

THE SHADOW OF TITAN ON MIMAS AND SATURN'S RINGS W. B. Hubbard¹, G. J. Consolmagno SJ^{1,2}, R. P. Boyle SJ², R. Hill¹, ¹Lunar and Planetary Laboratory, University of Arizona, Tucson AZ 85721, ²Vatican Observatory Research Group, Steward Observatory, University of Arizona, Tucson AZ 85721

ABSTRACT. We observed the Saturn system on November 7-9, 1995, at the Vatican Advanced Technology Telescope (VATT) on Mt. Graham, Arizona, using the portable CCD (PCCD) fast occultation imaging system of the University of Arizona. Along with imaging seven of Saturn's moons, we recorded a rare mutual event on the evening of November 9 (4:25 UT November 10) where sunlight at the Saturnian moon Mimas was eclipsed by Titan. The shadows of Rhea and Titan were also seen moving across the rings of Saturn itself. Analyzing the change in brightness in this shadow during these events may provide information about the structure of Titan's atmosphere, and the precise timing of the shadow-Mimas event will give improved precision to the ephemeris of Mimas' orbit.

BACKGROUND. In August and November 1995 the Earth and Sun crossed the plane of Saturn's rings, providing a rare opportunity to look for faint objects near Saturn and to observe mutual events of the Saturnian satellites [1,2]. (A similar favorable orientation of Saturn, Earth, and Sun will not occur again until the year 2038.) Observations of the ring plane crossing in November represented the first observations of planets at the VATT; thus they also provided a test of many aspects of the VATT's new technologies. Traditionally, only long focal length telescopes have been considered adequate for planetary observations, but the superb optics of the VATT f/1 mirror and favorable observing conditions on Mt. Graham provided excellent results.

OBSERVATIONS. Our primary sequence of observations consists of six hundred images of the east ansa of Saturn's ring, each a three second exposure through the R filter, taken over 30 minutes from 4:02 to 4:32 UT November 10. Saturn itself was masked from the CCD chip. Each pixel of the chip represented 0.3 arc-seconds. Seeing reached as good as 1.3 arc-seconds, but the focus of the VATT was not corrected during the run as the mirrors cooled, reducing the quality of some of the images; this problem will have to be addressed in future long-period imaging runs at the VATT. (With Gregorian optics, changes of as little as 5 microns in path length can significantly degrade the focus.) A passing weather front with high (20+ mph) winds and an occasional cloud also provided challenges; the telescope turned out to be remarkably stable, even aimed into the wind, but passing clouds degraded about 10% of our images.

The images were processed with "unsharp masking" to enhance contrast. The shadow of Titan can be clearly seen crossing the rings through the sequence, approaching Saturn as Titan moves past Saturn in its orbit. During this time Mimas is appearing from behind Saturn. Though Mimas itself is lost in the glare of the rings in the raw images, the enhanced contrast masking allows it to be clearly picked out from the background.

RESULTS. For our preliminary look at the Mimas light curve, one of us (Hubbard) picked out by eye, image by image, the position of Mimas and recorded its brightness using 5x5 and 3x3 pixel boxes around the image. A clear dip in brightness is seen in all boxes, with the smaller box showing the clearest results. At this writing, no definitive inference can be made about the shape of the dip, but it appears to last from 4:22 to 4:26 UT. Earlier calculations predicted eclipses from 4:22.21 to 4:25.22 [1] and from 4:21.0 to 4:27.4 [2]. Future data reduction will compare Mimas' position and brightness to that of the neighboring ring.

The shadow on the ring is much more clearly seen, and may provide our best evidence for the shape of Titan's shadow. That in turn can be used to draw inferences about Titan's thick atmosphere. This remains for future work, however [3].

REFERENCES. [1] Arlot J. E. and Thuillot W. (1993) *Icarus* **105**, 427. [2] Aksnes K. and Dourneau G. (1994) *Icarus* **112**, 545. [3] The University of Arizona PCCD observations are supported by NASA Planetary Astronomy Grant NAGW-1555. The VATT facility is comprised of the Alice P. Lennon telescope and the Thomas J. Bannan astrophysical laboratory.

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Vatican Advanced Technology Telescope

Mt. Graham International Observatory, Arizona

1995 Nov 10 04:48:03 UT

shadows of Titan and Rhea on rings of Saturn

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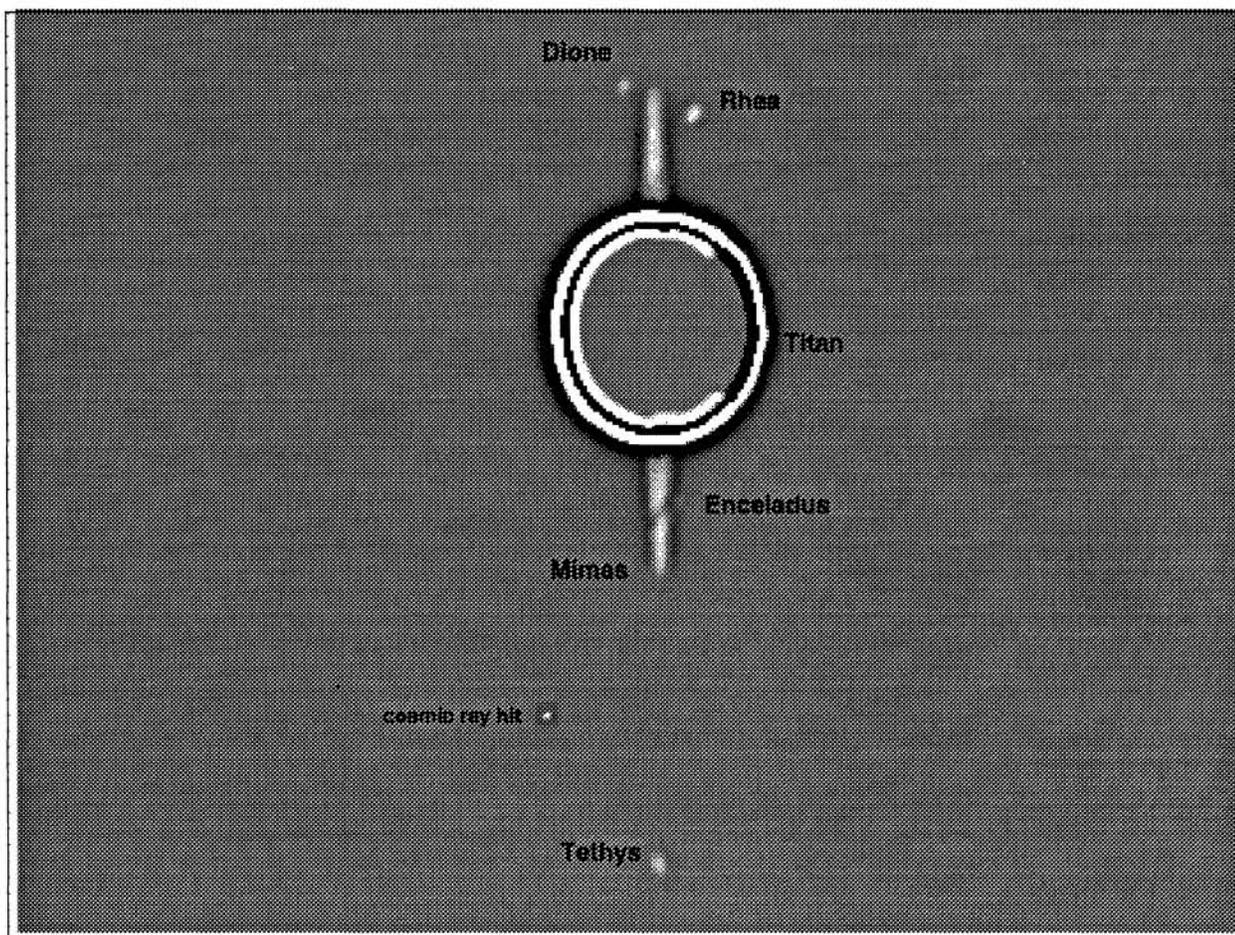


Figure 1: Processed image of Saturn following the Mimas/Titan event. Note the shadow of Titan visible in the lower ansa (near Enceladus) cutting diagonally across the ring, and the shadow of Rhea on the upper ansa, near the disk of Saturn. Mimas and Enceladus, though visible in the original image, are difficult to spot in this reproduction.