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Cassini-VIMS observations of Saturn's infrared aurorae

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Abstract

Over the past six years, the Cassini-VIMS instrument has been taking infrared observations of Saturn's auroral region. Up until recently, our studies of these aurorae have been limited to a very small sub-set of the total number of available images and yet have revolutionized our understanding of the infrared aurora of Saturn [1]. Here, we present the first results from a systematic survey of the current VIMS dataset, revealing a wealth of new images, providing a new view of Saturn's auroral region and suggesting where future observations may need to progress.

1. Systematic study of VIMS observations

Given the wealth of observations taken by VIMS over the past six years, an extensive search of the entire dataset has been necessary in order to be sure that all the available observations of Saturn's aurora have been found. We have assessed observations made by VIMS with either Saturn or the Rings as a target, and if these observations view either the auroral region or the night-side of the planet, they have been included in the overall dataset. This has resulted in over 10,000 potentially useful images covering a wide variety of integration times and spatial resolutions.

2. Data highlights

Of the large number of images available, a relatively small number are of the highest quality, resulting in only ~200 auroral images with integration times over 600ms – long enough to produce a strong auroral signature in multiple bins (as shown in Fig. 1). There are, however, a considerable number of moderate quality images that do allow the auroral morphology to be accurately measured (Fig. 2). This dataset includes several examples of sequences of auroral images that allow the variation in the aurora region to be high resolution images of small sections of the auroral oval that resolve auroral arcs with an accuracy of 0.1 degrees (Fig. 3).

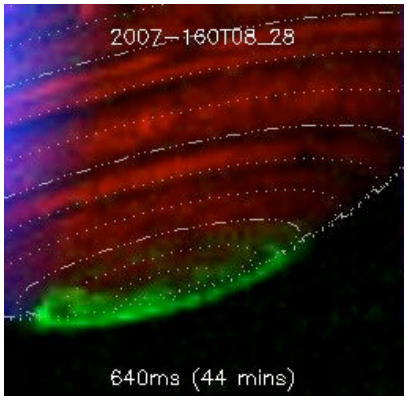

Figure 1: A three-colour image of Saturn's auroral region. Blue corresponds to reflected sunlight in the ~1 micron region; green is a composite image using multiple wavebands in the 3-4 micron region, including background subtraction, in order to highlight the aurorae as strongly as possible; red is thermal emission from lower layers at ~5 micron. Latitude is marked in steps of 15 (three-dot-dashed line) and 5 (dotted line) degrees.

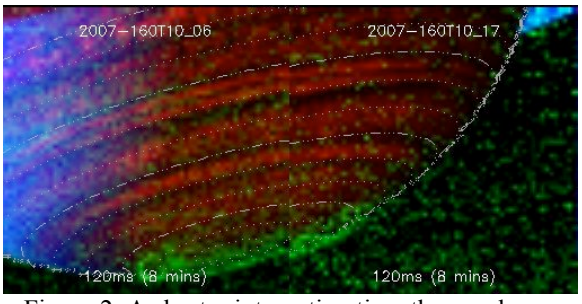

Figure 2: A shorter integration time three-colour image of Saturn's auroral region, taken from the same sequence of observations as Fig. 1. Although the signal is significantly weaker, the general auroral morphology can still be clearly discerned.

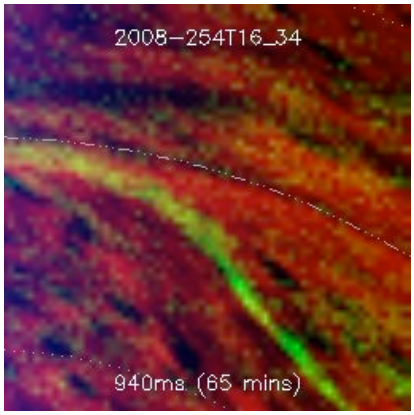

Figure 3: A high-resolution image of Saturn's auroral oval, looking down on the planet in detail. The main auroral arc is ~0.25 degrees latitude wide, with a secondary arc, seen on the left, even narrower.

2. Data mining

In addition to higher quality data, we are also investigating the potential for data mining, allowing the building up of strong signal using multiple frames of data. One example our preliminary tests have used is the binning of brightness on the night side of the planet into 0.5 degree bins of latitude. This test suggests a strong signal can be produced using images with integration times as short as 50ms. A second form of data mining consists of taking data that views the auroral region from an equatorial orbit over an extended period, as often occurs when VIMS makes rider observations on the back of other instruments, in order to build up information on brightness variability (Fig. 4).

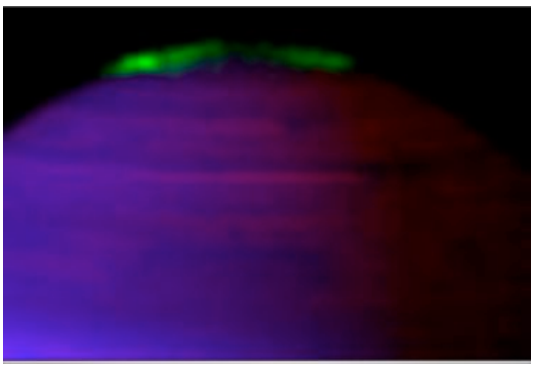

Figure 4: A frame from a movie showing the auroral intensity variability, taken from a sequence of CIRS rider observations, showing the aurora to change with both local time and in the planetary

References

[1] Stallard, T. and 16 co-authors. Complex structure within Saturn's infrared aurora. *Nature* **456**, 214-217 (2008)