

Airglow emission from Titan during eclipse

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Abstract

In this study, we take advantage of Saturn's shadow during three eclipse events to provide a strong constraint on the plasma contribution to UV and visible emissions from Titan's upper atmosphere. Faint UV emissions were observed by the Cassini UVIS (Ultraviolet Imaging Spectrograph) instrument during one event. Energetic plasma impact is inferred to produce such emissions, but the emitted intensity is more than an order of magnitude below that stimulated by photons on the dayside. Images from the Cassini ISS (Imaging Science Subsystem) instrument either show no emission or sometimes a very faint (~ 1 Rayleigh/nm) and nearly uniform airglow between about 300 and 1000 km altitude, too deep to be from plasma interaction. The mechanism responsible for these emissions is unknown at this time. There is no evidence for auroral structures in the spatially-resolved ISS images.

1. Introduction

Both solar UV photons and energetic particle bombardment from the plasma flowing past Titan or from auroras may contribute to the energetics of Titan's thermosphere and exosphere. Previous studies of UV emissions while Titan was illuminated by sunlight did not detect any contribution from the plasma [2]. In this study we searched for airglow while Titan was in Saturn's shadow to eliminate or strongly reduce any contribution from UV solar flux and to look for faint auroral structures that may be observable only with the spatial resolution available with the Cassini ISS instrument

2. Data

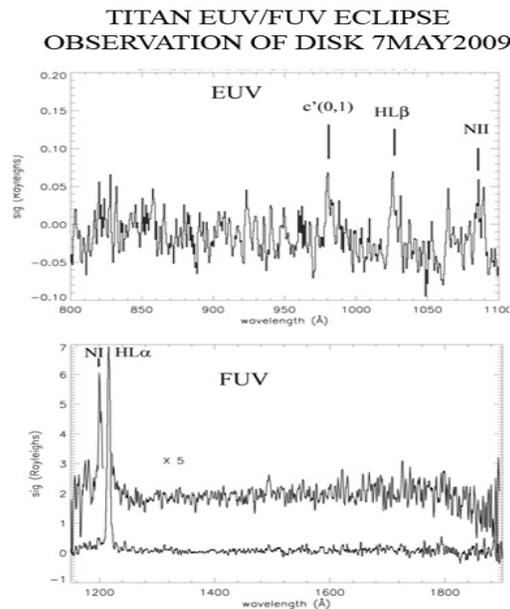
Images from Cassini ISS and spatial-resolved spectra from the UVIS experiment were obtained on three occasions listed in Table 1. In Table 1 the impact parameter is the radial distance of Titan from the center of Saturn's shadow as projected onto the sky plane and mapped into an elliptical coordinate system with the same aspect ratio as Saturn's equatorial and

polar radii. An impact parameter of 1.0 corresponds to the shadow line at the 1-bar level.

The impact parameter ranges from a low value of 0.48 during the first event to a high value of 1.015 during the last event. In many of the ISS images, especially at the higher values of the impact parameter, sunlight refracted or scattered by molecules or particles in the high atmosphere and perhaps by the rings is detectable and even saturates the long exposures at the highest impact parameters.

Table 1: Titan Eclipse Parameters

Time frame Year-doyThr:min:sec	Distance (km)	Impact Parameter
2009-127T08:31:22 – 2009-127T10:28:03	644030.8 - 677599.8	0.48-0.75
2009-334T21:34:26 – 2009-335T00:17:29	2408924.9 - 2453566.8	0.74-0.92
2010-001T20:58:43 – 2010-001T22:05:48	2357774.2 - 2376861.9	0.93-1.015



At UV wavelengths Saturn's atmospheric opacity is much higher and no sunlight is detected in any of the spectra.

Figure 1 shows the UVIS spectra for data taken on 7 May, 2009. This spectrum is the only one of Titan during eclipse that shows any nitrogen emissions. The most prominent is the Carroll-Yoshino C4' (0,1) 980-Angstrom emission. Ionized atomic nitrogen emission at 1085 Angstrom and a neutral atomic nitrogen line at 1200 Angstroms are also present. Noticeably absent are the Vegard-Kaplan and especially the LBH bands in the FUV which are very bright on the dayside.

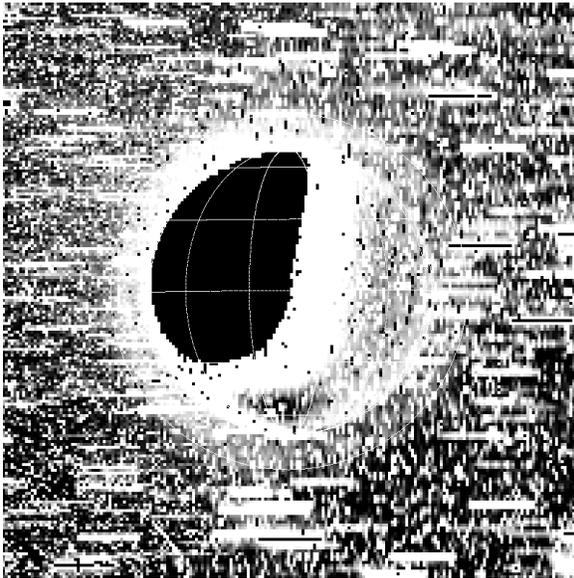


Figure 2, an ISS image from period 3

Most of the ISS images do not show any emissions. A few show what appears to be a very faint glow, almost uniformly distributed but a little stronger on the side facing Saturn and the sun. One of these is shown in Fig. 2. Figure 2 suffers from saturation in places where Titan is close to the penumbral region. Saturated pixels were set to 0. A latitude/longitude grid was superimposed, as well as circles at 300 and 1000 km altitude which correspond to the altitudes of an airglow emission. In addition, there are many horizontal star trails and noise from cosmic rays and residual bulk image subtraction in this 512s exposure. We are investigating the possibility that the apparent

airglow might be due to the spread of the brighter parts of the image interacting with the camera point spread function.

3. Summary and Conclusions

With the Cassini UVIS experiment we have detected airglow emissions from Titan's atmosphere that originate from plasma interaction rather than UV photons. These emissions are quite weak and only seen in the UV in one of three eclipse observations. Almost all of the most prominent lines seen on the dayside [2] are absent. Many of the ISS images do not show any sign of an airglow. If the apparent airglow seen in some images is real it is very faint (~ 1 Rayleigh/nm), very diffuse and on a global scale with emission between 300 and 1000 km. The color ratios do not show a consistent pattern and not the pattern expected from laboratory work [1] or theoretical calculation for electron impact on N_2 . We do not have an understanding of the process that would be responsible for these attributes. There is no suggestion of a focused emission region as might be expected from an auroral process.

Acknowledgements

Part of this work was performed by the Jet Propulsion Laboratory, California Institute of Technology

References

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