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ORIGINAL ARTICLE

Resonance in the earth-moon system around the sun including earth's equatorial ellipticity

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Abstract We have investigated the resonances in the earth-moon system around the sun including earth's equatorial ellipticity. The resonance resulting from the commensurability between the mean motion of the moon and Γ (angle measured from the minor axis of the earth's equatorial ellipse to the projection of the moon on the plane of the equator) is analyzed. The amplitude and the time period of the oscillation have been determined by using the procedure of Brown and Shook. We have shown the effects of Γ on the amplitude and the time period of the resonance oscillation using the data of the moon. It is observed that the amplitude decreases and the time period also decreases as Γ increases from 0° to 45°.

Keywords Earth-moon system · Earth's equatorial ellipticity · Resonances

1 Introduction

Resonance problem occurs frequently in nonlinear mechanics and celestial mechanics. Resonance may be described as a set of cases in which the periods of revolutions are in the ratio of two small integers. Resonance problems are usually manifested by the appearance, when integrating the equations of motion, of small divisors. The literature on the subject is extensive.

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Cook (1962) has investigated the effects of the gravitational attractions of the Sun and Moon on the orbital elements of an Earth satellite using Lagrange's planetary equations.

Expressions for the rate of change of the orbital elements averaged over one revolution are obtained. The author has identified fifteen resonance families and labeled them as numbers.

Hughes (1980) has discussed earth satellite orbits resonant with respect to lunisolar gravity and direct solar radiation pressure perturbations with particular reference to those resonances the occurrence of which is dependent only on the satellite's orbital inclination. All types of lunisolar resonance orbits are first classified in terms of the general commensurability condition which is then expressed as a function of the non-angular elements of the satellite's orbit and certain parameters of the perturbing forces. Criteria for determining the existence of the resonances dependent only on inclination are also found.

Breiter (1999) has studied the lunisolar apsidal resonances between the secular motion of an Earth satellite's orbit and the longitudes of the Sun and the Moon within a Hamiltonian framework. He has also analyzed the prograde C7 resonance for the Earth satellites as a member of the numerous family identified by Cook (1962).

Breiter (2000) has discussed the prograde C7 resonance within a simple model to meet the simplicity standard of Cook (1962) and to provide a brief description for the entire family. The resonance C7 is eccentricity (apsidal) resonance between the longitude of a satellite's pericentre and the mean longitude of the Sun. The resonance C7 is the strongest of the lunisolar apsidal resonances. After the reduction to a single degree of freedom, the problem is studied qualitatively for the prograde orbits around the Earth and Mars. Pitchfork, Saddle-node and saddle connection bifur-