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Dawn's Second Extended Mission at Ceres: A New Perspective

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Abstract

Dawn completed its primary mission, achieving all of its Level-1 requirements, in June of 2016 after spending 7 months in a low altitude mapping orbit (LAMO) at ~385 km distance to the surface. NASA approved a one-year extension of mission operations (XM1) at Ceres, between June 2016 and October 2017, to refine the primary mission data sets and obtain repeat observations to look for surface changes. The objectives of XM1 were achieved with sufficient hydrazine remaining on the spacecraft to support continued operations [1]. In October 2017, NASA approved a second extended mission for Dawn at Ceres (XM2), spanning perihelion passage (April 2018), to obtain new high-priority science data until the spacecraft runs out of hydrazine. At the time this abstract is being written, Dawn is on its way to its final orbit.

1. Dawn's Second Extended Mission

The primary science objective of XM2 is for Dawn to obtain elemental concentrations with high sensitivity and at the scale of geological units. Proximity to the target is key to improving the strength of the gamma ray and neutron signals, as well as improving the ability to spatially resolve the elemental variations. Considerable work and ingenuity by the Dawn Flight team has produced an eccentric orbit with periapsis lower than 50 km, enabling GRaND to directly measure the elemental composition of surface units with spatial resolution at least 7x better than in LAMO orbit. The measurements will occur during a particularly quiet period of solar activity so that the intensity of galactic cosmic rays, used to interrogate the surface, is maximum. This is indeed a perfect timing for this type of investigation.

Limited longitudinal coverage will be obtained in a resonant orbit that focuses on Occator crater and its ejecta, while also characterizing the ancient heavily cratered terrains in the north, and the more recent, large Urvara and Yalode basins in the south. Combining these very low altitude data with the extended background time series obtained during XM1 will improve the entire GRaND data set and yield a deeper understanding of surface geochemistry, including the concentration and distribution of subsurface ice, as well as the elemental concentration of the ice-free regolith. Comparison between very old terrains and material recently excavated from Ceres' crust will bring new insights into the origin of Ceres' surface, an open question at this time. Furthermore, imaging with the framing camera (FC) and infrared spectra with the visible and infrared mapping spectrometer (VIR) will bring additional perspectives on Ceres' geological evolution and in particular on the nature of the processes driving the emplacement of the Occator faculae. Gravity science carried throughout the low altitude orbit will be used to resolve the subsurface structure of these large craters.

During its course to the low resonant orbit, Dawn paused at an intermediate orbit with a periapsis close to LAMO to perform observations of the better-illuminated southern polar region with VIR. The objectives of that phase are to map the distribution of the ammonium signature against geological features. Dawn will carry out FC color imaging of high-priority targets in the northern hemisphere to obtain new or repeat coverage. Along with the GRaND results, these data will contribute to the goal of testing hypotheses of Ceres' origin and hydrothermal

evolution, as well as understanding cryomagmatic processes.

Lastly, throughout XM2 Dawn will keep monitoring for solar energetic proton events to be correlated with ground-based telescopic search for outgassing [2] in order to characterize the mechanism(s) of vapor production at Ceres, with applications to other ice-rich bodies.

2. End of Mission

Once the spacecraft runs out of hydrazine, it will lose the ability to maintain the solar arrays pointing to the sun, and the spacecraft will lose power. That time is expected in the early Fall 2018. Dawn will continue to orbit Ceres stably in the eccentric orbit for decades to come in accordance with the planetary protection requirements.

Acknowledgements

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References

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