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APPLICATION OF BROUWER-LYDDANE AVERAGING METHOD TO ORBITAL DYNAMICS IN THE GRAVITATIONAL FIELD OF SMALL BODIES

Abstract

The detection on small bodies has been more and more important in modern astronautics because of its unique value in technology and astronomy. The analysis on the orbital dynamics in the near-regime gravitational field of small bodies is a great challenge. However, traditional method usually can not provide analytic solutions of the orbit.

In this paper, Hamiltonian mechanics method which Brouwer used in the orbit around the earth is the main tool which is usually used in the gravitation of the earth apart from the traditional method which is to solve differential equations established by spatial coordinates through celestial mechanics. Due to the unique properties of the small body such as its small mass, irregular shape and complicated self-rotation, the difference is that the tesseral harmonics is the main influence besides the zonal harmonics which are generally ignored in the earth. Since this paper aims to study the orbit perturbation around the small body, spherical harmonics model is used to simulate the gravitation of the small body. Then we can build the disturbing potential function and Hamilton's function imitated that in the earth.

Then, the detailed steps are taken to study the orbital dynamics. Firstly, establish Lagrange orbit dynamic formulas and change them into Hamilton's canonical equations by replacing orbit elements with Delaunay variables. Then, two variable Canonical transformations based on the lie series are used to eliminate angle variables l and g separately in order to reduce the order of Hamilton's function. Finally, six variables have been calculated and divided into secular term, long period term and short period term. The analytic solutions of orbital elements can be got which can reveal the properties of orbital dynamics around the small body directly.

With the foundation of these calculations, a typical small body is chosen as an example in this paper and the properties about the equilibrium points and frozen orbits of it are analyzed then. At the end of the paper the results are compared with that calculated in traditional method.