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

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INTERSTELLAR PROBE: SCIENCE DISCOVERIES AT THE BOUNDARY TO INTERSTELLAR SPACE AND BEYOND

Abstract

The global nature of the interaction of the heliosphere and the Local Interstellar Medium (LISM) is among one of the most outstanding space physics problems of today. At the extreme boundary to interstellar space, a completely new regime of physical interactions is at work that shape the unseen global structure of our entire habitable astrosphere. Voyager 1 and 2 are soon nearing their end of operations inside of 170 AU and their payloads dedicated to planetary science have uncovered a region of space that defies our understanding. At the same time, IBEX and Cassini have obtained complementary "inside-out" ENA images of the heliospheric boundary region that cannot be fully explained. An Interstellar Probe through the heliospheric boundary, in to the LISM would be the first dedicated mission to venture into this largely unexplored frontier of space, where no one has gone before. Its dedicated suite of in-situ and remote-sensing instrumentation, would not only open the door for understanding the exotic physics acting at the boundary of the heliosphere and that of other astrospheres, but would also obtain the very first images from the outside of the global structure of the heliosphere. Beyond the Heliopause, the Interstellar Probe would offer the first sampling of the properties of the Local Interstellar Cloud and interstellar dust that are completely new scientific territories. Contributions across divisions would offer historic science returns, including a flyby of one or two Kuiper Belt Objects, first insights in to the structure of the circum-solar dust disk, and the first measurements of the Extra-galactic Background Light beyond the obscuring Zodiacal cloud. A study funded by NASA, led by JHU/APL is now progressing towards its third year of developing realistic mission architectures for an Interstellar Probe using systems ready for launch beginning 2030. The study trade space is bounded by requirements to be able to operate out to 1000 AU, use 400 W, and survive up to 50 years. Realistic staging configurations using an SLS Block 2 and a powered Jupiter Gravity Assist achieve asymptotic escape speeds of up to 8.5 AU/year. Here, we discuss the current state of understanding, the groundbreaking discoveries that await, notional model payload concepts, and the science and mission operations that would enable the beginning of humanity's exploration of interstellar space.