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LIE TRANSFORMATION METHOD APPLIED TO COLLINEAR EQUILIBRIUM SUBSTITUTES IN ELLIPTIC THREE-BODY PROBLEM

Abstract

Deprit and Hori derived an useful Lie transformation based on the simple idea that the solution of a Hamiltonian system is naturally a symplectic transformation. Meyer et al. (2009) gave a detailed description of this method and also demonstrated its application to the Circular Restricted Three-Body Problem (CRTBP). Duffy (2012) extended the classical one-parameter Deprit-Hori method into a two-parameter one, which is also applicable to a nonautonomous system. Then he analyzed the linear and nonlinear stability of the stability of the triangular point in the Elliptic Restricted Three-Body Problem (ERTBP), where his results consisted with existing results of those of Danby (1964), Alfriend (1968, 1969) and other researchers. This method is promising and it could be modified to be adaptable to the collinear point, which seems more appealing in practical space missions.

Although numerical methods were mature and powerful enough to help designing missions like ARTEMIS or DSCOVER, analytical method can accelerate calculations and provide more insights into the natural dynamics behind. Lindstedt-Poincaré (L-P) method had been utilized to construct libration point orbits (and its manifolds) in the CRTBP (Masdemont, 2005), and as well in the ERTBP (Hou and Liu, 2011; Lei et al., 2013). Lie transformation handles the problem from another point of view. It is directly based on the canonical transformation, so the resulted series solution can be treated as a local integral. Also, as shown by Duffy, it was easy to incorporate a continuous control into the system. What's the most important is that this promising method is less concerned in the field of spacecraft trajectory design. The authors would like to present an analytical approximation of the motion around the libration point region in the ERTBP. The results will be compared with that of numerical calculation and the classical L-P method. The Sun-Mercury system, whose eccentricity of the orbits is about 0.2056, will be used to demonstrate potential applications of this method to design a periodic orbit around the libration point region.