IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IP)

Author: Mr. Adam Nekolny
University of Arizona, United States

Mr. Leonard Vance
University of Arizona, United States
Prof. Jekanthan Thangavelautham
University of Arizona, United States

MISSION FEASIBILITY FOR INTERSTELLAR OBJECT EXPLORATION THROUGH UTILIZATION OF ADVANCED PROPULSION TECHNOLOGIES

Abstract

Interstellar objects have fascinated the scientific community around the world. With two detections of interstellar objects as of now, 1I/2017 (Oumuamua) and 2019 (Borisov), there have been many unanswered questions, with the Decadal survey highlighting interest in mineral and isotope composition. For the mission to be developed, extensive preparation and considerations have to be made, with the initial parts requiring a detailed analysis of potential points of arrival, with assumption of detection range, time of preparation for launch, and the time of flight towards the interstellar objects, which ultimately determines the necessary delta-v requirements for the spacecraft to achieve. This paper aims to present a simulation for the distribution of delta-v requirements for the spacecraft to achieve, towards thousands of artificially generated interstellar objects, which pose velocity characteristics of Oumuamua and Borisov, as well as objects launched from Kuiper belt, which would satisfy similar hyperbolic trajectory characteristics of the interstellar objects. For this simulation, the assumption of the detection range from Earth has been set at 3 AU, with it being assumed from the distance of initial detection of Borisov. Once the simulated interstellar objects cross the detection point on Earth, a determination of delta-v with respect to the time of flight is initiated, with delay and without delay in the mission launch. Based on the taken percentile of generated objects and velocities, a detailed plot of delta-vs and time of flights is created. This is done for the case of Earth being fixed within the 3D space, as well as simulated with dynamic Earth, as referenced by its ephemeris, to ensure that statistical values do or don't change when simulating thousands of artificial objects for each velocity characteristics.

With the detailed plots and distributions created, a feasibility analysis will be performed. This is done through considerations of different scientific interests by choosing instruments, after which propulsion methods are considered. Dependence on current and potential future propulsion methods determines regions of feasibility, with current technologies defining the highest mission success, followed by potential experimental propulsion methods for which their ranges of effectiveness are considered based on current research and predictions. Overall, the simulation aims to provide insight into machinery and navigation requirements for mission feasibility towards interstellar objects by assuming a large quantity and variety of ISOs.