Paper ID: 37313
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SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

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EDEM - EUROPA DIRECT ENCOUNTER MISSION. POSSIBLE SCENARIO OF AN ULTRA-STRONG MOMENTUM EXCHANGE TETHER APPLICATION FOR A FUTURE LANDING MISSION TO EUROPA

Abstract

In recent years, Jupiter's moon Europa has taken a leading position in the chart of search for extraterrestrial life in the Solar System. This is dictated by the suggestion that a giant salt water ocean exists beneath the ice crust of Europa. The thickness of the ice crust is estimated in the range of 3...30 km and will be determined in the frame of the upcoming NASA's Europa flyby mission. Despite the fact that these data will become available not earlier than in the late 2020s, the studies towards Europa landing and ice-penetration mission concepts have already begun. Considering the significant time gap between the upcoming orbiting and future landing missions, the latter one should be developed with respect to the evolving technologies that will become mature by the end of the next decade. The application of these technologies can increase ice-penetration probability and decrease the time needed for a robotic probe to pierce the ice crust and reach the mysterious under-ice ocean of Europa.

The current paper is devoted to the concept of a landing mission to Europa with optional kinetic ice-penetration capabilities. The mission concept is based on the application of an ultra-strong momentum exchange tether that is used for efficient deceleration of the Europa landing module and acceleration of the ice-penetration assets. The long-lasting angular acceleration of the tethered spacecraft is provided by a pair of electric thrusters. Several scenarios of the tether release at the approach to Europa are examined and the optimal scheme is selected. It produces low landing delta-v and very high impact velocity (30...40 km/s) of the ice-penetration assets. The impact energy is sufficient to form a deep tunnel in ice and thus reduce the working path of the drilling or ice-melting equipment that will be delivered to the impact site by the landing module.

The advantages and complications of the proposed mission concept are depicted in the paper along with a list of technologies that have to be advanced during the next decade in order to increase feasibility of the proposed mission and other projects with application of space tethers.