20th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond (4)

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THE PRAGMATIC INTERSTELLAR PROBE STUDY: RESULTS

Abstract

Interstellar Probe is a scientific mission to our heliosphere and its surroundings in interstellar space. Using an optimized set of modern scientific instruments Interstellar Probe will carry out investigations of (1) the processes within the heliosphere responsible for the formation of the heliospheric boundary, (2) the detailed physical processes at work in the heliosheath, (3) the global dynamics of the heliosphere, and (4) conditions in, and characteristics of, the very local interstellar medium, including the Sun's influence therein. To select and study a menu of science drivers, required measurements, and example payload instruments for such a mission, both an internal Johns Hopkins Applied Physics Laboratory (APL) team and a large number of external and unpaid volunteers were assembled via a set of four annual workshops from 2018 through 2021. This support community assembled a consensus science traceability matrix and self-selected Working Groups crafted a notional set of remote-sensing and in situ instruments to address both a baseline heliophysics mission and an augmented, which has additional planetary science and astrophysics goals. Detailed engineering and trade-off studies have shown that an interstellar probe mission supporting these science investigations can be designed, built, and launched in the near term of the 2030s. The nominal mission uses a super heavy lift launch vehicle (SHLLV) with additional 3rd and 4th stages and a separated spacecraft ("observatory") of 860 kg carrying about 90 kg of instruments. With a close Jupiter Gravity Assist, a spacecraft launched in 2036 would exit the solar system in the hemisphere of the incoming interstellar wind at about twice the current speed of Voyager 1, reaching

about 350 au in 50 years. Powered by two next-generation radioisotope thermoelectric generators and with a communications system designed to return data from as far away from Earth as 1000 au, the next step past the Voyagers would begin. The study, including science details, instrument examples, system trades, and cost and reliability estimates, has been published online (https://interstellarprobe.jhuapl.edu). The almost 500-page report is publicly available worldwide. As a large strategic mission, a future NASA Science and Technology Definition Team as well as members of the upcoming Solar and Space Physics Decadal Survey can draw upon this document as a reference from which to start in selecting science goals, solar-system-flyout direction, and potential instruments for a scientific payload for an Interstellar Probe mission that could be readied in this decade and launched within the next.