IAF ASTRODYNAMICS SYMPOSIUM (C1)
Virtual Presentations - IAF ASTRODYNAMICS SYMPOSIUM (VP)

Author: Prof. Yue Wang
Beihang University, China

Mr. Tao Fu
Beihang University, China

# ORBITAL STABILITY ANALYSIS AROUND THE PRIMARY OF A BINARY ASTEROID SYSTEM

**Abstract**

Asteroids are drawing increasing attention since they can offer insights into the origin and evolution of our solar system. Binary asteroid systems, which have two members orbiting around each other, are particularly interesting as they can reveal the secret of planetary evolution. Binary asteroid systems have been selected as the targets of near future missions, e.g., the Asteroid Impact and Deflection Assessment (AIDA) mission and the Janus mission. Due to the irregular shape and coupled orbit–attitude dynamics of the massive bodies, the binary system offers an extremely rich dynamical environment. The dynamics of the binary system itself and a massless particle in its vicinity, referred as the full two-body problem (F2BP) and the restricted full three-body problem (RF3BP), respectively, have been studied extensively.

In this paper, unlike most previous studies that focused on libration point orbits, we will focus on orbits around the primary of the binary system, with the gravity of the secondary modeled as a third-body perturbation. The stability of orbit dynamics around the primary will be studied by using semi-analytical techniques from aspect of the long-term oscillation of eccentricity. Our previous numerical investigations indicate that the eccentricity undergoes a large-amplitude long-period oscillation, which are caused by the secular perturbation of the secondary and may cause impact on the primary's surface. To study this problem, a newly proposed semi-analytical dynamical model, incorporating effects of the primary's oblateness and the secondary's non-spherical third-body perturbation, will be used to investigate the oscillation of the eccentricity, including its phase and amplitude, and the dependence on the initial orbital geometry. The analytical results can reveal the origin of the instability, predict unstable regions in the space of orbital elements, and determine the initial orbital geometry that can ensure the secular stability. Besides, the effects of the non-spherical third-body perturbation on the eccentricity evolution and stability will be also studied particularly.

The orbits around the primary of binary system 2003 YT1 are used as examples for our analysis and to provide special numerical data for verification of our analytical results. Although only 2003 YT1 is considered, the methods can be applied to study other binary systems in the case that the gravity of the secondary is modeled as a third-body gravity perturbation. The results will be useful to design long-term stable orbits around the primary of a binary system.