An iterative Encke's method for the determination of spacecraft's orbits

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Abstract

The so-called slingshot maneuver is of paramount importance in the planning and design of spacecraft missions. One or several flybys of a major planer are programmed in order to gain or loose energy in such a way that the spacecraft could reach its destination in a reasonable amount of time.

In the case of an Earth flyby, we must analyze the classical perturbations exerted on the ideal hyperbolic orbits by the Sun and the Moon. We must also take into account that the Sun and the Moon move through the sky as the spacecraft follows its orbit. In a second-order iteration the perturbation of the Earth itself upon the orbit perturbed by the Sun, the Moon and other planets must also be considered. This constitutes a second-order perturbation which deforms the orbit by a smaller amount. This iterative process can be developed for the subsequent perturbations by the Sun and the Moon and the Earth in order to determine the orbit to high precision.

We apply and test this method using recent Earth flybys data in NASA missions.

Key words: Encke method, Slingshot maneuver, Earth flyby.

[1] P. H. Borcherds and G. P. McCauley, *The Gravitational Three-Body problem: Optimizing the slingshot*, Eur. J. Phys. 15 (1994), pp. 162-169.

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