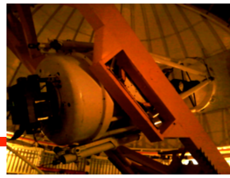

Webcam Observation of Saturn's C-Ring

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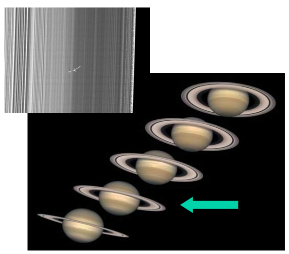
Introduction

-Changes in the rings of Saturn are difficult to detect from Earth-based telescopes because of their fine composition. Particulate bodies, like planetary rings, demonstrate strange phenomena without obvious causes and are made further puzzling by only being viewed in 2 dimensions. Spacecraft such as the Voyager and Cassini satellites, along with a few lucky snapshots during equinoxes, have resolved some of these phenomena. Figure 1 shows a new moon discovered by Cassini during an equinox. [2].

Objective

-Recently, previously unknown planar-perpendicular perturbations in the inner C-ring were shown to obscure segments of the rings from view, helping explain a 30-year old mystery concerning some mysteriously transient gaps in the less visible segments [1].

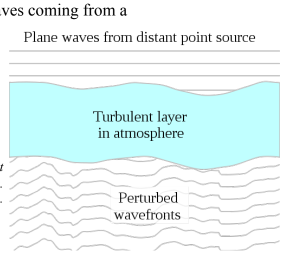
-Students from the Observational Astrophysics course at Carthage College took high quality images of Saturn to find evidence for these perturbations during January 2011. During this period, Saturn's C-ring was of limited visibility. Figure 2 shows examples of different Earth views of the rings as they change orientation.



Top: Figure 1. The arrow indicates the possible new moon. Bottom: Figure 2. During our observing run, the rings resembled the indicated picture of Saturn.. Images courtesy NASA/JPL.

Limitations and Difficulties

Ground based astrophotography is inherently difficult because of atmospheric turbulence. Rising hot air pockets and other weather phenomena distort images noticeably when viewed through a telescope. This is the cause for the "twinkling" effect of stars seen by the naked eye. Figure 3 demonstrates how light waves coming from a celestial object may be altered by a turbulent atmosphere through refraction and bending. This causes the observed image to appear fluid and periodically out of focus.



Right: Figure 3. The lines represent light waves coming from an object in space. Image courtesy wikipedia commons.

Solutions

1. Avoid the atmosphere.

-The Hubble Space telescope is not prone to atmospheric turbulence or light pollution because it is orbiting high above the atmosphere. This is extremely expensive and difficult, but one compromise is to build ground-based telescopes on high mountains and away from cities. The telescope used for this observing run was 8235 ft above sea level.

2. Correct the distortions.

-Some modern telescopes employ expensive corrective optics systems that change the shape of the mirror to cancel out the light wave distortions. Our telescope was not fitted with these optics, however.

3. Freeze out the atmosphere.

-Bursts of hundreds of images can be taken with a high speed camera in a few seconds. Distortions are statistically corrected for by stacking the clearer, higher quality frames together. Figure 4 shows a discarded exposure, a higher quality one, and a final stacked image. This was the method used in this project.

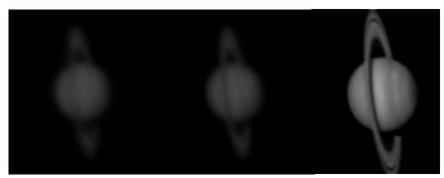


Figure 4. From left to right: Out of focus frame that was discarded, better in-focus frame used for analysis, final stacked image.

Image Capture Procedure

All images were taken through the 61" Kuiper Cassegrain style Reflector telescope at Steward Observatory, pictured left of the poster title. The image-recording device was the FLEA3 High Speed Web Cam, driven by Astro IIDC fire wire web cam recording software. A tertiary pickoff mirror deflected the center of the reflected image into the FLEA3 web cam (pictured right of the title), fitted with a 105mm Nikon Zoom lens. The lens allowed the image to be magnified into the entirety of the frame.

Because Saturn can be of magnitude 1 or brighter, very short exposure time was required for imaging. The camera captured up to 60 frames per second with less than 3 ms exposures per frame, resulting in bursts of 1-2000 frames in a matter of seconds. Astronomy image stacking software, such as Registax or Lynkeos, was then used to align the highest quality frames, combine them into a single stack, and adjust sharpness/contrast levels to obtain a final high quality image.

Results

Both observing nights for Saturn provided no better seeing than 1-2 arcseconds. Since it is so distant, this made fine details on the surface and in the rings especially difficult to make out. Figure 5 is a compilation of the highest quality images obtained from the run.

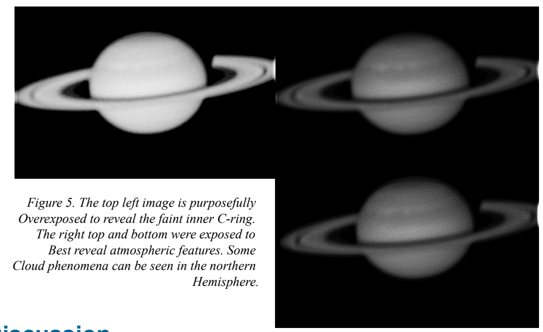
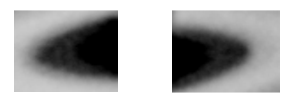


Figure 5. The top left image is purposefully Overexposed to reveal the faint inner C-ring. The right top and bottom were exposed to Best reveal atmospheric features. Some Cloud phenomena can be seen in the northern Hemisphere.

Discussion

The image batches in which the dark C-ring is visible (heavily overexposed) hint at irregularity. The left and right sides are blown up below. On the right side can be seen a bulge in the ring towards the planet, and a dark spot next to it. Anomalies like this are absent from other locations in the images, suggesting an actual physical cause and not an equipment malfunction. If the ring were mid oscillation in this image, a shadow cast by its edges could cause these peculiarities.



Conclusion

Few details could be made out in the inner ring band from the data available. The images/videos discussed reveal the before mentioned irregularity, but make no further suggestions about their nature.

References

Carroll, Bradley W., and Dale A. Ostlie. *An Introduction to Modern Astrophysics.* 2nd ed. New York: Pearson Publishing, 2006.

http://www.aolnews.com/2010/10/08/scientists-spot-tsunamis-in-saturns-rings/

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