ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations and Optimization - Part 2 (2)

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MISSION DESIGN AND ANALYSIS OF EUROPEAN ASTROPHYSICS MISSIONS

Abstract

Understanding the history and evolution of our universe in general and of stellar and planetary systems in our Galaxy requires the collection of photons in all wavelength bands utilising high-performance space observatories. Those observatories require a benign environment in order to achieve the required performance. The environmental requirements typically constrain stray-light, thermal, and dynamic parameters. In order to fulfil the different environmental requirements of these missions, the diversity of the family of libration orbits around the night-side co-linear Lagrange point L2 of the Sun-Earth three-body system is exploited. Here a general overview is given of that diversity and how it is mapped to the conditions at the perigee for transfers with and without deterministic manoeuvres. Free transfers always lead to large-amplitude orbits around L2, their properties (amplitudes, phases, non-linear behaviour) are related to the conditions at perigee. Launch scenarios with different degrees of freedom in the perigee geometry and different strategies of sharing the apogee raising between launcher and spacecraft propulsion for Soyuz (with circular parking orbit or direct injection) and Ariane 5 launches from French Guiana will be discussed. Besides the orbit selection and transfer analysis, an important aspect of libration missions is the maintenance of the operational orbit. For some missions it is required to maximise the time between maintenance manoeuvres, and for some the thrust authority is limited. In both cases the exponential nature of the state transition matrix has to be considered. If the equivalent velocity error in the unstable direction becomes too large, the orbit can become unrecoverable, leading to a departure from the environment of the Lagrange point within a few months. Here an analysis of the predictability of a libration orbit with controlled velocity in the unstable direction is also presented.