Are Weak Type II Radio Bursts Associated with Shocks Driven by Coronal Mass Ejections?

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12/22
8:30am

Introduction

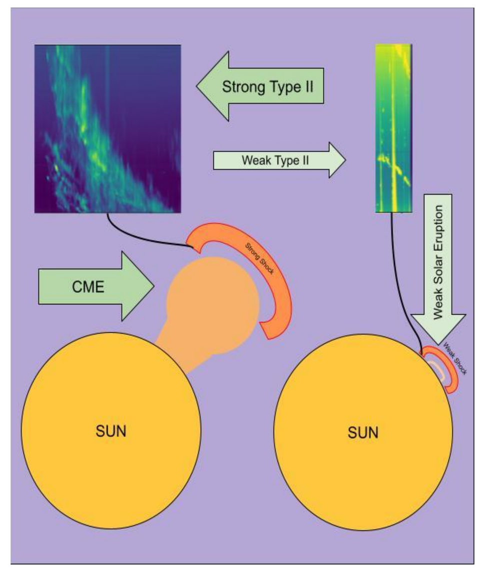
Background Radio sensing is important because the processes of electron acceleration and magnetic reconnection involved in flares and coronal mass ejections (CMEs) is visible in the radio spectrum. Type II radio burst usually associated with CMEs and shocks and are identified by a slow drift to lower frequencies with time in dynamic spectra.

Context. Type II indicates a shock in the corona due to it having a higher speed than local Alfven speed. This is because of the way the electrons were accelerated.

Weak Type II Weak type II radio bursts were categorized as being less than 10 minutes in total duration with low flux (<10 s.f.u).

Aims. To resolve the radio sources of the herringbone bursts found in type II solar radio bursts from 15–88 MHz.

Methods. Perform imaging spectroscopic analysis for weak radio burst to find the source, shape, location and brightness information. This is is used to infer the location of the shock front and its spatial-temporal evolution.



Instrument

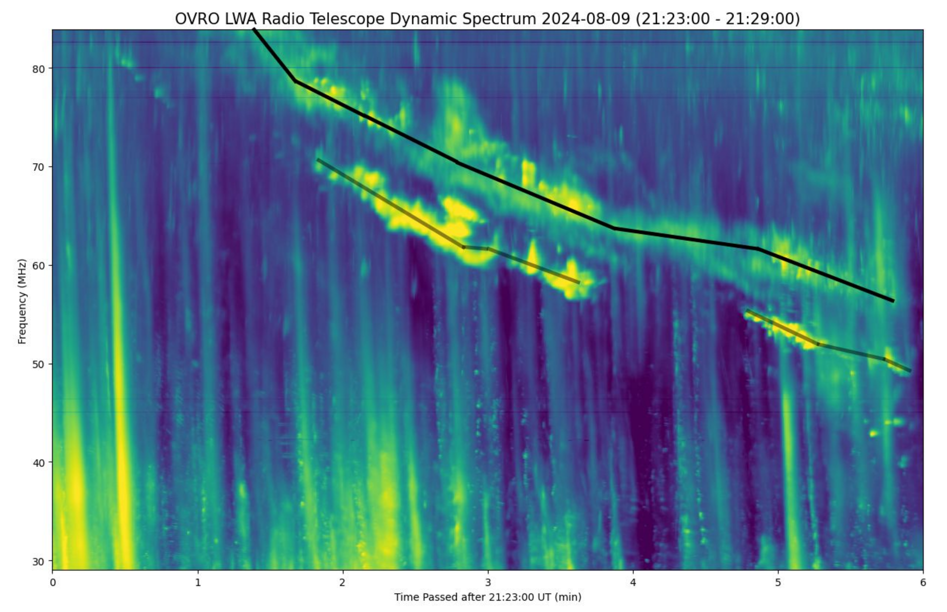
The Low Wavelength Array (LWA) 15-90 MHz

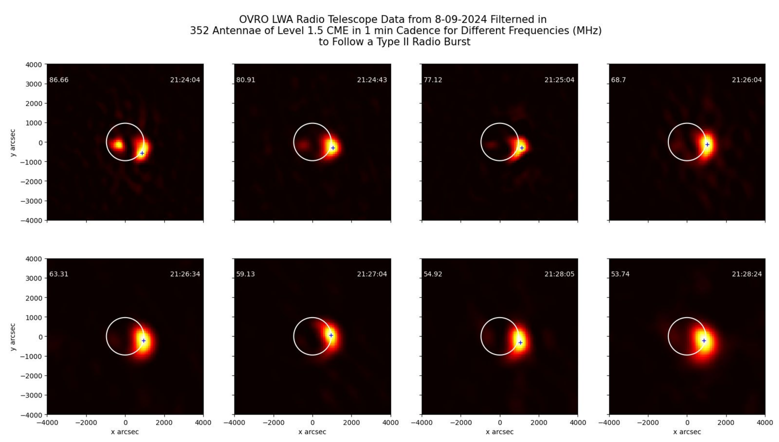
Fast Radio Imaging:
- Antennas: 48
- Candance time: 0.1s
- Frequencies: 768

Slow Radio Imaging:
- Antennas: 352
- Candance time: 10s
- Frequencies: 3072

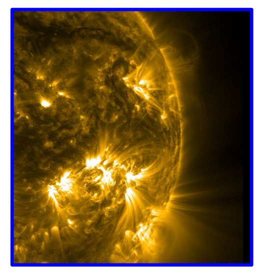
https://www.ovro.caltech.edu/projects-1

Observations

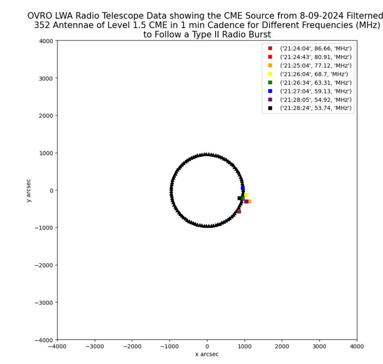


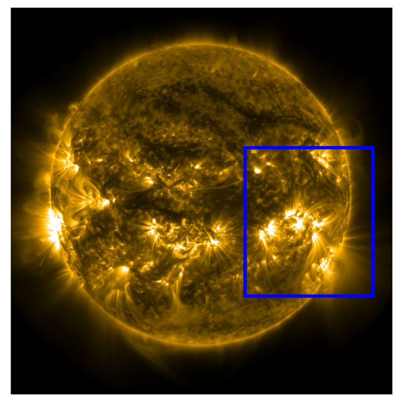


Frame 1

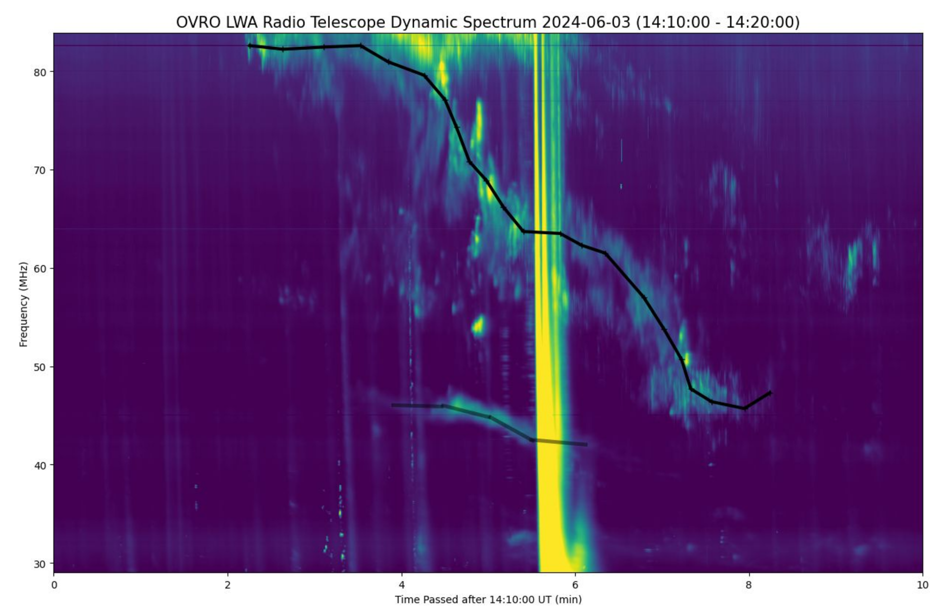


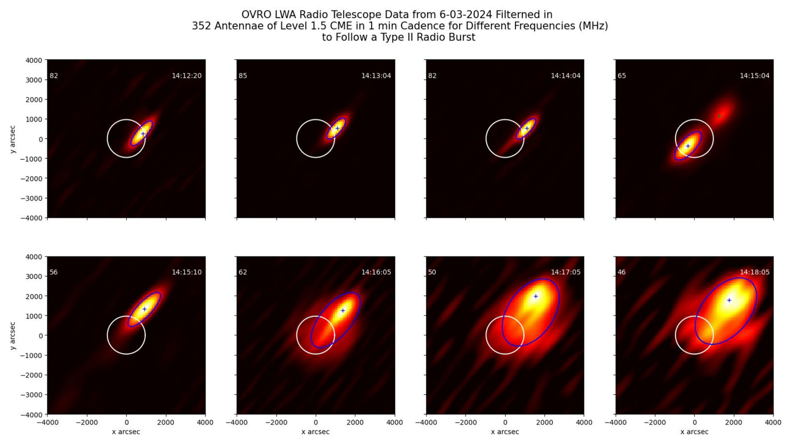
No matching EUV eruption found



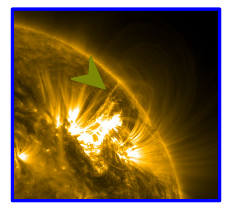


This trial was hard to Identify a EUV counterpart because there were two eruptions happening on the left side and none of them perfectly matched the area of the brightness source.

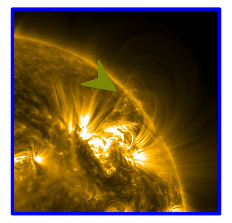




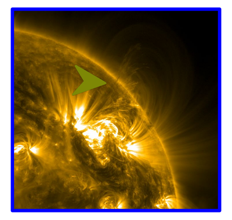
Frame 1

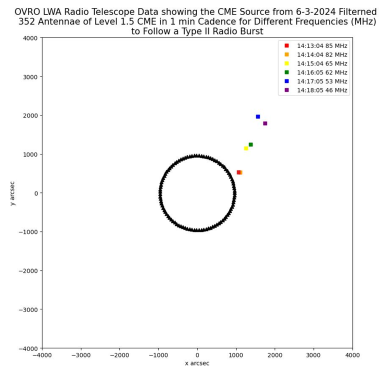


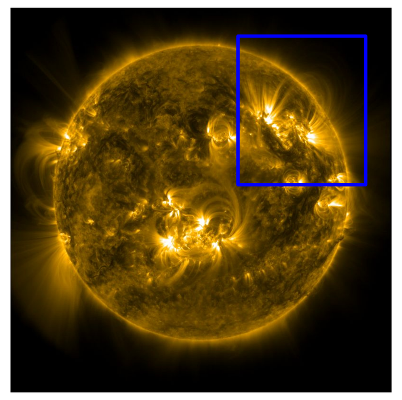
Frame 2



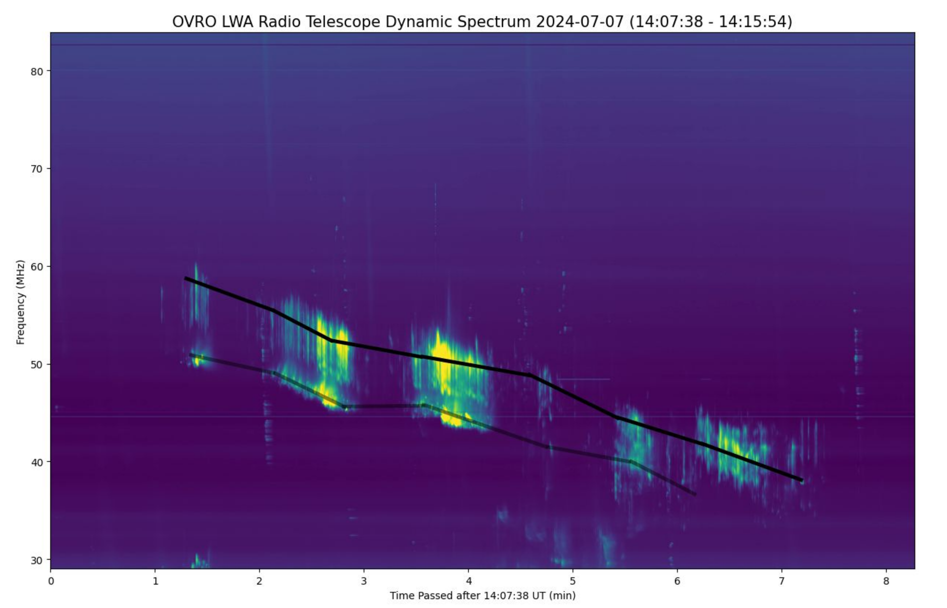
Frame 3

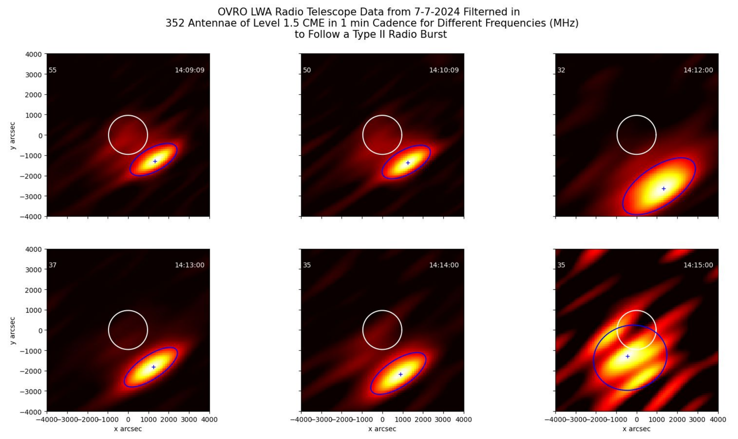




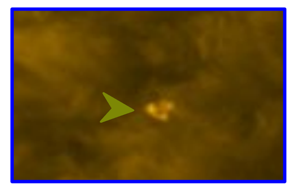


This imaging shows that the source originated from the top right. The three frames on the right show the corresponding solar eruption that was found at the same time.

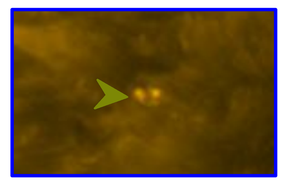




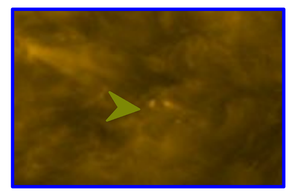
Frame 1

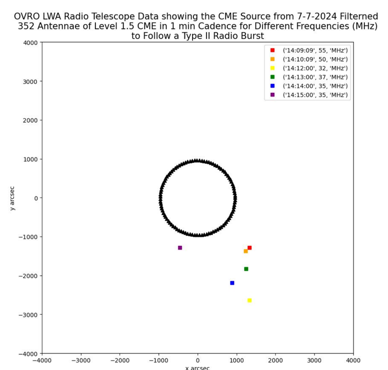


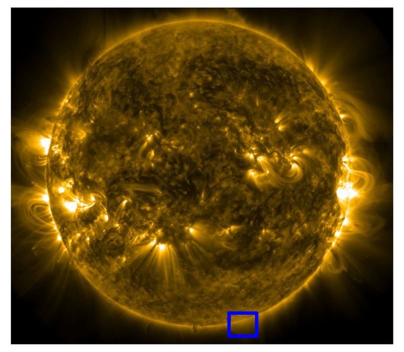
Frame 2



Frame 3







Like others, this event presents discontinuity in the frequency drift lane, and has band-splitting feature in the spectrum. The EUV counter-eruption was very small in comparison to the other examples.

Results

Trial number	Date	Duration (min)	Max Brightness Temp (MK)	Max Intensity (s.f.u)	Freq Range (MHz)	Discontinuity in Frequency Drift	Matching UV
1	5/25/2024 22:30:29	4.358	N/A	4.022	58.54 - 32.12	TRUE	NOT MEASURED
2	6/3/2024 14:12:10	6.062	322.6	3.15	83.96 - 44.52	FALSE	FOUND
3	6/16/2024 20:24:29	3.143	21.72	3.078	83.86 - 64.15	TRUE	FOUND
4	6/16/2024 20:25:50	0.761	2.068	1.143	58.40 - 53.67	FALSE	NOT FOUND
5	6/16/2024 20:37:46	4.682	7.45	3.4	48.06 - 37.21	TRUE	FOUND
6	7/2/2024 21:00:59	1.204	0.3	1.22	53.08 - 42.16	TRUE	FOUND
7	7/7/2024 14:08:40	6.325	3.81	3.74	60.17 - 37.58	TRUE	FOUND
8	7/30/2024 22:32:51	6.774	12.19	2.552	83.82 - 61.03	FALSE	FOUND
9	8/1/2024 21:01:32	8.202	98.7	2.994	83.86- 62.09	FALSE	FOUND
10	8/8/2024 0:36:19	8.940	593	4.98	53.11 - 32.48	TRUE	FOUND
11	8/9/2024 21:23:00	4.591	772	5.22	83.82 - 55.80	FALSE	NOT FOUND

Most of the small type IIs has discontinuity in the frequency drift (**6 of 11**), there are intensity variation sub-features along the frequency drift lane in the dynamic spectrum. For the small type IIs we found EUV counterpart activities (e.g. Jets, CMEs).

Conclusions

We found mini Type II and performed imaging spectroscopy on it
(1) The average of the total duration observed mini-Type II radio bursts is **5 min**.
(2) For brightness of mini-Type II, the max flux had an average **3.23 sfu**.
(3) The total frequency range has an average of **19.54 MHz**
(4) **Out of 10** weak type IIs measured, **8 had a matching** solar eruption in EUV imaging.

Discussion The radio burst have short duration, low brightness and narrow bandwidth, there are two possible explanations:
(1) it corresponds to weak shocks and the **shocks will quickly dissipate** and vanish due to the background resistance (and/or) shock and background magnetic field interaction
(2) there is long lasting shock, but will **only** generate radio wave **when emission condition meets**.

NJIT New Jersey Institute of Technology
NSF
Caltech
CPAESS Cooperative Programs for the Advancement of Earth System Science