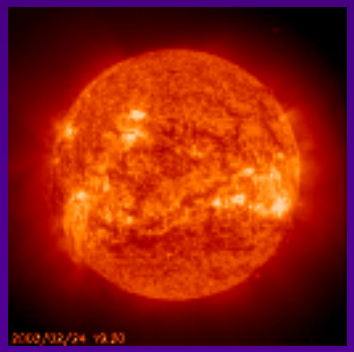
Dual Frequency Solar/Jupiter Radio Telescope



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Dual Frequency Solar/Jupiter Radio Telescope

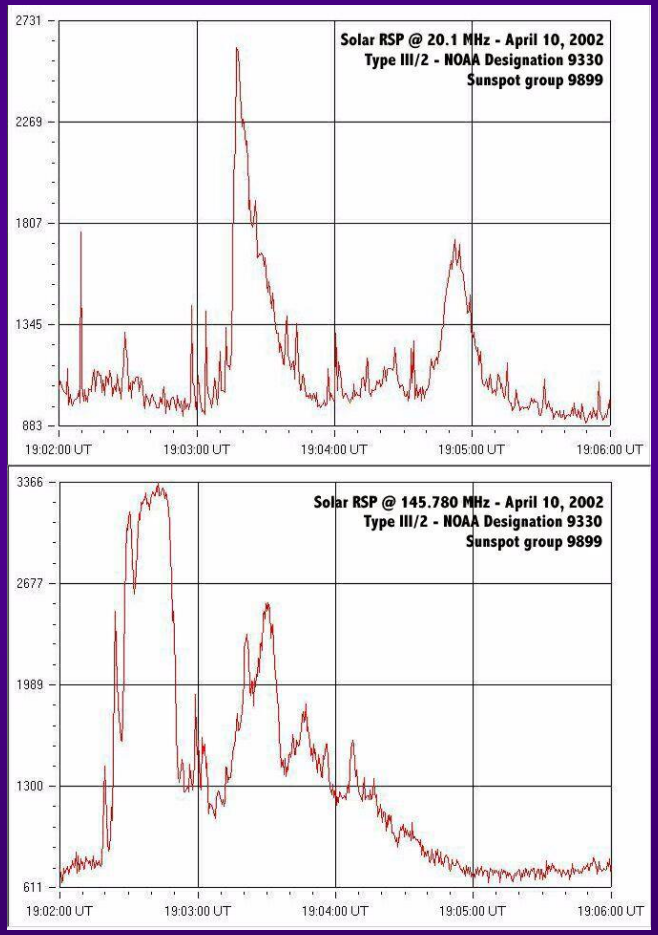
- Made possible by funding from the South Carolina Space Grant Consortium and SCSU NASA PAIR grant NCC 5-454
- Started with "I wonder what the solar burst looks like at higher frequencies?"
  - Is it the same shape?
  - Is it the same magnitude?

Dual Frequency Solar/Jupiter Radio Telescope

- This will be a continuation of work conducted from 2000 to 2002 observing solar and Jupiter radio bursts at 20 MHz as part of the NASA Goddard Radio JOVE program.
  - "A Year Of JOVE Solar Observations" Jan/Feb. 2002 SARA Journal
  - "An Inexpensive Atl-Azi Computer Controlled Antenna Drive" 2001 SARA Conference

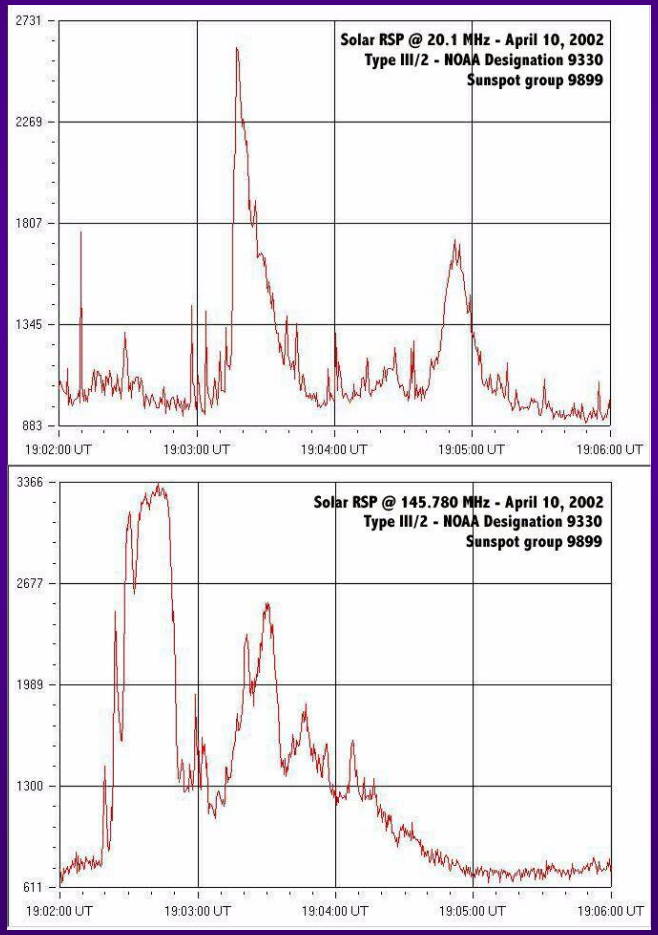
Dual Frequency Solar Observations

- Preliminary data suggests that there are significant differences in the propagation of solar radio bursts in both structure and arrival times at Earth as observed at high (145 MHz) and low (20.1 MHz) frequencies.

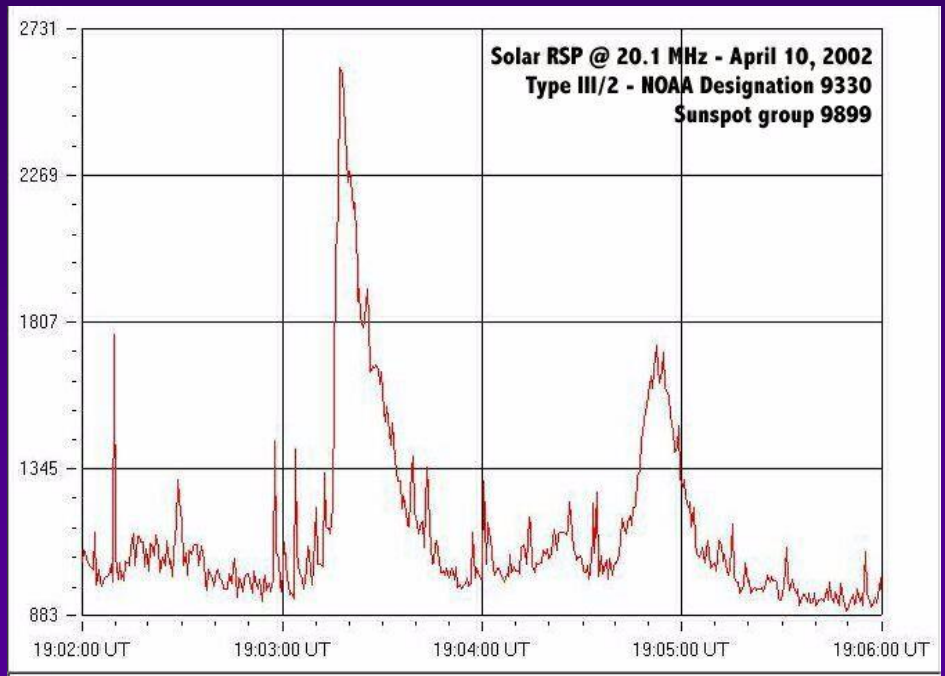


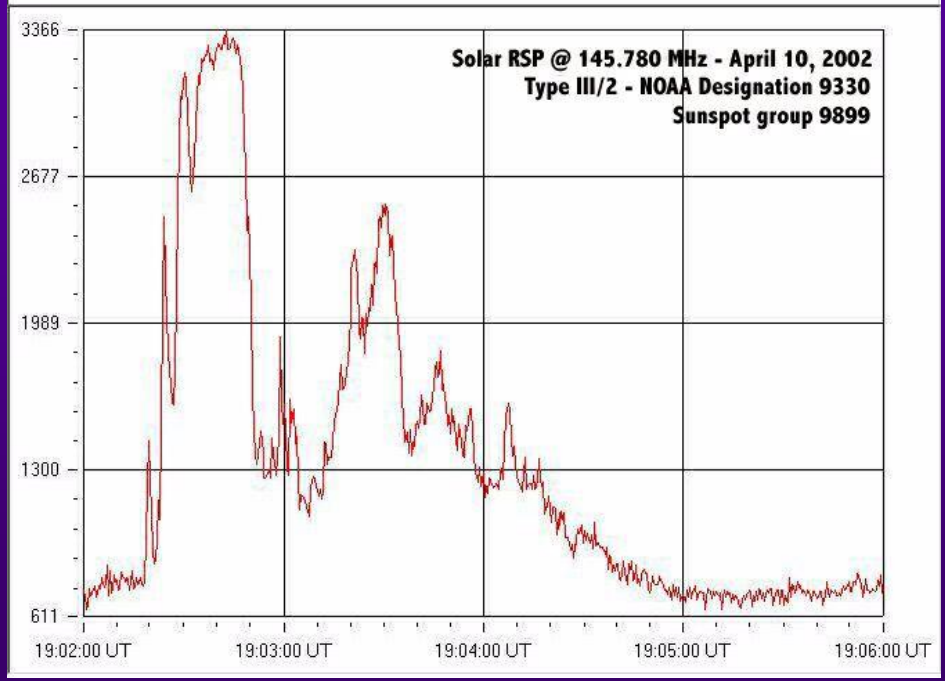
Was I seeing things?

- Data from two different radio telescopes separated by a mile - JOVE and 145 MHz telescope showed a time lag in arrival times of burst.



Comparisons





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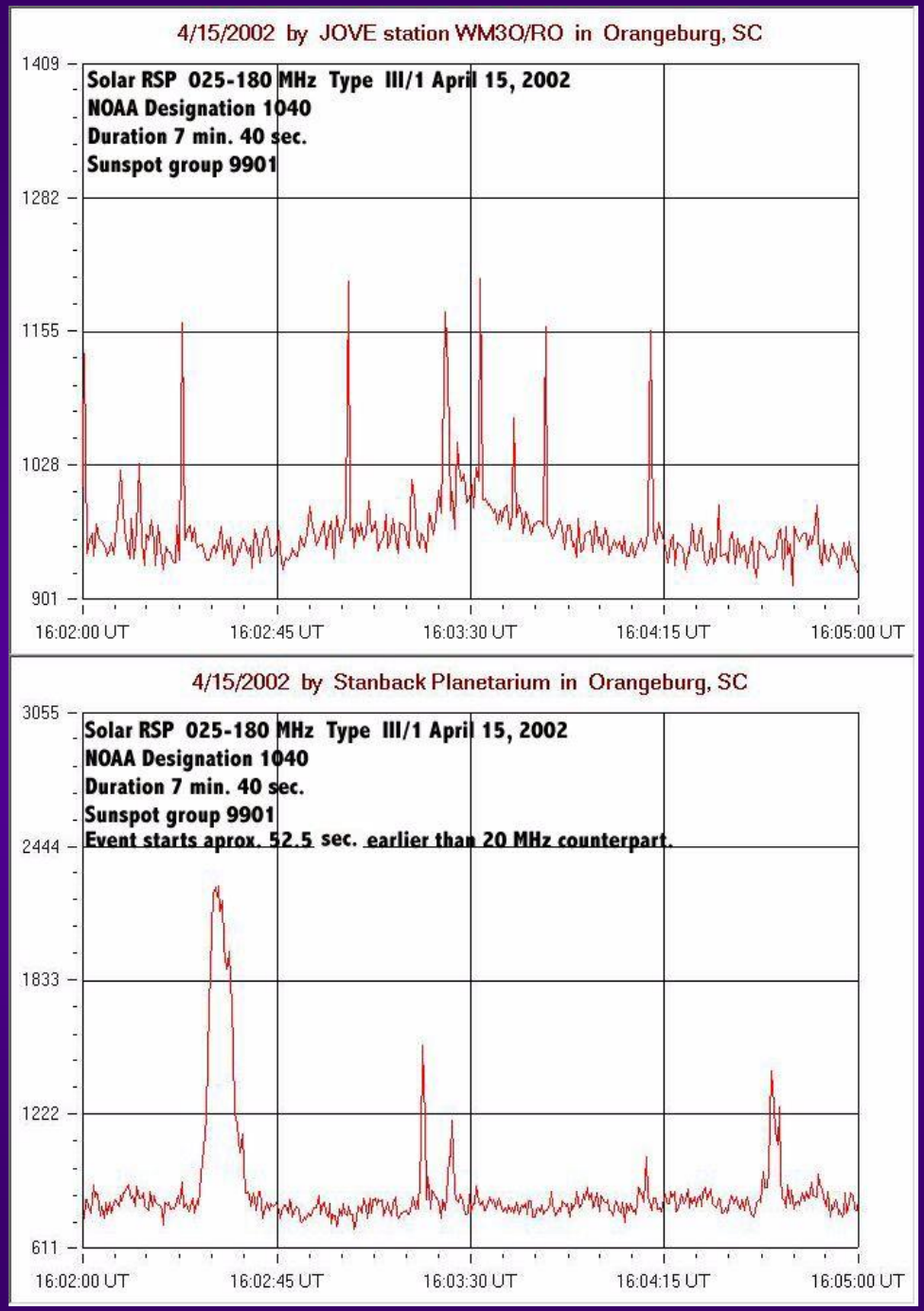

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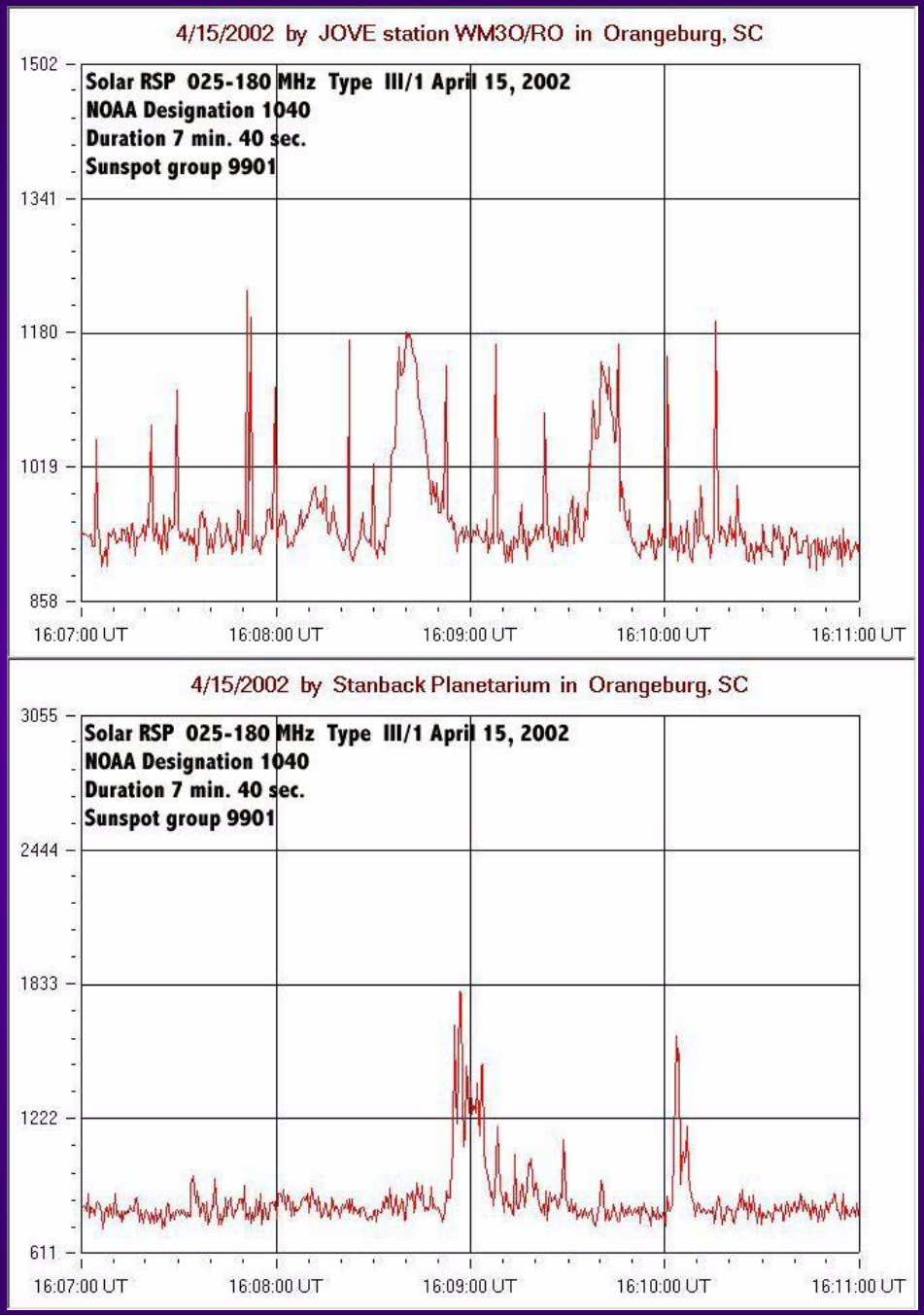

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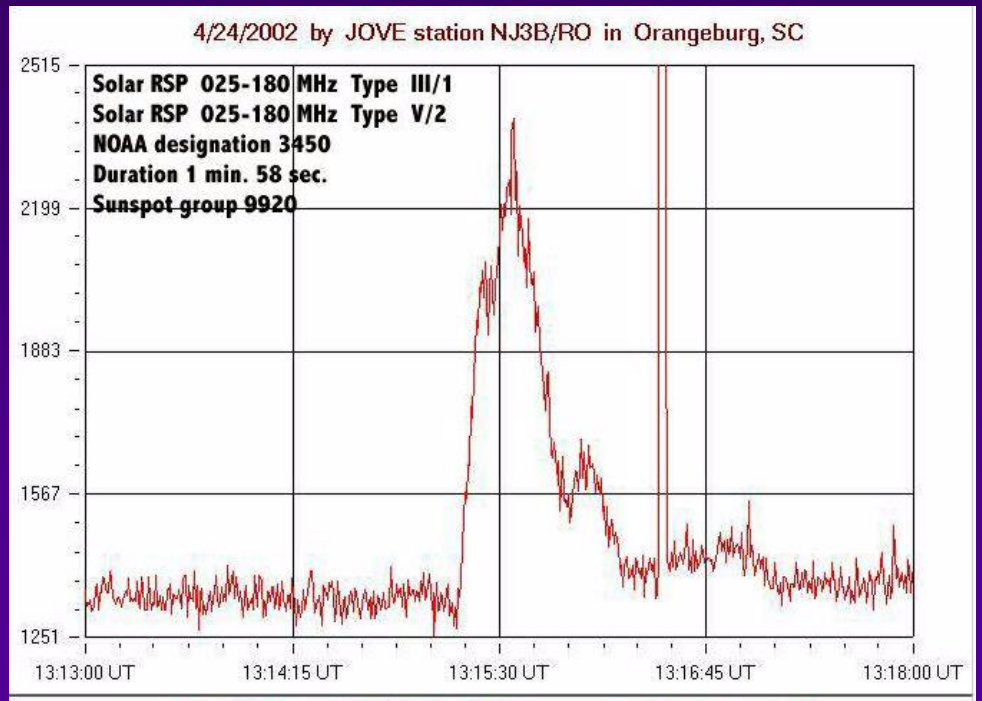

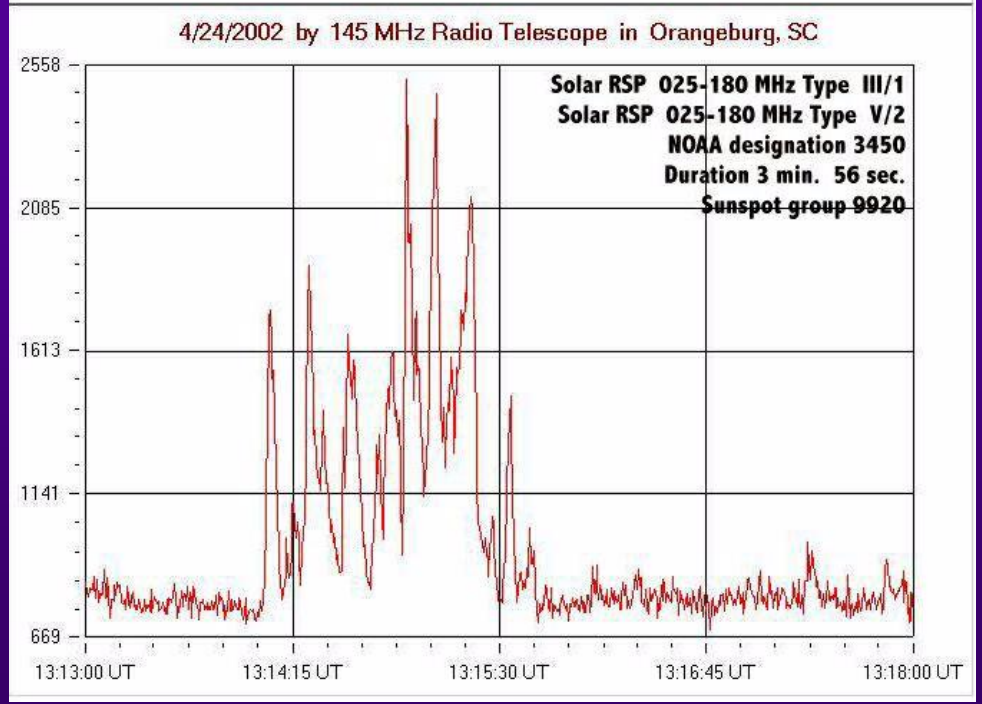

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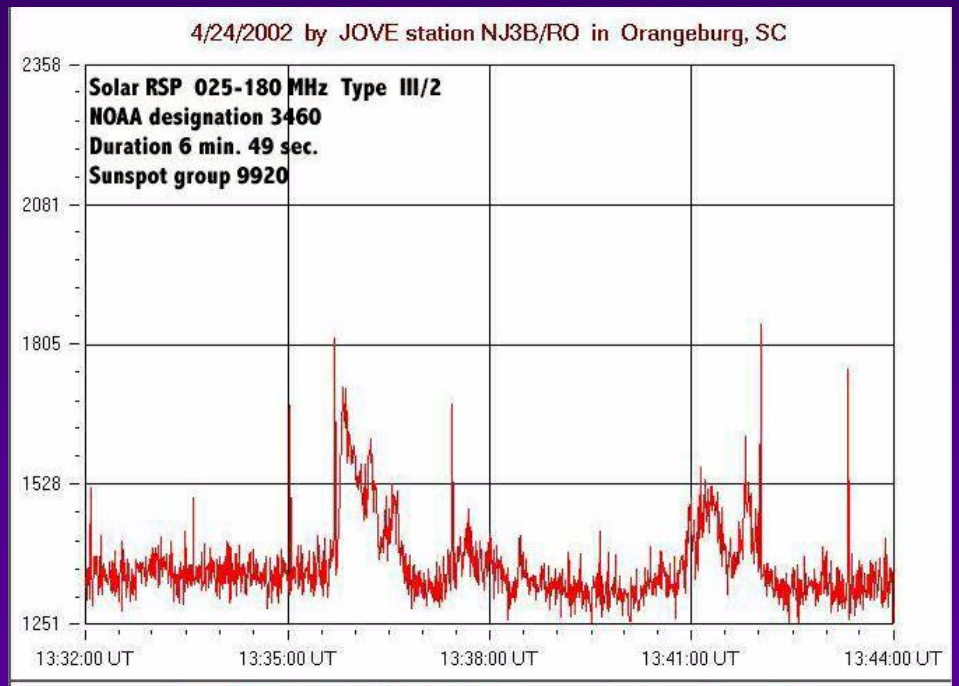

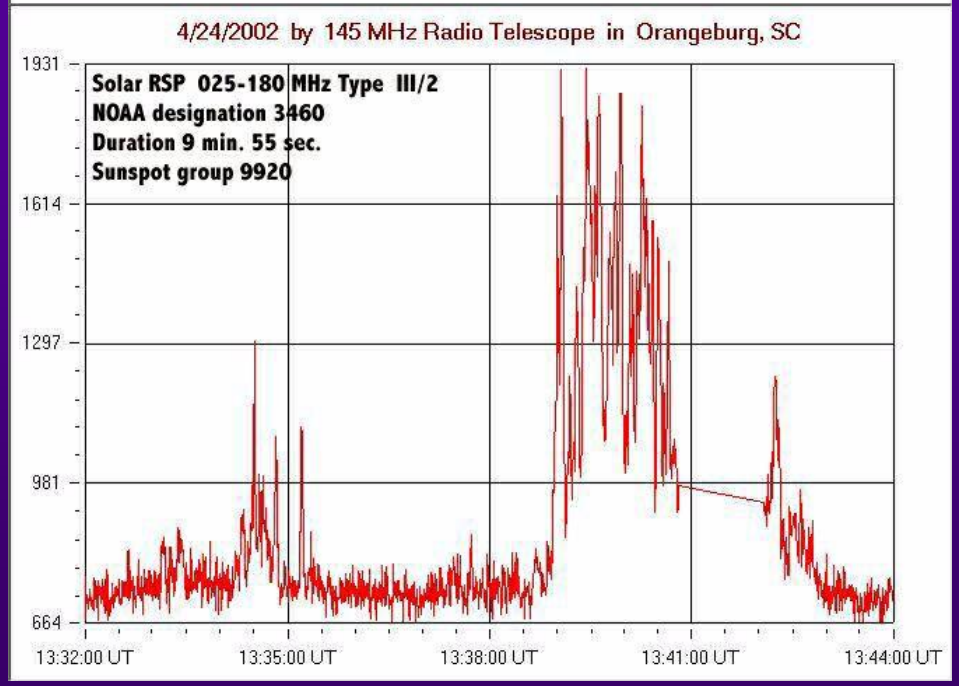

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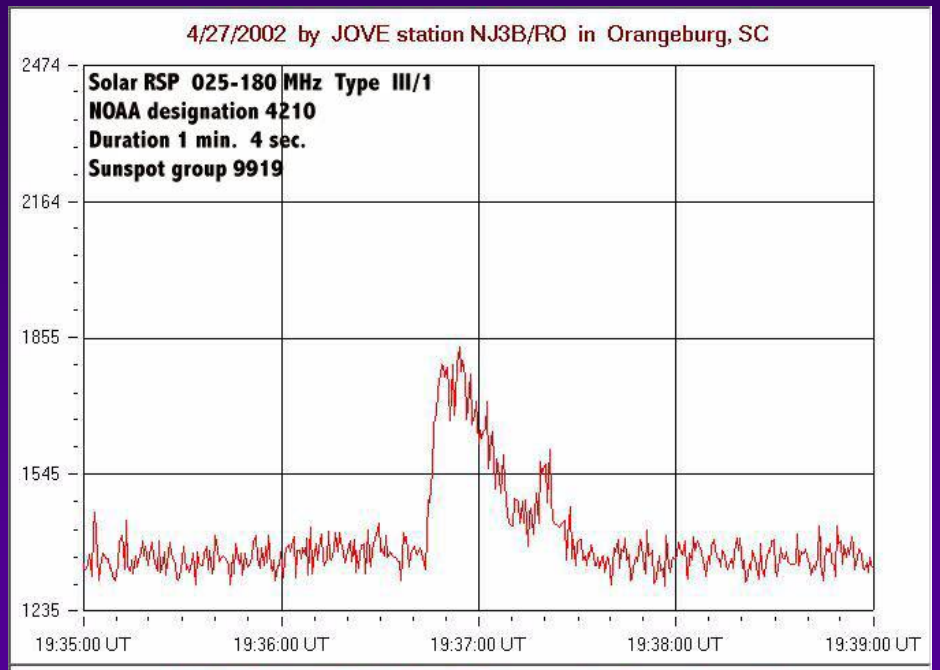

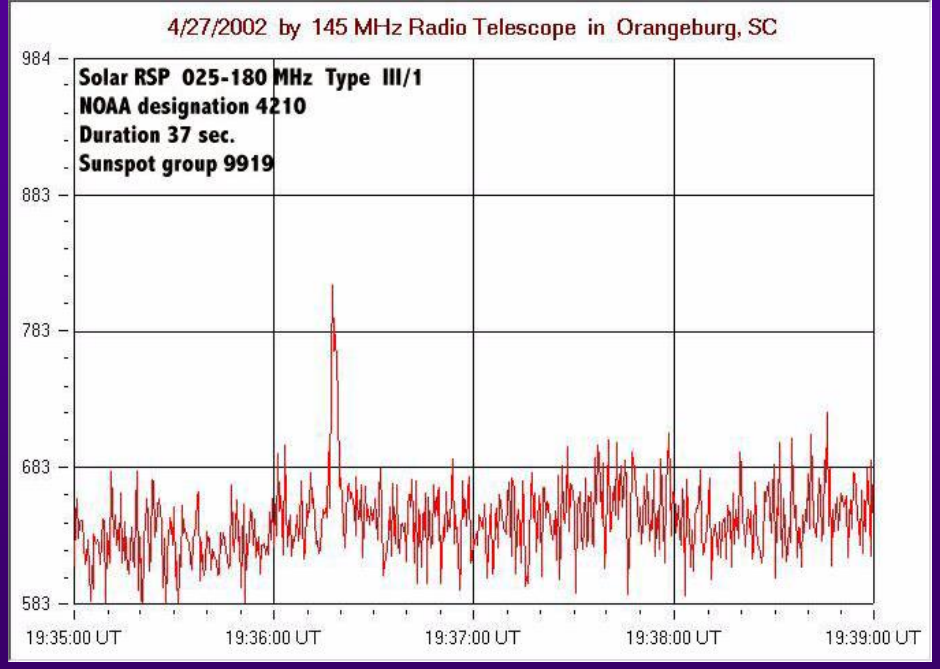

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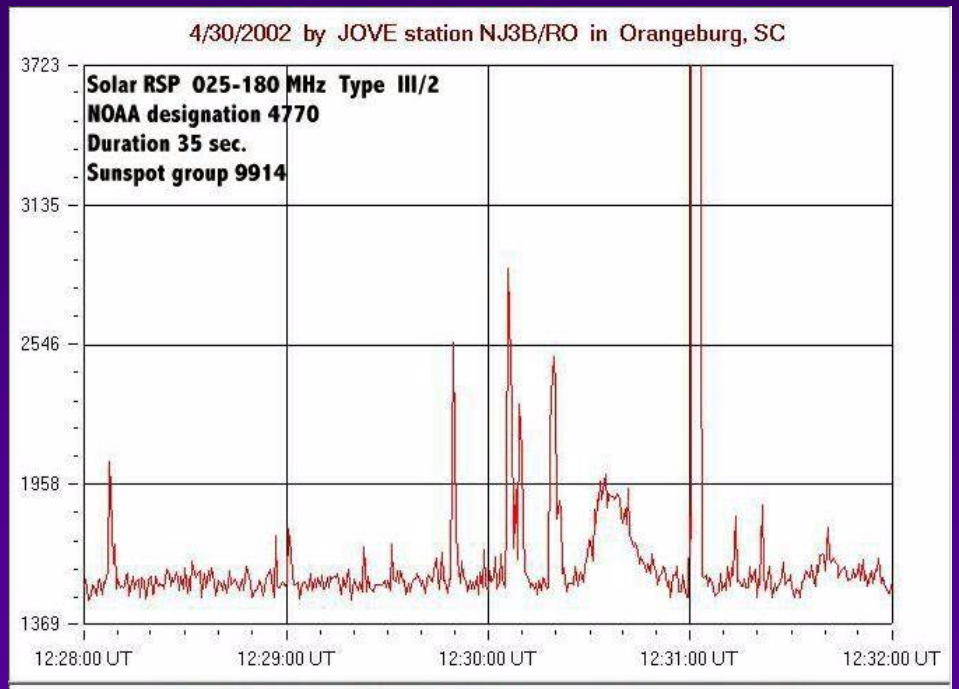

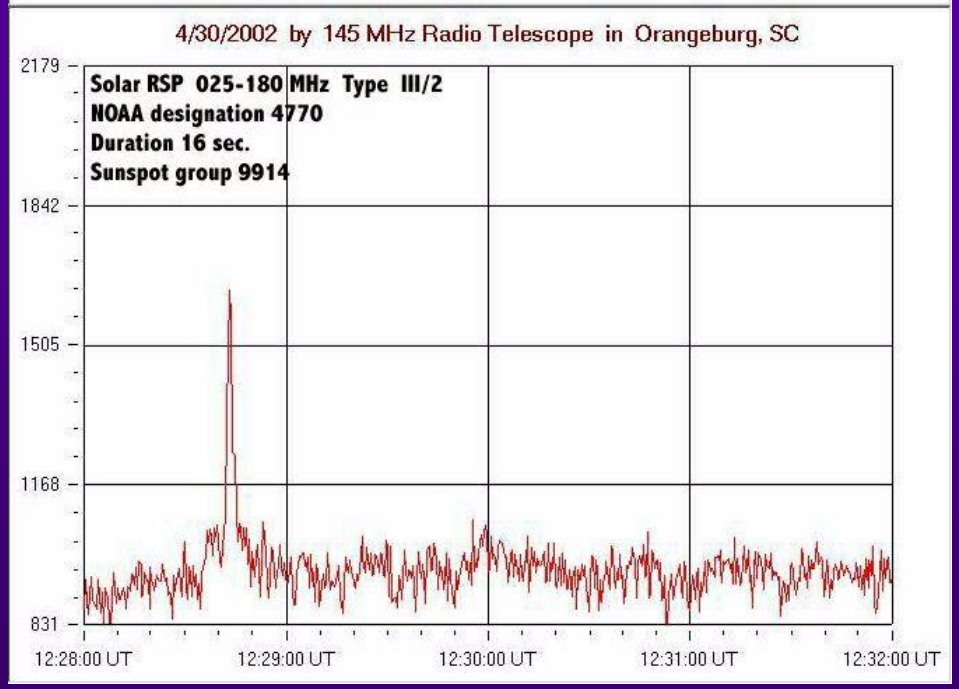

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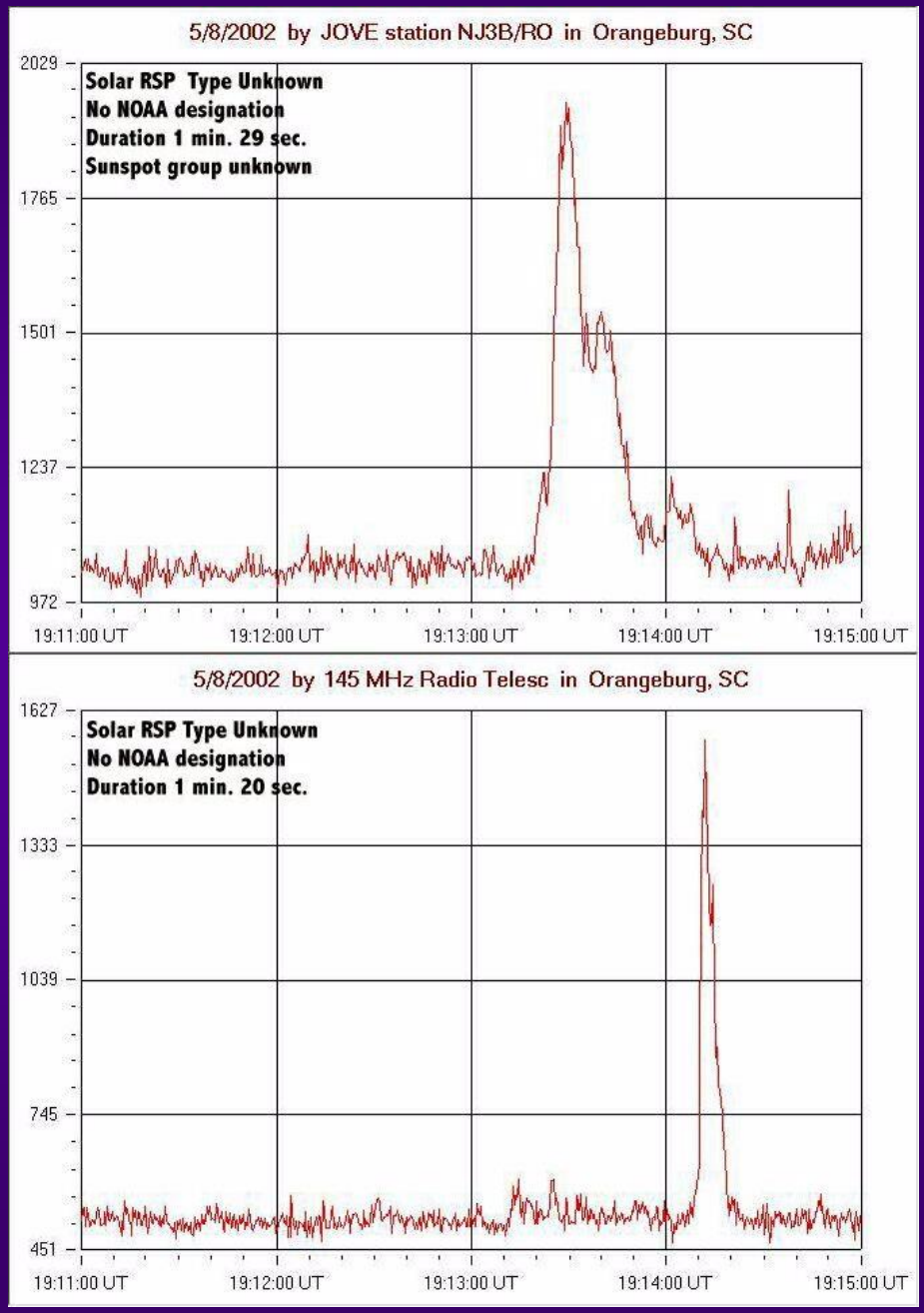
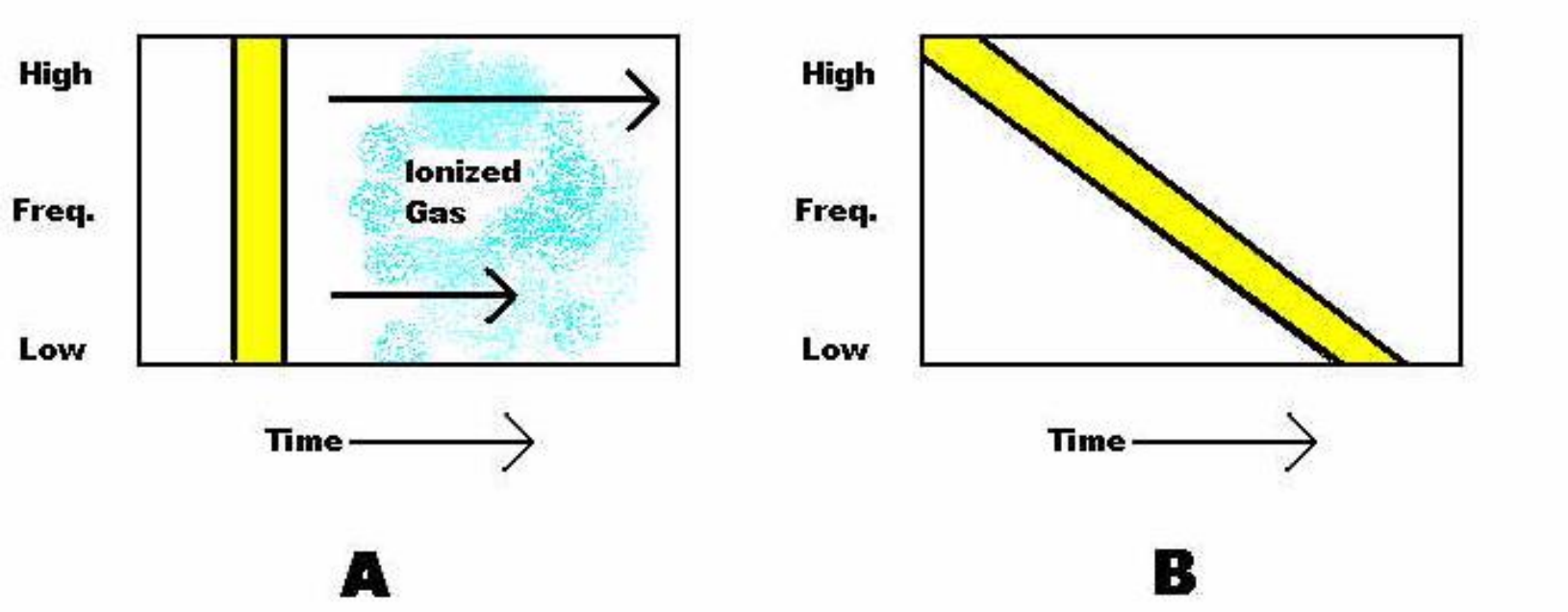


Dual Frequency Solar/Jupiter Radio Telescope Science

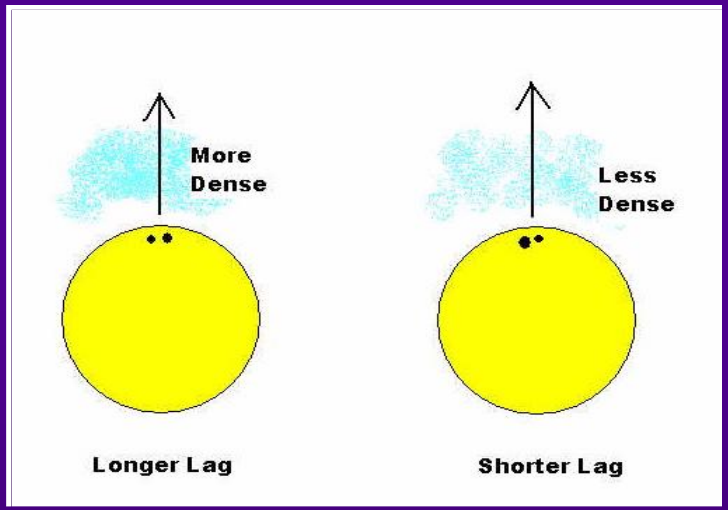
- Delay times
  - Time lag between the high frequency and low frequency ranges from a few seconds to as much as 80 seconds.
  - This can be explained two different ways.
    - All bursts generated at the same time but propagate differently though the solar plasma.
    - Bursts generated from high first to low frequency last.

What was the mechanism?



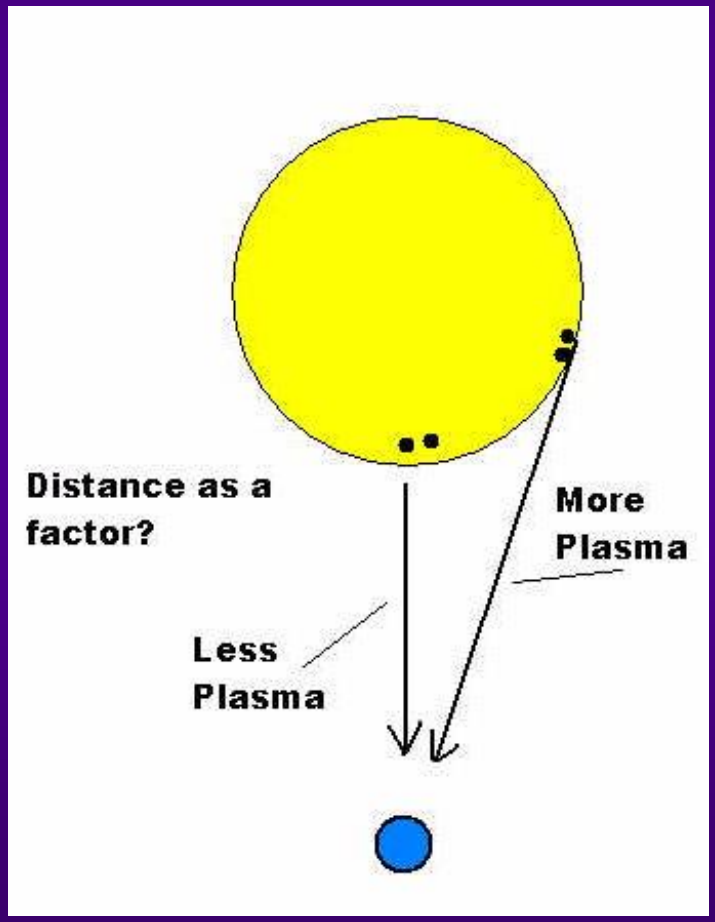
What was the mechanism?

- If the observed time lag is due to propagation through the solar plasma:
  - The variations in time from one observed event to another could be due to non-uniform density of the plasma above the event origin.

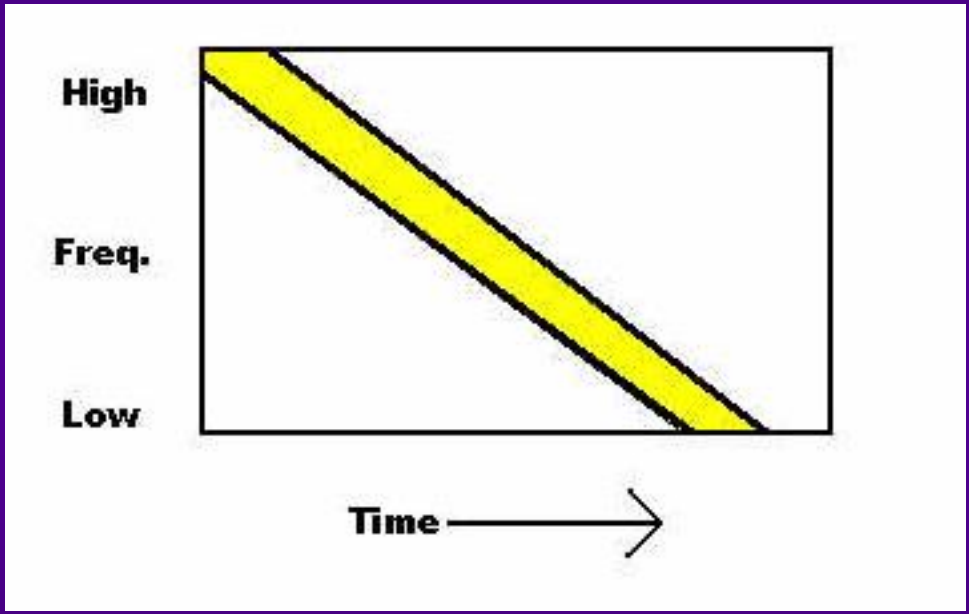


What was the mechanism?

- The variations in time from one observed event to another could be due to event origin distance from observer (limb Vs.. meridian)



What was the mechanism?



- If this is the mechanism:
  - Burst is generated from high frequency to low frequency.

Current data indicates

- What my current data indicates
  - Difference in arrival times at high/low frequency.
  - Difference in shape of wave at high/low frequency.
  - Difference in duration of burst at high/low frequency.

Was it the data?

- In both cases, I use SkyPipe software utilizing the atomic clock feature.
  - I was sure that the chart times were correct.
- I made sure both versions of SkyPipe were set up identically.
- I could, with reasonable certainty, eliminate the software.

Was it the receivers?

- Was there a possibility that different characteristics of the two different receivers be causing the delay?
  - JOVE receiver 20 MHz
  - Icom R-75 receiver 145 MHz
- After consulting Dick Flagg and Jim Sky, I was assured that this could not be the reason.

Where to go from here?

- A preliminary search on the Internet did not yield any information regarding delay times in received burst signals at different frequencies.
  - This didn't mean that there was no such study, just that I was unable to locate anything in my first searches.

Checking with authorities

- I e-mailed several solar radio observatories but could get no definitive answers.
- Dr. James Thieman (NASA Goddard) put me in touch with a solar physicist he knew.

My First Answers

- Introduction to solar radio astronomy and radio physics by A. Kruger. Kruger, Albrecht. Dordrecht ; Boston : D. Reidel Pub. Co., 1979.
- Radio physics of the sun : symposium no. 86, held in College Park, Md., U.S.A., August 7-10, 1979 edited by Mukul R. Kundu and Tomas E. Gergely. Dordrecht, Holland ; Boston : D. Reidel Pub. Co., Hingham, MA : distributed in the U.S.A. and Canada by Kluwer Boston,c1980.

Getting the real answers

- As early as 1958, in a paper titled, "On The Mechanisms of Sporadic Solar Radio Emission", by Ginzburg & Zhelezniakov.
  - "The **frequency drift** and some of their other peculiarities lead us to conclude that bursts of Types II and III are **generated by particle streams**."

Getting the real answers

- cont.
  - "We note that from the quantum point of view the instability of the stream in plasma is connected with the fact that this system has a negative absorption (i.e., the induced emission of plasma waves prevails over their absorption)."

More answers

- In his paper, “Solar Burst Observations at Metre and Decametre Wavelengths”, by D. J. McLean wrote:
  - “...although the basic feature of Type II bursts, **a slow drift from high to low frequencies**...”

More answers

- He further wrote:
  - "Now, almost 30 years later, we are quite confident that the early ideas of the generation of Type III bursts are basically correct; a stream of sub-relativistic electrons [generated by flares], accelerated low in the corona, passes out through the coronal plasma and at each level stimulates electromagnetic emission [radio bursts] at the local plasma frequency and its second harmonic."

Solar burst source regions

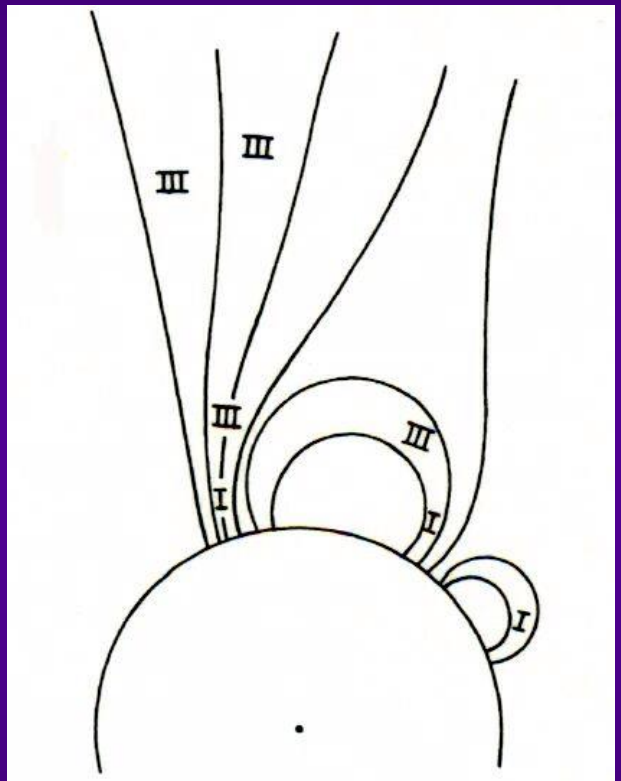
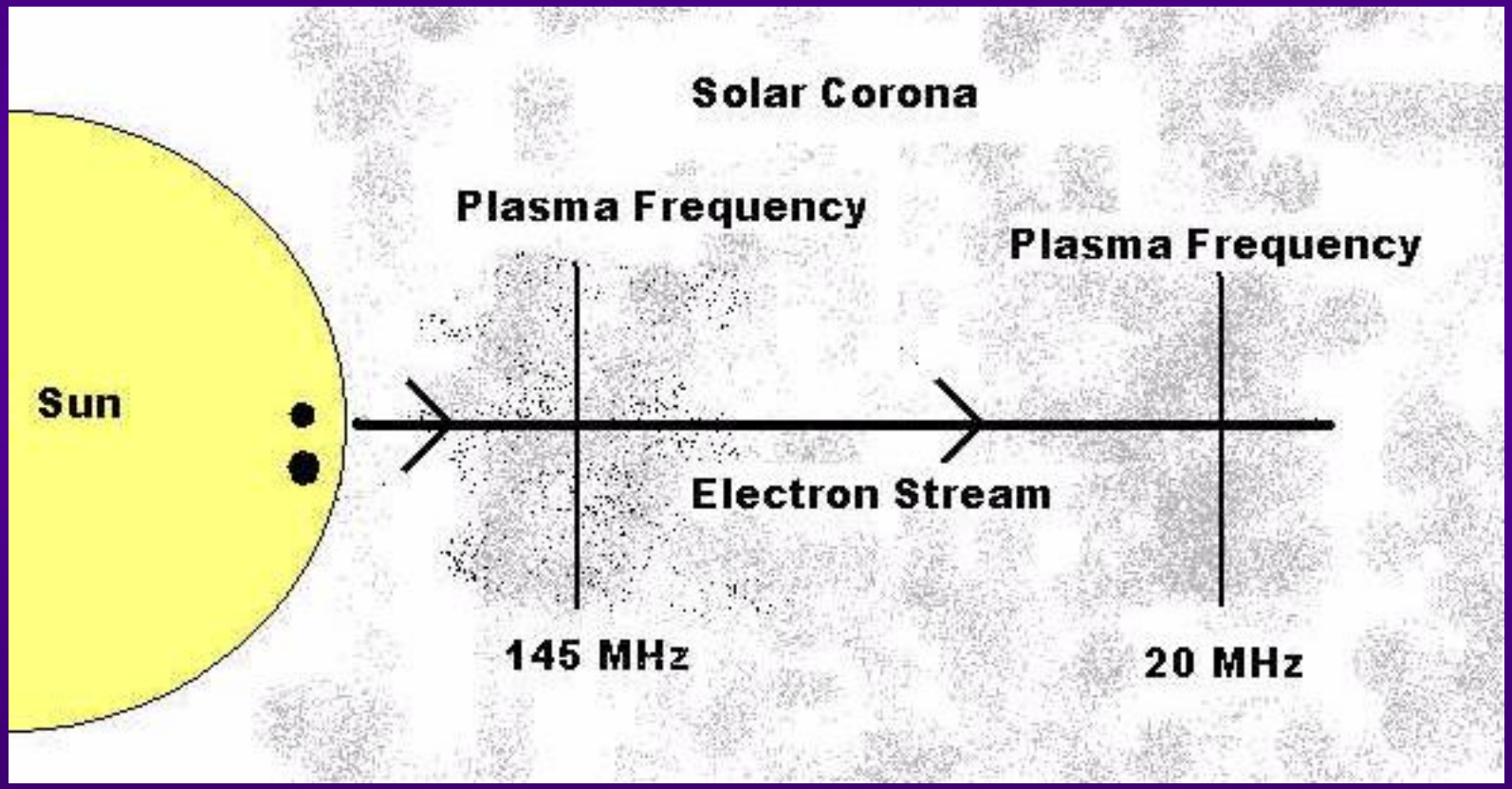


Figure 4. Proposed model of the source region, showing where the type I and (or) the type III storms take place.

What this means…



Higher frequency plasma is closer to the sun

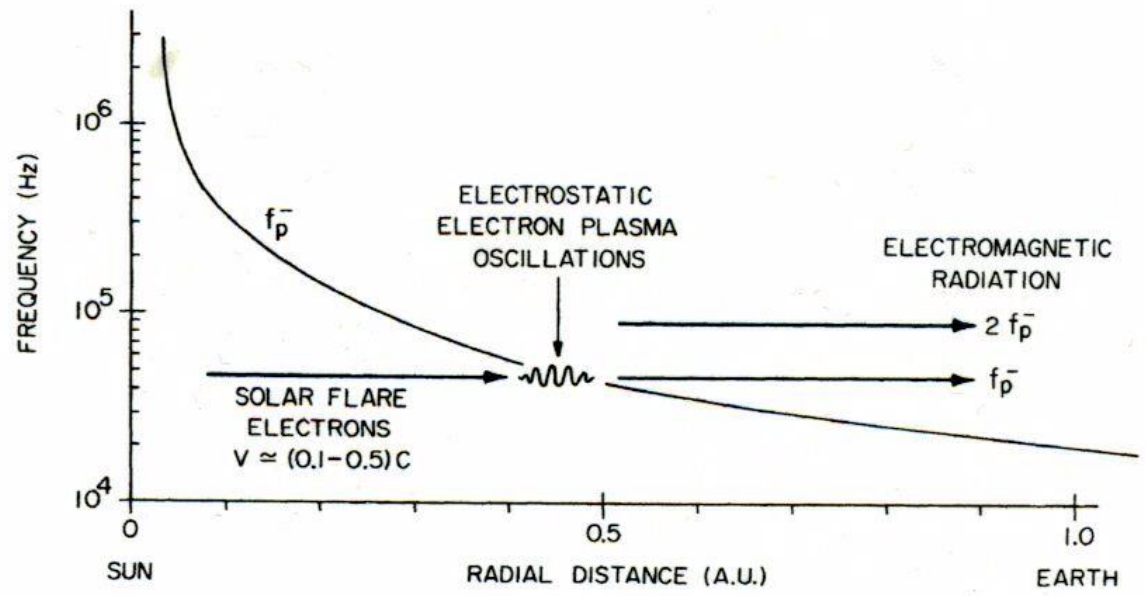


Figure 1. A representative radial profile of the electron plasma frequency in the solar wind illustrating the generation of electron plasma oscillations and the subsequent conversion to electromagnetic radiation at f_p^- and $2f_p^-$.

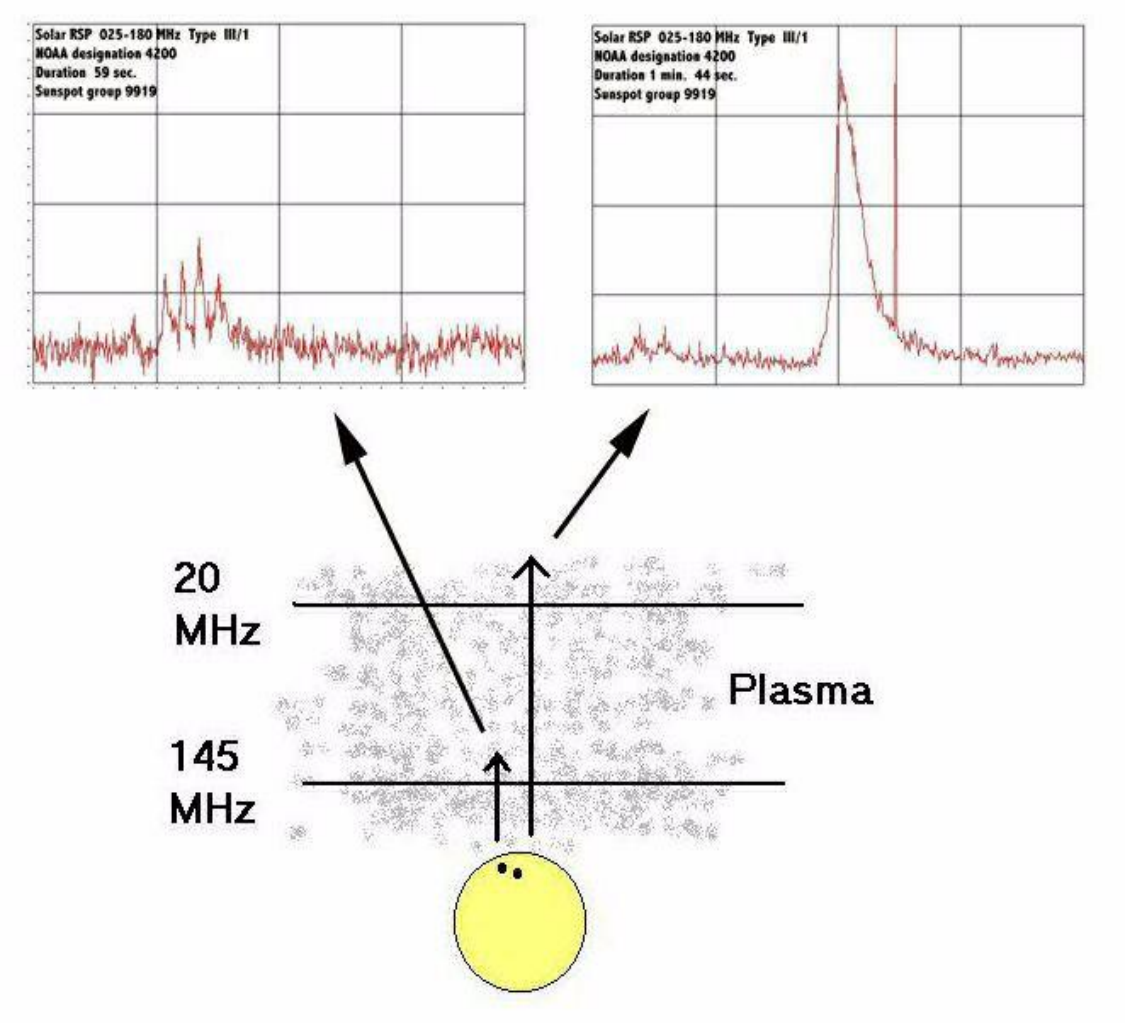
Time differences

- Current Understanding Of The Physics of Type III Solar Radio Bursts by K. Papadopoulous
  - "...it proved and explanation for why the electron streams appear to have such well defined velocities, or order c/3 at high frequencies, decreasing to c/2 or less at low frequencies."

Time differences

- If the arrival time is greater than one second, then bursts generated by multiple electron streams.
- If the arrival time is one second or less, then chances are that both bursts were generated from the same electron stream.

Multiple Frequency Type III Solar Burst Mechanism



Dual Frequency Solar/Jupiter Radio Telescope Project

Dual Frequency Solar/Jupiter Radio Telescope Project

- Made possible by funding from the South Carolina Space Grant Consortium
- SCSU NASA PAIR grant NCC 5-454

Dual Frequency Solar/Jupiter Radio Telescope

- The primary purpose of this project is to investigate this phenomena and provide real time radio astronomy data via the Internet for use in classrooms.

Dual Frequency Solar/Jupiter Radio Telescope Description

- The telescope consists of two antennas and two receivers to record radio bursts from the sun simultaneously at 145 MHz and 20 MHz for the purpose of investigating burst properties at these two different wavelengths.

Dual Frequency Solar/Jupiter Radio Telescope Description

- The radio telescope system is set up to run either automatically or manually as needed.
- All control equipment is housed in the SCSU radio telescope control room and is a permanent part of the SCSU radio astronomy program. The control room also serves as an exhibit in the SCSU Stanback Planetarium/Museum.

Dual Frequency Solar/Jupiter Radio Telescope Description

- The 20 MHz portion of this system will also be used to track and monitor Jupiter radio bursts.
- This is in support of our continuing work with the NASA Goddard Radio JOVE program.

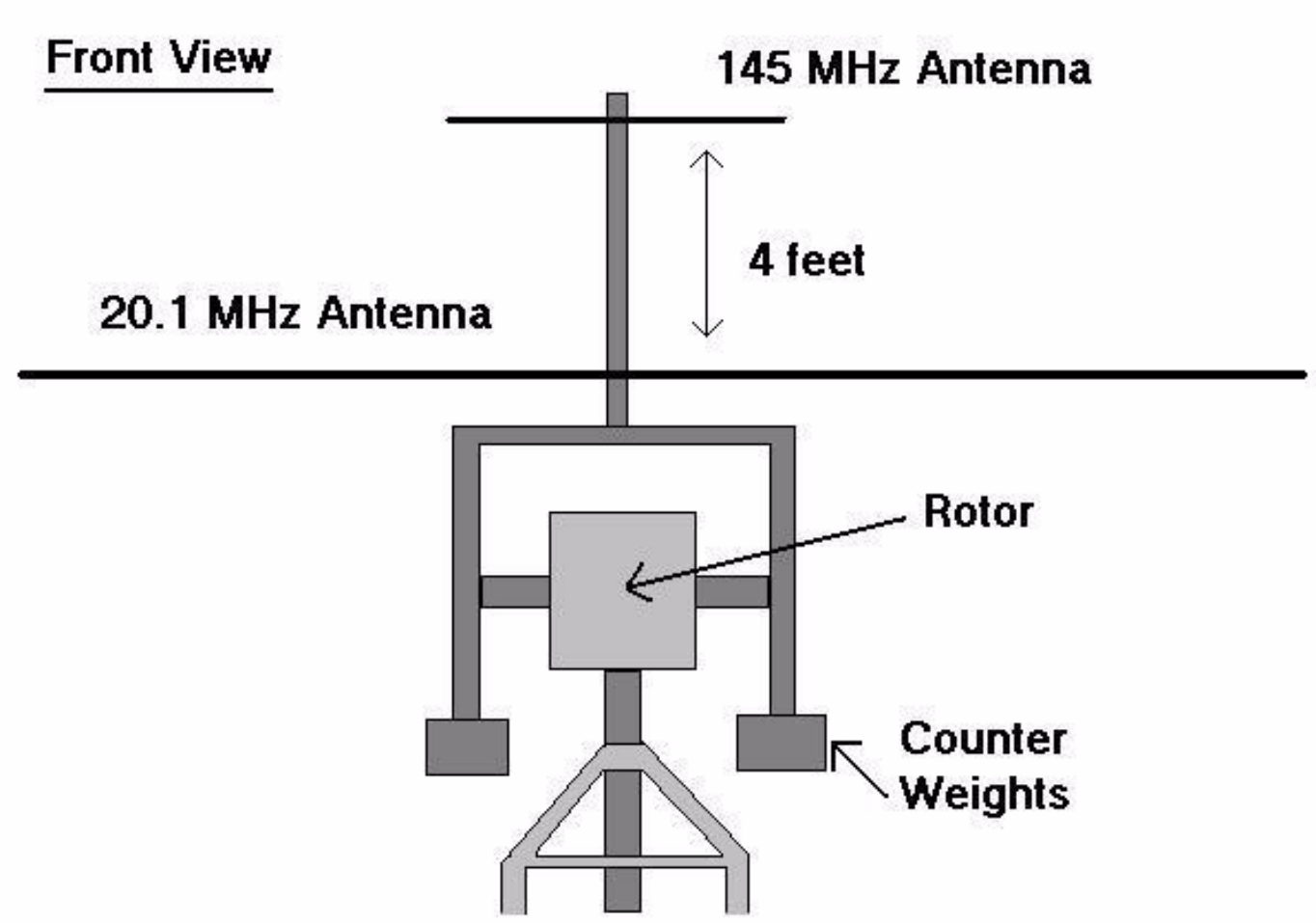
Dual Frequency Solar/Jupiter Radio Telescope Description

- Using the cross platform Windows Media technology, live audio streaming of Jupiter and solar storms will be conducted, with an archive of sound files available for download.
- Control circuitry will be constructed and speakers placed outside the control room for visitors, such as school groups, to be able to listen to the audio feed.

Dual Frequency Solar/Jupiter Radio Telescope Description

- Utilizing SkyPipe software (Freeware) as well as the Windows Media (Freeware) technology live audio streaming, K-16 educators across South Carolina or around the world will be able to hear and record observations for classroom purposes as if they were at the SCSU radio observatory.

Dual Frequency Solar/Jupiter Radio Telescope Description



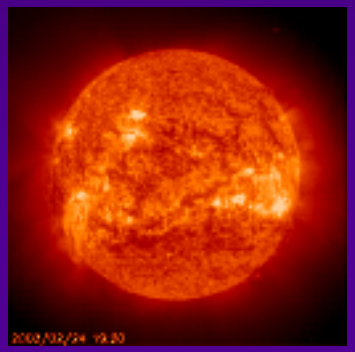
Dual Frequency Solar/Jupiter Radio Telescope Description

- Equipment list:
  - Yaesu G-5500 Alt-Azi computer controlled rotor.
  - Two, Icom R-75 Receivers
  - Down East Microwave High Dynamic Receiver Converter
  - Down East Microwave Low Noise Amplifier

Dual Frequency Solar/Jupiter Radio Telescope Description

- Equipment list:
  - Radio-Sky ADC 186 - 8 Channel A to D Converter.
  - SkyPipe software for displaying both receiver signals and tracking.
  - NOVA for Windows - tracking software.
  - Gateway Pentium PC.

Dual Frequency Solar/Jupiter Radio Telescope



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