
A study of three-dimensional "detour" transfers into artificial lunar satellite orbit following launches from space centers located in Russia

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The article presents the results of studies on low-energy "detour" transfer trajectories to an artificial lunar satellite orbit in the Earth-Moon-Sun system for spacecraft launched from a Russian space center. In this type of trajectories, the spacecraft (SC) first flies beyond the Moon's orbit, out of the Earth's sphere of influence. Its trajectory parameters are altered by the Sun's gravitational perturbations, which enables lunar gravitational capture of the SC to take place, reducing the delta-V budget of the mission. The SC velocity is required to be low enough when approaching the Moon's sphere of influence, which limits incoming trajectory inclination with respect to the Moon's geocentric orbit plane. Therefore, supplementary studies of "detour" trajectories for launches from Russian space centers are necessary. Calculations conducted in this research confirm the possibility of lunar gravitational capture for SC launched from Russian space centers onto a "detour" trajectory. In some of the trajectories considered, a gravity assist maneuver with the Moon is used to increase SC energy and change its orbit inclination.

Keywords: *low-energy detour trajectories, lunar gravitational capture, gravity assist maneuver.*

REFERENCES

- [1] Bryukhanov N.A., Gribkov A.S., Guzenberg A.S., Dudnik M.N., Evdokimov R.A., Egorov N.A., et al. *Luna — shag k tekhnologiyam osvoeniya Solnechnoy systemy* [Moon — a step to the Solar system development technologies]. Legostaev V.P., Lopota V.A., eds. Moscow, RKK "Energia", 2011, 584 p.
- [2] Ivashkin V.V. *Ob optimalnykh traektoriyakh poleta KA k lune v sisteme Zemlya — Luna — Solntse* [On optimal trajectories of space flight to the Moon in the Earth – Moon – Sun system]. Moscow, Preprint, Inst. Appl. Math., the Russian Academy of Science, 2001, 30 p.
- [3] Yamakawa H. *On Earth-Moon Transfer Trajectory with Gravitational Capture: a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Engineering*. Department of Aeronautics, University of Tokyo, 1992, 223 p.
- [4] Ivashkin V.V. O traektoriyakh poleta tochki ot Luny k Zemle s gravitatsionnym osvobozhdeniem ot lunnogo prityazheniya [About the Moon-to-Earth trajectories with gravitational escape from the Moon's attraction]. *Doklady Akademii Nauk* [Academy of Science Reports], 2004, vol. 398, no. 3, pp. 340–343.
- [5] Egorov V.A. *Prostranstvennaya zadacha dostizheniya Luny* [Three-dimensional problem of reaching the Moon]. Gurevich Yu.G. , ed. Moscow, 1965.

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