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SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

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THE ORBITAL DYNAMICS OF ADVANCED PLANETARY OBSERVATION SYSTEMS

Abstract

Technical developments in electric low-thrust propulsion systems are enabling a wide range of pioneering space applications previously infeasible using conventional high-thrust propulsion. Recent research has considered the use of low-thrust propulsion for the extension of Earth orbits, for example extending Sun-synchronous orbits to enable the free selection of orbit inclination and altitude. Within this work, the thrust magnitude required is not defined as a function of the local gravity field but instead by the magnitude of the perturbations within that field, augmenting the Earth oblateness perturbation to modify the Sun-synchronous orbit. This principle of using low-thrust propulsion to modify the perturbations has also been applied for the extension of Highly Elliptical Orbits (HEOs), with particular focus on Molniya-like orbits. These novel Earth orbits use continuous low-thrust propulsion to alter the critical inclination to any inclination required to optimally fulfil mission objectives whilst maintaining the zero change in argument of perigee condition essential to a Molniya-like orbit. As such, the inclination can be modified to give an inclination of 90 degrees, allowing improved observation of high latitude regions. Within this work the methods described are applied to investigate the development of orbits around other planetary bodies, to enhance remote sensing opportunities. For example at Mercury, where the reciprocal of flattening is so low that natural perturbations are of no use for generating Sun-synchronous orbits, continuous low-thrust propulsion may be used to generate these orbits where they otherwise may not be possible. As Sun-synchronous orbits allow near constant illumination conditions they are beneficial for remote sensing applications. This work therefore creates additional planetary observation opportunities providing more accurate data of the lesser-explored planets in the Solar System. In addition to enabling 'natural' orbits around other planetary bodies, low-thrust propulsion is also considered to extend existing orbits around, for instance, Venus and Mars to increase the number of vantage points and enable more accurate observations. One such example would be to enable HEOs inclined at 90 degrees to allow improved studies of Venusian and Martian Polar Regions.