BRIGHT RAY CRATERS ON RHEA AND DIONE. R. J. Wagner[1], G. Neukum[2], U. Wolf[2], N. Schmedemann[2], T. Denk[2], K. Stephan[1], T. Roatsch[1], and C. C. Porco[3], [1]Inst. of Planetary Research, German Aerospace Center (DLR), Rutherfordstrasse 2, D-12489 Berlin, Germany, e-mail: roland.wagner@dlr.de; [2]Inst. of Geosciences, Freie Universitaet Berlin (FUB), D-12249 Berlin, Germany; [3]Space Science Institute, Boulder, CO., USA.

Introduction: Craters with bright rays occur on terrestrial planets as well as on the icy satellites in the outer solar system [1][2]. Ray craters are morphologically fresh and superimpose other geologic units which implies that they are stratigraphically young. Bright crater rays fade with time. Their preservation is an indicator for the intensity of geological processes, especially erosion and erosion rates. However, the exact age of most ray craters on the terrestrial planets and on the icy satellites is not known since they can only be dated with cratering chronology models, except for the Moon where ages could be derived by radiometric ages of rock samples (e.g., [3][4]). For ray craters on the icy satellites of Jupiter, retention times on the order of 1 – 2 Ga were estimated [5]. In this paper we discuss bright rayed craters on two of the major icy satellites of Saturn in order (1) to date ray craters on high-resolution images by their superimposed crater frequencies, applying cratering chronology models [6][7], (2) to constrain stratigraphy and ages of older geologic units and more recent geological processes, (3) and to infer impact conditions and impactor origins.

Occurrence of ray craters on the satellites of Saturn: Small kilometer-sized craters with bright rayed ejecta are observable on all major Saturnian satellites, except Mimas and Hyperion (e.g., [8][9]). Larger bright ray craters several tens of kilometer in diameter are only found on Dione and Rhea. The Saturnian satellites lack large bright ray craters 50 – 100 km and larger which are observed on the icy satellites of Jupiter [10][11].

Imaging data: The icy satellites of Saturn are observed by the narrow angle (NAC) and wide angle (WAC) cameras aboard the Cassini orbiter in the Cassini Prime Mission (2004 – 2008), Cassini Equinox Mission (2008 – 2010) and Cassini Solstice Mission (since Sep. 2010). Bright ray craters are easily detectable in images taken at high sun, independent of image scale (except for small bright ray craters). Color ratio images also help to detect ejecta rays [12].

Selected ray craters: In this work we focus on two craters in the diameter range 30 – 50 km: ***Inktomi*** on Rhea, and ***Creusa*** on Dione. Only Inktomi was imaged by Cassini ISS at sufficient resolution (35 m/pxl) useable for geologic mapping in orbit 049 (Aug. 2007). ISS has imaged Creusa in several orbits but only at low resolution. In orbit 129, Creusa was imaged as part of a regional mapping imaging sequence of the sub-Saturnian hemisphere at a highest scale of 240 m/pxl. Unfortunately, Creusa was located close to the limb when these images were taken which impedes detailed geologic investigation due to the highly oblique view.

Inktomi (Rhea): Rhea's largest bright ray crater Inktomi (*Fig. 1*) has a diameter of 47.2 km and is located at lat. 14.1° S, long. 112.1° W. The butterfly wing ejecta pattern indicates an oblique impact from the west [13]. Recent analysis of VIMS data revealed clean H_2O ice without impurities at the crater and in its ejecta [14]. Reassessment of the images from orbit 049, using additional images taken from Inktomi and its surroundings, confirms a continuous ejecta blanket almost devoid of small craters and the low cratering model age of this crater (280 Ma [6][13] versus 8 Ma [7][13]). An anaglyph constructed from these images shows a hilly crater floor with a prominent but topographically low central peak complex (*Fig. 2*). While regular radial secondaries occur outside of the continuous ejecta blanket associated with the bright rays, clusters of numerous small craters could be identified in the eastern part of the crater floor and in the adjacent continuous ejecta [13]. These small craters most likely were created by material ejected at a steep angle [13][15]. An alternative, but less likely, explanation is the impact of primary impactor materal disintegrated into clusters of numerous small impactors [13].

Creusa (Dione): Dione's largest bright ray crater Creusa has a diameter of 36.2 kilometer and is centered at lat. 49.2° N, long. 76.3° W. Its bright rays extend over several hundreds of kilometers almost over the entire sub-Saturnian hemisphere, as seen in low-resolution images taken at comparably high sun (*Fig. 3*). Low-resolution VIMS data from orbit 043 showed the association of a strong H_2O spectral signal with the location of the crater and also revealed a significant influence of the extended ray system on the H_2O-dominated spectral properties of the leading hemisphere [12]. The morphologic freshness of Creusa and the pristine state of its rays infer the stratigraphic youth of this impact feature, indicating an age possibly less than 500 Ma. Images of higher resolution, taken under less oblique viewing conditions, are necessary for detailed geologic mapping and measurements of crater size-frequency distributions.

Summary: Of the nine major satellites of Saturn, only Dione and Rhea display young, morphologically fresh craters several tens of kilometers across with extended bright ray systems. In VIMS data, these craters and their rays are associated with strong H_2O ice absorption bands [12][14]. These craters most likely are much younger than 500 Ma, derived from crater counts of one of these features (Inktomi) [13]. The far-reaching spatial extension of the rays indicate high-velocity impacts, possibly from heliocentric cometary bodies. If the clusters of small craters in Inktomi were created by a disintegrated part of the primary projectile, this could also infer a low-strength body, such as a comet, as candidate impactor.

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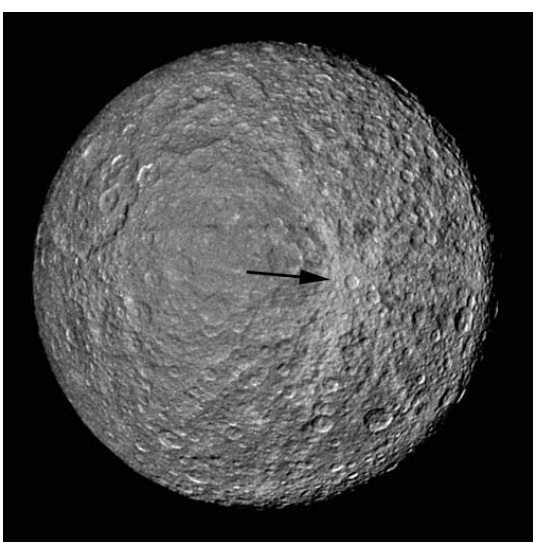

Figure 1: Bright ray crater ***Inktomi*** on Rhea; clear filter image from orbit 056, ISS NAC frame N1579246587; orthogr. projection, centered at 11° S, 133° W, scale 2.5 km/pxl. Arrow indicates direction of impactor.

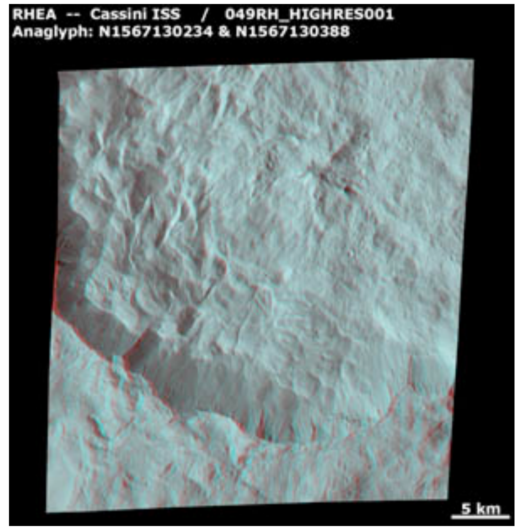

Figure 2: Anaglyph image of southern rim and interior of ray crater Inktomi; clear filter images from orbit 049, imaging sequence 049RH_HIGHRES001, image scale 35 – 45 m/pxl.

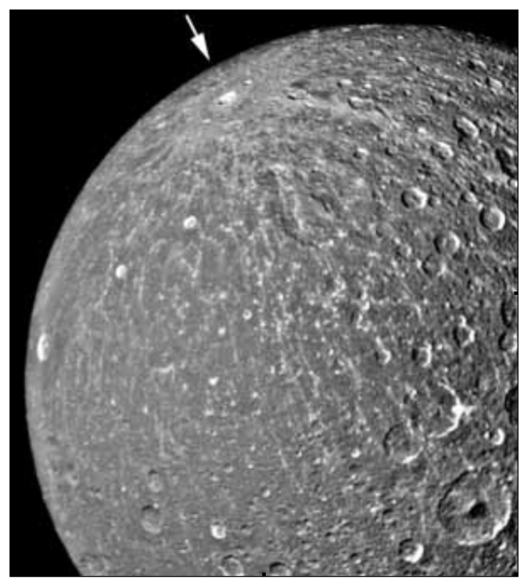

Figure 3: Bright ray crater ***Creusa*** on Dione (indicated by arrow) and its far-reaching ray system; ISS NAC frame N1649331848 (detail) from orbit 129, orthographic projection (center lat. 5° S, long. 35° W).