IAF ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (1) (3)

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EJECTA ORBITAL AND BOUNCING DYNAMICS AROUND ASTEROID RYUGU

Abstract

The scientific interest towards asteroids has increased in the last few years, leading to several successful missions such as Hayabusa (JAXA), Rosetta (ESA), Hayabusa2 (JAXA) and OSIRIS-REx (NASA). Several efforts have been made to study the environmental condition around asteroids, in order to characterize the dynamical behaviour of orbits about small bodies (Krivov, 1995, Scheers, 1997). One of the most challenging aspects of such missions is to collect and sample asteroid material by means of an on-ground collection, involving landing (or touch-down) and mining.

This paper analyses the evolution of the dust dynamics around asteroids in the context of the Circular Restricted Three-Body Problem, perturbed by the solar radiation pressure and the aspherical potential of the asteroid (up to $J_{2,2}$). The aim is to carry out a simplified analysis showing if particles ejected by means of a kinetic impactor can be temporary captured around the asteroid, leading to a potential threat for the spacecraft's sampling operations. The main goal of our work is to study two important mechanisms: (1) asteroid's surface bouncing trajectories and (2) on-orbit particles collisions. (1) The dynamics arising from the re-impact and bouncing of particles ejected from the asteroid surface is analysed by considering non-elastic collisions. (2) On-orbit collisions can potentially cause a trail of particles, captured for several months; this mechanism could explain the recent discovery of trails, observed for asteroid *P/2010 A2*. The artificial impact scheduled during the Hayabusa2 mission makes the asteroid Ryugu the ideal case study; furthermore, the images collected by the on-board DCAM3 camera could shed light on these complex behaviour. From the understanding of these two mechanisms, we could select the asteroid's impact location as a function of the high survival on-orbit probability. Since the dynamics involved is different depending on the particles size, as already showed by Garcia et al. (2014) and by Pinto et al. (2019), the location of particles changes in time as function of their lightness parameter. Therefore, the solar radiation pressure acts like a passive in-situ mass spectrometer, allowing future missions to consider on-orbit collection as an alternative to landing or touchdown operations.