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FINDING TRAJECTORIES TO SEND A SPACECRAFT TO AN ASTEROID TO CHANGE ITS ORBIT AROUND THE SUN

Abstract

In recent years, several missions have been proposed to reach asteroids and comets in the Solar System, such as: Aster, Dawn, MarcoPolo-R, NEAR Shoemaker, Osiris-Rex and Rosetta. Those bodies are very important in terms of science, because they keep information related to the origin of the Solar System. Another key point is that there is a growing interest in the problem of collision avoidance between an asteroid and the Earth. It means that it is very important to find trajectories to those bodies. The present paper focus on finding trajectories to send a spacecraft to an asteroid, with the idea of hitting the asteroid to change its orbits around the Sun, such that it does not collide with the Earth. The idea is to make a general study to find the compromise between time of flight, increment of velocity to send the spacecraft and the velocity of approach of the spacecraft with respect to the asteroid. A study like that is important, because the idea is to minimize time of flight and maximize the velocity of the spacecraft at the arrival in the asteroid. It is opposite to trajectories used in scientific mission, which usually searches for the minimum consumption of fuel. The time that the spacecraft needs to reach the target is very important in the modification of the orbit of the asteroid. It means that a trajectory with high fuel consumption, but short trip time, may be interesting or even necessary, considering the effects in the deviation of the trajectory. The dynamical model considers the restricted three-body problem, considering the Sun and the Earth as the primaries of the system. Besides gravity forces, the effects of the solar radiation pressure in the trajectory of a spacecraft is also included. This is important, because some trajectories may be longer, so accumulating those effects during a long time. Another point is that asteroid are small bodies, so the solar radiation pressure may change the trajectory of the spacecraft by an amount that may be enough for the spacecraft to miss the target, losing the goal of the mission. Those effects may also affect the velocity for launching and the impact. The effects of the solar radiation depends on the area/mass ratio of the spacecraft, so it is possible to increase or decrease those effects by adding or removing panels to the spacecraft, if it is interesting for the mission.