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ON THE MOTION OF 12-HOUR SATELLITES IN NEAR CIRCULAR ORBITS

Abstract

The motion of 12-hour satellites in near circular orbits is studied in this paper. The 2/1 orbital resonance problem is discussed in detail. A simplified orbital resonance model is established, whose Hamiltonian contains three resonant terms arising from the tesseral harmonics J_{32}, J_{44} and J_{52} of the Earth's gravitational field. This model can be applied to 12-hour satellites in near circular orbits with arbitrary inclinations. The two-dimensional phase planes of the simplified orbital resonance problem with J_{32}, J_{44} and J_{52} for 12-hour satellites in near circular orbits with different inclinations are investigated theoretically. It is found that there are two topologically different types of two-dimensional phase plane in principle; the satellites with their inclinations in the range of about $(67°, 74°)$ should have two libration centers and they can move in the double libration pattern around these two libration centers, which are markedly different from the Global Positioning System satellites, but their phase plane structures are not robust and crash easily under the effect of the Earth's actual gravitational field for their libration regions are narrow. Moreover, it is seen that the conventional ideal resonance model with J_{32} only can not be applied to 12-hour satellites in near circular orbits with their inclinations in the range of about $(67°, 74°)$ for their principal resonant term is J_{44}. The specific values of some main resonance characteristics including equilibrium points and the maximum libration half width of the uncontrolled Global Positioning System satellite are also given. The long-period variation of the inclinations of 12-hour satellites in near circular orbits is analyzed based on the Allan and Cook's theory. The variation amplitudes and periods of the inclinations are further presented and verified through long term numerical integrations.