

Stereo Solar Radio Observations in the Inner Heliosphere

SH21B-0405

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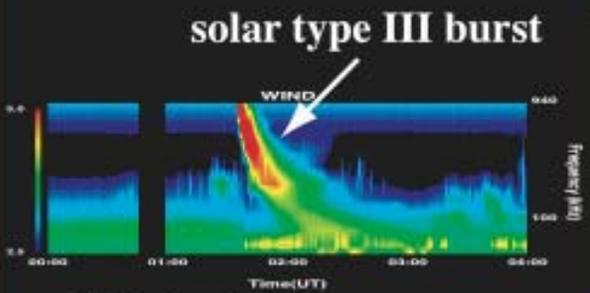
The STEREO/SWAVES radio observations will provide an unprecedented opportunity to observe and analyze solar radio emissions simultaneously from “stereo” viewpoints. The results from these observations and analyses will provide important new insights into the nature and physical origin of the radiation and its propagation through interplanetary space, as well as on the characteristics of the plasmas and magnetic field topologies observed remotely in the radio source regions. In addition to the unanticipated new discoveries that are likely to be made, the STEREO radio observations of solar related phenomena will provide important quantitative physical insights into the observed radio emission characteristics, some of which have already been hinted at by “limited and crude” two-spacecraft “stereo” observations.

Some specific areas of focus include:

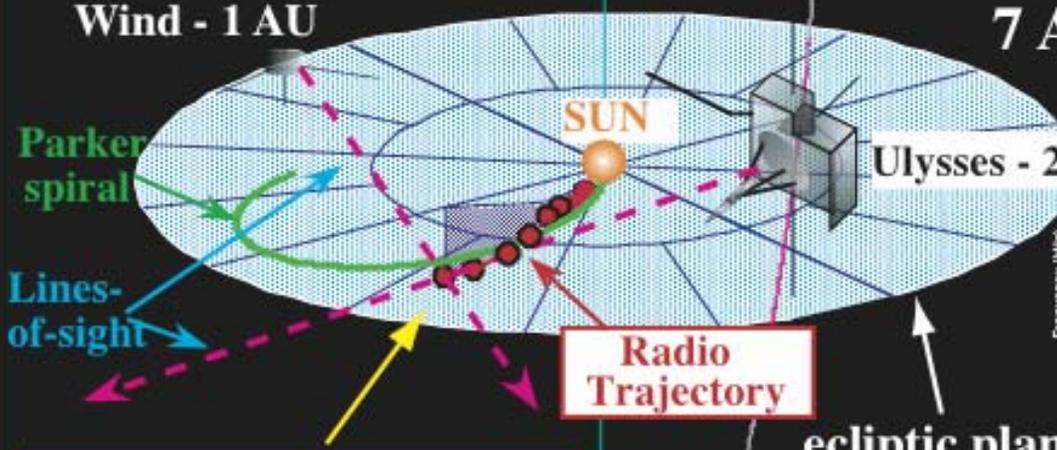
- **Nature and physical origin of the radiation characteristics of type II radio emissions that are generated by CME-driven shocks propagating through the solar corona and interplanetary medium**
- **Use stereo (spatial and temporal) triangulation to track CME/shocks through the IPM by locating the radio sources at consecutively lower radio frequencies**
- **Track electron beams through the interplanetary medium using stereo triangulation to determine the underlying interplanetary magnetic field topology, as well as to better understand the intrinsic radiation properties of type III bursts**
- **Nature and physical origin of the radiation characteristics of complex type III-like radio emissions associated with major flare/CME events**
- **Study the beaming characteristics and propagation effects for type II and III radio emissions**
- **Use source locations derived from 3D triangulation to derive coronal and interplanetary density models relevant to type II and III radio emissions**

Some specific examples that anticipate STEREO follow:

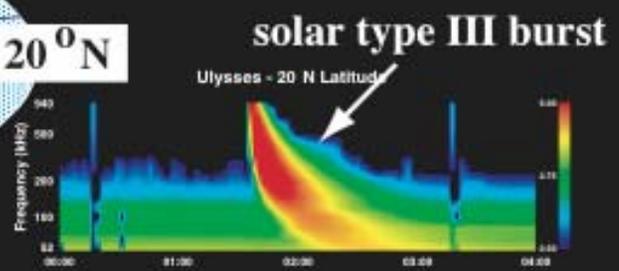
Radio source location by stereoscopic triangulation between widely separated s/c (Wind & Ulysses)



Wind - 1 AU



7 April 1995



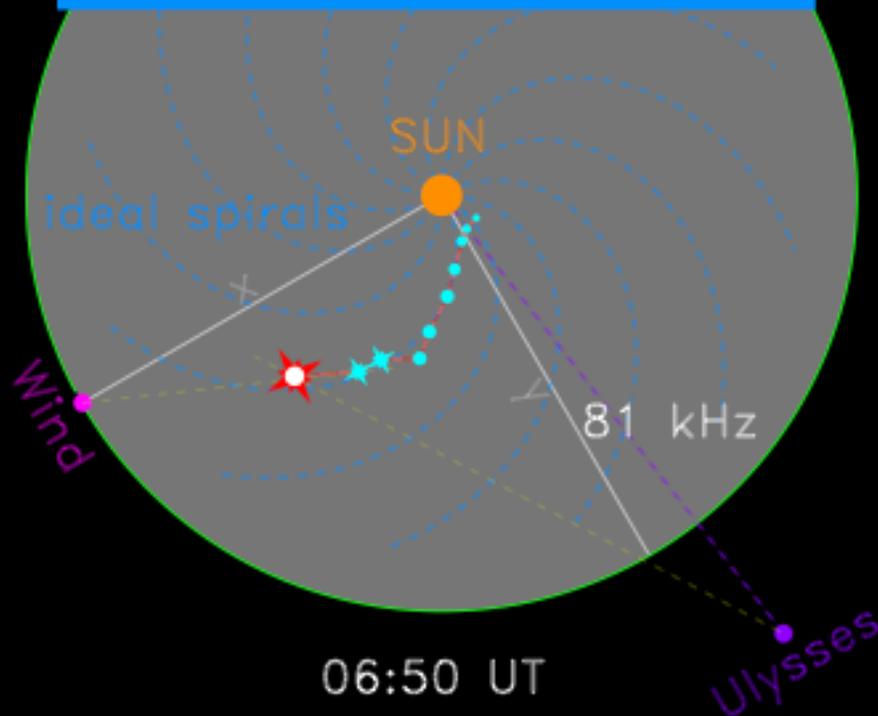
source location at frequency f is the point where two lines-of-sight intersect

Triangulation eliminates the need for a coronal & IP density model

Type III Radio Source Locations determined by "Stereo" Triangulation

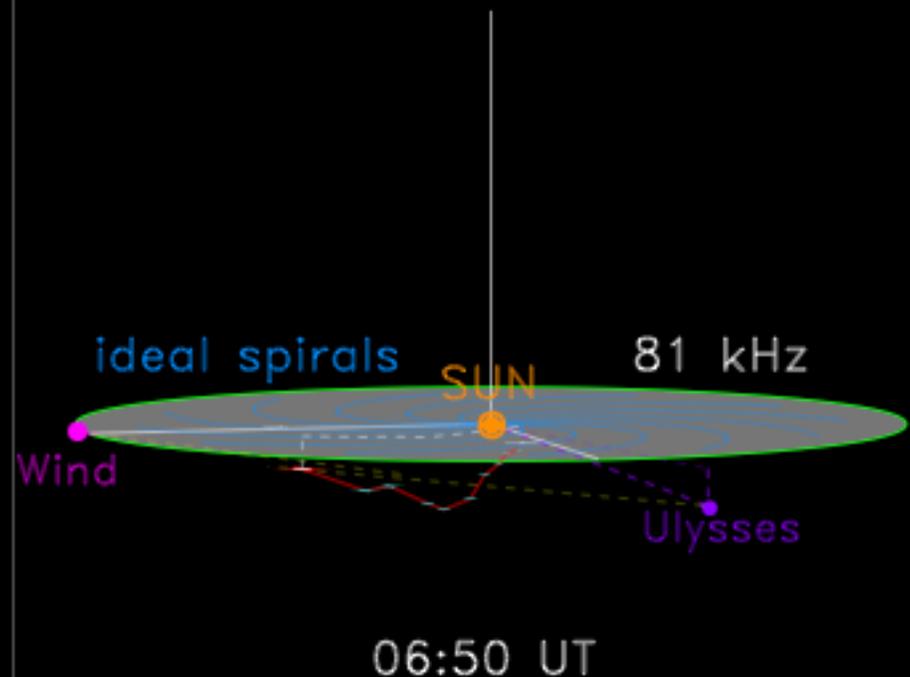
Wind/Ulysses Triangulation

2001 May 20



Wind/Ulysses Triangulation

2001 May 20

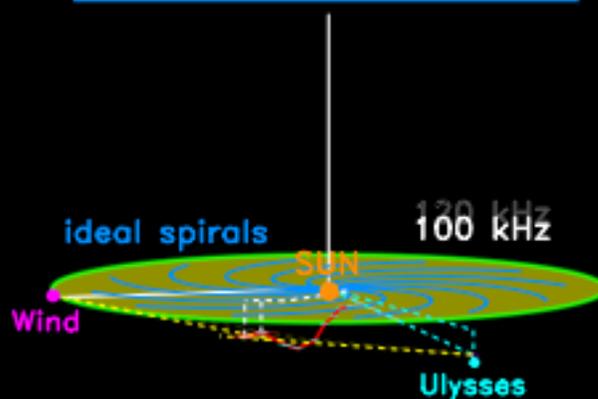


- **triangulated type III radio source locations at decreasing frequency trace out the interplanetary magnetic field topology**

Type III Radio Source Locations determined by Ulysses/Wind "Stereo" Triangulation

Wind/Ulysses Triangulation

2001 May 20

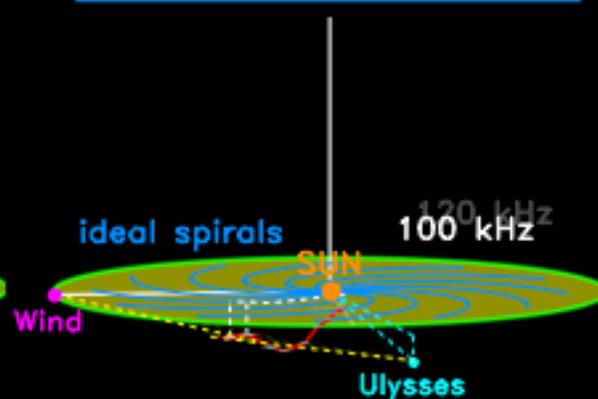


06:40 UT

"STEREO-A"

Wind/Ulysses Triangulation

2001 May 20

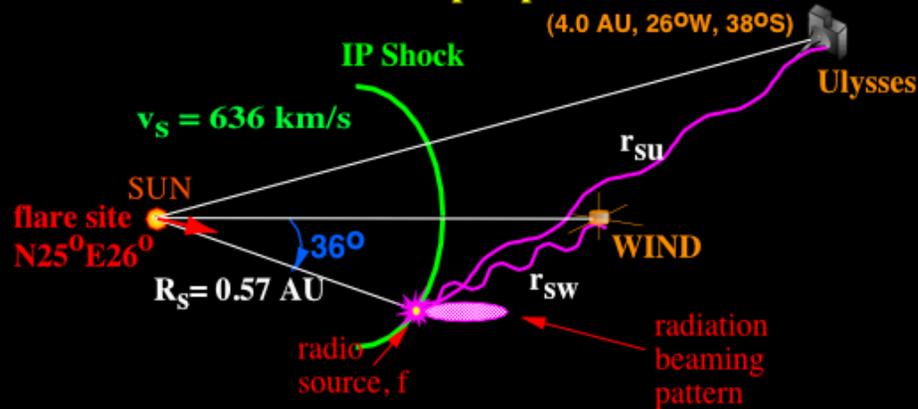


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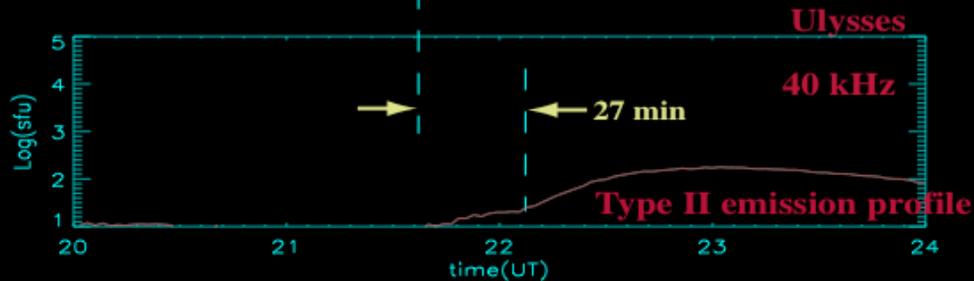
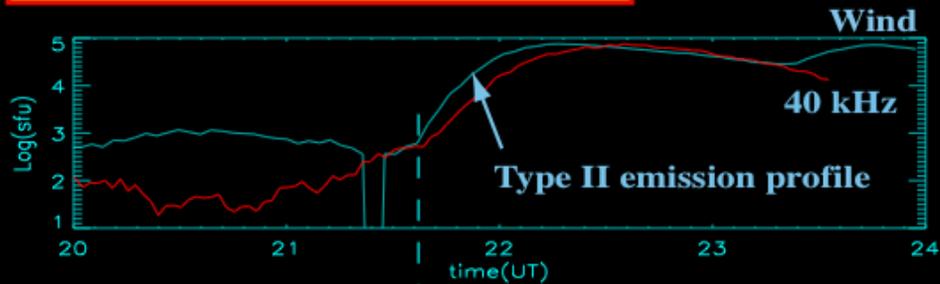
"STEREO-B"

Type II Radio Source Locations determined by "Stereo" Time Triangulation

View from above the ecliptic plane

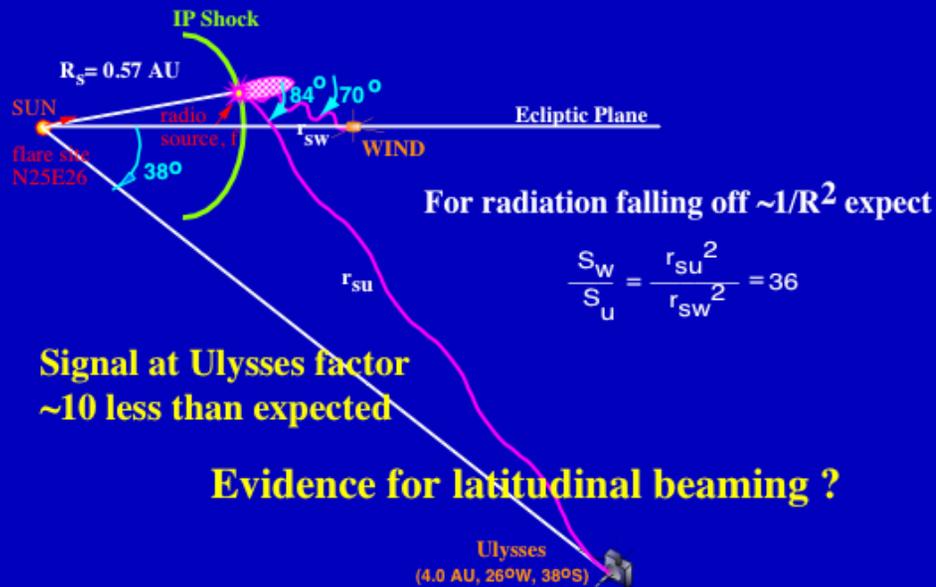
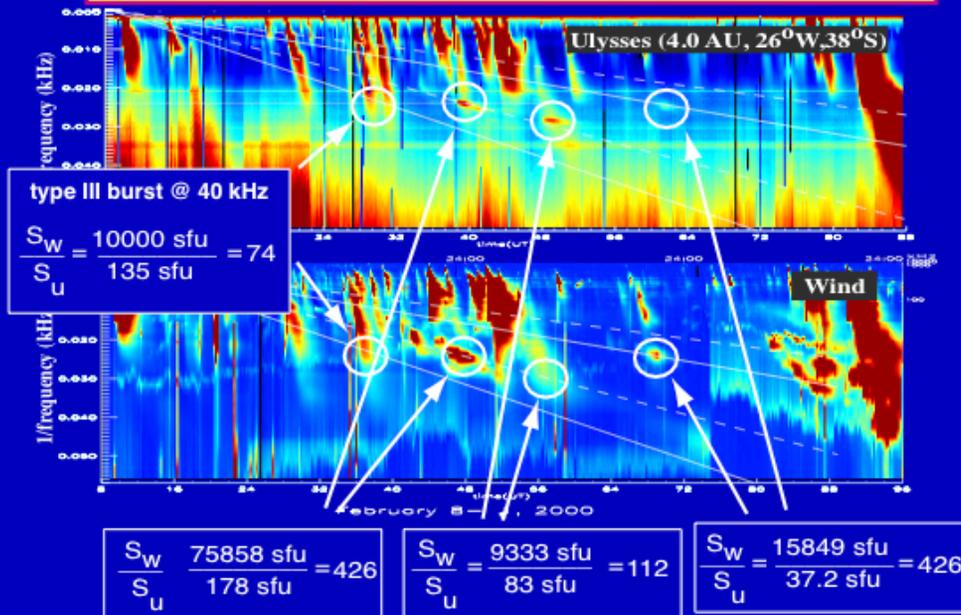


find source at (0.57 AU, 36°E, 10°N)

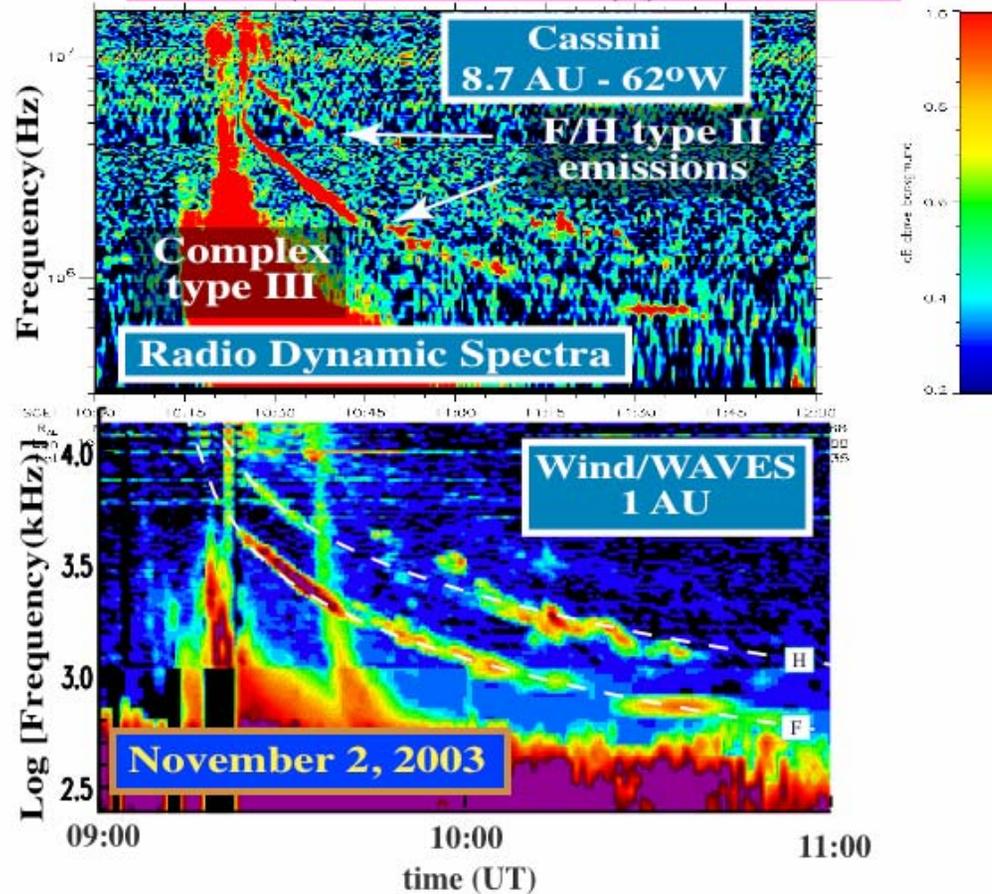


February 9, 2000

"Stereo" Observations of Type II Radio Source Intensities



"Stereo" Observations of High-Frequency Type II Emissions



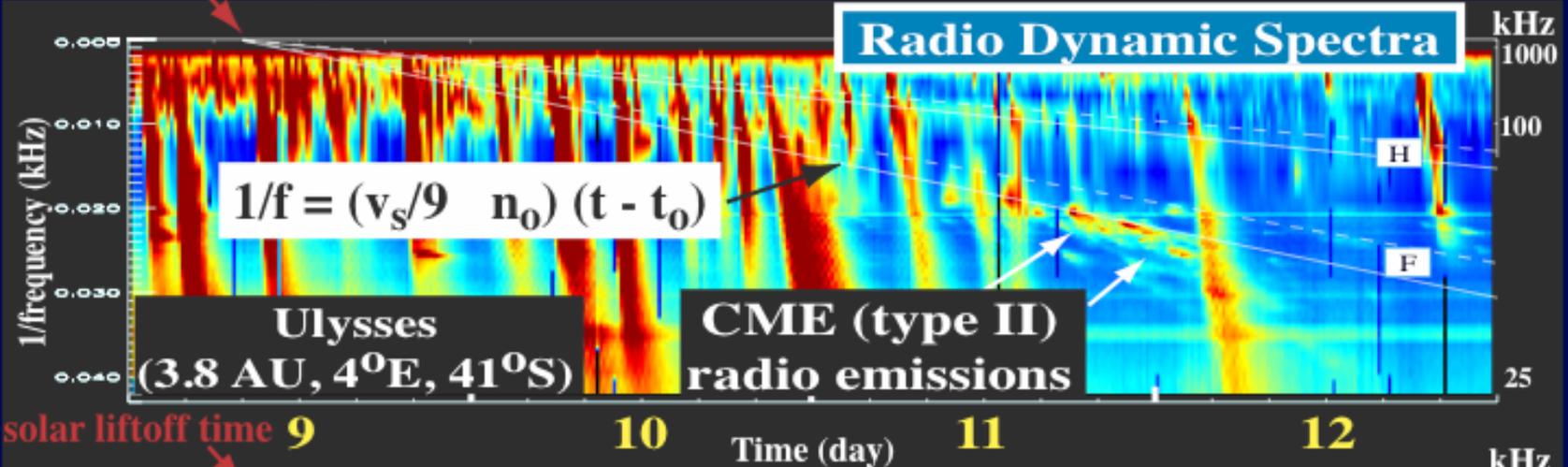
- Details of the sporadic, fundamental/harmonic frequency-drifting type II emissions are essentially identical, as seen by both "stereo" s/c
- The sporadic nature of the type II radiation at high frequencies must be intrinsic to the radio source region, e.g., not related to beaming or other propagation effects

"Stereo" Observations of Low-Frequency Type II Emissions - I

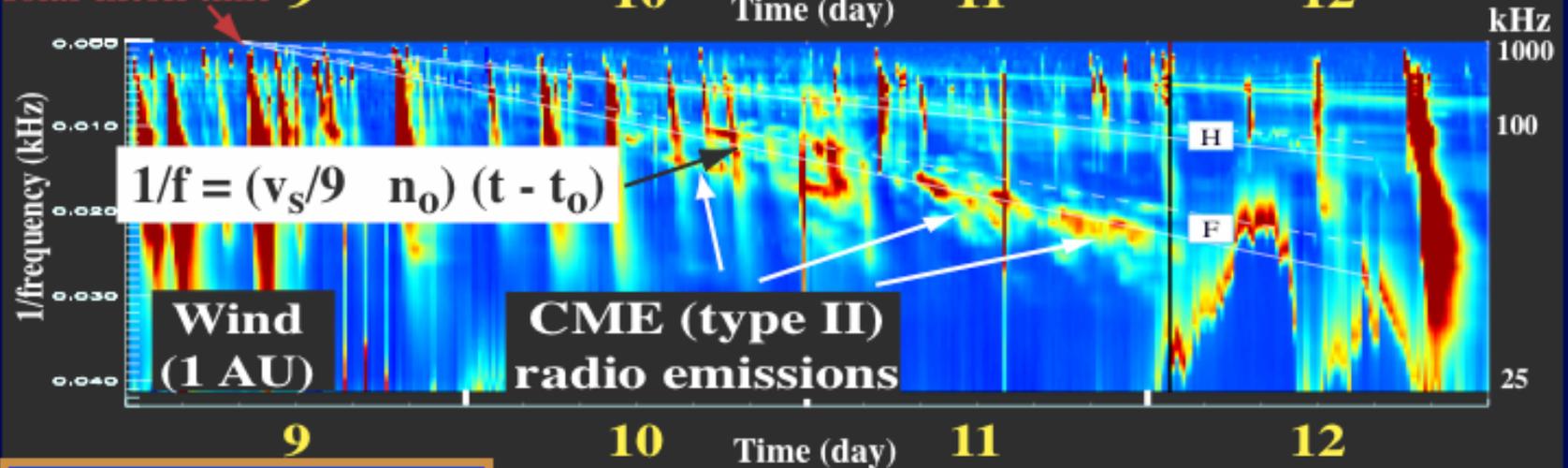
$$f = 9 \text{ n and } n \mu 1/R^2 \Rightarrow 1/f \mu R \mu v_s (t - t_0)$$

solar liftoff time, t_0

Radio Dynamic Spectra



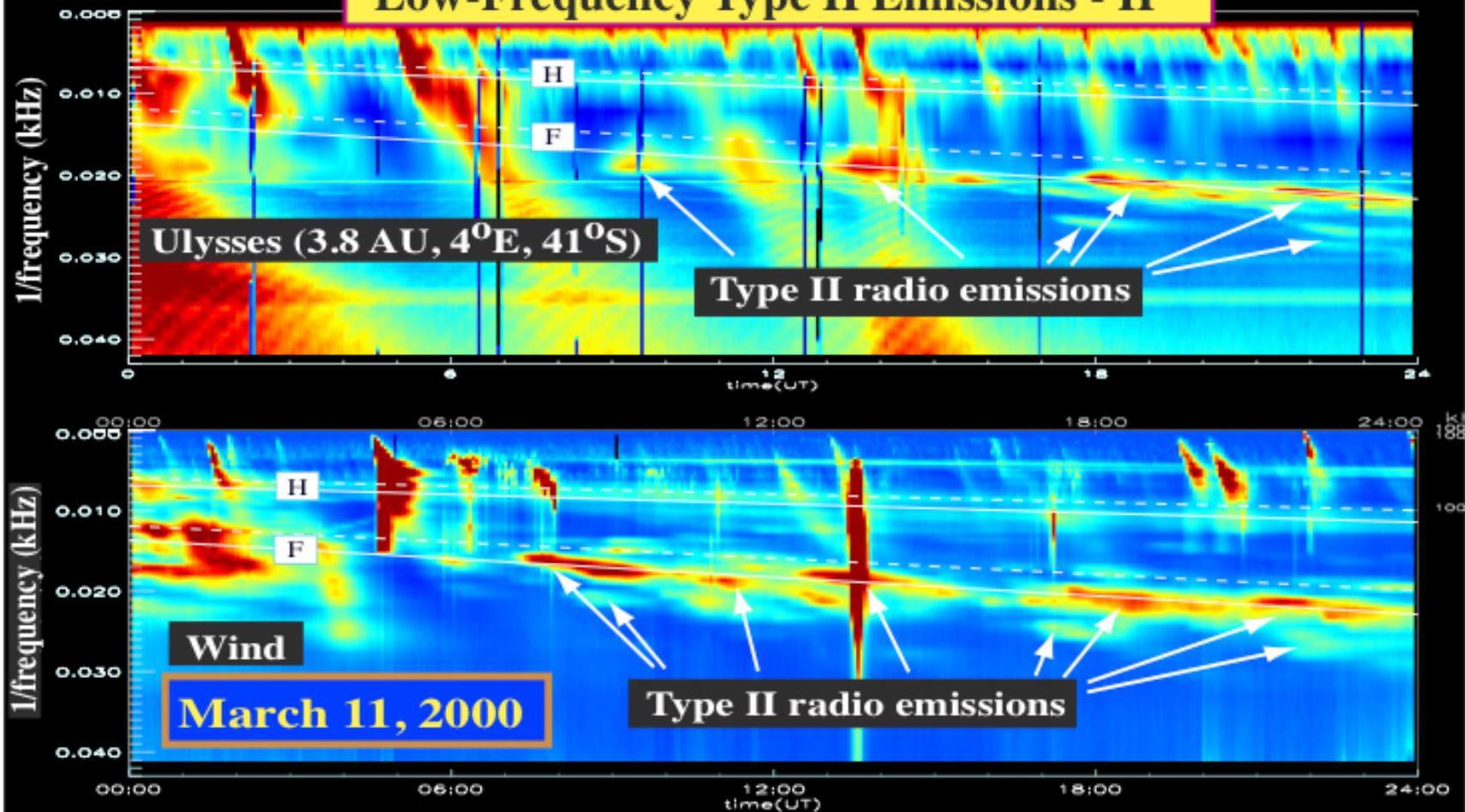
solar liftoff time 9



March 9 - 12, 2000

⇒ No evident acceleration of CME in IPM

"Stereo" Observations of Low-Frequency Type II Emissions - II

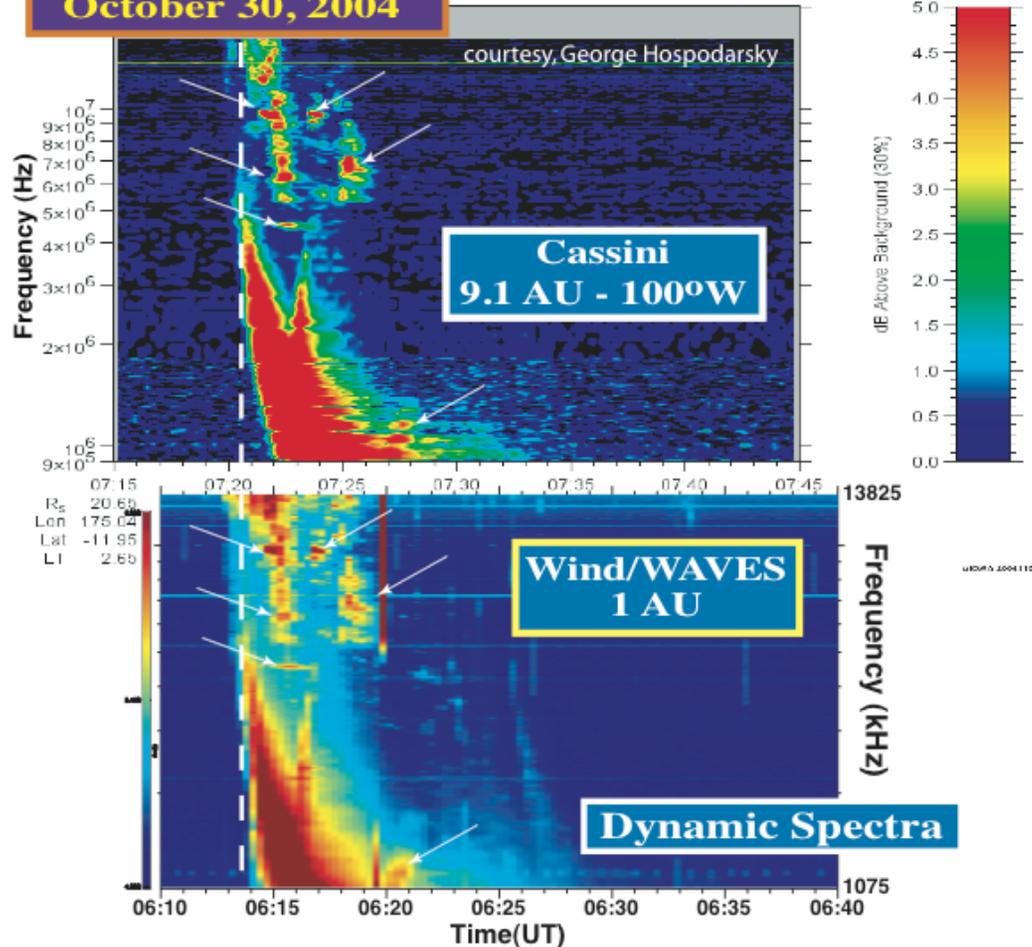


- Remarkable similarity in the sporadic structure of the type II radio emissions from these two "stereo" views
- The differences are mostly due to the differences in the radio receiver characteristic on Wind and Ulysses
- The STEREO spacecraft will have identical radio receivers

"Stereo" Observations of Complex Type III-like Emissions

October 30, 2004

2004-10-30 (304) 07:45

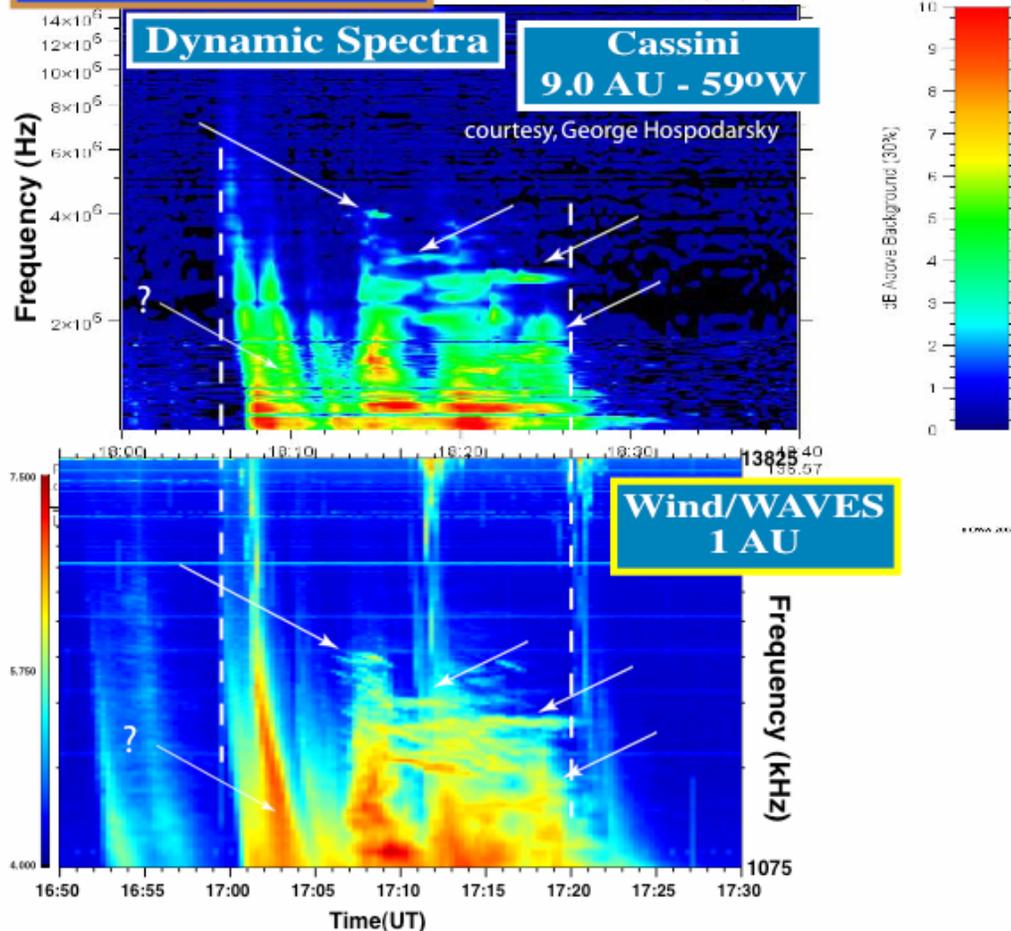


- The detailed fine structures are essentially identical as seen from the two "stereo" spacecraft
- These observations suggest that the fine structures of the complex type III-like bursts correspond to the intrinsic turbulent plasma through which the electron beam propagates

"Stereo" Observations of Complex Type III-like Emissions

September 19, 2004

2004-09-19 (263) 18:40



- Although the detailed radiation characteristics are essentially the same there appear to be differences in some of the finer details
- The radio receivers on the STEREO spacecraft will have identical frequency and time resolution
- Any observed differences in the radiation fine structure may represent differences in the disturbed plasma in the source region and/or signatures of the radiation characteristics, e.g., beaming, propagation effects