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THE DISPOSAL STRATEGY FOR BEIDOU INCLINDED GEOSYNCHRONOUS SATELLITE ORBITS

Abstract

It's well known that satellite orbits with the inclination around 56° can be highly unstable because of the overlap of secular resonances of lunisolar perturbations. Our former studies on Beidou inclined geosynchronous satellite orbits (IGSO) showed that the orbital eccentricity can be stimulated from nearly zero to almost 0.85 in 200 years. This long-term instability of orbits brings both negative and positive effects to the end-of-life disposal of satellites with inclined orbital planes. In this paper, two well-known disposal methods, namely graveyard orbits and re-entry orbits, are investigated for Beidou IGSO.

To find suitable values of initial phase angles, namely the ascending node Ω_0 and the argument of perigee ω_0, for the graveyard orbits of Beidou IGSO, the maximum eccentricity maps in 200 years are plotted for different values of orbital altitude and inclination. The results obtained by the semi-analytical propagator show that the stable window where the eccentricity growth is not excessive in 200 years is mainly located at $(\Omega_0 = 0, \omega_0 = 0)$. Moreover, the candidates of graveyard orbit provided by the stable window are propagated again by the accurate numerical method within 600 years. In this way, the graveyard orbits which are stable within 600 years can be selected.

The search practice for the fastest re-entry orbit with minimum fuel cost for a target satellite is formulated as a multi-objective optimization problem by Armellin et al. This problem can be solved with a semi-analytical orbit propagator and an evolutionary algorithm. Here, we use the same method to search the re-entry orbits for seven operational Beidou IGSO. The re-entry times and fuel costs of optimal solutions are presented in the form of Pareto front, by which we investigate the solutions' dependence on the initial phase angles, namely ω_0 and Ω_0, and the configuration of the Earth-Moon-Sun system. The change of the orbital elements due to the manoeuvre are presented, which show both agreement and difference with the Galileo case. The ephemeris of re-entry orbits is investigated to show the roles of five resonance angles in the growth of orbital eccentricity. The transport along the dynamical backbone of phase space is detected. At last, we investigate the stability of re-entry orbits by studying the divergence of nearby orbits.