DYNAMICS AROUND LIBRATION POINTS IN THE BINARY ASTEROID SYSTEM

Xiyun Hou[(1)]**, Xiaosheng Xin**[(1)]**, and Lin Liu**[(1)]

[(1)] *School of Astronomy and Space Science, Nanjing University, Nanjing, Jiangsu, China, 86-25-89687563, silence@nju.edu.cn*

Abstract: *The binary asteroid system is an interesting phenomenon in the asteroid population. They may come from a single asteroid by breakup events caused by thermal effects, gravitational tides, or by colliding with each other. Generally, there is a strong coupling between the mutual orbit and the rotations of the two asteroids. Some observed binary asteroid systems have evolved into synchronous or double synchronous state. In this contribution, we'll study the dynamics of libration points in a binary asteroid system which is trapped in the synchronous state. That is, we'll assume a primary with a shorter rotation period than the orbital period and a secondary with a rotation period same as the orbital period. The tri-axial ellipsoid model will be used for the two asteroids. We'll first study the existence of libration points, and then the stability of the motions around these points. Generally, the dynamical equilibrium points no longer exist in this system. However, special quasi-periodic orbits with two basic frequencies (one is the rotational period of the primary, and one is the orbital period) exist around the geometrical libration points of the corresponding restricted three-body problem (RTBP) of this system. These orbits are usually called dynamical substitutes (i.e., instantaneous equilibrium points) in literature. Depending on the size of the asteroids and the mutual distance, these orbits may reside inside the asteroids. This causes their non-existence in practice.*

As a first step to this problem, we'll study the orbit-rotation coupling problem of the synchronous system. A mutual potential truncated at the second order will be used. Assuming primary axial rotations, analytical solution of the mutual orbit along with the rotations truncated at the second order can be obtained. Next, we'll use this analytical solution to get the dynamical substitutes of these libration points, also truncated at the second order of the non-spherical terms. The effects of higher order non-spherical terms will also be discussed via the numerical approach. We'll integrate the mutual orbit with mutual potential truncated at high orders. Then we'll numerically compute the dynamical substitutes also via the numerical approach. The results will be compared with the analytical results truncated at the second order. A heuristic opinion at the current stage is that the non-spherical terms have negligible effects unless the two asteroids are very close to each other. There are two special cases: (1) the primary asteroid is a spheroid and the secondary asteroid is a tri-axial ellipsoid. In this case, the libration points still exist, but deviates a little bit from the positions of the corresponding RTBP; (2) the primary is a tri-axial ellipsoid and the secondary is a spheroid. In this case, the libration points no longer exist but are substituted by a period orbit with the same period as the rotational period of the first primary. These two special cases will be treated in this study.

To simplify the studies, we first fix the two asteroids (both mass and shape) and adjust their mutual distance and the rotation rate of the first primary. Next, we study the effects of different shapes and mass ratios of the two asteroids.

Keywords: *binary asteroid, libration point, stability*