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POWERED SWING-BYS COMBINED WITH ATMOSPHERIC DRAG AND LIFT

Abstract

The present paper study powered close approaches between a spacecraft and a planet. In a maneuver of this type there is an application of an impulse when the spacecraft passes by the periapsis of its trajectory around the planet. The dynamical system is composed by the planet, the Sun, and the spacecraft, forming a restricted three-body problem. The planet is assumed to have an atmosphere, which generates a drag as well as a lift force. The planet and the Sun are assumed to be in circular planar orbits. The equations of motion are the ones of the circular planar restricted three-body problem with the addition of the forces given by the atmospheric: drag and lift. The planets Mars and Venus are used for the numerical simulations. The initial conditions of the spacecraft are specified at the periapsis. The equations of motion are numerically integrated forward in time for the satellite, considering the modification of the velocity vector due to the impulse applied, until a point where it is at a distance that can be considered far enough from the planet and it is possible to disregard the effects of the planet and consider the Sun-spacecraft as a two-body system. Then, the orbit of the spacecraft is integrated backwards in time. The difference from the usual powered close approaches technique is the presence of the atmosphere of the planet, which generates a drag and a lift forces in the spacecraft. The primary objective of the present paper is to map the modifications of the orbits of the spacecraft due to the powered close approach with the planet. Emphasis is given to map the orbital parameters of the spacecraft after the close approach with the planet. Then, the effects are compared with the same maneuvers performed without the inclusion of the atmosphere. The main parameters are varied: the magnitude and direction of the impulse, the angle of approach and the periapsis distance of the close approach and finally the velocity of approach of the spacecraft. The goal is to find the best combination to allow captures by the planet. In particular, a search is done in order to find the combinations that give the minimum eccentricities for the final orbit around the planet. Those orbits can be used in missions going to one of those planets.