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The Comet Interceptor Mission

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Comets are undoubtedly extremely valuable scientific targets, as they largely preserve the ices formed at the birth of our Solar System. In June 2019, the multi-spacecraft project Comet Interceptor was selected by the European Space Agency, ESA, as its next planetary mission, and the first in its new class of Fast (F) projects [Snodgrass, C. and Jones, G. (2019) Nature Comms. 10, 5418]. The Japanese space agency, JAXA, will make a major contribution to Comet Interceptor. The mission's primary science goal is to characterise, for the first time, a yet-to-be-discovered long-period comet (LPC), preferably one which is dynamically new, or an interstellar object. An encounter with a comet approaching the Sun for the first time will provide valuable data to complement that from all previous comet missions, which visited short period comets that have evolved over many close approaches to the Sun. The surface of Comet Interceptor's LPC target will be being heated to temperatures above the its constituent ices' sublimation point for the first time since its formation.

Following launch, in 2029, the spacecraft will be delivered with the ESA Ariel mission to the Sun-Earth L2 Lagrange Point , a relatively stable location suitable for later injection onto an interplanetary trajectory to intersect the path of its target. This allows a relatively rapid response to the appearance of a suitable target comet, which will need to cross the ecliptic plane in an annulus which contains Earth's orbit.

A suitable new comet would be searched for from Earth prior to launch, and after launch if necessary, with short period comets serving as a backup destinations. With the advent of powerful facilities such as the Vera Rubin Observatory, the prospects of finding a suitable comet nearing the Sun are very promising. The possibility may exist for the spacecraft to encounter an interstellar object if one is found on a suitable trajectory.

An important consequence of the mission design is that the spacecraft must be as flexible as possible, i.e. able to cope with a wide range of target activity levels, flyby speeds, and encounter geometries. This flexibility has significant impacts on the spacecraft solar power input, thermal design, and dust shielding that can cope with dust impact speeds ranging from around 10 to 70 km/s, depending on the target comet's orbital path.

Comet Interceptor has a multi-spacecraft architecture: it is expected to comprise a main spacecraft and two probes, one provided by ESA, the other by JAXA, which will be released by the main spacecraft when approaching the target. The main spacecraft, which would act as the primary

communication point for the whole constellation, would be targeted to pass outside the hazardous inner coma, making remote and in situ observations on the sunward side of the comet. The two probes will be targeted closer to the nucleus and inner coma region.

Planned measurements of the target include its nucleus surface composition, shape, and structure, its dust environment, and the composition of the gas coma. A unique, multi-point 'snapshot' measurement of the comet- solar wind interaction region is to be obtained, complementing single spacecraft observations made at other comets.

We shall describe the science drivers, planned observations, and the mission's instrument complement, to be provided by consortia of institutions in Europe and Japan.

The Comet Interceptor Team: Team members are listed at www.cometinterceptor.space