Deployable and Inflatable Structures for Space Exploration, Astronomical Observation, and the Development of Advanced Technologies

Specific Seminar – Curriculum 6

March 12, 2025, 3 p.m.

Speaker:
Riccardo Augello - Department of Mechanical and Aerospace Engineering (DIMEAS), Politecnico of Turin

Abstract:
This advanced doctoral course provides a rigorous overview of deployable and inflatable space structures, with emphasis on the mechanics, materials, and verification methods required to realize large, lightweight systems that exceed launch vehicle fairing constraints. The course contrasts kinematic deployables (hinged, telescoping, tape-spring and boom-based architectures) with pneumatically deployed inflatables, framing both within a unified set of performance drivers: packaging efficiency, post deployment stiffness, dimensional stability, and robustness to space environmental hazards. Building on representative mission classes students will develop quantitative understanding of key phenomena that govern feasibility and reliability, including deployment dynamics, joint and contact nonlinearities, wrinkling and buckling of thin membranes, viscoelastic effects, thermal–structural coupling, and stability requirements.
The course will also cover material and subsystem selection (composites, high-performance fabrics and films, coatings and multilayer insulation, restraint and inflation systems) and will critically examine damage tolerance and risk mitigation strategies for micrometeoroid/orbital-debris impacts and radiation/thermal cycling. Finally, the course connects analysis to practice through qualification and validation pipelines, i.e. ground testing limits, gravity offload, deployment cycling, thermal-vacuum testing, and correlation of reduced-order and high-fidelity numerical models, using case studies (e.g., ISS expandable modules and large deployable observatories) to highlight best practices and open research problems. By the end, students will be able to formulate architecture trade studies, define verifiable requirements, and propose research-grade modeling and test campaigns for next-generation large deployable/inflatable systems.

Short Bio

Riccardo Augello is a Postdoctoral Fellow under the Marie Sktodowska-Curie Actions, which is a researcher mobility programme funded by the European Commission. Augello received his Ph.D. in Mechanical Engineering at Politecnico di Torino, Italy, in February, 2021. His research project focused on the development of advanced mathematical theories based on nonlocal mechanics for the geometrical nonlinear analysis of composite structures. Augello joined Caltech in March 2023 as a part of his European research project “NOnlinear analysis for VIrTual design of composite deployAble Space booms and membranes” (NOVITAS). The project aims to generate novel advances in the mathematical modelling of ultra-thin deployable and foldable composite structures.

Online attendance:

Information on remote participation can be requested by sending an e-mail to dn_sst@unitn.it

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