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DESIGN OF THE EXTENDED MISSION FOR THE RELAY SATELLITE OF CHINA'S CHANG'E-4
MISSION TO VISIT EARTH-MOON TRIANGULAR LIBRATION POINT REGIONS

Abstract

China plans to launch the world's first soft-landing craft, Chang'E-4, on the lunar far-side in 2018. To facilitate the communications between the landing craft and ground stations on Earth, a relay satellite will also be launched in advance. The relay satellite will be put into a halo orbit around the Earth-Moon L_2 libration point with an expected mission lifetime of about 3 years. Apart from the transponders necessary for TT&C and a scientific payload developed in cooperation with the Netherlands, the low-frequency radio detector, the relay satellite is also equipped with an imaging camera. In view of possible residual fuel at the end of the nominal mission onboard the relay satellite, an extended mission design concept for the relay satellite is discussed in this paper, which proposes a visit to the Earth-Moon triangular libration point (TLP) regions.

The Earth-Moon TLP regions have long been of great interest to both astronomers and engineers alike. The speculations of possible "Trojans" in these regions are frequently found in the literature. Nevertheless, the Japanese explorer Hiten flying past the proximity of TLPs in the 1990s and the recent imaging of this region by American OSIRIS-REx spacecraft on way to asteroid Bennu both obtained null results. In addition, from an engineering point of view, proposals to utilize these vantage points to carry out deep space interferometry experiments are promising. However, no dedicated spacecraft has ever been flown to these regions and made in-situ observation and exploration of the environment. This paper first shows the design in the real ephemeris model of feasible low-energy transfer trajectories from the halo orbit of the relay satellite's nominal mission to the TLP regions. Preliminary considerations of mission operations and observation strategies are then discussed. The recently discovered stable orbits in the literature around, though a bit far away from, the TLPs, will be the main target of the imaging camera to confirm whether they might possibly host small bodies. If successfully carried out, this extended mission will for the first time explore the Earth-Moon TLP regions "on the spot" and hopefully conduct detailed survey of their physical environment to enable future utilization of the assets.