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CAESAR: RETURNING A SAMPLE OF COMET 67P/CHURYUMOV-GERASIMENKO

Abstract

The Comet Astrobiology Exploration Sample Return (CAESAR) mission, under consideration for NASA's New Frontiers Program, will acquire and return to Earth a minimum of 80 g of surface material from the nucleus of comet 67P/Churyumov-Gerasimenko (67P). CAESAR will preserve the sample in a pristine state and return its evolved volatiles by capturing them into a separate reservoir. The science afforded by such a sample is unprecedented. CAESAR is derived from a line of Orbital ATK solar electric propulsion (SEP) spacecraft, which includes Dawn and GEOSTAR-3. It uses three NEXT-C thrusters and three power processing strings to provide redundant support for the operation of two thrusters, simultaneously, across their full throttle range, with power (30 kW at 1 AU) coming from two Roll Out Solar Arrays (ROSA). CAESAR launches in 2024 from Cape Canaveral, Florida. The ion propulsion system (IPS) is activated after a 60 day commissioning period and is operated with a conservative duty cycle $\leq 90\%$. The outbound cruise includes an Earth flyby and arrives at 67P in March 2029, at a solar distance of 3.5 AU. CAESAR enters orbit around 67P and incrementally lowers its altitude over a period of months, using strategies pioneered by Rosetta and OSIRIS-REx. Survey phases are used to build navigation products, while simultaneously providing imaging needed to select a primary touch-and-go (TAG) site. CAESAR's TAG sequence draws heavily on OSIRIS-REx, with modifications to accommodate unique properties of 67P. After a deorbit burn, three deterministic burns, refined by closed-loop linear corrections from an onboard optical navigation system, deliver CAESAR to within 25 m of the selected site. Cameras on the spacecraft and inside the sampling system document collection. After TAG, the spacecraft autonomously executes a back-away burn. After verifying and stowing the sample, CAESAR begins passively cryopumping the volatiles from the sample into a separate reservoir, preventing sample alteration. While this is going on, CAESAR begins a slow drift away from 67P. The IPS is reactivated in November 2033, once CAESAR is again at 3.5 AU. The inbound cruise includes an Earth flyby and culminates with the release/reentry of CAESAR's Sample Return Capsule (SRC), which is derived from those used on JAXA's Hayabusa and Hayabusa2 missions. The SRC lands in Utah on November 20, 2038, and is promptly recovered, thermally controlled, and transferred to NASA's curation facility.