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THE PRAGMATIC INTERSTELLAR PROBE STUDY: THE EVOLUTIONARY JOURNEY OF OUR HABITABLE ASTROSPHERE

Abstract

During its twenty revolutions around the galactic core, our Sun and its protective magnetic bubble

have plowed through dramatically different interstellar environments and witnessed several supernova explosions. The extreme range of interstellar plasma, gas, dust, high-energy galactic cosmic rays and flow speeds on this "solar journey" have all shaped the solar system that we live in. Today, our protective magnetic bubble -the Heliosphere - is leaving the Local Interstellar Cloud and will enter a completely new environment of interstellar space on very short galactic times scales (1000 years) that, again will change the entire heliospheric interaction and its shielding from interstellar matter. An Interstellar Probe on a fast trajectory through the heliospheric boundary in to the Very Local Interstellar Medium (VLISM) would provide answers to what physics upholds the boundary, how it responds under dynamic influences of our solar cycle, and ultimately sample the unexplored VLISM to understand how our habitable system has evolved through its galactic journey, and what will happen in the future. As such, an Interstellar Probe would represent humanity's first step into the galaxy to understand our home within it. A four-year NASA-funded mission concept study of a pragmatic Interstellar Probe has now been completed and culminated in a 500-page report (interstellarprobe.jhuapl.edu) marking the most complete study of an Interstellar Probe ever done. The idea of an Interstellar Probe dates back to the 1960's, when also the ideas of a probe to the Sun and its poles were formed. An international team of scientists and a team of engineers at the Johns Hopkins University Applied Physics Laboratory (APL) have studied the pragmatic mission concept that would make a launch in the 2030's a reality. Detailed staging analyses using the upcoming SLS Block 2 have demonstrated that asymptotic speeds in excess of seven Astronomical Units per Year (au) are already possible with a Jupiter Gravity Assist. Equipped with dedicated instrumentation, Interstellar Probe would measure particles, fields and waves starting already shortly after launch to understand the physical processes that build up the heliosphere and shields us from interstellar dust (ISD) and galactic cosmic rays (GCRs). Beyond the heliopause, Interstellar Probe would be given access to the unshielded properties of the VLISM, including the interstellar magnetic field, plasma and gas that would tell us about the present state of the interstellar cloud and what may lie ahead. Here, we give an overview of the science discoveries that await along the journey, spanning not only the heliosphere and VLISM, but also exploration of Kuiper Belt Objects, the circum-solar dust disk and the extra-galactic background light.