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LOCATION AND STABILITY OF DISTANT RETROGRADE ORBITS AROUND THE MOON

Abstract

Recently has grown the interest of placing natural or artificial objects in the neighborhood of the Moon. We numerically investigate a region of retrograde orbits around the Moon associated with the C Family of periodic orbits and the quasi-periodic orbits that oscillate around them (Broucke,1968; Winter, 2000). We have given continuity to Winter (2000) investigations by introducing a more realistic dynamical scenario, one based on the four-body Sun-Earth-Moon-particle problem. Our results showed that the region of stability diminished to approximately 4% the original size encountered for the CRTBP, mainly due to the Sun's gravitational field. Nonetheless, the size of the region continues to be significant and we were able to found DROs around the Moon with eccentricity following $e = 2.25963 \times 10^{-6} a + 0.23845$ (standard error of 1%) and semi-major axis values of the initial osculating orbits, varying between 110,000 and 185,000 km, remaining stable for a timespan of 104 lunar periods. This set of distant orbits from the Moon are characterized by a narrow range of acceptable initial positions (0.8-0.83) and velocities of about 0.5, in the rotating Earth-Moon frame. The out of plane amplitude oscillations of about 15,000 km presented by these DROs are a natural outcome of the significant Moon's inclination of 5.15 degrees. Some results presented on this work can be useful for lunar missions, such as the ones that would require prolonged stays around the satellite and use stable distant orbits as "parking" orbits, such as the advanced concepts of NASA's Asteroid Redirect Mission, proposed a few years ago.

References

Broucke R. A., Periodic orbits in the restricted three-body problem with earth-moon masses, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, 1968.

Winter O. C., The stability evolution of a family of simply periodic lunar orbits, Planet. Space Sci., 48, 23, 2000.