OBSERVATIONS OF BI−DIRECTIONAL FIELD ALIGNED ELECTRONS AND SOLITARY WAVES IN THE PLASMA SHEET

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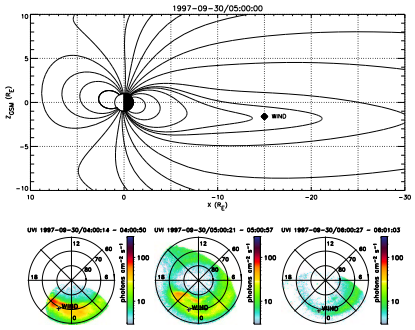
Introduction

• The presence of strongly peaked field aligned electron distributions in the near−Earth equatorial plasma sheet has been known for some time [*McIlwain*, 1975; *Parks et al.*, 1979; *Hada et al.*, 1981; *Klumpar et al.*, 1985, *Sugiyama et al.*, 1997]
• Recently, observations of low frequency broadband electrostatic noise (BEN) in the plasma sheet [*Scarf et al.*, 1974, *Gurnett et al.*, 1976] have been reinterpreted to be the signature of isolated pulses termed electrostatic solitary waves (ESW) [*Matsumoto et al.*, 1994].
• Simulations have suggested that these wave forms can be generated by drifting electron beams [*Omura et al.*, 1996].
• Using WIND plasma and wave data, we show the presence of bi−directional field aligned (i.e., counter−streaming) electron distributions in conjunction with solitary wave forms in the plasma sheet at 15 R_E.



Ionospheric Electron Source

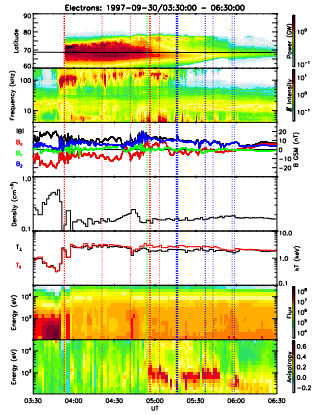
• Between 01 and 15 UT on 30 September 1997, WIND was located in the midnight sector of the plasma sheet (|Y| < 10 R_E) at a radial distance of 15 R_E.

• Ground and space−based observations indicate that a substorm onset occurred just before 4 UT.

• Global auroral images combined with magnetic field models suggest that WIND mapped to the region of auroral activity.

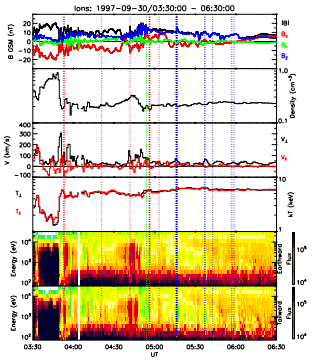
• Additionally, nearly symmetrical counter−streaming electron distributions (see below) indicate a closed field line topology.

⇒ Taken together, these observations imply that the source of the counter−streaming electrons is the auroral ionosphere.



Electron Overview

From top to bottom:
• Keogram (auroral intensity vs. latitude)
• frequency spectrogram
• magnetic field
• electron density
• electron temperature
• electron energy spectrogram
• electron anisotropy spectrogram

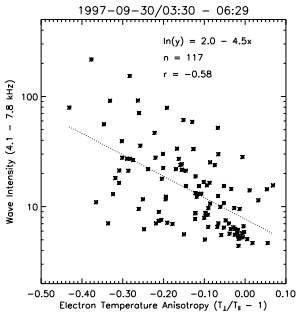


⇐ Anisotropy = A(E) = $\int f(E,\alpha)\cos(2\alpha)\,d\alpha / \int f(E,\alpha)\,d\alpha$ (after *Hada et al.* [1981])
A(E) > 0, field aligned distributions; A(E) < 0, perpendicular; A(E) = 0, isotropic

Ion Overview

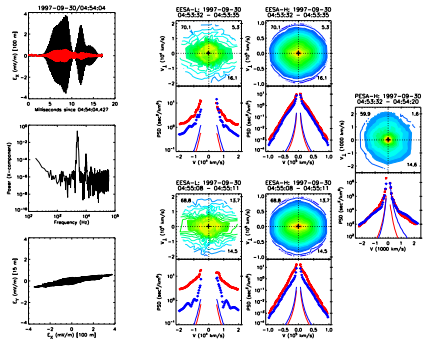
From top to bottom:
• magnetic field
• ion density
• ion velocity
• ion temperature
• Earthward ion energy spectrogram
• tailward ion energy spectrogram

• vertical lines denote times of Time Domain Sampler (TDS) data
• colors correspond to solitary, 5 kHz, and 500 Hz wave forms.

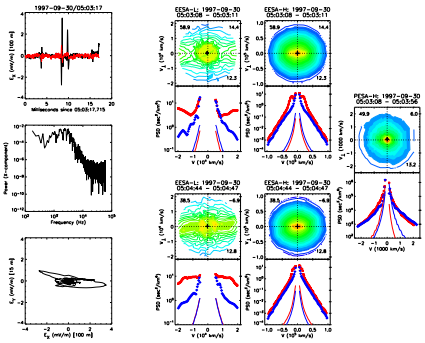


Increasing negative electron temperature anisotropy (i.e., field aligned distributions) is correlated with increased wave power at frequencies below f_{pe} (≤ 10 kHz).

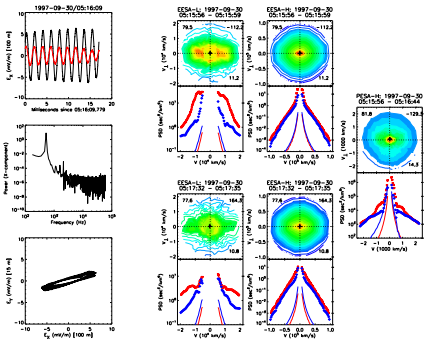
5 kHz Waves (frequency ~ f_{pe})



Solitary Waves (duration ~ 1 ms)



500 Hz Waves (frequency ~ f_{ce})



Summary

• Using WIND plasma and wave data, we show the presence of counter−streaming electron distributions and beams in the plasma sheet at 15 R_E.
• The low frequency (≤ f_{pe}) wave power appears correlated with the electron temperature anisotropy.
• Solitary waves, waves near f_{pe}, and waves near f_{ce} in the spacecraft frame are seen in conjunction with strongly field aligned bi−directional electron distributions.
• We suggest that the counter−streaming electron distributions are responsible for the generation of the observed wave forms, though future study is necessary.

Unanswered Questions/ Future Work

• What is the source of the waves?
  • Produced locally by interacting streams of electrons?
  • Propagate from the ionosphere?

• How do the waves modify the particle distributions?
• How do the particle distributions modify the waves?

⇒ Kinetic simulations with the observed distributions and plasma parameters are necessary.

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