

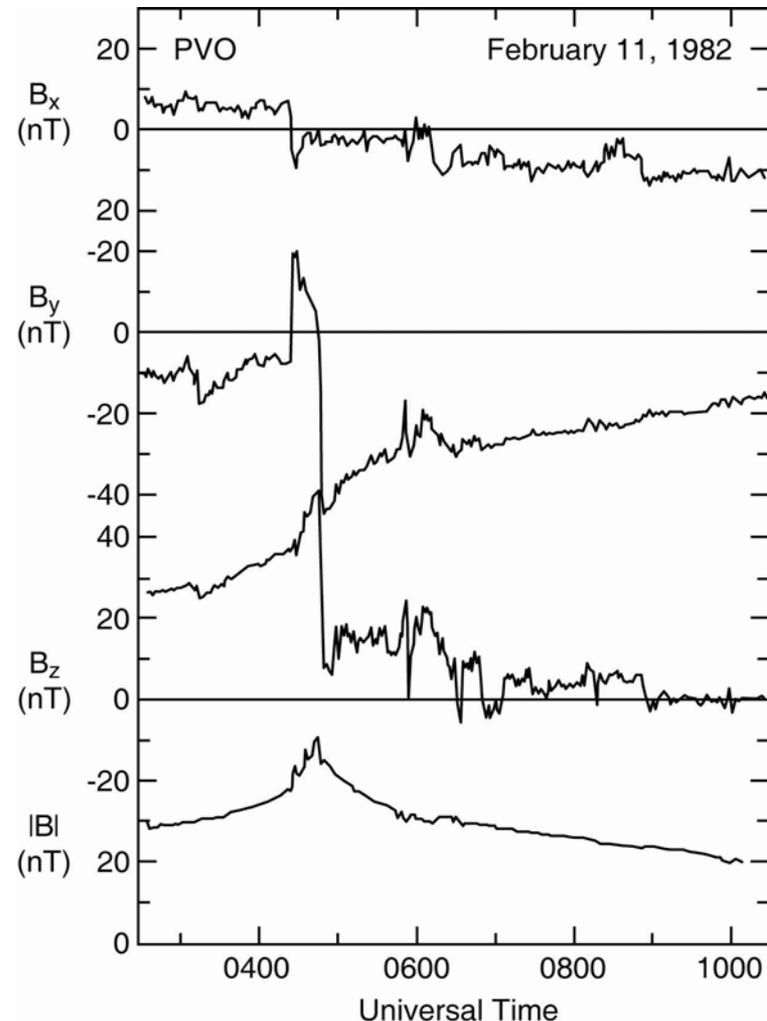
# Interplanetary Magnetic Flux Enhancements as seen by STEREO

C.T. Russell, L.K. Jian and  
J.G. Luhmann

18<sup>th</sup> STEREO Science Working Group  
April 20-22  
Meudon, France

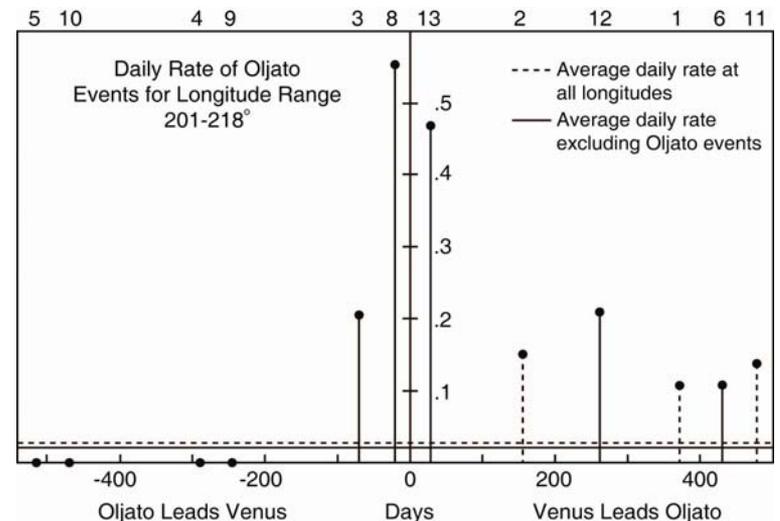
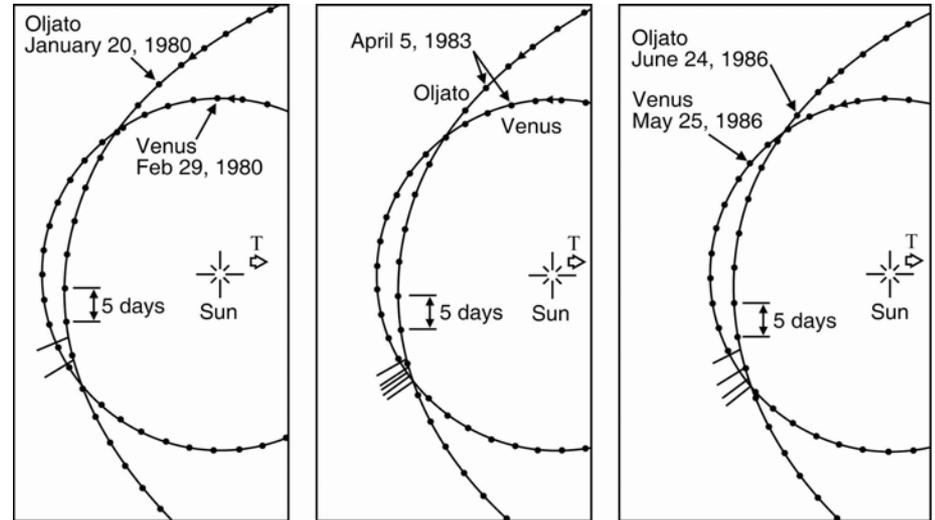
# What is an Interplanetary Field Enhancement?

- The Pioneer Venus mission detected cusp-shaped magnetic enhancements at 0.72 AU.
- These were about 1 hour in duration and of the order of 25% enhancement.
- The largest of these was hard to ignore.
- They usually have a sharp current sheet near the center of the event.
- They occur at all radial distance and are somewhat stronger closer to the Sun.
- They have a tendency to occur at fixed ecliptic longitude.

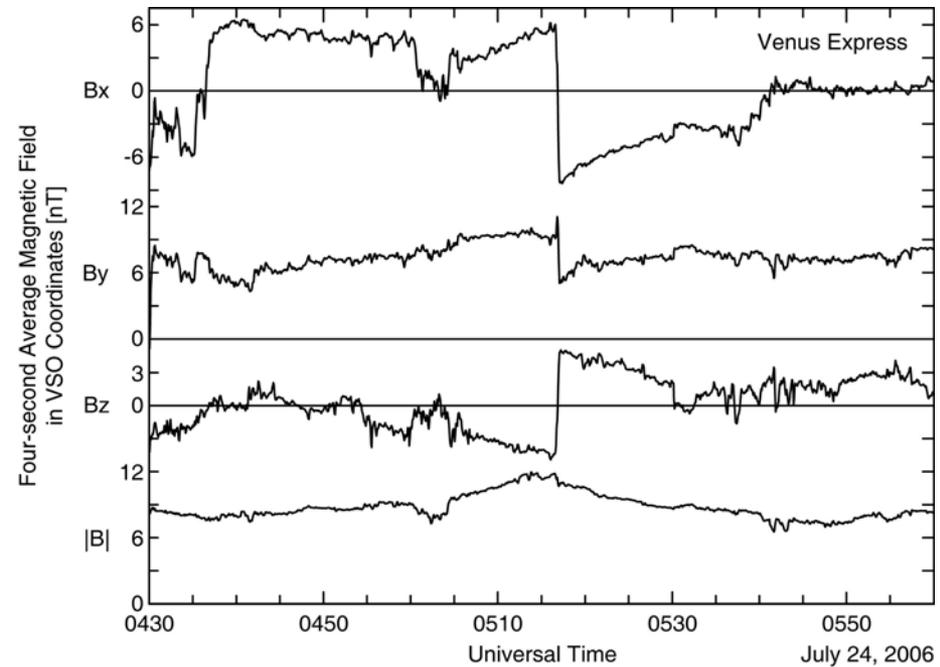
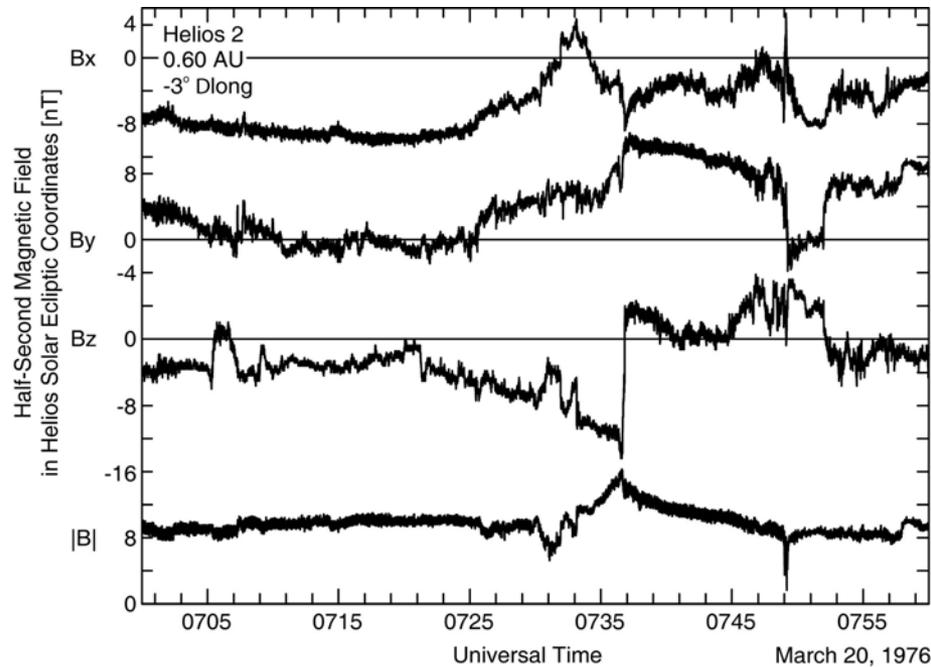


# The Most Probable Cause

- The asteroid 2201 Oljato was apparently the source of a significant fraction of the events seen by Pioneer Venus.
- The events were seen before and after the conjunction of the asteroid with Venus, so it was material in the asteroid's orbit and not the asteroid itself that caused the perturbations of the solar wind.
- The source of the disturbance is most probably the interaction of the solar wind with charged dust.

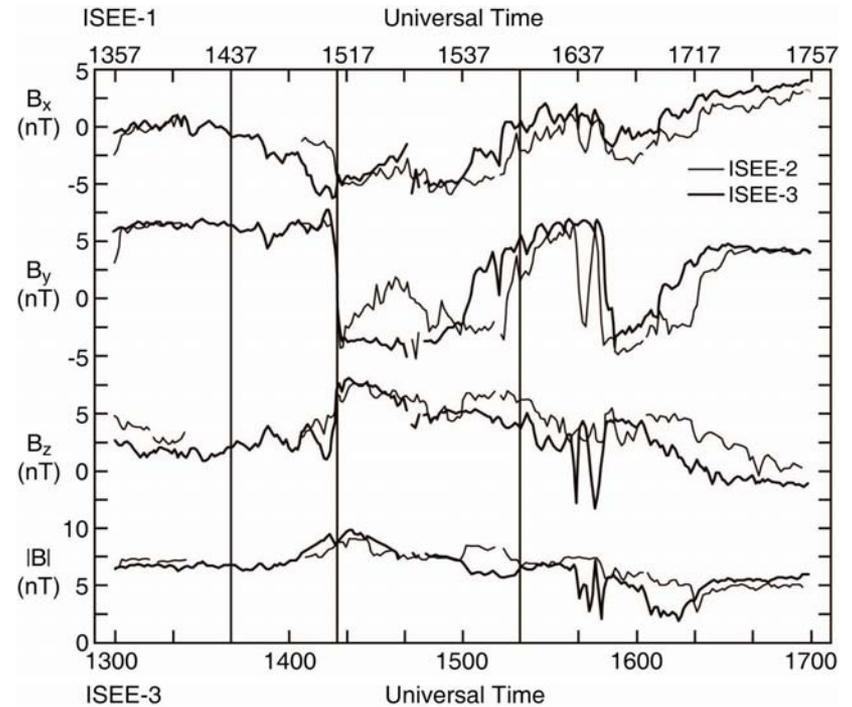
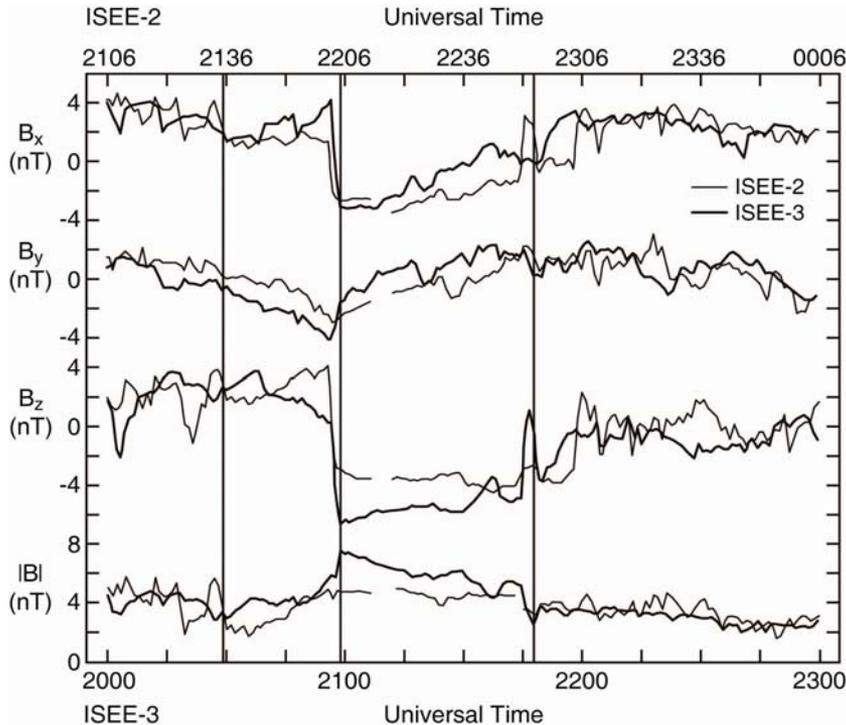


# Radial Distribution



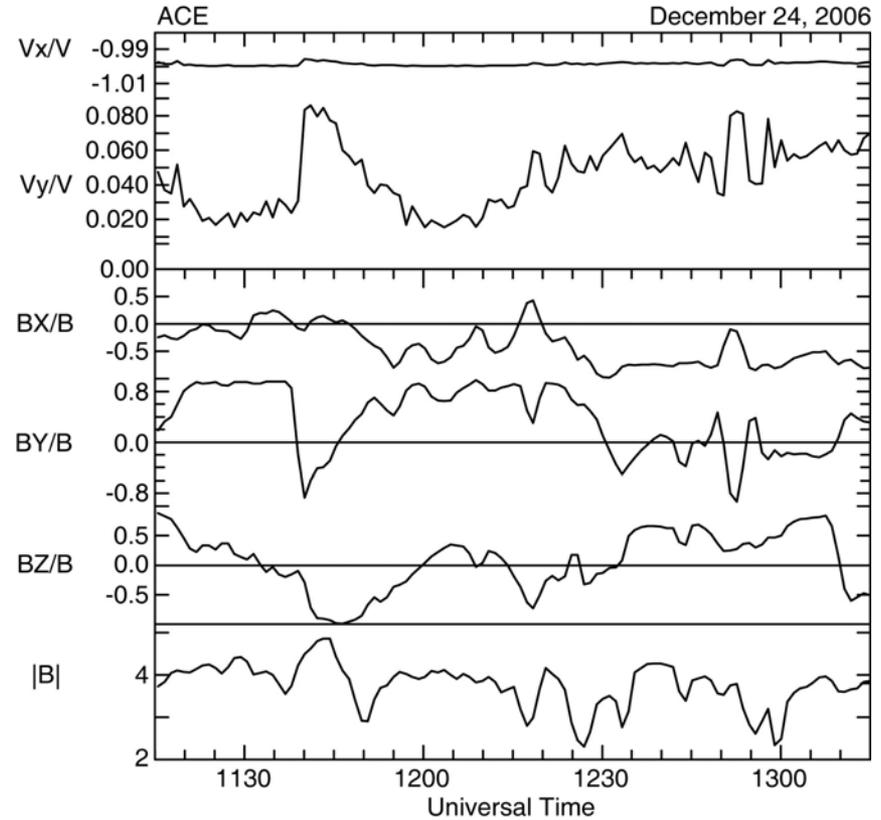
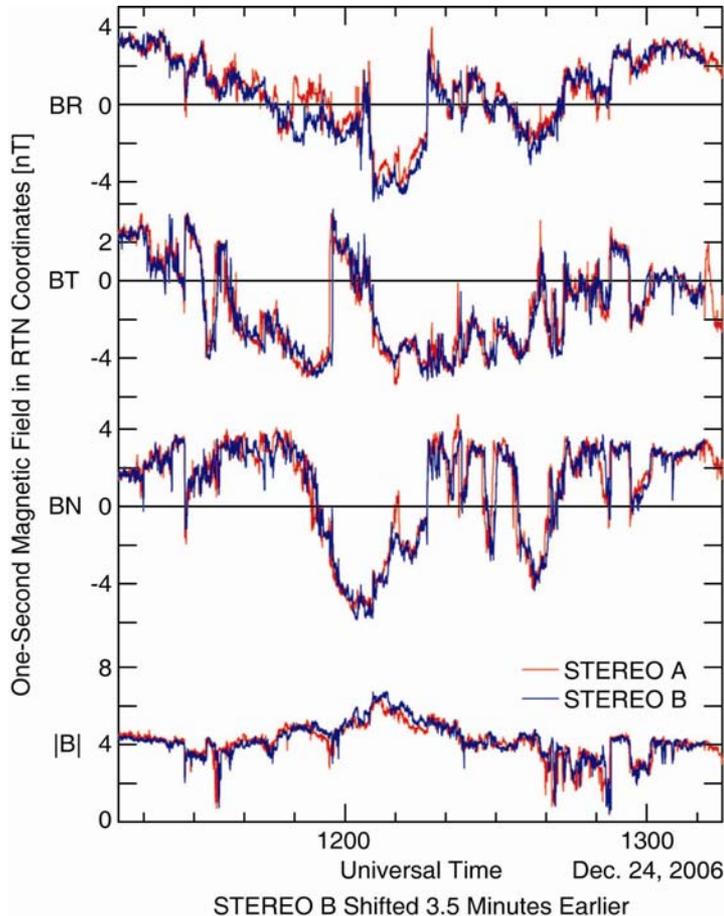
- IFEs are seen inside the orbit of Mercury, at Venus by both Pioneer Venus and now Venus Express, at Earth by IMP, ISEE and STEREO and by Ulysses.
- They have been observed for over 3 decades.

# Direction of Motion: Radial



- The same IFE has been detected by multiple spacecraft on several occasions: Venera 13 to Venera 14; ISEE 3 to ISEE 2 (twice); and STEREO A to STEREO B.
- In each case, the sequence of detections is consistent with radial convection of the structure with the solar wind flow.

# STEREO Multipoint Observations

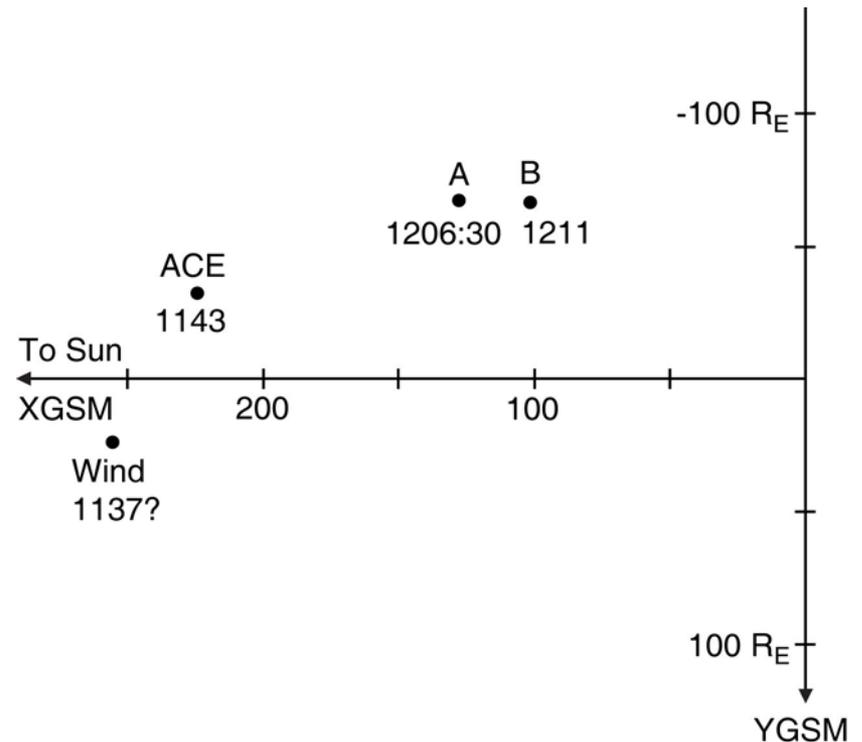


08 XGSM	223.74	223.73	223.71	223.71
09 YGSM	-31.57	-31.74	-31.98	-32.27
10 ZGSM	23.91	23.67	23.34	22.92

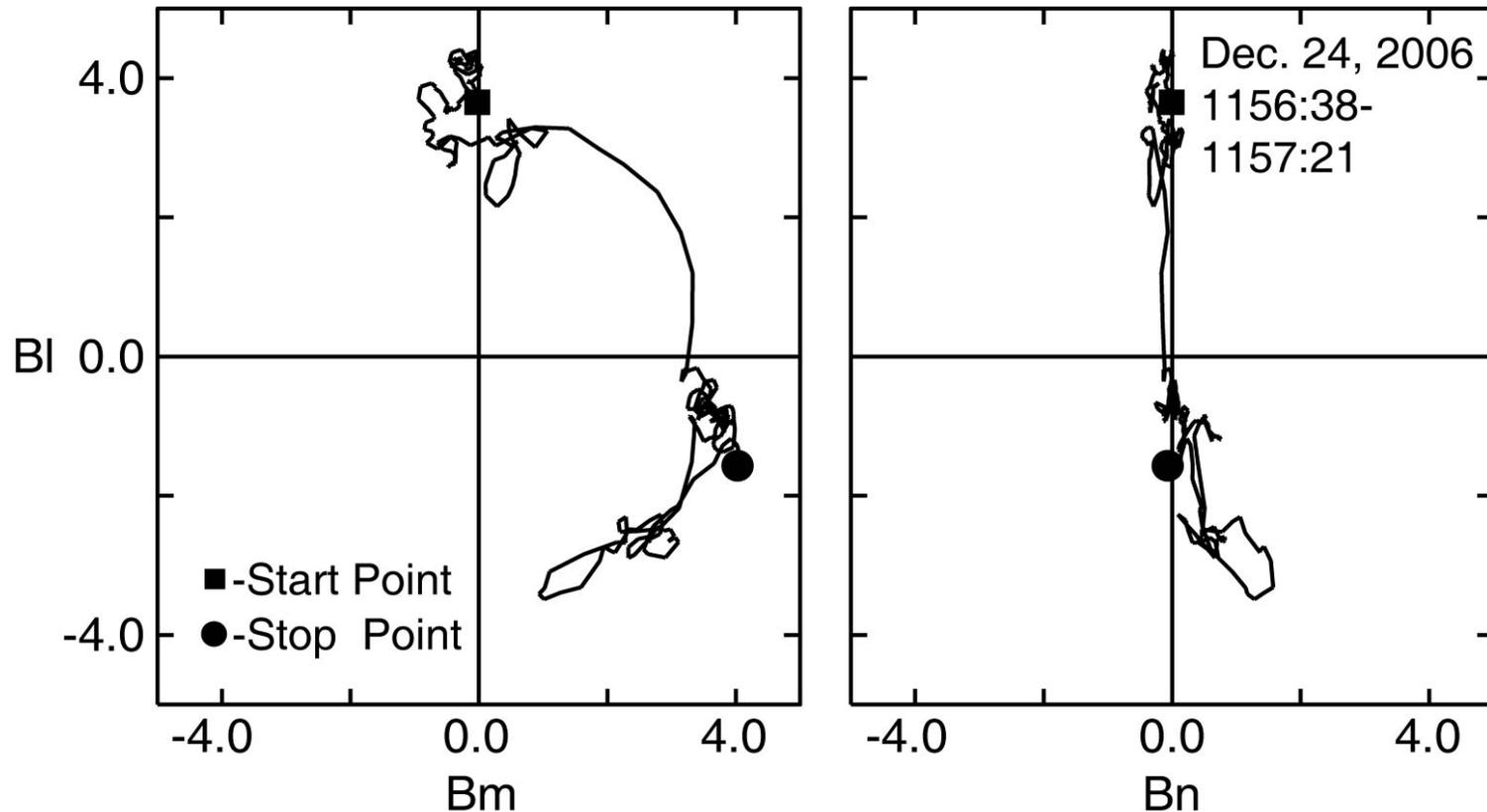
- When STEREO A and B were close together and near the Earth, an IFE went by that was detected by 3, possibly 4 spacecraft.

# Direction of Motion

- The solar wind is flowing 640 km/s on December 24, 2006.
  - It would take 4.5 minutes to flow from STEREO A to B.
  - It would take 20 minutes to flow from ACE to STEREO B.
  - It would take 25 minutes to flow from Wind to STEREO B.
- The delay times are consistent with a disturbance flowing at slightly less than the solar wind speed.
- ACE shows a slightly slower speed when the disturbance crosses it plus a deflection in V.
- Wind shows similar slowing and deflection but a drop in B.



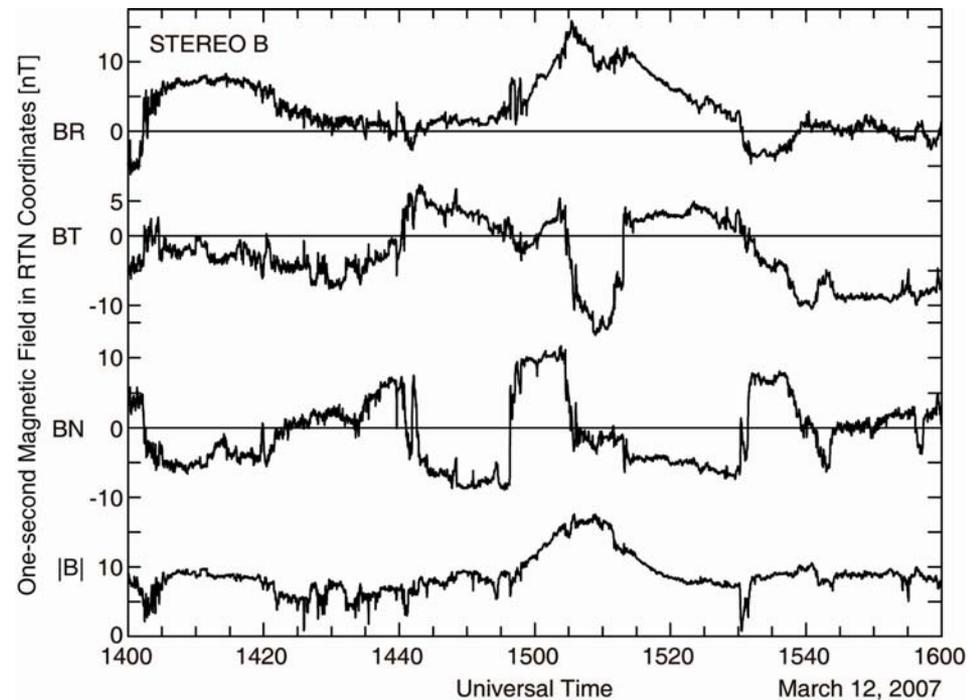
# Reconnection in Current Sheet

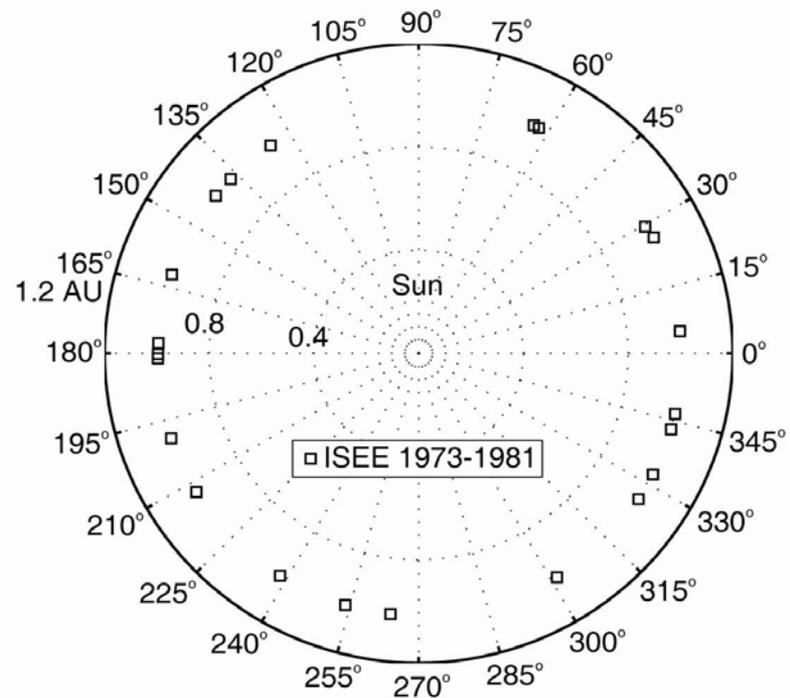
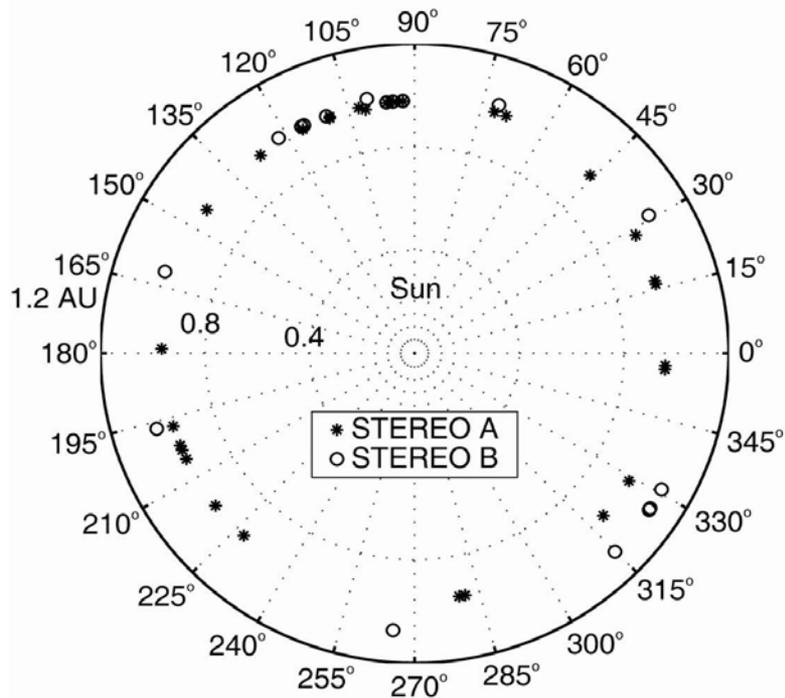


- The structure of the main current sheet is very reminiscent of the Earth's magnetopause.
- Seldom is there any depression in the field at the current sheet. Thus the reconnecting material is cold.

# STEREO Survey

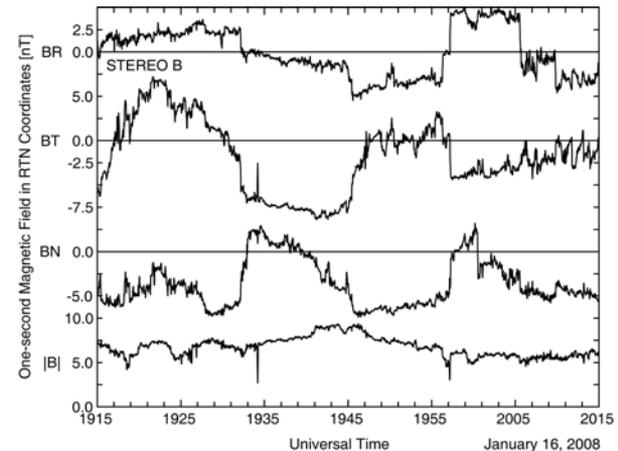
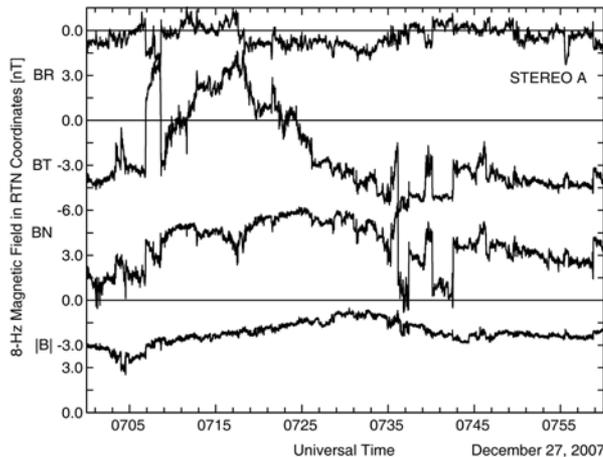
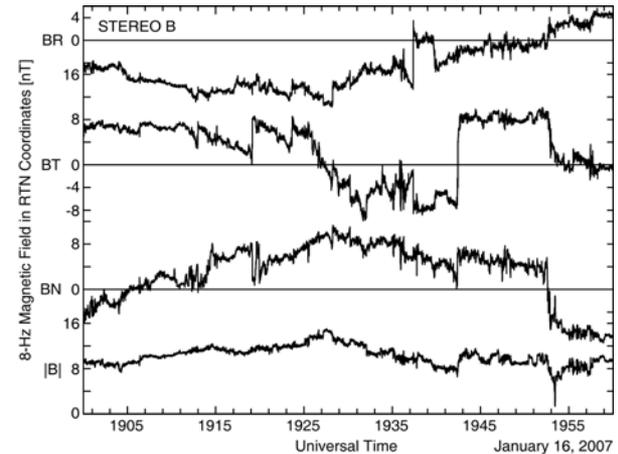
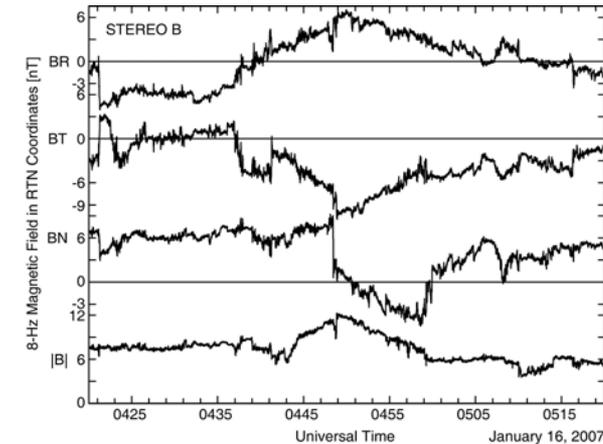
- Examined all magnetometer data from launch to January 31, 2008
- Made a list that will be put on web
- Plotted the ecliptic longitude and radial distance of each sighting
- An earlier study of several years of IMP and ISEE data was published by Arghavani et al (1985)
- Statistical scatter similar to that in present study.





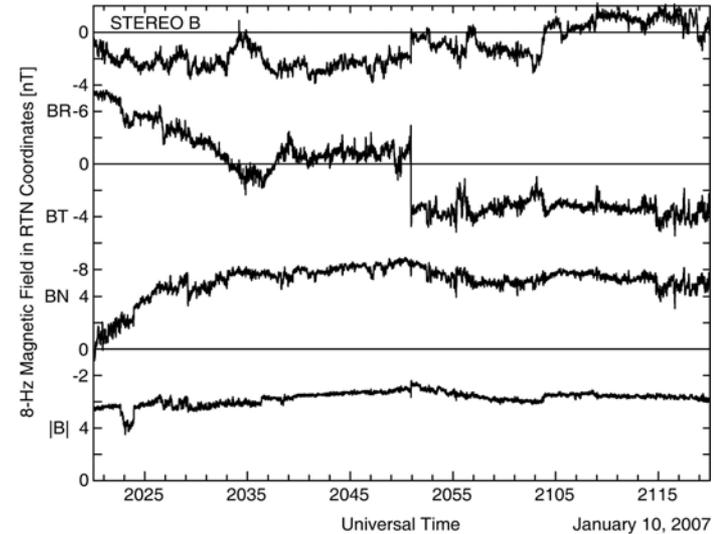
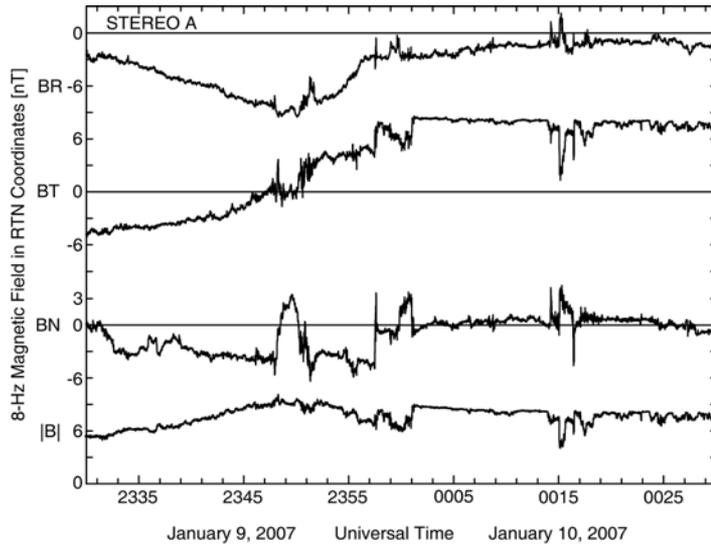
- Longitudinal distribution of IFEs is far from uniform.
- There are 10 events from 100° to 120° over the two spacecraft and many precisely overlap.
- Both spacecraft are close to 1 AU here.

# Four Signatures at 116° Ecliptic Longitude

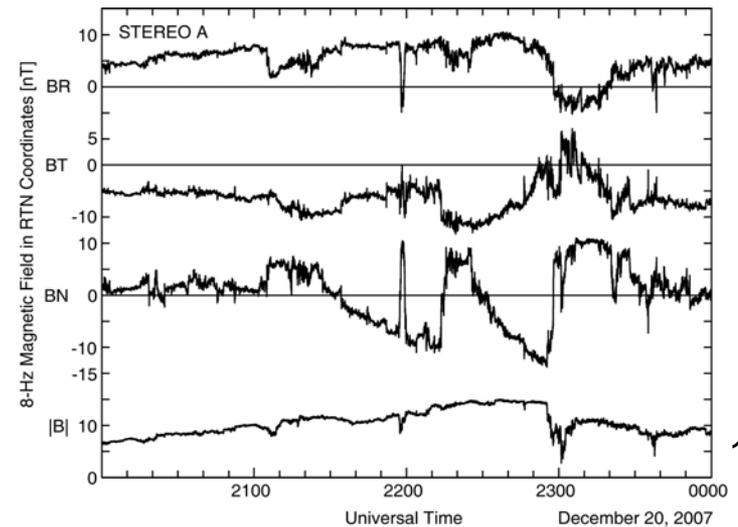


- The chances of detecting 4 IFEs within one degree with our sample size is vanishingly small but this has occurred with A and B and two passes through this region.
- The events are not exact duplicates, but they are similar in appearance.

# Three Events at 110° Ecliptic Longitude



- The events at 110° are not as similar.
- The event on December 20 is longer than usual, but not as long as an ICME and has complex interior structure unlike a magnetic cloud.



# Summary

- IFEs are ubiquitous in the inner solar system.
- Their sources are fixed in ecliptic longitude.
- The disturbances are carried outward from the Sun at about the solar wind velocity.
- IFEs contain strong current sheets that appear to be reconnecting, but no heating seems to occur.
- These structures should be numerically modeled but no one has attempted such a model.
- These interactions and their cousins in the solar wind may be very important to the removal of material from the inner solar system.