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TRANSITION IN ORBITAL RESONANCE IN INCLINED GEOSYNCHRONOUS ORBIT AND THE IMPLICATION ON ITS LONG-TERM EVOLUTION

Abstract

Under the perturbation of lunisolar gravitation, the orbit inclined around 55 degrees undergoes various complex secular resonances. Previous studies have shown that this effect has significant impact on the 12-hour GNSS satellite orbits, as well as BDS (BeiDou Navigation Satellite System) 24-hour Inclined Geosynchronous Orbit (IGSO), all of which are inclined around 55 degrees. As a result, these orbits will have increasing eccentricities in decades.

For BDS IGSO, the eccentricity can reach as large as 0.85, making the decommissioned satellite reenter the atmosphere. It is shown that the fastest decay takes place around 120 years. For some more stable cases, the decommissioned satellite is trapped in a stable equilibrium state, however, the eccentricity still gradually increases. The increasing eccentricity increases the short period variation in the semi-major axis and affects the orbital resonance, induced by the tesseral terms such as J_{22}, between the semi-major axis and the longitude. A possible consequence of the increasing short period variation is that the satellite, once trapped around one stable equilibrium of the orbital resonance, may escape from such state and transit to another stable equilibrium.

The interaction between the secular resonance and orbital resonance represents a typical chaotic behavior. The implication on the long-term evolution is twofold. One is that the decommissioned satellite may wander in the longitude and becomes a threat to other operational satellites. The other is that the chaos implies sensitivity to initial conditions. In certain cases, small errors in the initial values may lead to unexpected transition at certain point in the future. Simplification in the dynamic model for long-term simulation is also possible to cause distinct evolutions.

Here in this presentation, we report such transition in orbital resonances in BDS IGSO. This is common when the eccentricity is large enough. Moreover, for special cases, we find distinct patterns when the dynamic model is simplified in long-term evolution. We will discuss this effect and whether this chaotic behavior can be suppressed by complying with the IADC recommendation at their end of life.