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RAPID ACCESS TO THE INTERSTELLAR MEDIUM: A FEASIBILITY STUDY

Abstract

To access the interstellar medium with today's technology requires 30 to 40 years, significantly longer than most mission lifetimes or even people's careers. The goal of our study was to explore mission concepts that will reach the interstellar medium in a primary mission's lifetime of 10 year or less. Faster access to the interstellar medium would allow high-capability science probes, with many relevant instruments, to explore the interstellar medium beyond the heliosphere system in-situ. Science targets include the hydrogen wall structure, bow wave/shock, foreground emissions and interstellar dust, just to name a few. Further, such a capability would enable rapid exploration of multiple Kuiper belt objects in a much shorter time frame than current methods allow. Finally, distant targets include the solar gravitational lens regions deep into the interstellar medium beyond 500 AU which may enable direct imaging of exoplanets using the natural magnification enabled by gravitational lensing from our Sun. To rapidly access the interstellar medium, JPL has performed a detailed feasibility study. Approaches investigated included using Nuclear (fission) Electric Propulsion (NEP), very large Solid Rocket Motor (SRM) and a solar perihelion burn, Solar Thermal Propulsion (STP) with a solar perihelion burn, and solar electric propulsion. In this paper, we will present the results of this multi-year study. We have found that a perihelion burn out performs direct NEP when targeting distant objects. Even more effective is to combine NEP after a solar perihelion burn, where the perihelion burn provides a significant kick in acceleration. When comparing SRM to STP, in the near term, when balancing risk and development cost, SRM would provide the best return on investment, with escape velocities reaching as high as 16 Au/yr (perihelion + NEP). However, we believe that it is also possible, with significant technology development investments, for STP to outperform SRM's, with speeds of 16 to 19.5 Au/yr (perihelion + NEP), accessing the interstellar medium more rapidly. This paper will also identify key areas of technology development that would enable STP to outperform today's SRM technologies.