Dynamics and Control for Solar Sail Mission Application

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Solar Sails are a novel propulsion system that takes advantage of the Solar Radiation Pressure (SRP) to propel a spacecraft by providing it with large and highly reflecting membranes. The impact and further reflection of the photons emitted by the Sun on these membranes will accelerate the spacecraft. Although the acceleration given by the SRP is very small compared to a classical thruster, this one is continuous and unlimited. Which enables new and challenging mission concepts.

In this talk we will focus on the motion of a solar sail in the Earth-Sun system. As a dynamical model we use the Restricted Three Body Problem (RTBP), where we assume the Earth and Sun to be point masses orbiting around their mutual centre of mass in a circular way, and the satellite as a mass-less particle that is affected by their gravitational attraction but does not affect them. Moreover, we include the effect of SRP due to the solar sail, which depends on three parameters: β the sail lightness number, that represents the sail efficiency, and two angles α, δ, defining the sail orientation.

We will describe the different invariant objects in the system: equilibrium points, periodic and quasi-periodic orbits. Showing how they vary when we change the parameters of the system. We will also focus on the practical application of these invariant objects for different mission applications. Moreover, we will describe how to use the information on the dynamics of the system to derive simple station keeping strategies to remain close to unstable equilibrium points and periodic orbits.