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Discontinuous compression structures: From tensegrity planetary landers to lightweight metamaterials

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ABSTRACT:

The term tensegrity, derived from tensional integrity, refers to a certain class of structural systems composed of bars and strings. Through adequate pre-stressing of their string members, tensegrity structures generally become mechanically stable. Traditional approaches for modeling their behavior assume that (i) bars are perfectly rigid, (ii) cables are linear elastic, and (iii) bars experience pure compression and strings pure tension. In addition, a common design constraint is to assume that the structure would fail whenever any of its bars reaches the corresponding Euler buckling load. In reality, these assumptions tend to break down in the presence of dynamic events. In the first part of this talk, we will introduce a physics-based reduced-order model to study aspects related to the dynamic and nonlinear response of tensegrity-based planetary landers. We will then adopt our model to show how, under dynamic events, buckling of individual members of a tensegrity structure does not necessarily imply structural failure, thus significantly expanding the design space for such vehicles. In the second part of this talk, we will show how lessons learned from our study of tensegrity planetary landers can be translated into to the development novel metamaterials. We will introduce the first known class-two 3D tensegrity metamaterial, and show that this new topology exhibits unprecedented static and dynamic mechanical properties.

BIOGRAPHY:

Julián J. Rimoli is the Department Chair and Henry Samueli Faculty Excellence Professor of Mechanical and Aerospace Engineering at the University of California, Irvine. He obtained his Engineering Diploma in Aeronautics from Universidad Nacional de La Plata, Argentina, in 2001. He received his M.Sc. and Ph.D. in Aeronautics from Caltech in 2005 and 2009 respectively. Upon graduation Dr. Rimoli accepted a postdoctoral associate position at the Department of Aeronautics and Astronautics of MIT, where he performed research for over a year and a half. He joined Georgia Tech in 2011, where until 2022 he was the Pratt & Whitney Professor of Aerospace Engineering. His research interests lie within the broad field of computational mechanics of materials and structures, with special interest in problems involving multiple length and time scales, and in the development of theories and computational techniques for seamlessly bridging them. He is a Fellow of ASME, an Associate Fellow of AIAA, and is the recipient of the NSF CAREER Award, the Ernest E. Sechler Memorial Award in Aeronautics, the James Clerk Maxwell Young Writers Prize, and the Class of 1940 Teaching Effectiveness Award.