

Station keeping in a binary asteroid system

M.Y. Morimoto (1) and H. Yamakawa (1)

(1) Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency, Japan
(mutsuko@isas.jaxa.jp)

Recently, an enormous number of asteroids has been discovered and observed in detail. Some of them have satellites and are called "binary asteroids". This paper describes orbits nearby such binary asteroids. With low thrust acceleration, a spacecraft is kept in a certain region relative to primary and secondary masses of a binary asteroid system and it orbits about those positions periodically; this is called "station keeping" control.

This paper assumes the restricted three-body problem (R3BP) to generate periodic orbits. In this problem, the motion of a negligible mass (i.e., spacecraft) moving under the gravitational influence of two primary masses is described. The two masses are assumed to have circular orbits about their common center of mass and to gravitationally attract the spacecraft although the spacecraft does not affect the two masses. Here we use a rotating frame, in which the two primary masses are fixed on x axis.

In the R3PB, there are five equilibrium points known as "Lagrange points", each of which is in equilibrium between gravitational forces of two primary bodies and centrifugal force in the rotating frame. To keep spacecraft at arbitrary points, continuous acceleration is applied to cancel the gravitational forces of the two primary bodies and the centrifugal force. Therefore, this study utilizes low thrust propulsion systems to generate periodic orbits. By continuous low thrust acceleration, various types of periodic orbits are constructed.

Required acceleration of periodic orbits with low thrust is dependent on the mass ratio and orbital parameters such as distance between two masses and orbital periods of secondary masses. Orbital elements of secondary bodies are well known by observations; however it is still difficult to determine exact masses of primary and secondary bodies. Therefore, this study assumed general binary asteroid systems. We can define various binary asteroids by setting these parameters and then analyze various periodic orbits in these binary systems. These analyses are useful to consider mission design and in-situ observation plans of binary asteroids.