

**Prof. Daniele Mortari**

Professor of Aerospace Engineering  
Department of Aerospace Engineering  
Texas A&M University - 3141 TAMU- USA

### **"From Art to Science: The Flower Constellations Theory Evolution"**

This year the Flower Constellations theory celebrates its 16th birthday. Many years were needed to fully understand the implications and to develop the theory. This new satellite constellations design tool is now ready for applications. The theory introduces a new class of space objects characterized by shape preserving configurations where the whole constellation behaves as a rigid object. By using minimal parameterization (Hermite normal form) the 2D Lattice Flower Constellations allows to include all spatial and temporal symmetric solutions, while the extension to 3D Lattice allows designers to use any inclination when selecting elliptical orbits under  $J_2$  perturbation. Recently, the Necklace theory applied to 2D and 3D Flower Constellations exponentially increases the space of potential solutions while keeping limited the number of satellites and launches (costs).

The evolution of the mathematical theory is presented, showing some potential configurations to improve existing applications as well as configurations proposing new applications! The number of applications are many, including, positioning, communication, radio occultation, interferometric, and surveillance systems. In particular, the Flower Constellations theory allows to design conjunction-free constellations with many thousands of satellites and a new class of orbits/constellations, called  $J_2$  propelled systems, where the Earth oblateness perturbation is used (rather than control) to cover spatial volumes around the Earth to measure or monitor physical quantities.