Transfer Trajectories for the Lunarsat Mission

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LunarSat is a micro-spacecraft that will be sent into an orbit around the Moon to perform scientific investigations concerning the lunar environment and its characteristics. LunarSat is designed by young engineers, scientists, and students from around Europe, with support from numerous institutions and space industry. It shall be launched as an auxiliary payload on an Ariane 5 ASAP platform and shall have a mass of up to 120 kg in GTO. LunarSat will orbit the Moon in a highly elliptical polar orbit with its perigee above the lunar south pole area. This orbital strategy yields the possibility to obtain images of the lunar south pole region with a resolution never achieved before. These data is supposed to be used to support the lander mission segment of EuroMoon, the planned European lunar south pole landing mission.

LunarSat will be launched on an Ariane 5 rocket as a secondary payload on the ASAP 5 structure, a circular platform mounted to the interface of the Ariane 5 upper stage. It was developed to provide launch opportunities for micro auxiliary payloads with a total mass of less than 120 kg. The overall mass constraint determines the Δv capability of the microspacecraft and therefore the mission targets, being feasible.

Trajectory analyses for the LunarSat orbiter mission have been conducted employing direct, Hohmann-like as well as bi-elliptic transfer orbits. In particular, transfer strategies from a standard Ariane 5 GTO to the Moon have been investigated. The results of this study along, with reference Δv requirements are presented in this paper. The results found, using these transfer strategies demonstrated the feasibility of a lunar microsatellite mission, but the requirement of the initially proposed payload mass could not be satisfied. Therefore, it was necessary to further reduce the velocity requirements. The most promising strategy seemed to be a lunar ballistic capture orbit using strong solar perturbations. A study towards optimization of these new type of lunar transfer orbits has been conducted. The solutions found, show the capability of considerable velocity requirement reductions and make microsatellite space exploration missions a reasonable alternative

In summary, the results indicate that future microsatellite exploration missions to the Moon, but also Mars and some small bodies in the solar system are feasible. Employing third-body perturbations and ballistic capture orbits, as methods to reduce the velocity requirements compared to a conventional trajectory design, these investigations show the point towards the feasibility of microsatellite space exploration missions. Considering a launch scenario as a secondary payload with its constraints on the initial trajectory parameters this study could also contribute to low-cost launch opportunities for future microsatellite space exploration missions.