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Conceptual analysis of interplanetary missions involving gravity-assisted maneuvers with the moon and the use of solar sails

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Gravity-assisted maneuvers with other planets, also known as swing-bys, are often utilized in interplanetary missions to alter the trajectory and speed of spacecraft about to the Sun to save propellant [1]. Spacecraft such as Voyager 1 and 2 (1977 -), Ulysses (1990 - 2009), and Rosetta (2004 - 2016) employed this technique with success.
Solar sails are an alternative propulsion form that does not require propellant consumption. They utilize the radiation pressure exerted by sunlight on surfaces with high reflective power attached to spacecraft. The light reflected by these surfaces transmits a propulsive force to the spacecraft [2]. The Ikaros (2010 - 2015), LightSail 1 (2015), and LightSail 2 (2019 - 2022) missions demonstrated the effectiveness of these devices.
This word explores these two concepts for planning low-cost interplanetary missions. Firstly, a spacecraft is launched toward the Moon using a natural route derived from periodic orbits around the Lagrangian equilibrium point L1 of the Earth-Moon system [3]. This route ensures a swing-by with the Moon that reduces the ΔV required to escape the Earth's gravitational field by up to 5%. Following the swing-by, a solar sail is deployed to provide continuous acceleration to the spacecraft. The effectiveness of combining these concepts is investigated by examining the limits of the ratio of spacecraft mass to sail mass and sail loading.
The results indicate that using a combination of swing-by with the Moon and solar sails reduces propellant consumption and flight time when traveling between Earth and target celestial bodies (such as planets and asteroids) compared to missions using conventional transfers, swing-by maneuvers, or solar sails only.

References
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Poster