Paper ID: 43999
oral

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimization (2) (9)

Author: Dr. Ariadna Farres
NASA Goddard/University of Maryland, Baltimore County (UMBC), United States

Mrs. Cassandra Webster
National Aeronautics and Space Administration (NASA), Goddard Space Flight Center, United States

WIDE-FIELD INFRARED SURVEY TELESCOPE AND STARSHADE FORMATION FLYING DYNAMICS AT SUN-EARTH L2

Abstract

The Wide-Field Infrared Survey Telescope (WFIRST) is a NASA observatory designed to answer questions about dark energy and astrophysics. Planned for a launch in 2025 to an orbit around the Sun-Earth L2 (SEL2) Libration Point, WFIRST will use a 2.4 meter mirror along with Wide-Field and Coronagraph Instruments to achieve its mission objectives. While the primary objective using the Coronagraph Instrument (CGI) is to search for exoplanets, the use of an external occulter such as a Starshade would make the detection of Earth-sized planets in habitable zones of nearby stars possible.

In this Formation Flying concept, WFIRST will remain in its baseline mission orbit about SEL2. Starshade will be offset from WFIRST's orbit, and must fly a specific trajectory to align itself with WFIRST in order to occult a set of pre-determined target stars given by a notional Design Reference Mission (DRM). With Starshade occulting the target stars, the CGI on WFIRST will observe nearby exoplanets that would otherwise be unseen. The challenges of these formation alignments at SEL2 include achieving the observation locations with respect to WFIRST for each target star, maintaining alignment during the observations while at a nominal 37,000 km away from each other, while also managing the unstable SEL2 environment. Starshade will essentially operate like a hybrid solar sail and will undergo large perturbations due to Solar Radiation Pressure (SRP) which will affect the Delta-V (ΔV) required for operations. Orbit maintenance maneuvers will be required in order to keep both WFIRST and Starshade in the SEL2 environment.

In this paper we want to analyze the total ΔV of the WFIRST and Starshade formation flying mission concept. We will focus on both the transfer from one observation to the other, and the maintenance of the formation during observations. As both spacecraft have different area-to-mass ratios, SRP plays an important role on the total ΔV cost, and must be taken into account. Moreover, their relative position along the orbit also has an important effect. We will start our analysis considering the Restricted Three Body Problem (RTBP) including SRP as a model. This will enable us to have a better understanding of the dynamics and the invariant objects that play a role on the WFIRST and Starshade formation flying mission concept. Finally, we will extend this analysis to a higher fidelity model using a commercial software to compare and verify the results.