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ORIGINAL ARTICLE

Resonance in a geo-centric satellite due to earth's equatorial ellipticity

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Abstract The resonances in a geocentric satellite due to earth's equatorial ellipticity have been investigated. The resonance at five points resulting from the commensurability between the mean motion of the satellite and the earth's equatorial ellipticity is analyzed. The amplitude and the time period of the oscillation have been determined by using the procedure of Brown and Shook. A comparison of their effects on the orbital elements has also been studied. It is observed that the amplitude and the time period of the oscillation decrease as Γ (angle measured from the minor axis of the earth's equatorial ellipse to the projection of the satellite on the plane of the equator) increases in the first quadrant for all the resonance cases.

Keywords Geo-centric satellite · Geo-stationary satellite · Earth's equatorial ellipticity

1 Introduction

Satellite orbits resonant with respect to the perturbing influence of the Earth gravitational field have been extensively studied in recent years. The motion of an artificial satellite is effected by various forces, some of which are the earth's gravitational field, atmospheric drag, solar radiation pressure, the lunar and solar gravitational fields, relativistic effect and the Poynting Robertson drag.

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The literature is extensive with works dealing with the subject of resonance in satellite orbits. Sehnal (1959) discussed the influence of the equatorial ellipticity of the earth gravitational field on the motion of a close satellite. The method of variation of constants is applied to discuss the perturbation of angular elements. It is shown that the amplitude of the short-periodic terms is about 20 seconds of arc and by the long-periodic terms about one order higher. The long-periodic terms arise through the commensurability of the motions of the satellite and the Earth.

Blitzer (1966) discussed the motion of a satellite under the influence of the longitude-dependent terms of the geopotential in a frame of reference rotating with the mean motion of the satellite. He has explained the resonance effects on the satellite orbits with the geopotential.

Gedeon (1969) has studied the whole spectrum of orbits with respect to tesseral resonance effects on satellite orbits. Resonance effects have been noted on eccentric synchronous and subsynchronous orbits and on orbits with far from commensurate periods.

Garfinkel (1982) has surveyed the problem of resonance in Celestial Mechanics. His main contribution to the methodology is the formation and the solution for the ideal resonance problem. If the resonance is simple, all the singularities in the solution are removed by means of regularizing function. On the other hand if the resonance is doubled, the second critical divisor seems irremovable and a global solution may be precluded. The problem of resonance as it arises in the various cases on the motion of a satellite has been studied by Bhatnagar and Gupta (1977). They discussed the resonance in the motion of an artificial earth satellite caused by solar-radiation pressure. The Hamiltonian and the generating functions occurring in the problem are expanded in the power series of small parameter β, which depends on solar radiation pressure.