EPSC Abstracts
Vol. 8, EPSC2013-372, 2013
European Planetary Science Congress 2013

Simultaneous conjugate observations of small-scale structures in Saturn's dayside ultraviolet auroras: Implications for physical origins

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Abstract

Conjugacy of Saturn's auroras was studied using unique near-equinox HST images. Dawnside patches are consistent with expectations for second harmonic ULF waves. Dusk transients are strictly non-conjugate, suggesting an open flux tube origin.

1. Introduction

Small-scale features have previously been observed Saturn's UV auroras. Grodent et al. [1] reported the occurrence of groups of auroral "spots" in the dawn and noon-sector oval of ~1000-3000km in size. It was suggested that these structures might be formed by Kelvin-Helmholtz waves. Radioti et al [2] reported the existence of isolated auroral patches in the dusk sector shown to be transient in nature, brightening and decaying on ~10-30 min time scales. It was suggested that this could be formed by hot plasma injections within the magnetosphere.

Small-scale features in Saturn's dayside UV auroras were examined using images obtained on 32 Hubble Space Telescope visits close to Saturn equinox when both northern and southern emissions were simultaneously observed, allowing their interhemispheric conjugacy to be investigated.

2. Observations

Eastward-propagating patches in the dawn-to-noon sector were observed on ~70% of visits, which when present were nearly always observed both north and south. The patches were generally not closely conjugate, however, but typically displaced in local time by ~0.5–1 h, with maxima in one hemisphere falling near minima in the other. An example of this behaviour can be seen in a sequence of HST images shown in Figure 1. Averaged angular velocities were ~80% of rigid corotation, larger than plasma angular velocities reported in the outer magnetosphere to which the emissions are likely conjugate.

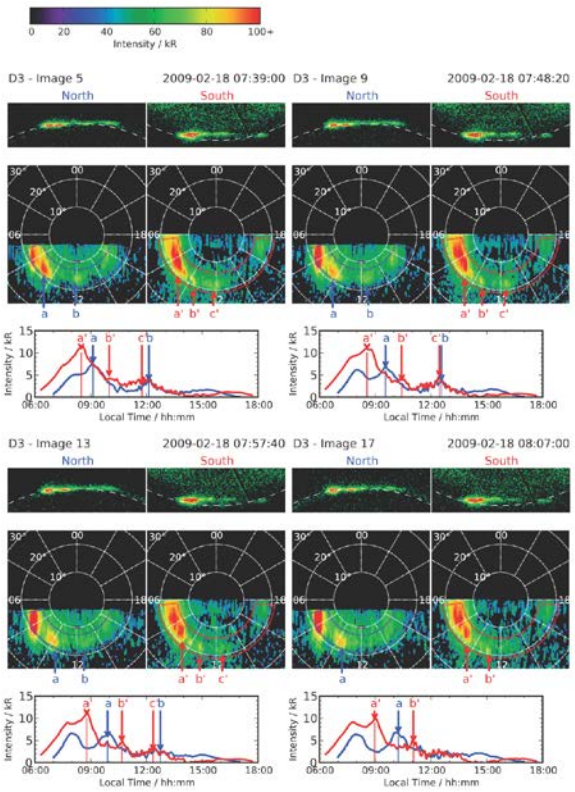

Figure 1: Auroral patches shown propagating from dawn to noon. Patches are not closely conjugate, instead displaced in local time.

Transient dusk sector emissions of ~10–30 min duration were also observed on ~40% of visits, and found to be strictly nonconjugate, with enhancements

in one hemisphere, north or south, being unaccompanied by enhancements in the other. An example of this transient behaviour can be seen in Figure 2.

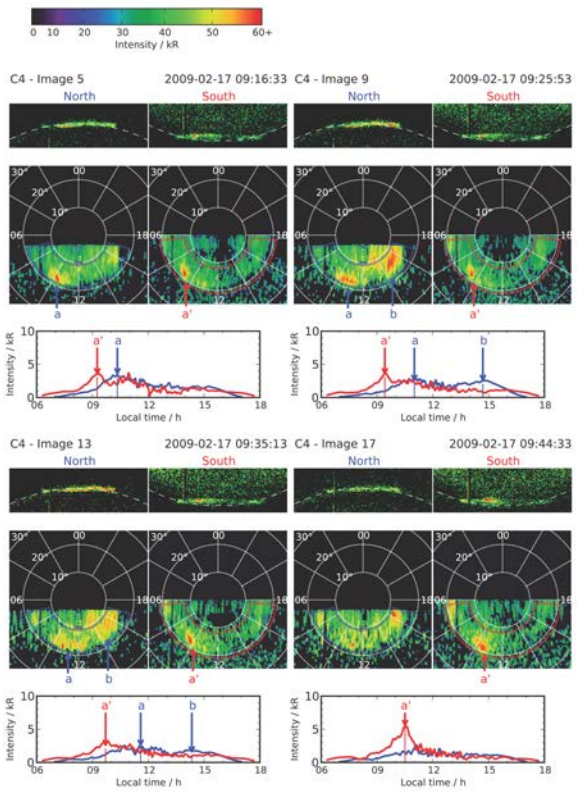

Figure 2: Transient auroral patches shown in the dusk sector. These patches are nonconjugate and in this example appear in the northern hemisphere only.

3. Discussion

We suggest the dawn sector patches are associated with field-aligned currents of eastward-propagating ULF waves, specifically second harmonic Alfvén resonances with typical azimuthal wave numbers m≈20 and plasma rest frame periods ~80 min, plausibly driven by drift-bounce resonance with hot magnetospheric water ions.

For the dusk transient patches we suggest an association with open flux tubes, and discuss one scenario where hemispheric symmetry is broken on newly opened flux tubes via the interplanetary magnetic field Y component, plausible consistent with nonconjugate events north and south, preferential postnoon occurrence, and time scales of a few tens of minutes, though the expected relationship with the Y component remains to be established.

The results outlined here are presented in more detail in [3].

Acknowledgements

This work is based on observations made with the NASA/ESA Hubble Space Telescope, obtained at the Space Telescope Science Institute, which is operated by AURA, Inc. for NASA. Work at Leicester was supported by STFC grant ST/H002480/1, and CJM was supported by a STFC Quota Studentship. We thank S. Kellett for access to the data employed in this study, and I. J. Rae for useful comments on ULF FLRs.

References

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