Alpha Centauri Exoplanet Satellite (ACESat): Heliocentric Orbital Design.

Abstract

The existence of an Earth-like exoplanet is of particular interest to the scientific community. Missions such as Kepler and Transiting Exoplanet Survey Satellite (TESS) are unable to measure a planet's spectra, and the observed candidates are too far away for biomarkers to be detectable with foreseeable technology. From recent Kepler data, it is estimated that Alpha Centauri, our closest star system, has a 40-50% chance of supporting a habitable Earth-like planet around each star. It is also the easiest location to search for Earth-like planets due to its close proximity to us. This has motivated the study and design of a coronagraph to look for habitable Earth-like planets around Alpha Centauri by Rus Belikov and Eduardo Bendek, called ACESat.

This paper describes the optimization of the interplanetary trajectory for ACESat to meet project objectives given design and implementation constraints. Specifically, design trades involving instrument stability, maximum range between the spacecraft and Earth after mission lifetime and launch availability have been studied. A heliocentric orbit similar to Kepler and Spitzer is most desirable due to its uninterrupted stare time to the southern portion of the equator, stable thermal environment and minimal required station keeping. The driving parameter for mission success centers on the pointing stability of the instrument, with a less than 10 arc second maximum deflection, however the instrument also has a stringent thermal requirement for proper functionality. Since this particular orbit does not experience eclipses and has a consistent thermal environment, it is most favorable for meeting science requirements. Also, the maximum Earth-spacecraft range after three years is bounded at 0.5 AU for communication requirements, depending on launch availability. ACESat can potentially fly as a secondary payload on the Evolved Expendable Launch Vehicle (EELV) riding up to Geostationary Transfer Orbit (GTO) before performing a heliocentric orbit insertion burn, obtaining the desired trajectory with minimal cost.

In order to search for life outside of the solar system, the trajectory design of such a mission must undergo multiple iterations and trades to ensure accurate detection capabilities of the coronagraph. ACESat will inevitably increase our understanding of planetary formation and binary star systems.