Optimization of Transfers to Neptune

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Abstract: Here a mission to Neptune for the mid-term 2008–2020 is proposed. A direct transfer to Neptune is considered and also Venus, Earth, Jupiter and Saturn gravity assists are used for the trip to Neptune. Several mission options are analyzed, such as: Earth–Neptune, Earth–Jupiter–Neptune, Earth–Saturn–Neptune, Earth–Jupiter–Saturn–Neptune, Earth–Venus–Earth–Jupiter–Neptune, Earth–Venus–Earth–Jupiter–Saturn–Neptune. All the transfers are optimized in terms of the ΔV. The goal of this study is to compare the mission options in order to find a good compromise between the ΔV and time of flight to Neptune.

Keywords: Neptune’s system; swing-by; interplanetary mission.

Mathematics Subject Classification (2000): 70F99, 70M20, 78M50.

1 Introduction

On August 20, 1977, the Voyager 2 was launched towards the exploration of our solar system. On August 25, 1989, it passed by Neptune. The gravity assist is a proven technique in interplanetary exploration, as exemplified by the missions Voyager, Galileo, Cassini etc. NASA’s Solar System Exploration (Hammel et al. [1]) theme listed a Neptune mission as one of its top priorities for the mid-term (2008–2013). The interplanetary trajectory of the spacecraft is represented by a series of segments of undisturbed Keplerian motion in the gravispheres of relevant celestial bodies, while on the boundaries of these segments, the trajectory passes from the gravisphere into the heliosphere and vice versa. Studies of the interplanetary flight with gravity assist maneuvers are known to deal with cases where the spacecraft, on its way from one celestial body to another, approaches...