

CASSINI AND GALILEO IMAGING OBSERVATIONS OF IO. A. McEwen¹, P. Geissler¹, M. Milazzo¹, E. Turtle¹, L. Keszthelyi¹, C. Porco¹, D. Simonelli², M. Belton³, and the Galileo SSI Team. ¹LPL, University of Arizona (mcewen@lpl.arizona.edu); ²Cornell University; ³Belton Space Exploration Initiatives, LLC.

Introduction: Galileo completed its 29th periapsis with Jupiter on December 29, 2000 and the closest approach to Jupiter by the Cassini spacecraft occurred the next day. Both spacecraft cameras imaged Io, especially during eclipses to observe high-temperature hot spots and visible aurora.

Galileo Observations: The imaging experiment completed three sets of Io observations in the last days of 2000: (1) full-disk images at ~10 km/pixel to provide a global mosaic in 4 colors; (2) observations of the Prometheus plume; and (3) 8 sets of images (clear, violet, and 1 micron filters) providing a temporal sequence of an Io eclipse on Dec 31. The global mosaic will enable mapping of color and albedo changes on Io over the past ~2 years, since the nominal mission. We have not yet (as of 1/10/01) seen any of the Galileo images, but we will present initial results at LPSC.

Cassini Observations: Several hundred Io images from Cassini have been returned in the past 2 weeks, and data acquisition and playback are continuing. Only very preliminary results can be described here, but more complete initial results will be described at LPSC. The Cassini images are ~60-120 km/pixel scale, whereas the latest images from Galileo are 10-15 km/pixel. However, Cassini can acquire unsmearred long-exposure images (i.e., in eclipse) whereas Galileo images in eclipse have always been smeared by at least 3 pixels and up to ~25 pixels. Cassini's camera also has many more filter combinations than Galileo, and greater UV sensitivity.

Eclipse Observations: Cassini has observed Io during 4 eclipses (Dec 29, Dec 31, Jan 1, and Jan 5). The Dec 29 and Jan 1 observations are movies with ~150 images,

mostly clear filters but interspersed with 4 other bandpasses. Cassini also observed the beginning portion of the eclipse seen by Galileo on Dec. 31, but with a subspacecraft position ~30 degrees to the east. This should enable stereo viewing of the glowing gases, and measurement of hot spot intensities at different emission angles. In addition, the intriguing sub-Jovian field of bright spots (faint hot spots or small gas vents; ref. [1]) was imaged simultaneous against the disk (by Galileo) and on or near the limb (by Cassini). Cassini has shown that the diffuse glow over the sub-Jovian region is especially bright in the UV, consistent with SO₂ gas [2]. Many filter combinations were utilized on the Jan 5 eclipse, to search for new spectral features.

Hot Spots: Pele is by far the most prominent hot spot seen in eclipse, but there are at least 8 others. The 3 brightest spots (after Pele) are all east of Pele--one is probably Pillan, another may be Marduk, and at least one is a hot spot not previously detected. Faint hot spots are also present at Loki, Fuchi, Acala, and other locations. Images in the clear (200 to 1100 nm), IR4 (>970 nm), and other near-IR bandpasses will enable determination of brightness temperatures [3].

Pele Lava Lake: We have analyzed 50 clear-filter images from the Dec. 29 eclipse to monitor the intensity of Pele. The intensity drops very gradually by about 45% as Pele moves toward the limb, proportional to cosine(emission_angle)^{1.6}. This gradual drop in apparent intensity could be due to the emission angle alone, from a combination of reduction of projected area and from hot lava progressively hidden in a network of cracks. Alternatively, there may have been an actual gradual cooling over ~ 2 hours. The fluctuations in intensity over time periods of a

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few minutes are less than 5%; this is quite remarkable because a silicon detector sees only hot (>900 K) lava that is seconds to at most a few minutes old at wavelengths near 1 micron [4]. The combination of characteristics of Pele are indicative of an active lava lake [5]. The Cassini data indicate that the crust is almost continuously overturned or disrupted. The Cassini image sequences can be used to constrain models for physical processes in the lava lake [6].

Visible Aurora: During Io eclipses we see colorful emissions from sulfur dioxide, sodium, neutral oxygen, and perhaps other components of the atmosphere and active volcanic plumes [2]. There is evidence from Galileo eclipse images for spatial and temporal variability in these emissions related to orbital longitude, magnetic longitude, time in eclipse, and plume activity [7]. The Cassini eclipse movies will be used to test and refine these models.

Plumes: Cassini observations of sunlit Io for surface and plume monitoring were nearly all lost when science observations were halted to study an anomaly in the performance of one of the reaction wheels. There are some partially-illuminated images of Io just before

or after full eclipse that are unsaturated in the UV filters. As expected, they reveal the active plumes much better than is possible at visible wavelengths, because the plumes are relatively bright and surface relatively dark in the near-UV. The images reveal a plume-like glow near Pele, seen projecting into sunlight when the vent is just across the terminator on the nightside. However, it is unclear pending further analysis whether the plume vent is Pele or one of 3 other hot spots seen to the east of Pele. We also see a plume-like feature over Io's north pole, which corresponds to a bright limb glow seen in eclipse. Images of Io transiting Jupiter show a bright spot just beyond the terminator which indicates that the Prometheus plume is still active.

References: [1] McEwen, A., et al. (1998) *Icarus* 135, 181-219. [2] Geissler, P., et al. (1999) *Science* 285, 870-874. [3] McEwen, A., et al. (1998) *Science* 281, 87-90. [4] Keszthelyi, L., and A. McEwen (1997) *GRL* 24, 2463-2466. [5] Davies, A., et al., (2001) submitted; LPSC XXIX (1998). [6] Davies, A. (1996) *Icarus* 124, 45-61. [7] Geissler, P. et al. (2001) submitted.