# ON TRAJECTORIES FOR THE EARTH-TO-MOON FLIGHT WITH CAPTURE BY THE MOON

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Theoretical qualitative and "exact" numerical study in the Earth-to-Moon trajectories of new, recently found “detour” type [Belbruno E.A., and Miller J.K.; Hiten Project of Japan; Yamakawa H. et al; Biesbroek R., and Janin G. (ESA); GMV (Madrid); Koon W.S., et al; Ivashkin V.V.; etc.] is carried out. These trajectories have an initial flight from the Earth to a large distance (of about 1.5 m km) and the following passive flight to the Moon orbit, an approach to the Moon with decreasing an energy of a particle (spacecraft) selenocentric motion first to zero value, then to a negative one and with a temporary capture to an elliptic orbit of the Moon satellite. These trajectories have smaller delta-V than usual ones of direct flight to the Moon for soft landing or transfer to the Moon's satellite orbit.

A qualitative analysis of the Sun's gravity effect on lifting the particle’s orbit perigee is performed for the first, initial part of the trajectory. Conditions for the particle passive approach to the Moon orbit are given. A qualitative analysis of possibility to decrease by the Earth gravity the energy of the particle selenocentric motion from a positive hyperbolic value to the zero parabolic one and to begin the capture of the particle motion by the Moon is given for the second part of the trajectory. A model of this process is developed; its analytical solution is obtained. It shows mechanics for damping the particle selenocentric energy and the capture beginning. The Earth’s gravity effect on the following decrease of the particle energy from zero to a negative value corresponding to the elliptic orbit of the Moon satellite is studied for the third, final part of the trajectory.

Algorithms to calculate these trajectories are developed for the Earth-Moon-Sun-particle system with taking into account the gravity of the Earth (with its second zonal harmonic), the Moon, the Sun and with additional accounting the gravity of all other planets. The numerical simulation is performed, and a set of these trajectories is determined. Their main properties are given. It is shown they are in a good enough accordance with results of the qualitative theoretical analysis. The effect of the gravity perturbations for all the planets is evaluated. There is also analyzed a problem - how variations in initial kinematical parameters (time, position, velocity) influence on the trajectory.

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***Key words:*** Earth-to-Moon trajectories.