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

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A NOVEL MISSION CONCEPT FOR NEAR TERM EXPLORATION OF THE INTERSTELLAR MEDIUM (ISM)

Abstract

Two recent Keck Institute of Space Studies (KISS) workshops on the topic of exploration of the interstellar medium (ISM) have made it clear that science from a robotic mission to the ISM spans across multiple scientific disciplines and would be compelling to the Heliophysics, the Astrophysics and the Planetary science community. Motivated by this goal, we present a mission concept capable of reaching the ISM ($\sim$200 AU) in $\sim$20 years. Flyby of a large Kuiper Belt Object (KBO) as the spacecraft escapes the solar system is also considered. The mission affords a launch date in February 2027 and takes advantage of NASA's new SLS Block-1b launch vehicle. The spacecraft is launched on a ΔV-EGA-Jupiter-Sun trajectory with an Earth escape v-infinity of $\sim$6.85 km/sec and achieves a low solar perihelion of 2.8 solar radii. Taking advantage of the Oberth effect, a large ΔV ($\sim$5.5 km/sec) maneuver at the solar perihelion is performed, allowing the ISM probe to escape the solar system at a hyperbolic excess speed of $\sim$63 km/sec, almost 4 times that of Voyager 1. The flight system consists of a delivery stage and a $\sim$550 kg ISM probe. The delivery stage is responsible for injecting the ISM probe in a scientifically preferred direction and consists of a bi-prop element for performing deep space maneuver and trajectory corrections, a thermal protection system for surviving close to the Sun and a solid rocket motor for achieving the required perihelion ΔV. The baseline ISM probe is designed to be a dual eMMRTG powered, spin stabilized spacecraft with a 1-meter high gain antenna. The spacecraft hardware is selected to be dual cold case redundant with long operational life times (20+ years). The total science payload as identified during the two KISS workshops is found to be $\sim$40 kg (with contingency). The proposed mission concept is shown to be possible within a New Frontiers-class cost cap ($\sim$1B$) and has the capacity to usher in a new era of space exploration in which the ISM is being explored as a science destination, much like Outer planets are explored today.