DAWN'S CONTINUED EXPLORATION OF CERES. C A. Raymond[1], C. T. Russell[2], M. D. Rayman[1], C. A. Polanskey[1], S. P. Joy[2], J. C. Castillo-Rogez[1], M. C. De Sanctis[3], A. Nathues[4], T. H. Prettyman[5], and the Dawn Team; [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109, USA (carol.a.raymond@jpl.nasa.gov); [2]University of California Los Angeles, IGPP/EPSS, Los Angeles, CA, 90095, USA; [3]IAPS/INAF, Rome, Italy, [4]MPS, Göttingen, Germany, [5]Planetary Science Institute, Tucson, AZ, USA.

Introduction: Dawn completed its primary mission, achieving all of its Level-1 requirements, in June of 2016 after spending 7 months in the low altitude orbit (LAMO) at ~385 km. NASA approved a one-year extension of mission operations (XM1) at Ceres to refine the primary mission data sets and obtain repeat observations to look for surface changes. The objectives of XM1, described below, were achieved with sufficient hydrazine remaining on the spacecraft to support continued operations. 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. The two extended mission phases are described here, as well as the science objectives achieved and planned.

XM1: June 2016 – Oct 2017: XM1 began at the LAMO altitude (~385 km), where additional observations were made by the Gamma Ray and Neutron Detector (GRaND) for over 9 weeks to improve counting statistics and collect data under different gain settings to search for evidence of nickel. At the same time, additional off-nadir imaging was obtained to complete the data set used to construct a high-resolution topographic model at ~35m/pixel resolution. Additional radiometric tracking data contributed to an increase in the resolution of the gravity field to degree and order 18. High-resolution framing camera (FC) color imaging and visible-infrared mapping spectrometer (VIR) spectra were obtained for several high-priority targets, including Occator crater.

Dawn then spiraled up to an orbit at ~1500 km altitude, equivalent to the first high-altitude mapping orbit (HAMO). In this HAMO-type orbit, full 7-filter color mapping with the framing camera was completed in the south polar region, and repeat coverage was obtained over the rest of Ceres to compare to the previous HAMO full-color data set. In addition, long-exposure images were collected to search for ice in persistently shadowed regions. Infrared spectra of high-priority targets (including Juling and Oxo craters) were obtained, which had proved difficult to capture in the LAMO orbit.

In the third phase, Dawn spiraled up to an orbit at ~7200 km altitude to obtain GRaND background spectra with the goal to improve the accuracy of analyses of data acquired at low altitude. In the final phase of XM1, the spacecraft ascended to an eccentric orbit (~20,000 × 50,000 km) and rotated the orbit plane to perform an opposition observation. The phase curve was obtained down to 0.7 degrees in the panchromatic and three color filters. The spacecraft stayed in this distant, hydrazine-conserving orbit to complete acquisition of GRaND background data and monitor for solar energetic particle fluxes implicated in sputtering a transient exosphere, while the second extended mission proposal was being evaluated.

XM2: Oct 2017 – TBD 2018: NASA approved Dawn's second extended mission at Ceres with the goal of obtaining elemental concentrations with high sensitivity and spatial resolution. 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. Dawn will enter 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. The measurements will occur during a particularly quiet period of solar activity, ensuring the intensity of galactic cosmic rays, used to interrogate the surface, is maximum. Limited longitudinal coverage will be obtained in a resonant orbit that focuses on coverage of Occator crater and its ejecta, while also characterizing the ancient heavily cratered terrains in the north, and large Urvara and Yalode basins in the south. Combining these very low altitude data with the extended background time series 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 which provides clues about processes that shaped the regolith, crust, and interior.

In the course of achieving the low resonant orbit, VIR observations of the better-illuminated southern polar region will be obtained, as well as FC color imaging of high-priority targets 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 cyromagmatic processes.

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. It will continue to orbit Ceres stably in the ec-

centric orbit for decades to come in accordance with the planetary protection requirements.

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