DAWN FRAMING CAMERA CLEAR FILTER IMAGING ON CERES APPROACH. A. Nathues[1], M. V. Sykes[2], I. Büttner[1], D. L. Buczkowski[3], U. Carsenty[4], J. Castillo-Rogez[5], U. Christensen[1], P. Gutierrez-Marques[1], I. Hall[1], M. Hoffmann[1], R. Jaumann[4], S. Joy[6], H. U. Keller[7], E. Kersten[4], K. Krohn[4], J.-Y. Li[2], S. Marchi[8], K.-D. Matz[4], T. B. McCord[9], L. A. McFadden[10], K. Mengel[1], V. Mertens[4], S. Mottola[4], W. Neumann[4], N. Mastrodemos[5], D. P. O'Brien[2], K. Otto[4], C. Pieters[11], S. Pieth[4], C. Polanskey[5], F. Preusker[4], M. D. Rayman[5], C. Raymond[5], V. Reddy[2], J. Ripken[1], T. Roatsch[4], C. T. Russell[6], M. Schäfer[1], T. Schäfer[1], P. Schenk[12], N. Schmedemann[13], F. Scholten[4], S. E. Schröder[4], F. Schulzeck[4], H. Sierks[1], D. Smith[14], K. Stephan[4], G. Thangjam[1], M. Weiland[4], D. Williams[15], M. Zuber[14]; [1]Max Planck Institute for Solar System Research, Göttingen, Germany (nathues@mps.mpg.de); [2]Planetary Science Institute, Tucson AZ, USA; [3]Applied Physics Laboratory, Johns Hopkins University, Laurel MD, USA; [4]DLR, Berlin, Germany; [5]Jet Propulsion Laboratory, Pasadena CA, USA; [6]University of California, Los Angeles CA, USA; [7]Institut für Geophysik und extraterrestrische Physik, TU Braunschweig, Germany; [8]Southwest Research Institute, Boulder CO, USA; [9]Bear Fight Institute, Winthrop WA, USA; [10]NASA Goddard Space Flight Center, Greenbelt MD, USA; [11]Department of Earth, Environmental, and Planetary Sciences, Brown University, Providence RI, USA; [12]Lunar and Planetary Institute, Houston TX, USA; [13]Institute of Geological Sciences, Freie Universität Berlin, Berlin, Germany; [14]Massachusetts Institute of Technology, Cambridge MA, USA; [15]Arizona State University, Tempe AZ, USA.

Introduction: Having completed its investigation of 4 Vesta in late 2012, the NASA Dawn mission has been in transit to its second target, the dwarf planet Ceres [1]. It will be captured into Ceres orbit on March 6, 2015 and commence detailed science observations in April.

During its approach, Dawn is scheduled to conduct a number of sequences for purposes of navigation, instrument calibration and early rotational characterization of Ceres. Visible and near-infrared spectra will be acquired as well. The Framing Camera (FC) obtained its first resolved image of the planet on December 1, 2014 (Fig. 1). On January 25, 2015, Dawn is expected to image Ceres at a resolution 1.3x that of earlier HST observations [2].

In February, 2015, Dawn will characterize the surface of Ceres twice as it rotates, at FC resolutions of 3.7x and 7x that of HST, respectively. This last corresponds to ~4 km on Ceres.

While future mapping observations will be made at much higher resolution (415 m during Survey orbit, 138 m during High Altitude Mapping Orbit, 35 m at Low Altitude Mapping Orbit), the approach imagery is sufficient to immediately address some fundamental hypotheses and will reveal many Ceres surface structures for the first time.

Does Ceres Have Substantial Subsurface Water Ice?: Very early in the approach, Dawn's imaging will provide refined and firm estimates of Ceres' global shape, which provides direct insight into interior structure and thermal state. Thermodynamic modeling [3] and HST observations [4] of Ceres indicate a differentiated body with a rocky core and ice-rich mantle [5]. If Ceres harbors a thick ice-rich shell, then crater morphologies should resemble those on icy satellites with similar surface gravity [6], namely Dione, Tethys, Rhea and Iapetus. In the absence of other effects, most larger craters on Ceres will thus be dominated by large central peaks. The transition diameter from simple to complex craters on the Saturnian satellites is ~4 to 6 km (as measured by shape [7]) and ~8-10 km (as measured by occurrence of central peaks). We may begin seeing this transition on Ceres in approach imaging.

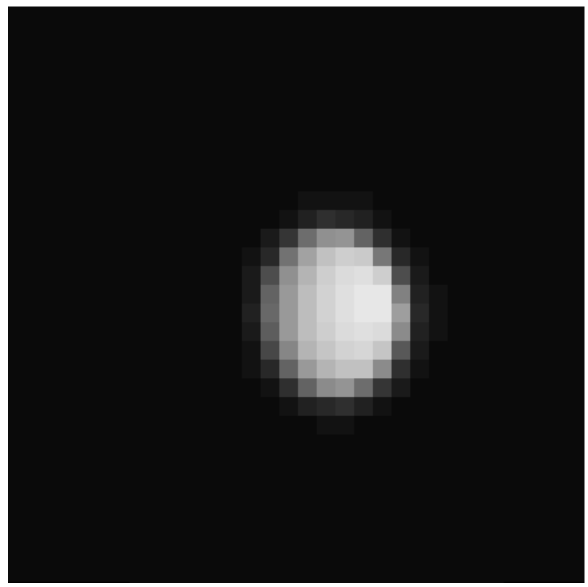

Figure 1: The first resolved image of Ceres from Dawn at a distance of 1.1 million km.

Several authors [8,9] predict that viscous relaxation will dominate surface morphology, resulting in a very smooth equatorial region unable to support deep craters larger than ~4 km. However, even fully relaxed craters on Enceladus leave residual topographic rings, as the crater rim is resistant to relaxation. Relaxed craters on Ceres should be recognizable, as circular ridges or perhaps as palimpsests similar to those observed on Galilean satellites (e.g., [10]).

Given Ceres' low obliquity, ice will be colder at higher latitudes and able to sustain larger relief structures over time. Near the poles, the Ceres surface should be richer in deep craters, though even there basin-sized structures may have relaxed over billions of years. [6,6.5].

Large-Scale Surface Morphologies: HST observations [2] have revealed 11 regional albedo landmarks, whose nature may be elucidated during the approach.

Ice-rich bodies over a wide range of temperature regimes exhibit a variety of surface structures arising from tectonics and solid-state convection (e.g., [11]). Thermal modeling of Ceres indicates past and possibly present water reservoirs in the interior and the existence of heat sufficient to drive solid state convection until recent time [3, 12]. Ceres' small variations in albedo over its surface [13] have been interpreted as evidence for recent resurfacing via mobile-lid convection [12], i.e., transfer of material to the surface following fracturing, as suggested for icy satellites [14]. Such interior processes may be manifested by surface structures that are active or relict from an earlier time.

Investigating Longitudes At Which Water Vapor Has Been Observed: Water vapor near the surface of Ceres has been observed by the Herschel Space Observatory roughly centered at two different longitudes [15] and an earlier single OH florescence detections was reported from the International Ultraviolet Explorer [16]. Detection and identification of these species is a principal focus of the Visible and near-InfraRed imaging spectrometer (VIR) working in tandem with FC. The latitudes of the Herschel emissions are unconstrained. Several mechanisms have been proposed for water vapor emission, including cryovolcanism, recent impacts exposing subsurface ice and comet-like emissions. Whether there could be a connection with an interior liquid water reservoir is unknown. The necessary crater size would be below the resolution of Dawn approach images. However, any unusual physical structure correlating with the emission longitudes would be of interest.

Checking for Temporal Variations of the Surface: The initial rotational characterization observations of Ceres can be reduced in resolution to compare with earlier mapping of Ceres by HST ten years earlier [2]. Such a global comparison provides an opportunity to determine whether there is any major resurfacing or modest-scale activity ongoing today that might be evidenced.

Satellites: Previous searches for satellites orbiting Ceres have yielded no detections [17,18]. Throughout approach, beginning with the initial calibration images on December 1, Dawn has obtained images of the orbital environment about Ceres that is comparable to or better than previous satellite searches in sensitivity, though in a sample of space much smaller than the Hill sphere. A dedicated satellite search campaign is scheduled for February 4, 2015 with additional images acquired until April 15, 2015. The goal is to search for satellites below the previous upper limit of 1 km [18].

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