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ON THE APPROXIMATION OF GRAVITATIONAL FIELD OF A DYNAMICALLY SYMMETRIC RIGID BODY BY TWO BALLS

Abstract

We study a dynamically symmetric homogeneous rigid body and examine a possibility to approximate its gravitational field by that of two homogeneous balls. The criterion choosed is that, for the original body and its approximation, the components of the Euler-Poinsot tensor up to the third order should coincide. The developed approach is applied to analysis of three almost dynamically symmetric asteroids, namely, (2063) Bacchus, (216) Cleopatra, and (433) Eros. This approach makes it possible to systematically apply methods for studying the libration points for uniformly rotating and precessing dumbbell-shaped bodies, developed in the works of V.V. Beletsky and A.V. Rodnikov [1-3].

In the 1960s, approximation of the attraction potential of an arbitrary dynamically symmetric body was mostly done using the attraction potential of a pair of material points. A method for such an approximation was proposed in [4-10]. It turned out that for oblate bodies the respective dumbbell should be extended into the complex region and equipped with complex masses.

Such approximation is of special interest because the problem of the motion of a point in the field of two fixed attracting centers is fully integrable. Its study was carried out by V.M. Alekseev [11]. In the case, when the points are replaced by homogeneous balls, the approximation still remains valid, but allows one to study the problems of dynamics for a larger class of motions, when a dynamically symmetric asteroid performs a double-frequency precession.

References

[1] Beletsky V.V. Generalized restricted circular three-body problem as a model for dynamics of binary asteroids. Cosmic Research. 2007. Vol.45. No.5. P.408 – 416.

[2] Beletsky V.V., Rodnikov A.V. Stability of triangle libration points in generalized restricted circular three-body problem. Cosmic Research. 2008. Vol.46. No.1. P.40 – 48.

[3] Rodnikov A.V. Triangular libration points of the generalized restricted circular problem of three bodies for conjugate complex masses of attracting centers. Rus. J. Nonlin. Dyn., 2014, vol. 10, no. 2, pp. 213 – 222.

[4] D. Kislik, "Motion of a Satellite in the Earth's Normal Gravitational Field," in: Artificial Earth Satellites (Izv. Akad. Nauk SSSR, Moscow, 1960), Issue 4, pp. 3–17 (In Russian).

[5] P. Aksenov, E. A. Grebenikov, and V. G. Demin, "The Generalized Problem of Motion About Two Fixed Centers and Its Application to the Theory of Artificial Earth Satellites," Astron. Zh. 40 (2), 363–375 (1963) [Sov. Astron. 7 (2), 276–282 (1963)].

[6] V. G. Demin, Motion of an Artificial Satellite in an Eccentric Gravitation Field (RKhD Press, Izhevsk, 2010) (In Russian).

[7] Vinti J.P. Theory of an accurate intermediary orbit for satellite astronomy. Journ. Res. Nat. Bur. Standards. 1961. Vol.B65. No.3. P. 169 – 201.

[8] Brower D., Clemence G. M. Methods of Celestial Mechanics. N.Y.: Academic Press. 1961. 620 p.

[9] V. G. Demin, Motion of an Artificial Satellite in an Eccentric Gravitation Field (RKhD Press, Izhevsk, 2010)(In Russian).

[10] Beletsky, V. V. (2001). Essays on the motion of celestial bodies. Springer Science & Business Media.

[11] V.M. Alexeev, Generalized three-dimensional problem of two fixed centers of gravitation-a classification of movements, Bull. Inst. Theoret. Astron. 10 (1965) 241–271.