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ESA F-CLASS COMET INTERCEPTOR: A FIRST CLOSE-UP STUDY OF A DYNAMICALLY "NEW" OBJECT

Abstract

While the scientific return of past comet missions is unquestioned, all previously visited comets had approached the Sun on many occasions and, consequently, have also undergone substantial surface compositional and morphological modifications. Comet Interceptor proposes instead to explore a *dynamically new comet* (DNC), which will be visiting the inner Solar System for the first time. The baseline design of Comet Interceptor involves three spacecraft elements working together to ensure a low-risk, bountiful, interdisciplinary scientific return through unprecedented multipoint measurements. A main spacecraft, i.e. *mothercraft*, would make remote observations of the target from afar, to protect it from the dust environment and act as the primary communications hub for all other mission elements. Two smaller *daughtercraft* would venture much closer to the target, carrying instruments to complement and enhance the scientific return from other mission elements. Comet Interceptor is a candidate mission proposal within the second evaluation phase of ESA's Science Programme call for Fast (F) Mission Opportunities. The call aims at defining a modest mission, to be launched together with ESA's M-Class mission ARIEL in 2028. Comet Interceptor will be piggy-backed and deployed in a Libration Point Orbit near the Earth-Sun L2 point. There, it will remain until a suitable DNC is discovered. This paper presents the trajectory and navigation analysis carried out in the preparation of the proposal. A key issue for Comet Interceptor is to investigate the feasibility to perform a close proximity fly-by to an undiscovered DNC. Hence, the paper first presents a set of synthetic DNC trajectories based on historic hyperbolic comets with perihelion distance smaller than 1.2 AU. Note that Pan-STARRS's survey is discovering DNCs at a rate of 1.7 objects a year and that, by the time that Comet Interceptor is launched, LSST will also be in operation, almost certainly increasing the DNC discovery rate. A three-manoeuvre intercept transfer in patched-conics was optimized for a large number of synthetic comets (i.e. >500). The statistical results of these optimisations show that the probability to have an opportunity to intercept a DNC with 1.5 km/s is good: The median waiting time at the L2 point should be of 2.5 years for a 1.5-km/s intercept.

While instead would only 1 year if Δv-budget of 3 km/s was available. Finally, the accuracy of the fly-by distances, and thus the achievable minimum approach, is also investigated, assuming standard radiometric tracking capabilities and optical relative motion navigation.