systems exhibit remarkable capabilities for rapid actuation and energy-efficient motion, often leveraging mechanical instabilities such as buckling and snapping. These phenomena allow organisms to perform swift and powerful movements with minimal energy consumption. Examples include trap-jaw ants with mandibles that can snap with incredible speed and force, as well as bacterial flagella which revert their swimming direction thanks to flagellar buckling. Inspired by these evolutionary adaptations, sophisticated tasks such as delicate object manipulation, augmented sensing capabilities, and dynamic shape transformations can be obtained by designing reconfigurable structures with controlled buckling or snapping instabilities. In this talk, we will first present two novel instability-based metamaterials to (i) control transition wavefronts thanks to geometric frustration, and to (ii) preprogram reversible sudden reconfigurations with a single pressure input, respectively. Finally, rapid actuation and sensing capabilities will be demonstrated in “pac-man” grippers leveraging buckling instability of free thin-shell domes. Both theoretical, numerical, and experimental approaches will be discussed. Applications spanning from fast sequential actuation, flow control, wave manipulation, and tactile sensing will be showcased.