July 2021

IAF ASTRODYNAMICS COMMITTEE

Latest Developments

The most notable trend is certainly the increasing application of artificial intelligence and machine learning techniques (deep learning, neural networks) across all astrodynamics subfields: in guidance, navigation and control in the context, for example, of proximity operations, reentry guidance and on-board orbit estimation; in mission design, operations and optimization to assist in the elaboration of large amounts of data when dealing with space security operations and decision making; in attitude dynamics for imaging-based attitude determination. Orbit design is highly focused on space surveillance (asteroid deflection) and small body missions (including comet flybys and missions to yet-to-be-discovered comets) also with smallsats or microsats, and efforts are devoted to the study of deep-space dynamical environments. The interest in the exploration of cislunar space, Mars (Mars sample return missions) and its moons has increased considerably. Trajectory design in multi-body systems has moved towards stability and perturbation analyses of spacecraft in quasi-periodic orbits, tori, distant retrograde orbits, near rectilinear halo orbits and co-orbiting configurations around the libration points. Guidance and orbit & attitude control methods for constellations and satellite swarms are in continuous development given the growing impact of this type of missions in geocentric orbit. Large, complex and transformable structures are studied from the point of view of autonomous control. Eventually, in the area of attitude control, the renovated focus is on passive (magnetic, aerodynamics) methods.

Breakthroughs (any highlight, recent news or innovations)

- Roscosmos announced the realization of a highly-inclined orbital station, whereas China's orbital station project is in progress.
- Russia and China announced a joined project for a lunar station.
- NASA/JPL continues to prepare a mission to explore of the Sun's gravitational lens as a mission target. This challenging plan requires new ideas of flight dynamics and navigation.
- Developments are expected in interplanetary mission design techniques on the basis of math-like invariant manifolds with extension to the four-body problem and in the area of station-keeping of multi-agent missions like formation flying with involvement of artificial intelligence.

Action plan for the year 2021

- Special Events: the 2021 Edition of the Breakwell Memorial Lecture 2021 will be imparted by Prof. Martín Lara from University of La Rioja (Spain)
- Samara State University will hold the XVI International Summer Space School "Future Space Technologies and Experiments in Space"