

# Tracking Space Weather events with ASKAP and Parkes

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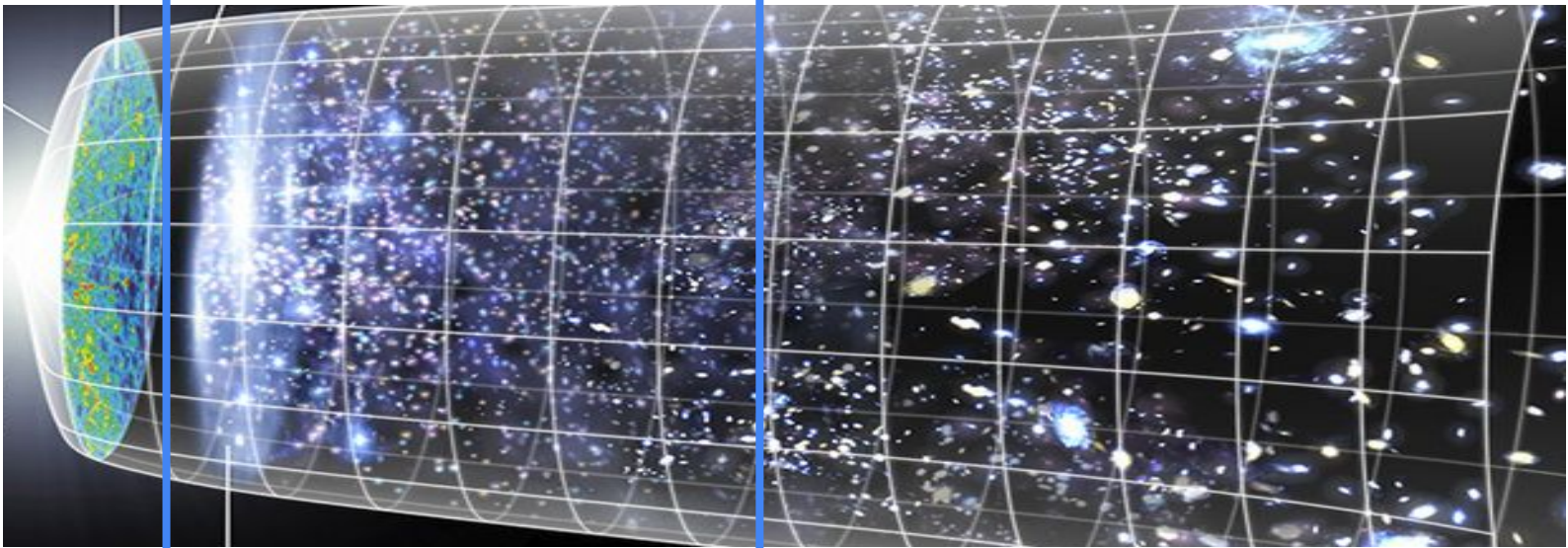
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**Ron Ekers**

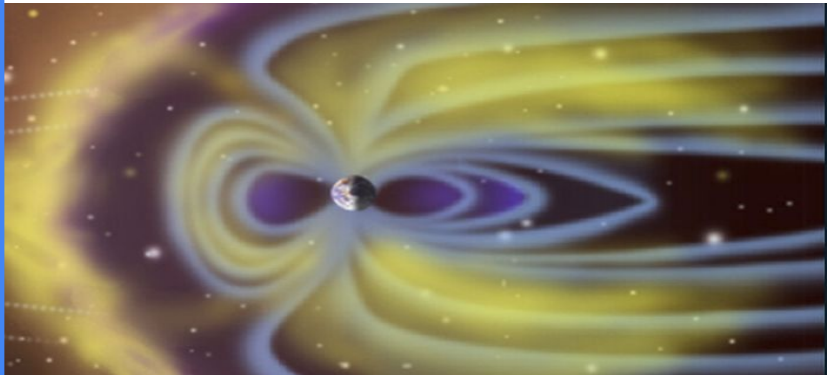
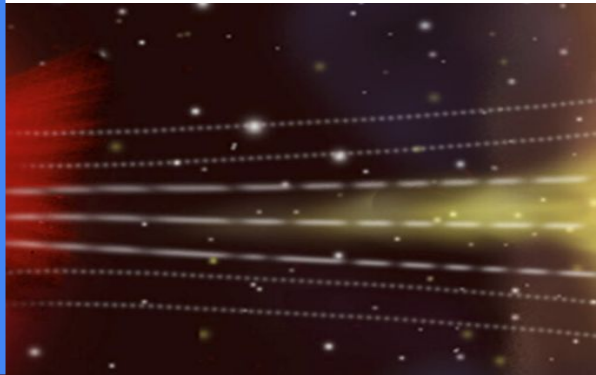
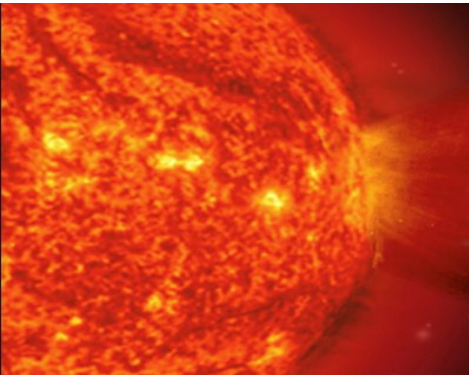
ATUC, 2022-Nov-8



Detailed Observations

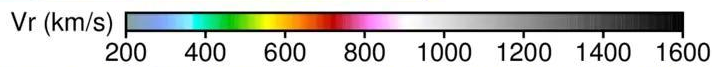
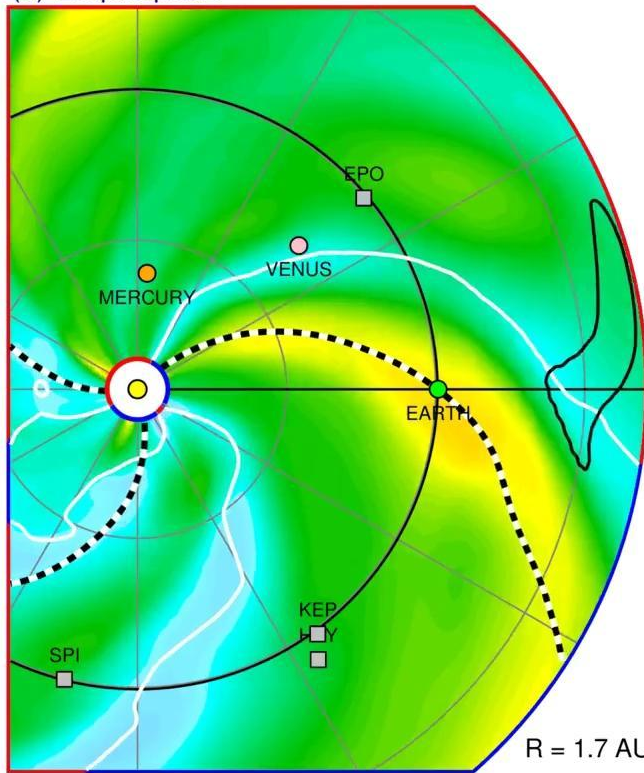
Models (that we know are wrong!)

Detailed Observations



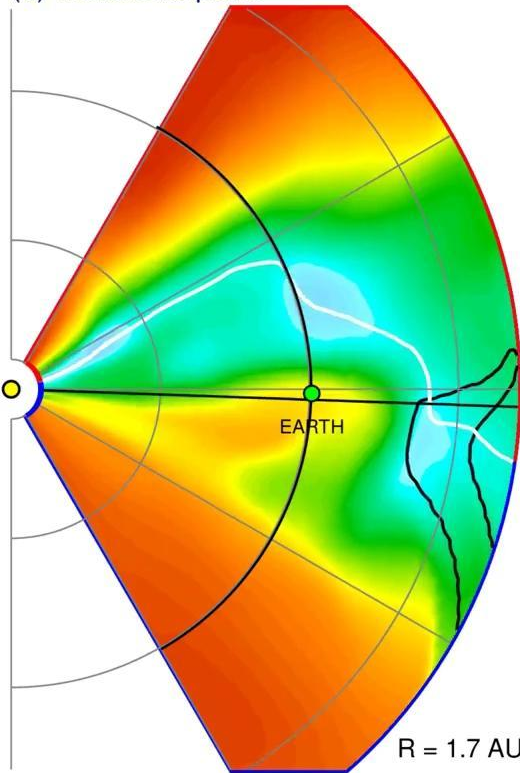
2017-05-21T00:00

(a) Ecliptic plane



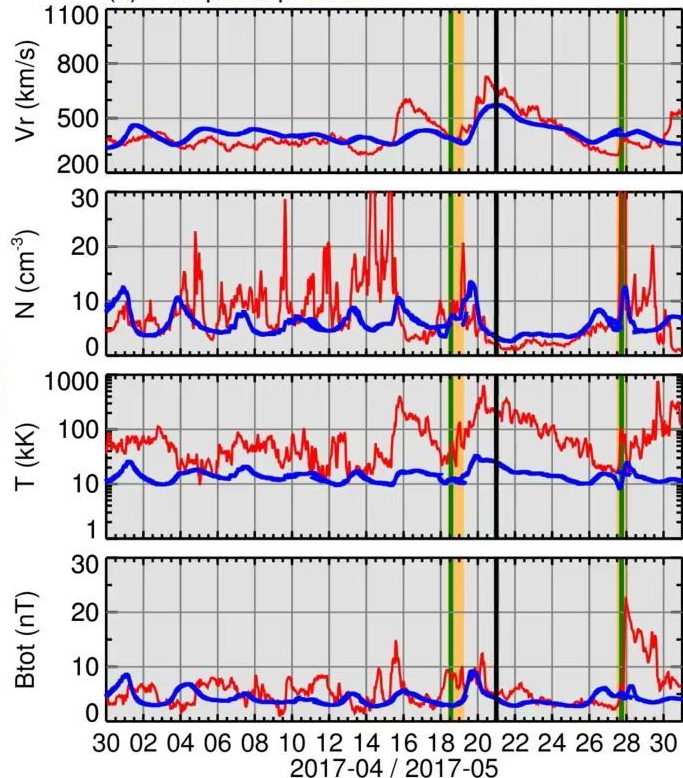
EARTH

(b) Meridional plane



2017-04-30T00 + 21.000 days

(c) Temporal profiles



Helioweather.net

HelioWeather

ENLIL-medres + GONGz-WSAtu/gongz + Cone / a9b1 / d4t1x1p2-donki / g53h10d02 / mcp1va2d

# Radio Observations are key

- (almost) The only methods for remotely sensing the solar wind in interplanetary space
- Heliosphere is a foreground for all astrophysical radio sources
- Modern wide-field interferometers are extremely well-suited to these observations

## Interplanetary Scintillation

- IPS is not just useful for Heliosphere measurements
  - We can do astrophysics too!
- IPS is not the only radio probe of the heliosphere
  - Scatter broadening
  - Phase scintillation (LBA, Guifré Molera Calves and students, UTas)
  - Faraday rotation measurements
- We can also measure the ionosphere
- There is also radio imaging of the Sun



## Pure Science

- General properties of the Heliosphere
- How do CMEs propagate?
- What are their properties
- Proof-of-concept observations

- Quiet Heliosphere
- Non Earthbound CMEs
- Latency less important

## Applied

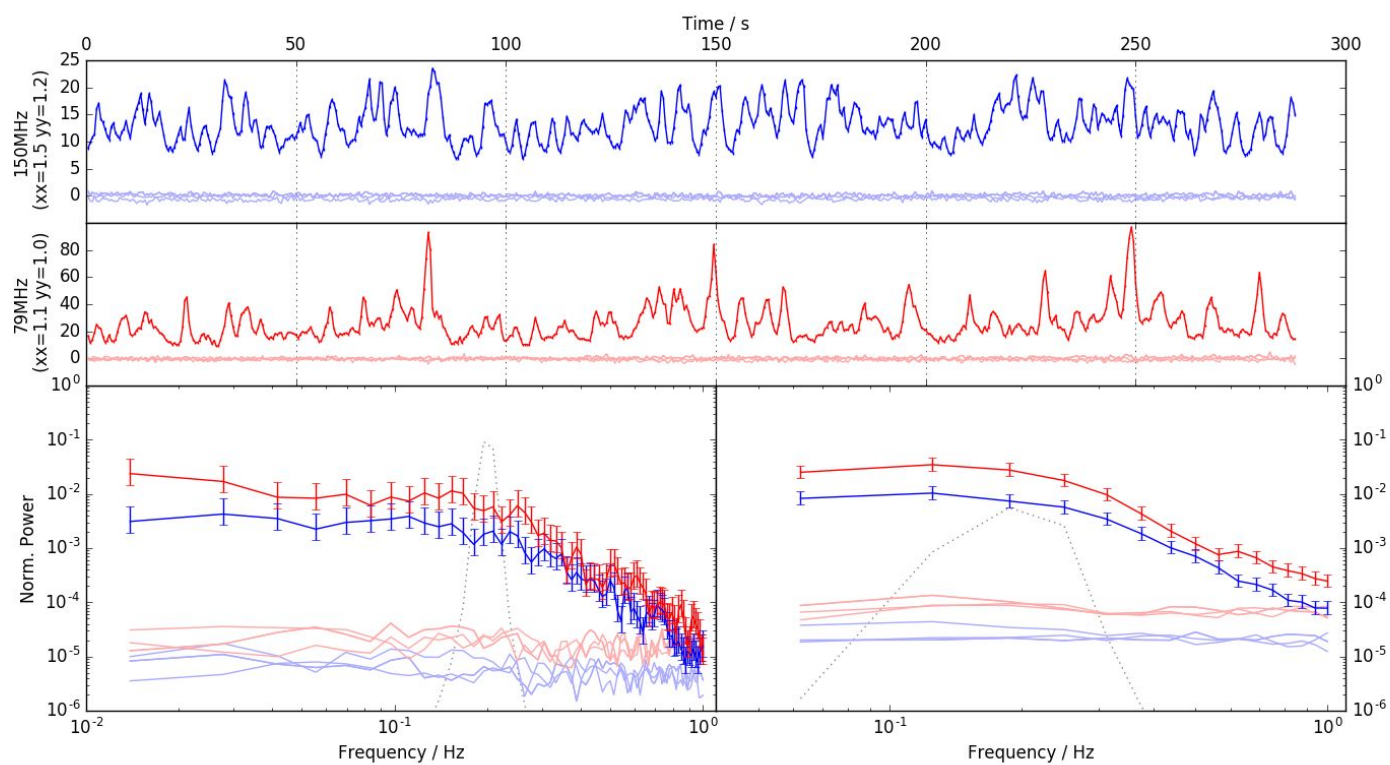
- Improving Space Weather Forecast accuracy at the Earth
  - Is CME Earthbound?
  - When will it arrive
  - What is the magnetic field orientation?
- Latency more important
  - ◆ Result ~10 hours post observation or better
  - ◆ Somewhat trickier to observe Earthbound CMEs from Earth.

# IPS With the MWA

$8^{\circ} \times 6^{\circ}$

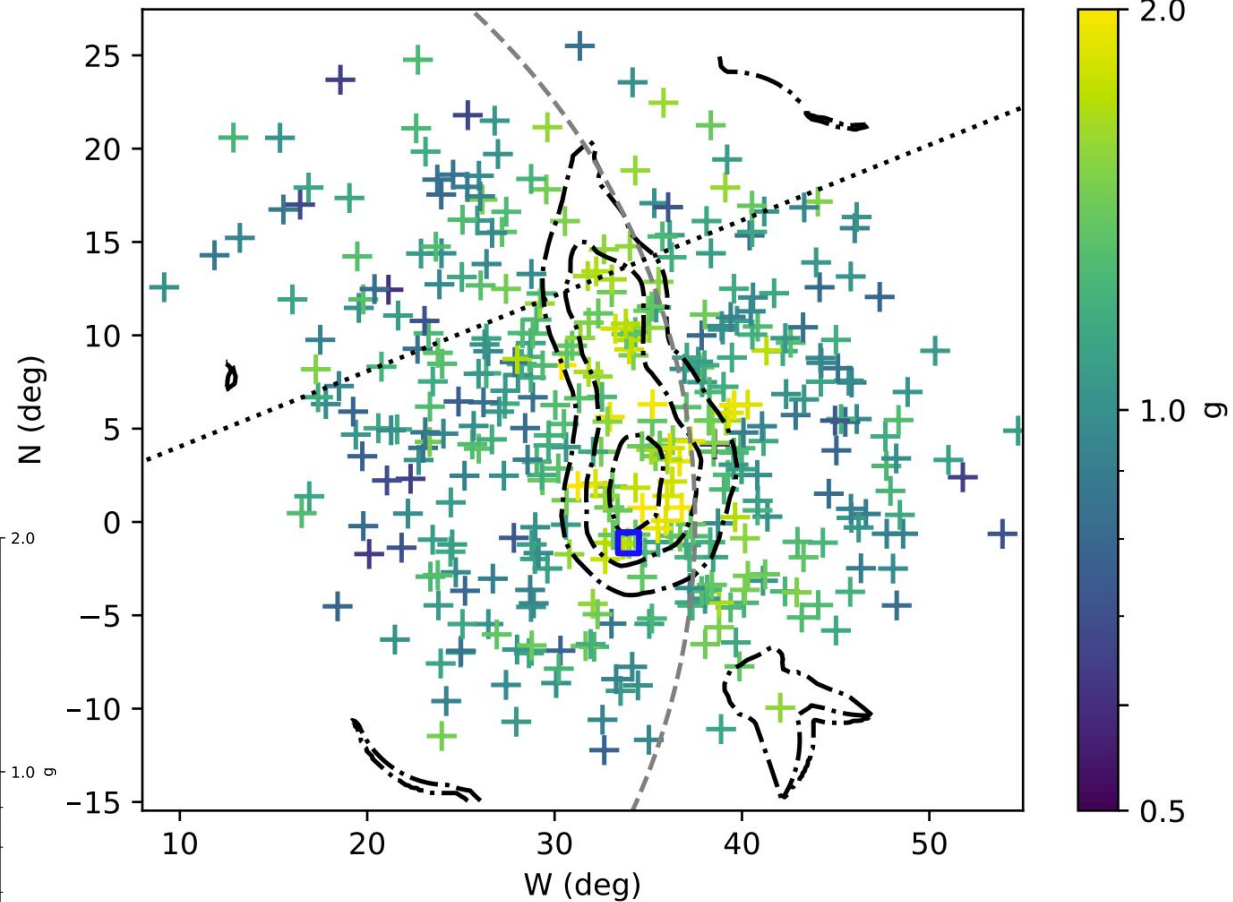
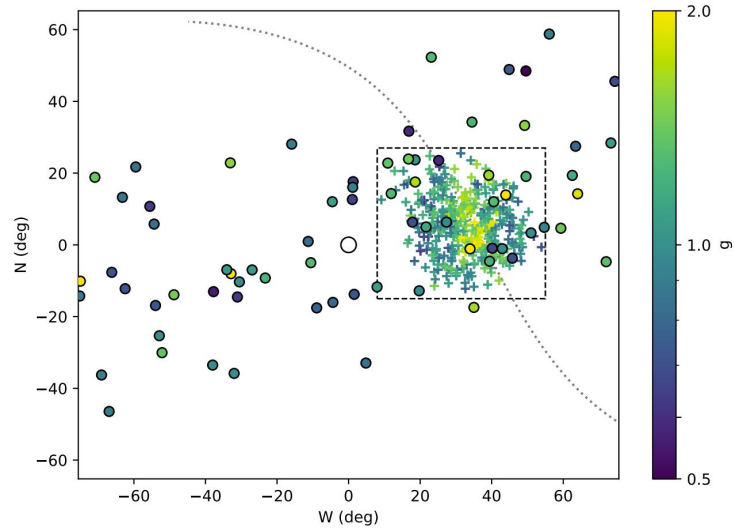
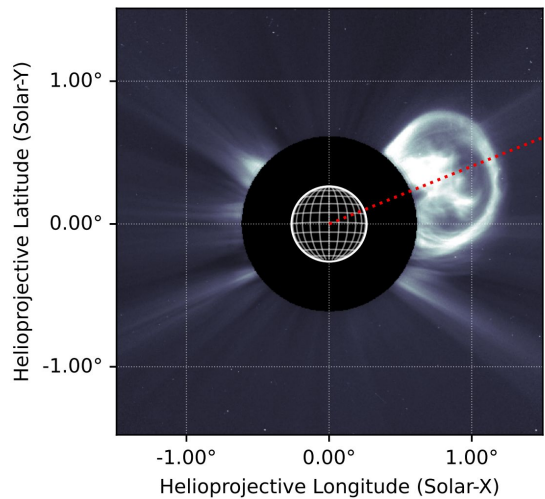
0.5s  
interval





Scintillation pattern encodes velocity,  
turbulence parameters (on  $\sim 100\text{km}$  scales), radio source structure etc.

**Changes in scintillation index reflect changes in density**



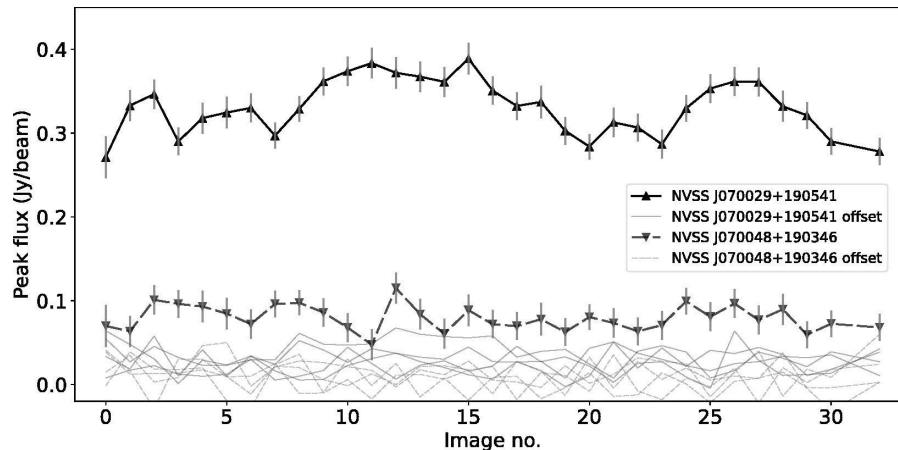
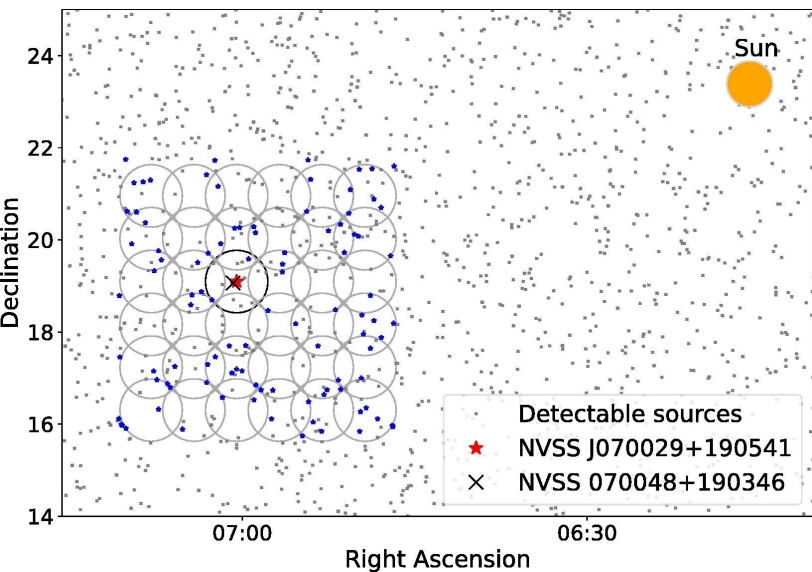
Clear detection of a  
(broadside) CME!



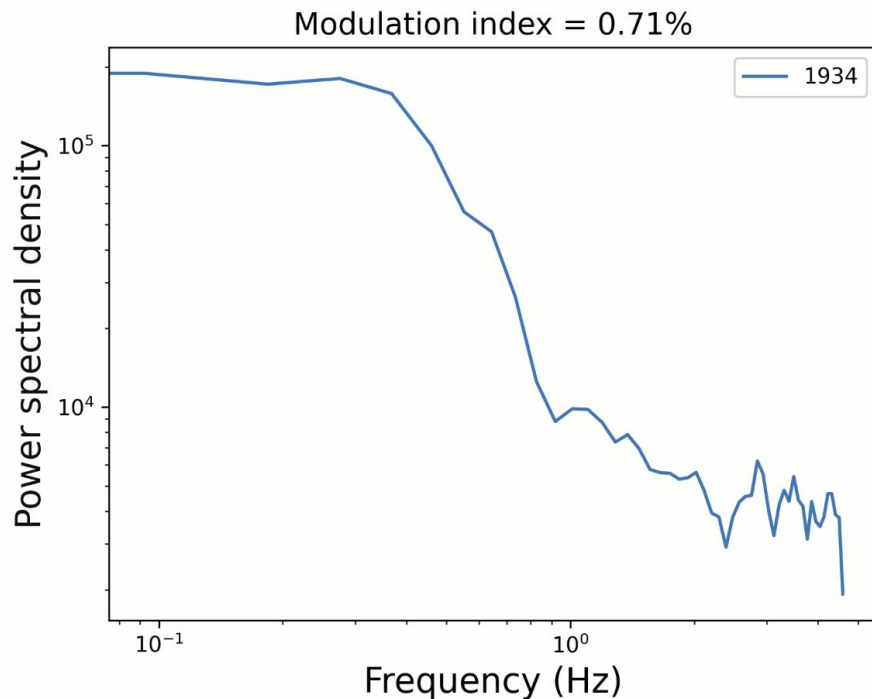
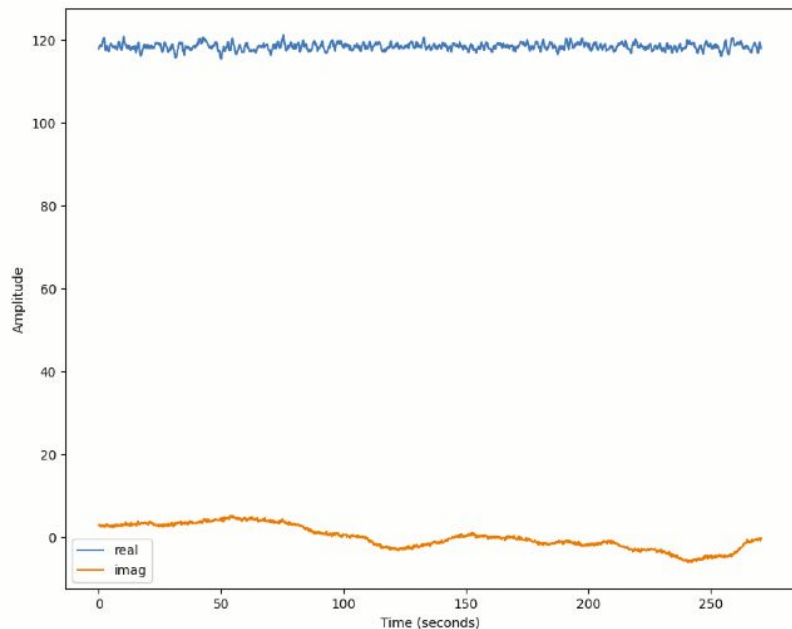
# ASKAP

Best suited to IPS observations at  $<20^\circ$  (due to higher frequency)

- Covers elongations between Coronagraph and MWA
- Similarly to the MWA, could cover most solar angles with approx.  $10 \times 5$ -minute pointings



# ASKAP Update - CRACO test on 1934-638



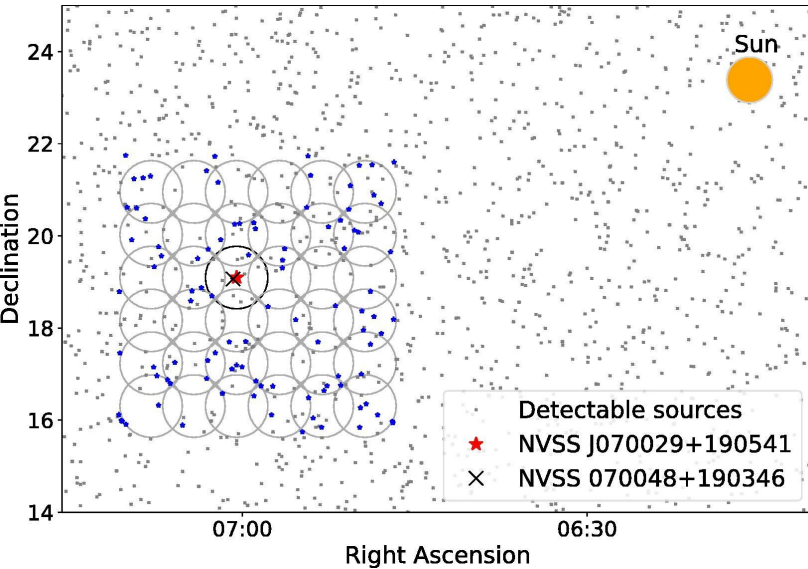
270s of data  
~100ms resolution

**IPS at 1GHz, 90° from the Sun!**

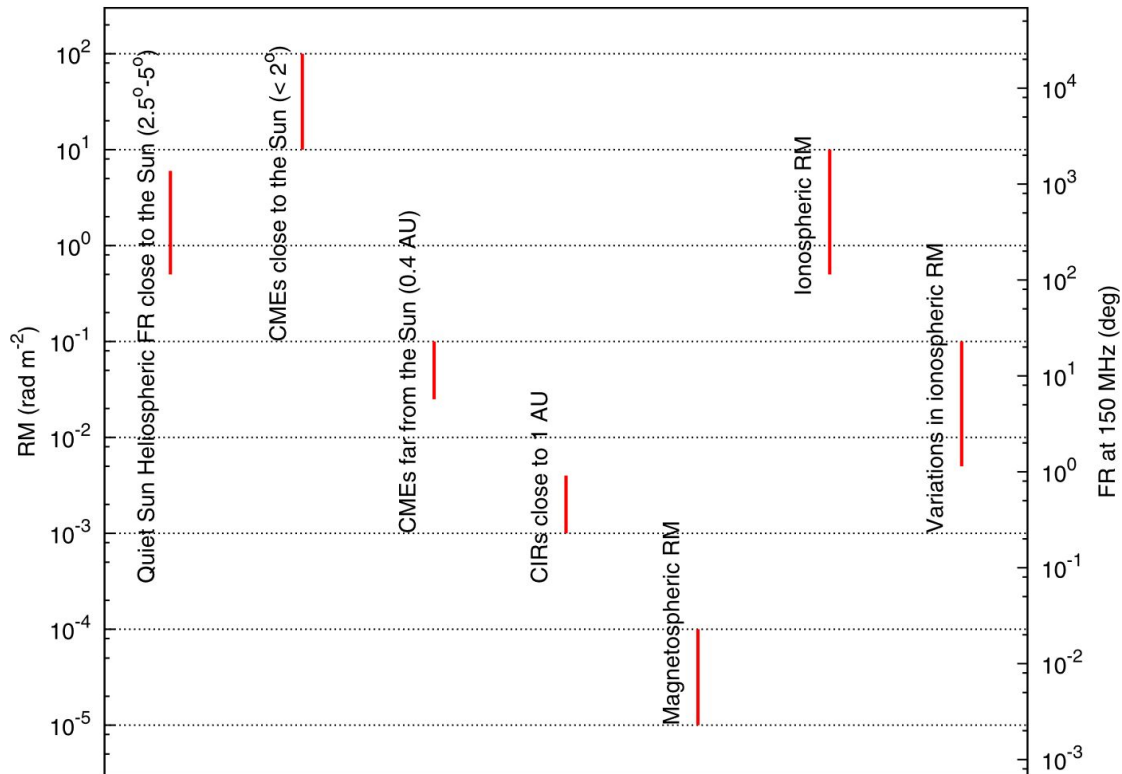
With thanks to **Vivek Gupta**, Keith Bannister and the CRAFT Team

# CryoPAF?

- 2-4 square degrees
- 30-50 sources detectable (0.5-1 per PAF beam)



# Remote sensing of magnetic fields with polarimetry

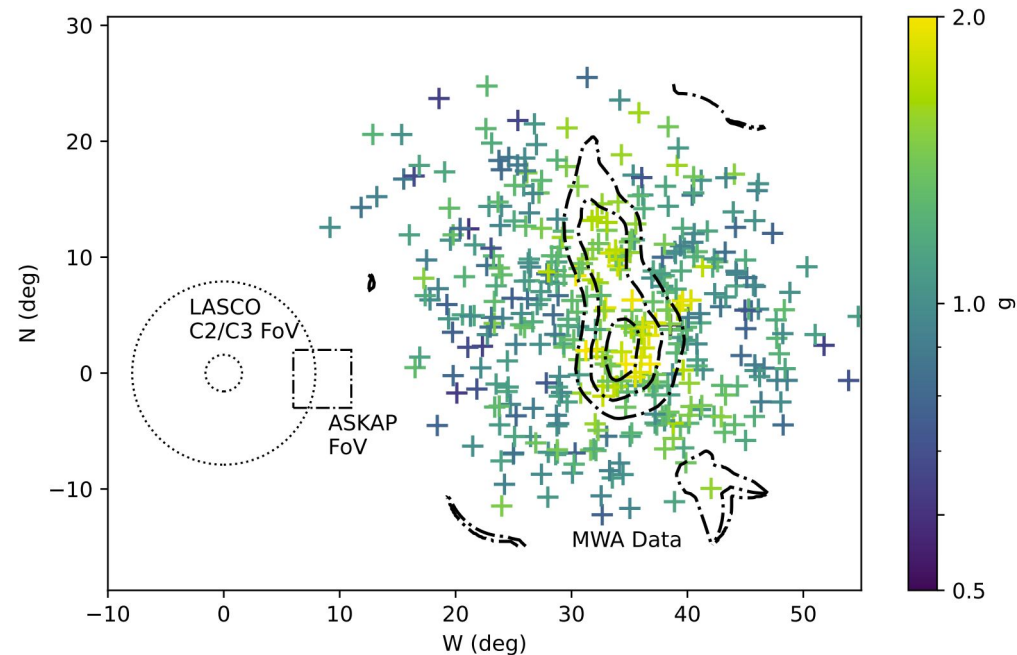


Oberoi & Lonsdale doi.org/jdtr

- IPS tells us where to look
- Wide-band, low-frequency polarimetry gives us the precision
- MWA may allow us to track ionospheric variations as well
- Still many challenges remaining!

# Conclusions

- We can use MWA IPS to track CMEs!
- Use of ASKAP for IPS measurements has been proven
- Potential for future science campaigns with both instruments
- Potential for triggering on white light detections near the Sun



- *Potential* for monitoring Sun and Solar wind

