IAPETUS IMAGING DURING THE TARGETED FLYBY OF THE CASSINI SPACECRAFT.

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Introduction: On September 10, 2007, the Cassini spacecraft performed its first and only targeted Iapetus flyby [1] at an altitude of 1620 km. Approach occured over the unlit leading, departure over the illuminated trailing hemisphere. About 450 images from the ISS experiment [2] have been sent to Earth during the time period of ±1 d around closest approach.

Data: The best spatial resolution of the ISS images is 10 m/pxl. These data cover an area near 0°N/ 165°W at phase angles between 83° and 29°. Inbound coverage includes a 1x4 mosaic of the crescent at 145° phase (visible surface between 120°W/terminator and 150°W/limb; ~500 m/pxl), a 1x3 mosaic at mid latitudes (40°N; 80 m/pxl), high-resolution (33 to 12 m/pxl NAC and 330 to 120 m/pxl WAC) mosaics of the ridge near 140°W and the "Voyager mountains" at 185°W (oblique views), as well as other observations.

High-resolution (17 to 144 m/pxl) outbound observations at low phase angles (~30°) cover dark and bright terrain samples, mid-southern-latitude and equatorial dark/bright transition zone terrain, nadir-looking views of the "Voyager mountains", and terminator mapping at ~290°W. A global mosaic (420 to 460 m/pxl), consisting of 15 panels, is centered at 10°S/ 247°W. The best (although oblique) view of high southern latitudes has a spatial resolution of 240 m/pxl.

High-level information about the observation planning as well as all images can be found on the Iapetus flyby planning web page at FU Berlin [3].

"Voyager mountains": Discovered in 1999 [4], the informally called "Voyager mountains" have now been observed for the first time at very high resolution. There are at least nine isolated mountains located between 185°W and 245°W at the equator. Different to the impression from the low-resolution Voyager images, the three easternmost mountains are not completely bright, but show bright patches only at their eastern flanks and are otherwise covered by dark material. Limb measurements of one mountain indicate a height of about 10 kilometers, with the basis ~50 km wide and average slopes between ~20° and ~30°.

Equatorial ridge: The equatorial ridge, discovered on 25 Dec 2004 [5], shows a strong topographic variation similar to the parts located further east, which have been observed at medium resolution on New-Year's Eve 2005 [6], [7], [8]. The Digital Terrain Model of [7] describes its topography for longitudes east of ~140°W. During the recent targeted flyby, parts of the ridge located between 125°W and 185°W have been observed at medium and high spatial resolution. Here, the ridge has an average width of ~60 km and is up to ~18 km tall. At 158°W, the morphology shows a sudden change. East of this longitude, it has a flat "roof", while west of it, the ridge has a triangular profile. The ridge also becomes shallower here, and disaggregates into two isolated ridges with lengths at the order of 50 km. West of 173°W, only quite shallow hills can be seen up to the easternmost of the "Voyager mountains" at 185°W.

All parts of the ridge which have no obvious steep slopes are covered by numerous impact craters. At the flanks, many signs of downslope movement can be seen. These areas show significantly less craters, probably a result of land slides. The overall topography, especially its rather dramatically changing character with longitude and the ability of the ridge to hold large craters with sharp rims, argues for a solid structure [7] but not for a pile of rubble, as proposed by [9].

From a global perspective, the ridge (including the "Voyager mountains") spans over more than 1/2 of Iapetus' equator, but might have spanned around the full circumference originally. It is most prominent and almost continuous between 50°W and 245°W, with a minor gap only between 70°W and 85°W. An isolated bright mountain exists at 340°W [7]. The huge impact basin on the sub-Saturn hemisphere (centered at 18°N/ 25°W) might have destroyed a former ridge between ~350°W and ~50°W. The currently available data are insufficient to make a definitive statement if there are any significant mountains between 245°W and 270°W. There might be a very degraded basin between ~270°W and 330°W (Fig. 2 in [7]), its formation might have destroyed the ridge at this location. This leaves virtually no place on the equator where no excuse might be found why the ridge is absent there. However, it is also possible that there was never any ridge between ~245°W and ~50°W.

Local albedo: While the global brightness dichotomy is known for centuries, the new data revealed that there is only very little "gray" shading in between either dark or bright areas, even in the transition zone. The dark material visible on the surface is areally, not intimately mixed with the bright terrain.

A very distinct surface property of the dark/ bright material distribution in the transition zone and on the equatorial to mid-latitude parts of the trailing side is that dark slopes face towards the equator, while bright slopes are facing poleward. The amount of dark equatorward-facing slopes diminishes towards higher latitudes, with dark material patches being almost absent at high latitudes.

These distribution properties argue for a thermal effect as the cause. The slightly warmer surface temperatures on the equatorward-facing slopes up to mid-latitudes seem to be sufficient to sublime the bright ice of the surface over time, leaving behind a dark material lag deposit. This mechanism of thermal segregation was previously suggested as a major cause for the global brightness dichotomy [10], [11], [12]. For the first time, we can see this now as a local phenomenon as well, strongly supporting the idea that thermal effects play a major role in shaping Iapetus' landscape.

Trailing-side basins: Cassini data revealed numerous large basins on Iapetus. The largest on the trailing side, centered at 39°S/260°W and known from very low resolution data taken in 2004 [5] has been identified as a double structure, with the older basin showing a diameter of ~380 km. The younger one destroyed about 1/3 of the older one and has a size of ~450 km.

Small bright craters in dark terrain: From ISS data, a strong indication that dark material is lying over bright terrain are the numerous small bright craters detected in the high-resolution images from the flyby. Such craters were already seeked for in earlier data, but nothing was found due to the insufficient spatial resolution of these images (up to 730 m/pxl [6], [8]).

Brightness and age measurements, described in detail in a companion abstract [13], indicate that bright ejecta from a fresh impact might fade by a factor of 2 quite rapidly within the order of $\sim 10^5$ years, and down to about twice the brightness of the dark surroundings within a few tens of millions of years only. This rapid fading might also explain why there is mainly dark or bright material on the surface, but almost no gray, as stated above.

Dark terrain blanket thickness: The existence of these small craters (up to some dozens of meters in diameter) indicates that the dark blanket is very thin, probably no more than a few meters, possibly only decimeters. On the other hand, we expect the dark material being thicker than only millimeters because of the evidence for mass wasting and because of the ability of the Cassini 2.2 cm RADAR to distinguish between the dark and the bright terrain [14].

Global brightness dichotomy: For the explanation of the global brightness dichotomy, the new data support the previously suggested [15] combination of the effects described by Spencer *et al.* [10], Denk *et al.* [11], and Soter [16]/ Buratti *et al.* [17] in the following way (given is a combined description of facts, findings, and models): (1) Iapetus has a synchronous rotation, hence a leading and a trailing side. (2) We have an exogenic source for reddish, slightly darker material ([17] suggests the outer retrograde moons of Saturn as the source), which brings in this material onto the leading side and which is responsible for the *color dichotomy* of Iapetus detected in Cassini ISS data [11]. (3) Iapetus' orbit is far out compared to the other regular moons of Saturn. This makes it the first and primary obstacle for material spiraling in on retrograde paths. Hyperion (reddish in color and not as bright as the other Saturnian moons!) is the next obstacle, while Titan as the third sink protects all the remaining regular moons from being coated that way. (4) Iapetus has a very slow rotational period (almost 80 d), allowing the sun to warm its surface more than any other place in the Saturnian system. (5) The combination of these effects allows thermal segregation [10] to act globally at low- and mid-latitudes (up to ~50° latitude) of the *leading* side, which has the "slightly warmer starting condition" due to the exogenically implanted material. On the *trailing* side, only equatorward-facing slopes at low- and mid-latitudes became warm enough for the sublimation process to initiate effectively. The remaining surface, especially the poles, is too cold for a significant water ice loss. Especially the poles rather act as a sink for water ice [10], consistent with the detection of bright polar caps on Iapetus by the ISS instrument. The presumably thin, but not ultra-thin dark blanket supports the thermal model, but would be inconsistent with the idea that exogenic material alone is responsible for the *brightness* dichotomy. Instead, the dark material blanket should be a residual of a formerly bright surface where the water ice has been lost.

References: [1] Pelletier F.J. et al. (2007) AAS/AIAA, AAS07-255. [2] Porco C.C. *et al.* (2004) *Space Sci. Rev. 115*, 363. [3] http://www.geoinf.fu-berlin.de/projekte/cassini/cassini_fu_iapetus_flyby.php. [4] Denk T. et al. (2000) *LPSC XXXI*, abstract #1596. [5] Denk T. et al. (2005) *LPSC XXXVI*, abstract #2262. [6] Porco C.C. et al. (2005) *Science 307*, 1226-1236. [7] Giese B. et al. (2008) *Icarus 193*, doi:10.1016/j.icarus.2007.06.005. [8] Denk T. et al. (2005) *LPSC XXXVI*, abstract #2268. [9] Ip W.-H. (2006) *GRL 33*, L16203. [10] Spencer J.R. et al. (2005) *37th DPS*, abstract 39.08. [11] Denk T. et al. (2006) *EGU*, abstract EGU06-A-08352. [12] Mendis and Axford (1974) *Ann. Rev. Earth and Planetary Sci. 2*, 419-474. [13] Schmedemann N. et al. (2008) *LPSC XXXIX*, abstract #2070. [14] Ostro S.J. et al. (2006) *Icarus 183*, 479-490. [15] Denk T. et al. (2005) *37th DPS*, abstract 39.07. [16] Soter S. (1974) *IAU Colloq. 28*. [17] Buratti B.J. et al. (2002) *Icarus 155*, 375.