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SOLAR-PHOTON SAILS AS SECONDARY PAYLOADS IN THE NEAR-TERM INTERSTELLAR PROBE: AN EARLY TEST OF THE SUN-DIVER MANEUVER

Abstract

The Near-Term Interstellar Probe (IP) is a robotic spacecraft that could exit the solar system at multiples of the Voyager 1 Interstellar Cruise Velocity. In its baseline configuration, this 478 kg probe, with a 40 kg science payload, would be launched by the Space Launch System (SLS) on a Jupiter-bound trajectory. Jupiter's gravity would be used to insert the probe and its attached kick stage into a parabolic solar orbit with a very small perihelion. At perihelion, the kick stage would be ignited to perform an "Oberth Maneuver" and eject the IP from the solar system at a velocity in excess of 10 AU/year. This approach is adequate to explore the heliopause and the near interstellar medium out to about 600 AU. But unless we can apply nuclear- or thermonuclear-pulse propulsion, the interstellar-exploration limits of the Oberth maneuver will soon be reached. One way to utilize this mission (which could be flown around 2030) to demonstrate the effectiveness of a propulsion system capable of longer distance exploration is to fly one or more near-term Aluminum-Kapton bilayer solar-photon sails stored in CubeSats aboard the SLS upper stage. It is shown that such sails could survive unfurlment at 0.145 AU. Sail size and sail-payload masses are sufficient to allow multi-kilogram sail craft to exit the solar system via this "Sun Diver Maneuver" at velocities comparable to or in excess of the Voyager 1 interstellar cruise velocity. Communications with these craft near the Sun and science possibilities on their outbound leg are discussed. More advanced diffractive and desorptive sails may be ready for flight by the planned launch date of the Interstellar Probe.