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Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond (4)

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ENABLING INTERSTELLAR PROBE WITH THE SPACE LAUNCH SYSTEM (SLS)

Abstract

The concept of a probe to the interstellar medium grew from the studies that accompanied the initial planning for a “Grand Tour” mission to the outer planets of the solar system. In 1976 a study was undertaken at the Jet Propulsion Laboratory (JPL) of an “interstellar precursor mission” as a stepping stone from the outer solar system to interstellar flight. Only recently with the measurements by the Voyager missions and the remote observations of Energetic Neutral Atoms (ENAs) by the Interstellar Boundary Explorer (IBEX) mission in Earth orbit and the Ion and Neutral Camera (INCA) on Cassini in Saturn orbit, has the complexity of the solar-wind interaction with the interstellar medium begun to emerge. Although these missions continue to operate and provide new insights, the ultimate reach of the Voyagers is limited by their onboard radioisotope power systems, and it is clear from their observations as well as those from IBEX and INCA that further progress requires a faster, deeper probe of near interstellar space. Such an Interstellar Probe has two obvious, significant science objectives: (1) sample the fields and particles populations in situ of the nearby interstellar medium, and (2) discern the global structure of the heliosheath. The scientific yield of Objective (1) is of high astrophysical value, connecting in situ and remote measurements of the interstellar medium for the first time. The scientific yield of Objective (2) is equally high, with the goal of resolving the puzzles posed by the recent observations from Voyagers 1 and 2 and IBEX and INCA. For example, the dominant feature in the IBEX ENA image – the “ribbon” – still lacks a definitive explanation. Addressing these objectives requires a realizable engineering solution for a near-term Interstellar Probe, which combines an adequate (but realistic) payload and propulsive capability. While many exotic approaches to rapid, solar-system escape have been discussed over the last four decades, none of these is currently sufficiently advanced to implement on a mission during the next

10 to 15 years. However, with a new capability (the Large Upper Stage) being considered for the Space Launch System (SLS) extremely large launch C_3s (200 km^2/s^2 to 350 km^2/s^2) should be possible for an Interstellar Probe. By using a Jupiter gravity assist, travel times of 25 to 35 years to 200 AU will be possible; by launching in the mid-2020's, the path of such a probe can be directed toward the heliospheric "nose"/ribbon.