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

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A PRAGMATIC INTERSTELLAR PROBE MISSION: PROGRESS AND STATUS

Abstract

A robotic "Interstellar Probe" through the outer heliosphere and into the nearby "Very Local" interstellar medium (VLISM) has been studied for 60 years. A mission that uses today's technology can take the first explicit step on the path of interstellar exploration, paving the way scientifically, technically, and programmatically for more ambitious future journeys (and more ambitious science goals). The central technical question for such a mission has always been propulsion. "Near-future" capabilities have always been the backdrop for defining engineering requirements, but the real issue is the union of compelling science goals with engineering and technical reality. It is this philosophy that led from the "Solar Probe" pre-phase A engineering study at the Johns Hopkins University Applied Physics Laboratory (APL) beginning in 2002 to the launch of Parker Solar Probe in 2018. To provide input to the upcoming Solar and Space Physics Decadal Survey, NASA's Heliophysics Division has funded APL to consider a near-term, "pragmatic" Interstellar Probe mission. The study has as its charge to engage the broad science and technical communities, focused on heliophysics, but also including potential planetary and astrophysics goals, and assemble a "Menu" of what science could be accomplished on a mission launched in the time frame of the next Decadal and how that mission could be accomplished. Broad engineering requirements

frame the study consisting of (1) Readiness: ready to launch no later than 1 January 2030; (2) Downlink: return science data from up to 1000 astronomical units away; (3) Power: no more than 400 watts required at the beginning of mission and no more than 200 watts available at mission's end; and, (4) Longevity: spacecraft lifetime of not less than 50 years. Critical trade-offs, including mass versus flyout speed and downlink rate versus communications system are not new, and neither are enabling technologies: radioisotope power systems (RPS) and large launch vehicles. Such requirements have already forced some downselects: radio-frequency (rather than optical) communication links, radiatively-coupled (rather than conductively coupled) thermoelectric converters, and ballistic trajectories (rather than use of low-thrust propulsion). For moderate mass spacecraft, near-term trades support the use of the Space Launch System (SLS) Block 2 configuration with existing or near-term kick stages and a Jupiter gravity assist. An "advanced" concept using a near-Sun ("Oberth") maneuver is also being investigated by building from Parker Solar Probe thermal shield technology. We provide a progress report on continuing refinements and trades being addressed in the study.