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MODELLING AND STABILITY ANALYSIS OF GENERIC NON-KEPLERIAN ELLIPTIC ORBITS FOR SOLAR SAILS WITH REFLECTION CONTROL DEVICES

Abstract

Using the reflectivity control technology to generate non-Keplerian orbits for solar sailing has been investigated for several years. Based on this propulsion technology, this paper presents a new approach to design generic elliptic displaced orbits in sun-centered two-body problem. To univocally describe the sail's motion, a mathematical model has been established in the new synodic reference frame and every stationary point to the dimensionless dynamical model represents an elliptic displaced orbit in the sun-centered inertial reference frame. Two novel types of sun-centered elliptic displaced orbits have been discussed in some detail and the histories of the sail's desired parameters for generating corresponding elliptic displaced orbits can be obtained by algebraic equations. Taking into account the sail's near-term performance, the maximum lightless number is assumed for a solar sail to seek all elliptic displaced orbits generated by it. The set of the allowed orbits corresponds to an allowed region in the phase space. Additionally, the local stability of the elliptic displaced orbits in the allowed region is discussed with the use of linearization technique and Floquet theory. The result indicates the allowed region can be divided into stable region and unstable region. Compared with the previous studies, this work finds a different conclusion that a part of solar sail elliptic displaced orbits are unstable. Moreover, the generic elliptic displaced orbits proposed in this paper extend the previous concept of elliptic displaced orbits. Based on the new mathematical model, the concept of the patch problem of elliptic displaced orbits can be discussed in future work.