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COMET INTERCEPTOR: AN ESA MISSION TO A YET UNIDENTIFIED TARGET

Abstract

As of today, 8 different comets have been visited by 10 spacecraft. These missions have provided invaluable knowledge about comet compositions, shapes, and structure, however all of these visited comets had previously completed multiple orbits around the Sun. The predictability of their return is clearly a key aspect for their accessibility, including the planning, development and launch of missions capable of intercepting them. However, the multiple passages through the inner solar system substantially alters the morphological and chemical characteristics of comets, hindering the understanding of its formation. ESA F-Class mission Comet Interceptor (Comet-I) aims to visit a comet that has yet to enter the inner solar system and, as such, is also yet to be discovered. In 2029, Comet-I will share a ride with ESA's M4 ARIEL to a quasi-Halo orbit around the Sun-Earth Lagrange 2 point (SEL-2). The coupling of the orbital energy at SEL-2 together with its dynamical instability allows for Comet-I to depart the Earth gravity well with an excess escape velocity in the range from 0.8 to 1 km/s. Added to this, Comet-I propulsion system can perform a total of 600 m/s of Δv change. Given this orbital manoeuvrability, the paper presents an accessibility analysis to all historic long period comets discovered since 2000. This is a set of 83 objects, which crossed the ecliptic plane at heliocentric distances between 1.5 and 0.7 AU between January 2000 and December 2023. Out of these, 29 comets would have been reachable by Comet-I if they would have been discovered with warning times ranging 1 to 4 years. The Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) is expected to provide comparable warning times, and so, enable the capability to reach undiscovered objects with modest Δv capabilities. This paper describes the current work at the Comet-I Target Identification Working Group to assess the likelihood of different discovery scenarios, in an effort to inform the decision-making process of whether to intercept the first available newly-discovered long period comet or wait for a potentially more scientifically compelling object.