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

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OVERVIEW OF THE KECK INSTITUTE FOR SPACE STUDIES (KISS) WORKSHOPS ON THE
SCIENCE AND ENABLING TECHNOLOGIES FOR THE EXPLORATION OF THE INTERSTELLAR
MEDIUM (ISM)

Abstract

The Caltech Keck Institute for Space Studies(KISS) recently completed a study l by the authors to define the next steps in the exploration of the Interstellar Medium(ISM). The impetus for this study were recent discoveries: 1) Voyager detection of the Heliopause, ground based observations of Kuiper Belt Objects and 3) Kepler Telescope discovery of large numbers of ExoPlanets around distant stars. These discoveries provide a framework of interstellar space that will be the explicit focus of future exploration. As such, the region beyond the Heliopause and into the pristine interstellar medium represents a new frontier for scientific exploration. The KISS proposal team of 32 co-investigators held two workshops in September 2014 and January 2015. One aspect of the workshop was the realization that there exist innovative set of mission designs with existing propulsion techniques to reach the ISM in 8-10 years, compared to Voyager's 36 years. Moreover, such a spacecraft could reach exit velocities of ~ 13 AU/year, ~ 4 times faster than Voyager.

The workshops investigated the compelling science investigations including: i) zodiacal infrared background dust science (1-100 AU); ii) Heliophysics and science of the local ISM (10 – 150 AU); iii) Kuiper Belt Object (KBO) science (40 – 100 AU); iii) science of the pristine ISM (150 – 300 AU); iv) Parallax science (30 – 200 AU); and v) gravitational lensing science (> 500 AU).

The mission approach, referred to as ISM Reference Mission 1.0 involves a launch on the SLS Block 1B, a Jupiter gravity assist, and a perihelion Oberth maneuver at 2.8 – 3.5 solar radii. The mission concept and capabilities draw upon the technologies being developed by the Solar Probe Plus mission (2018) under development by the Applied Physics Laboratory (APL) and NASA Ames. The Thermal Protection System (TPS) is one of such technologies. The Workshops considered a menu of other technologies including: solar sails, beamed energy, eSAIL, nuclear power, optical communications and others relevant to reaching towards another star. Key technologies assessed for the reference mission include: propulsion, thermal protection system, power, autonomy and resilience, miniaturized instruments and CubeSat technologies, communications technologies such as Ka-band (RF) and laser communications (optical). Applications for additional interstellar precursors beyond the reference mission were also discussed.