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Topic: Space Mission & Campaign Design

Rapid reconnaissance missions based on ESA's Comet Interceptor

Colin Snodgrass[1], **Geraint H. Jones**[2], **and Cecilia Tubiana**[3]
[1] *University of Edinburgh, Royal Observatory, Edinburgh, UK, csn@roe.ac.uk*
[2] *Mullard Space Science Laboratory, University College London, UK*
[3] *INAF - Istituto di Astrofísica e Planetologia Spaziali, Rome, Italy*

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ABSTRACT

Comet Interceptor (CI) is a mission led by the European Space Agency (ESA), with a significant contribution from the Japanese Space Agency (JAXA), that will perform the first *in situ* investigation of a Long Period Comet (LPC). As LPCs are typically only discovered a few months prior to their closest approach to the Sun, and do not return for many thousands of years, a mission to one relies on designing, building, and launching the spacecraft before its target is known. CI will take advantage of the increased distance at which comets are discovered by modern survey telescopes (expected to significantly increase with the beginning of the Vera C. Rubin Observatory's LSST in 2024) to target a newly discovered comet found a few years prior to its perihelion. While this is not long enough to plan and build a dedicated mission, it is long enough to reach the necessary encounter point from a waiting position in space. CI will wait in a halo orbit around the Sun-Earth L2 point, taking advantage of a shared launch with the *Ariel* space telescope that will operate there. It is expected to launch in 2029, and can wait for a few years for a suitable comet to be found, with an expected comet encounter in the mid 2030s.

A similar mission architecture could be of use for planetary defence as a way to obtain rapid reconnaissance of a newly-discovered hazardous asteroid. A spacecraft waiting in space could obtain resolved images and other in situ measurements of an asteroid within a year or two of discovery, depending on its orbit and the necessary transfer time; this would be significantly quicker than any new mission could be developed and launched.

CI is designed to study a comet, including in situ sampling of its gas, dust and plasma environment as well as multi-wavelength remote sensing cameras. It includes two releasable probes that will perform closer fly-bys of the nucleus than the main spacecraft, which will maintain a safe distance from the hazardous inner coma. A mission dedicated to a first-look characterisation of a potentially hazardous asteroid could be significantly simpler, comprising a single spacecraft without the need for dust shields, and with a simplified remote sensing payload. Of the CI payload, the most useful instruments for characterising an asteroid will be the primary imaging camera CoCa and the multi-spectral camera MIRMIS, which includes thermal infrared observations. This payload would enable morphological

assessment (e.g. bulk shape and surface particle size distributions), compositional measurements (approximate mineralogy), and for thermophysical models of the surface's response to sunlight to be developed. A mass measurement may also be possible by radio science tracking of the spacecraft, should the asteroid be sufficiently large and/or the closest approach distance be small enough. These would be critical inputs to any mitigation mission.

We will present the CI mission design and discuss what this experience tells us about possible rapid response missions.

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