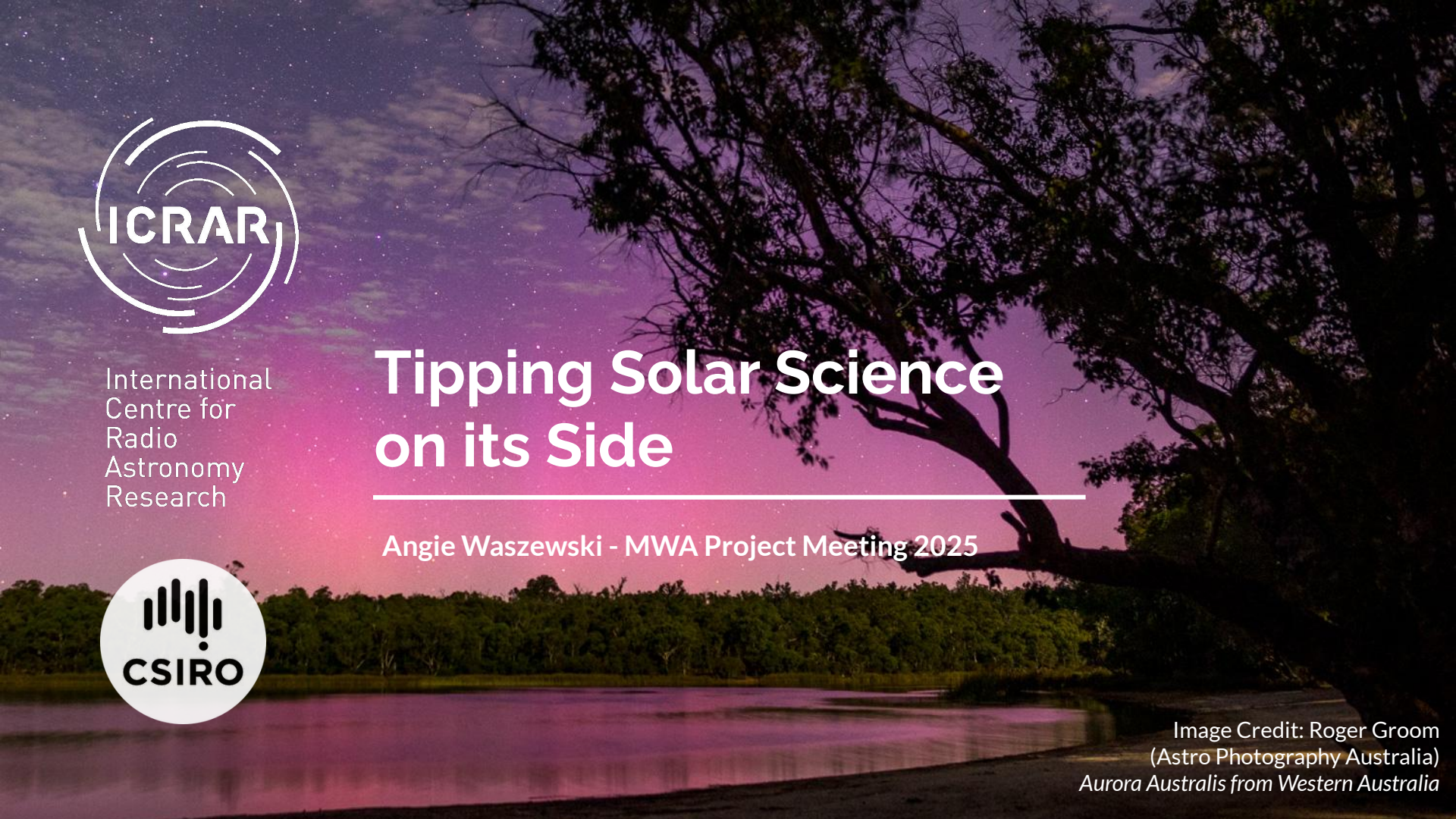


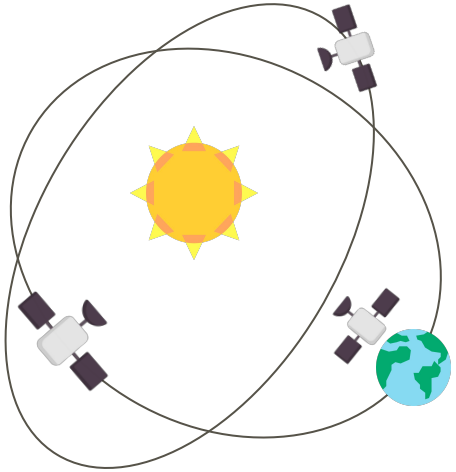
International Centre for Radio Astronomy Research

Tipping Solar Science on its Side

Angie Waszewski - MWA Project Meeting 2025

Image Credit: Roger Groom (Astro Photography Australia)
Aurora Australis from Western Australia

Spacecraft Observing



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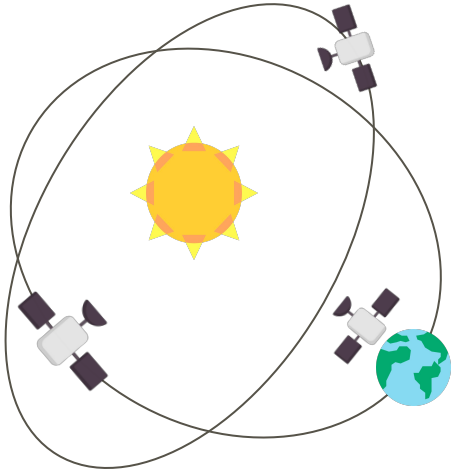
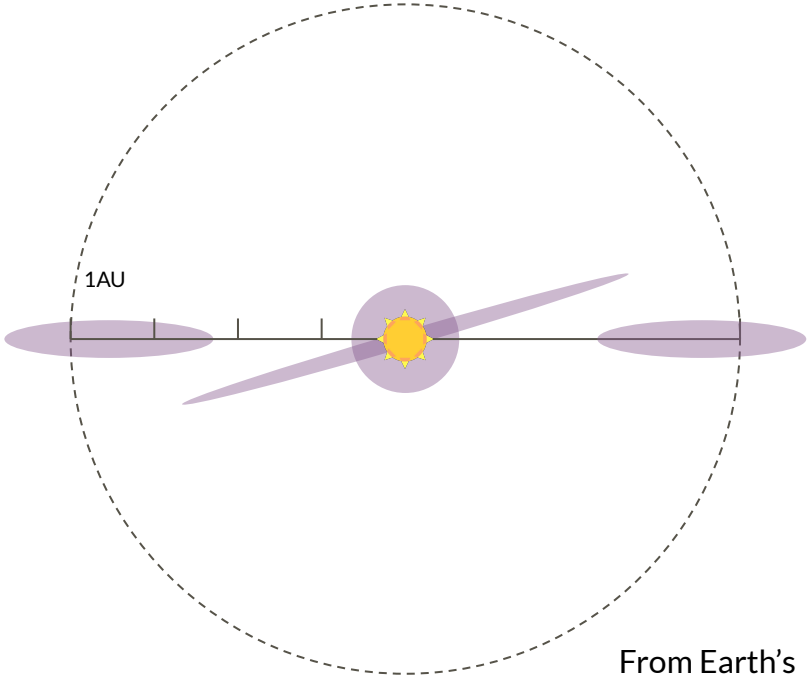
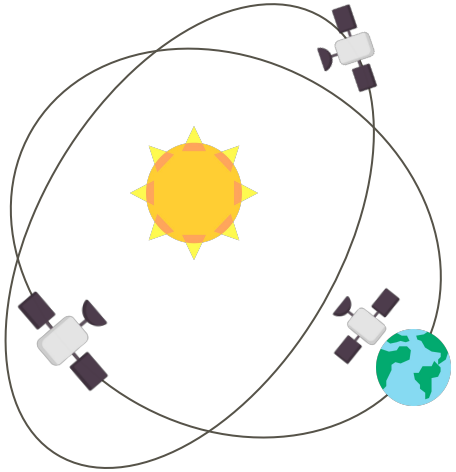


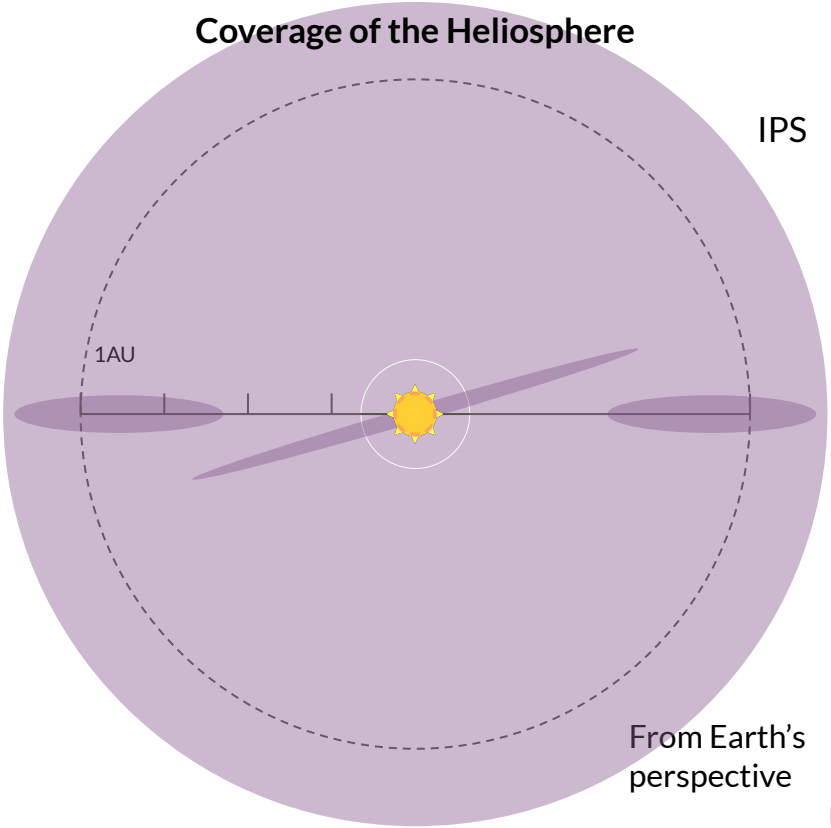
Coverage of the Heliosphere



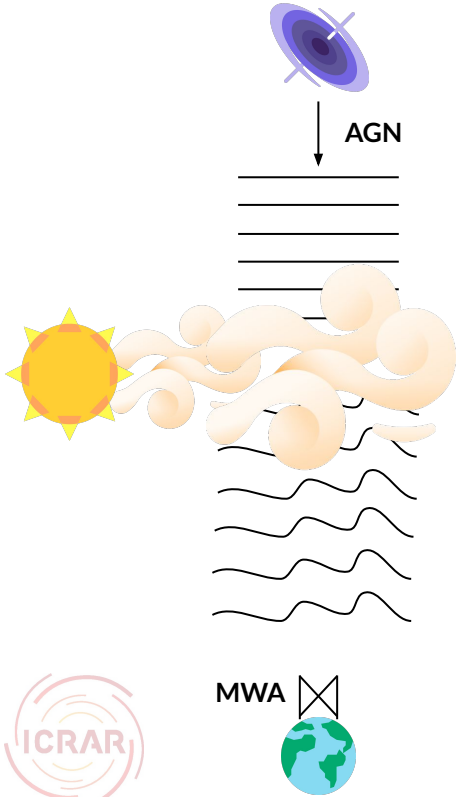
From Earth's perspective

Spacecraft Observing



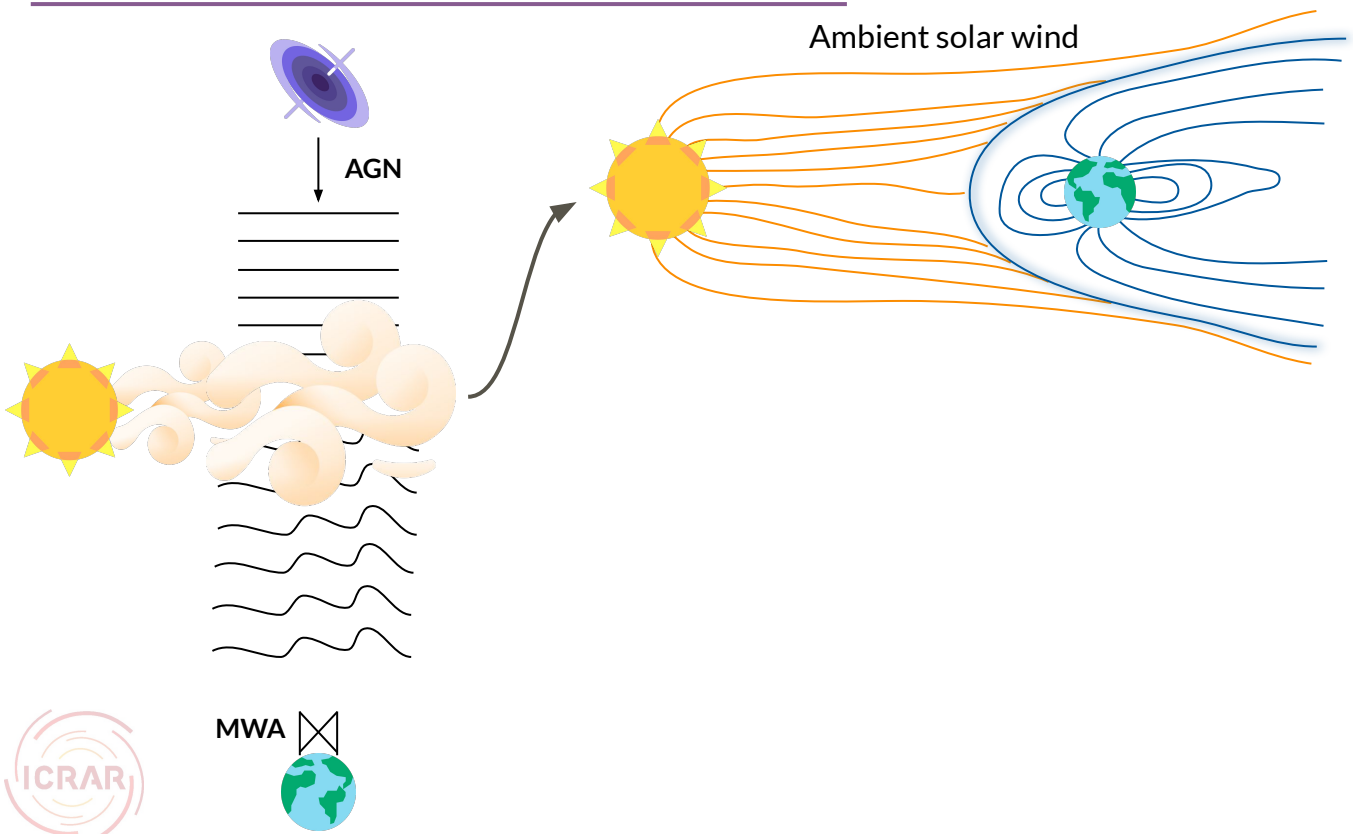


Interplanetary Scintillation (IPS)



Credit: Chhetri, R.

Interplanetary Scintillation (IPS)



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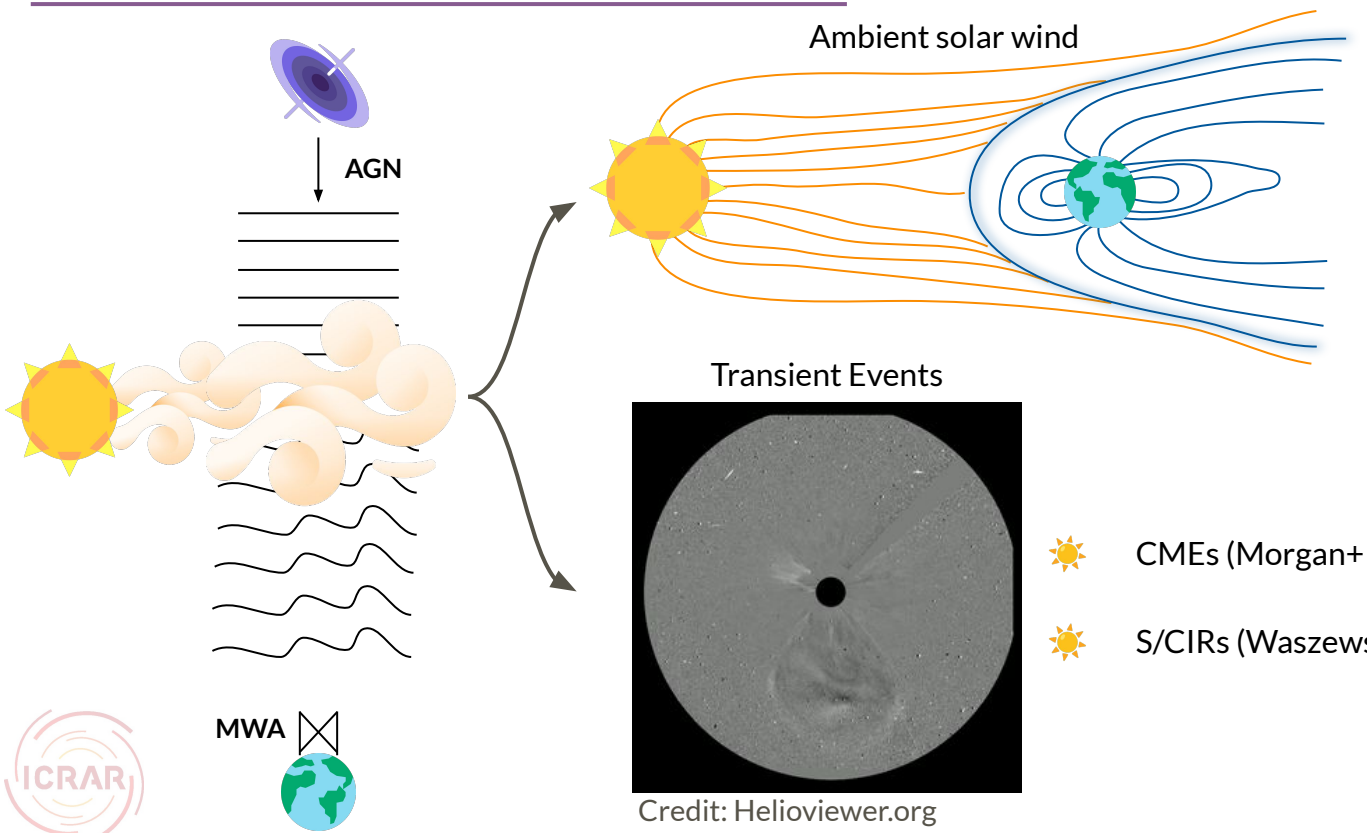

Credit: Helioviewer.org

- CMEs (Morgan+ 2022, Waszewski+ 2025)
- S/CIRs (Waszewski+ 2023, 2025)

MWA - Imaging

MWA is a wide-field imaging machine!

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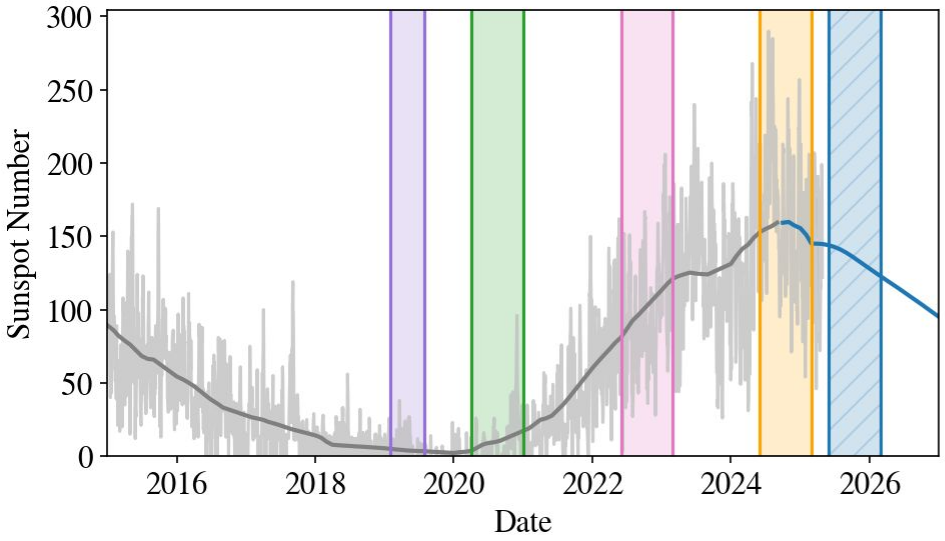
- Observations taken during every extended-config semester since 2019
- Data ranging from solar minimum all the way to solar maximum, sampling ramp-up phase as well



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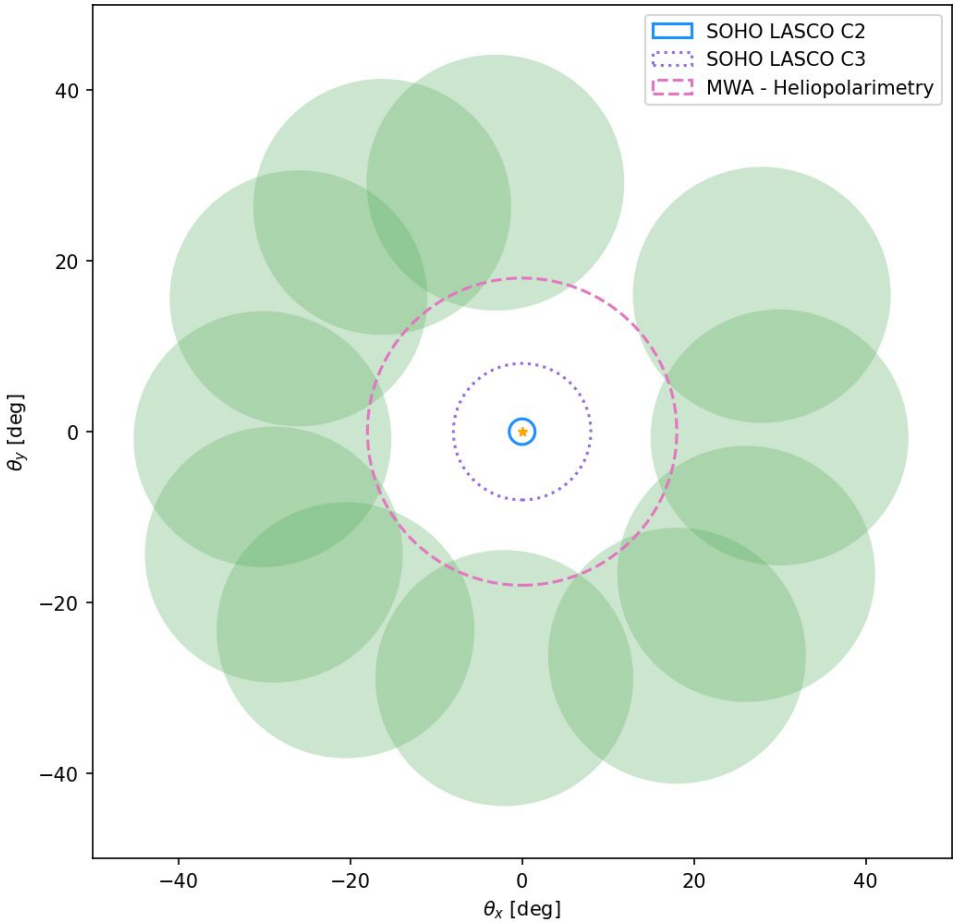
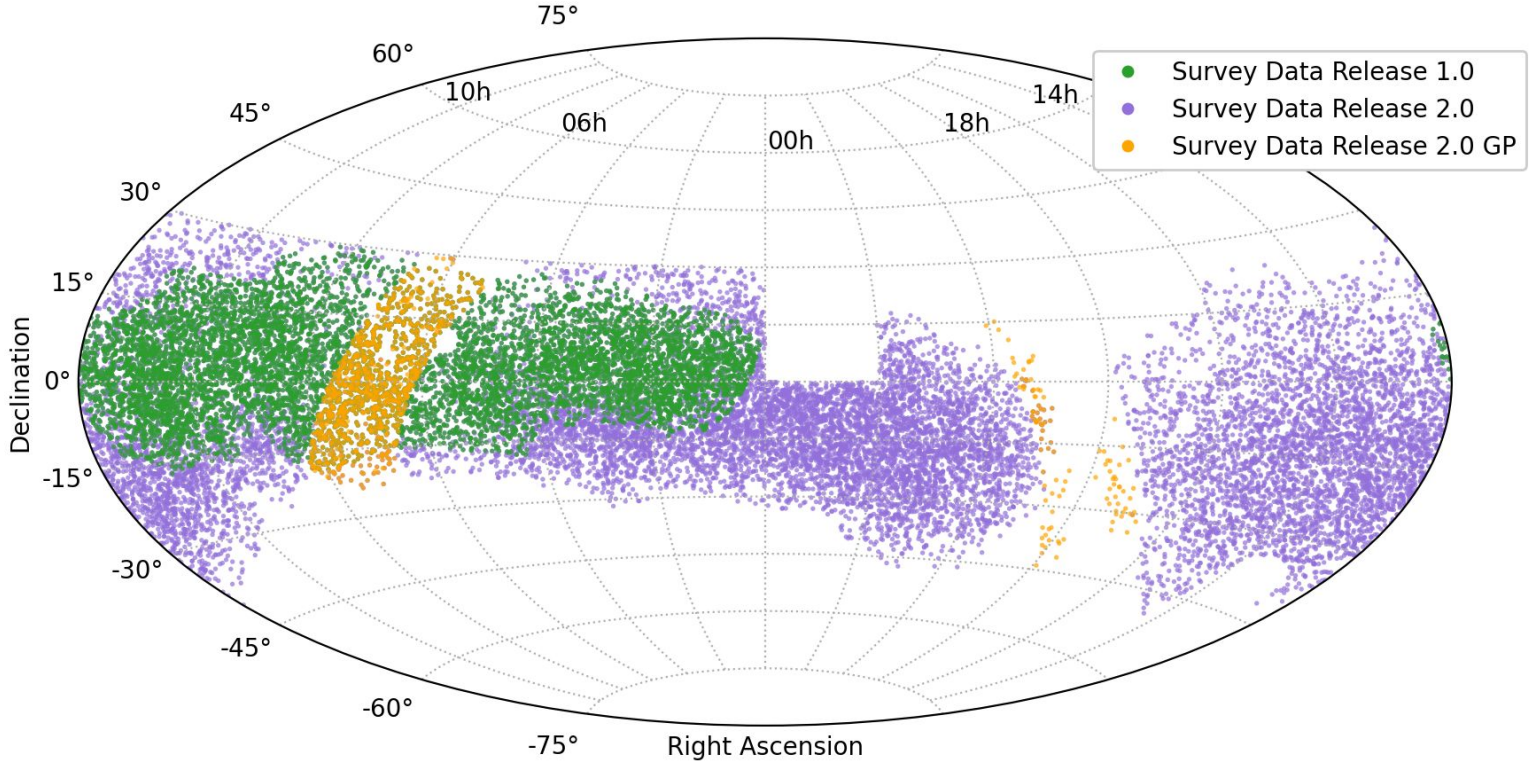
MWA is a wide-field imaging machine!

- Observations taken during every extended-config semester since 2019
- Data ranging from solar minimum all the way to solar maximum, sampling ramp-up phase as well
- ~6-8x 10min observations per day
- 162MHz
- 0.5s timing integration



MWA Phase II IPS Survey



Ambient Solar Wind

Check out the paper here

- “Shape” of the solar wind first discovered by IPS
  - Validated by Ulysses polar flyby

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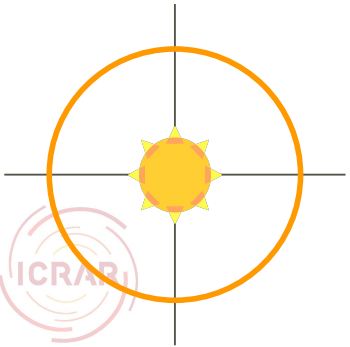
Solar Maximum



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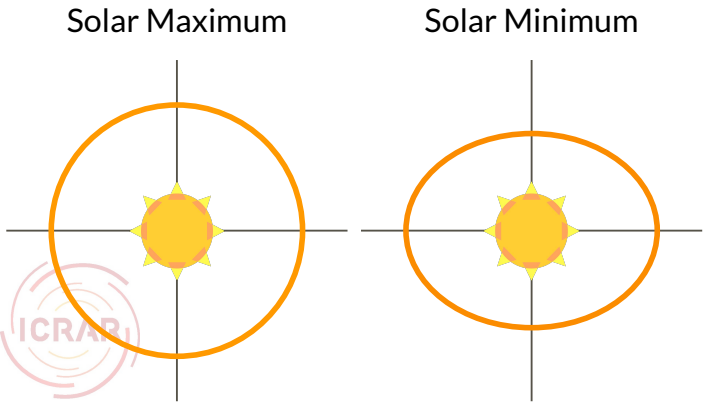

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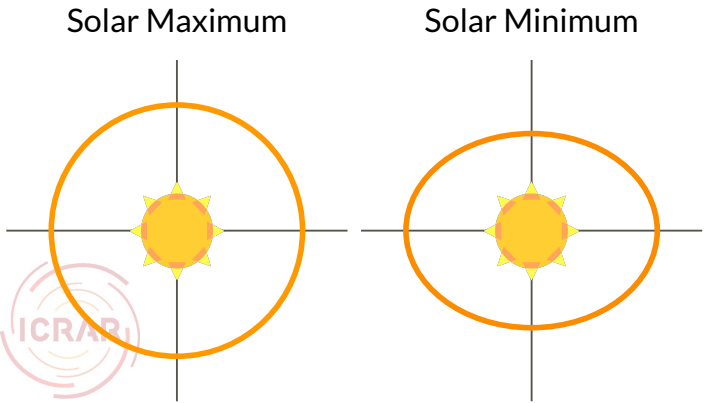

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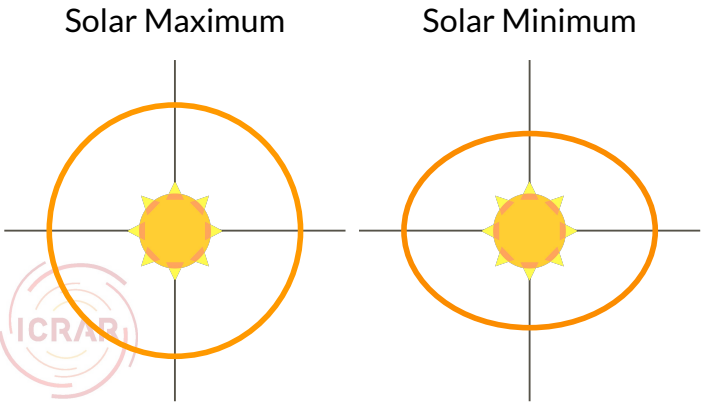

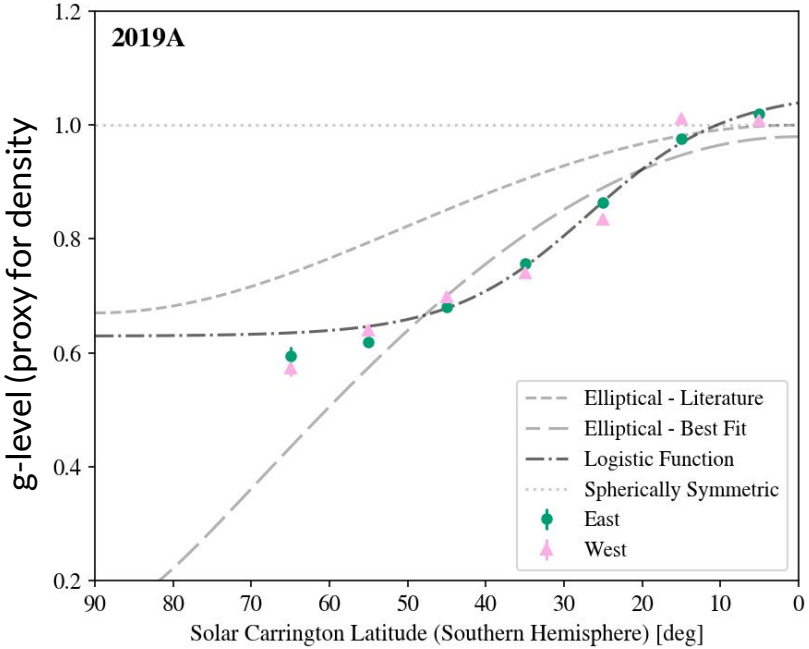

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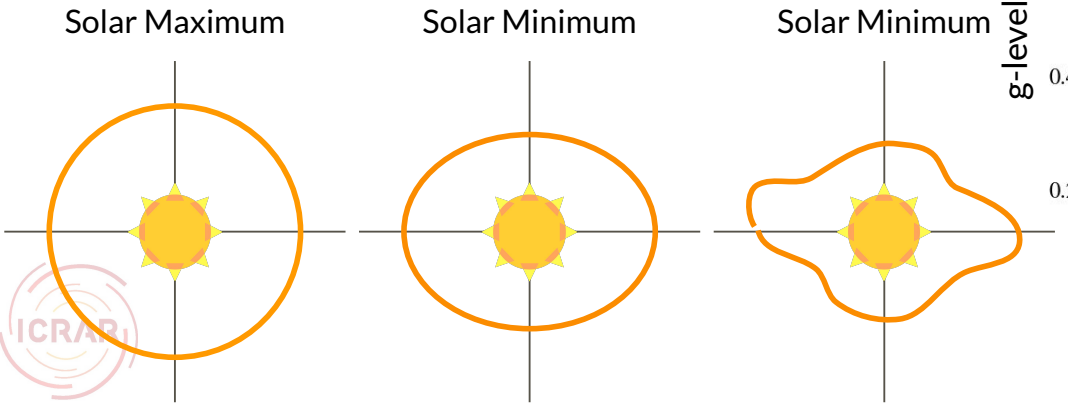

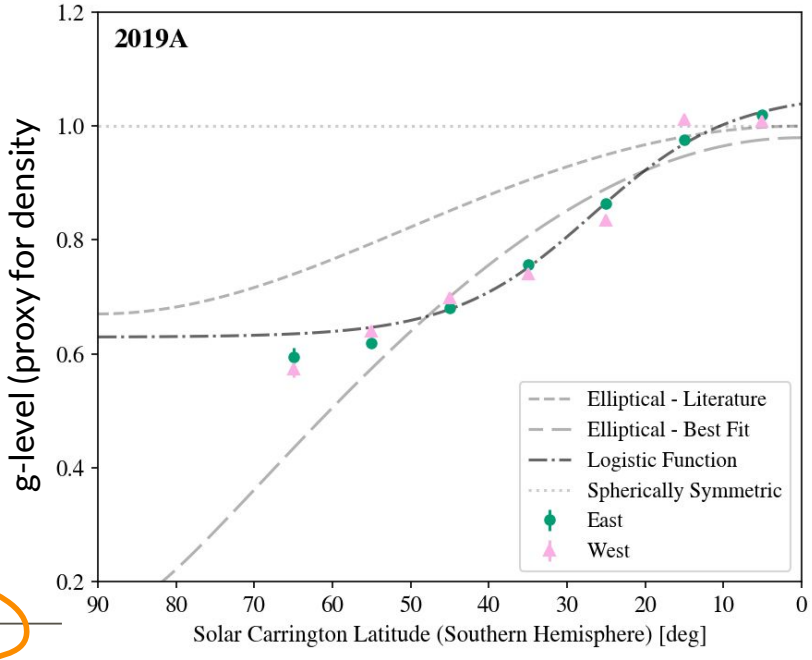

Ambient Solar Wind

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- "Shape" of the solar wind first discovered by IPS
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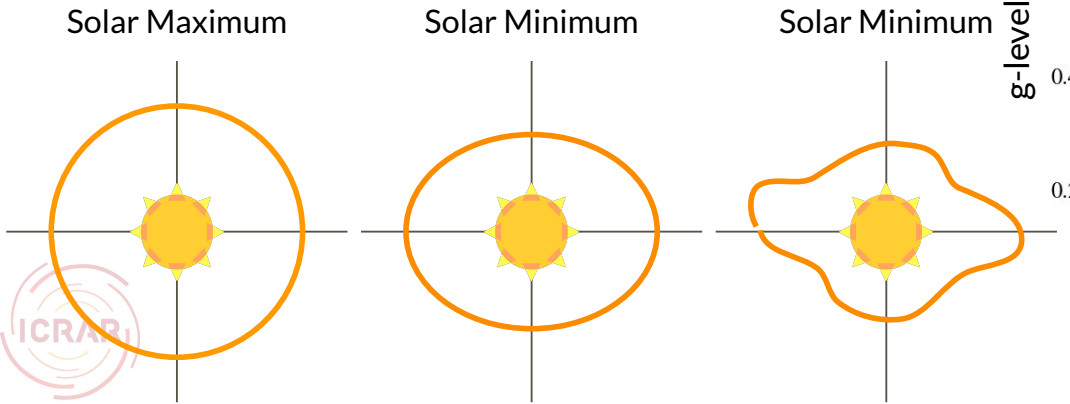
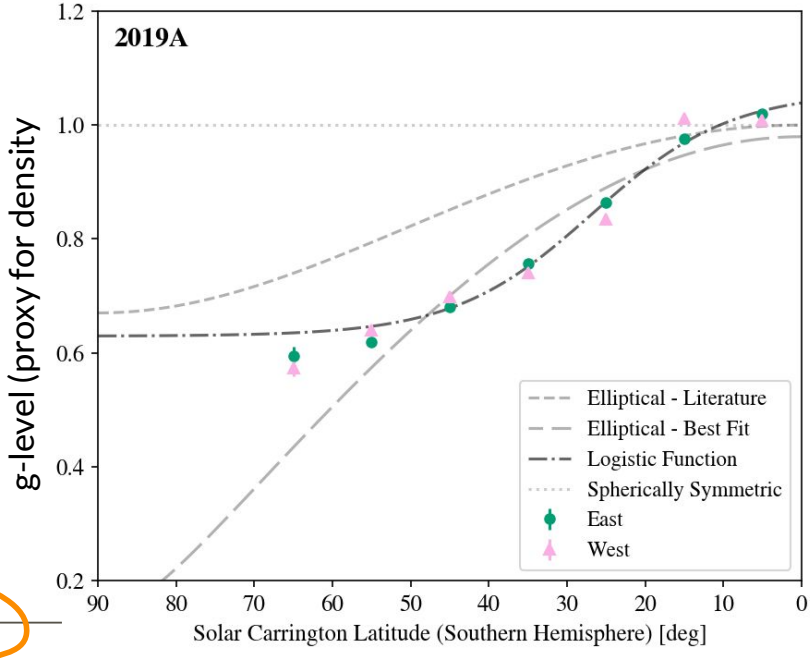
- Studies of previous solar cycles 20 to 22 (70's to 90's) confirmed this elliptical shape
- Potential solar cycle and solar elongation dependence - Important for pulsar timing!





Transient Events

- Cross-matched with a series of catalogues
  1. CDAW SOHO LASCO CME Catalogue
     - Manual CME detection in whitelight images
  2. CACTus CME Catalogue
     - Automated CME detection in whitelight images
  3. STEREO-A SIR + ICME Events lists
     - Based on manual identification in in-situ measurements

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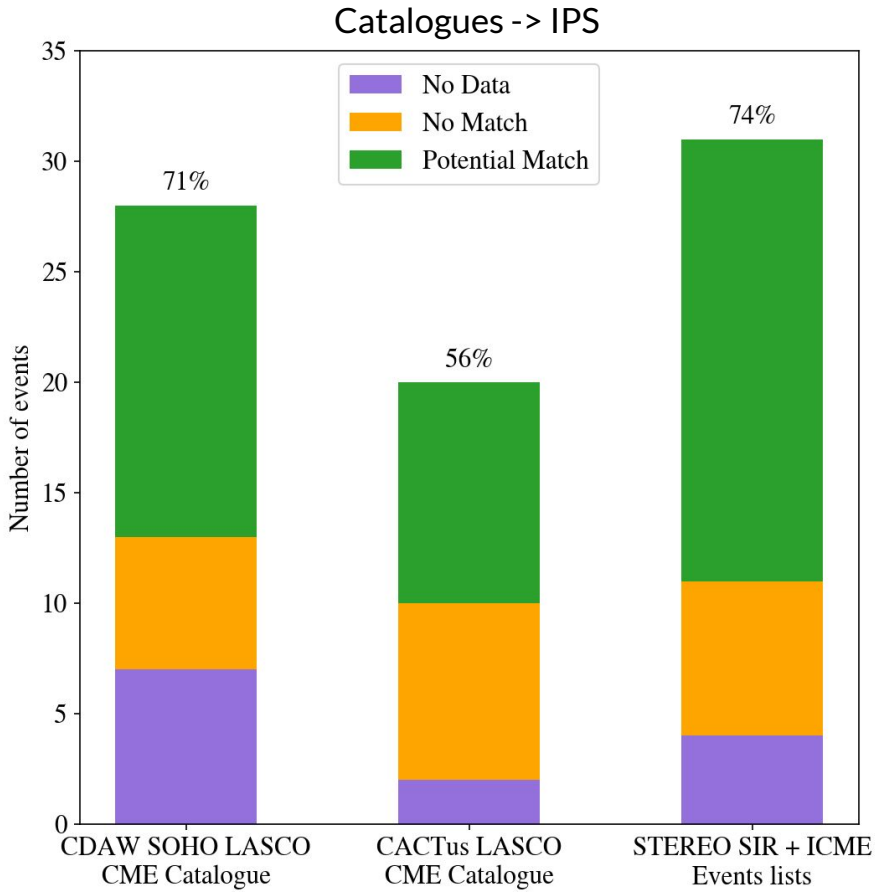
  3. STEREO-A SIR + ICME Events lists
     - Based on manual identification in in-situ measurements
- 84% of catalogued events had MWA IPS data available
- 68% of those events had a potential match in MWA IPS observations



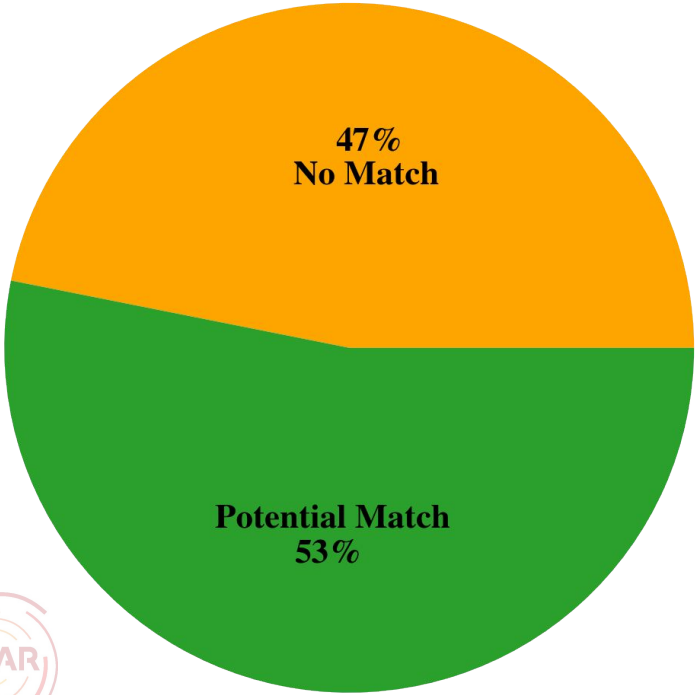
Transient Events

IPS -> Catalogues

- First identify features in MWA IPS observations and see if those features were matched in the previous analysis

Transient Events

IPS -> Catalogues



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Transient Events

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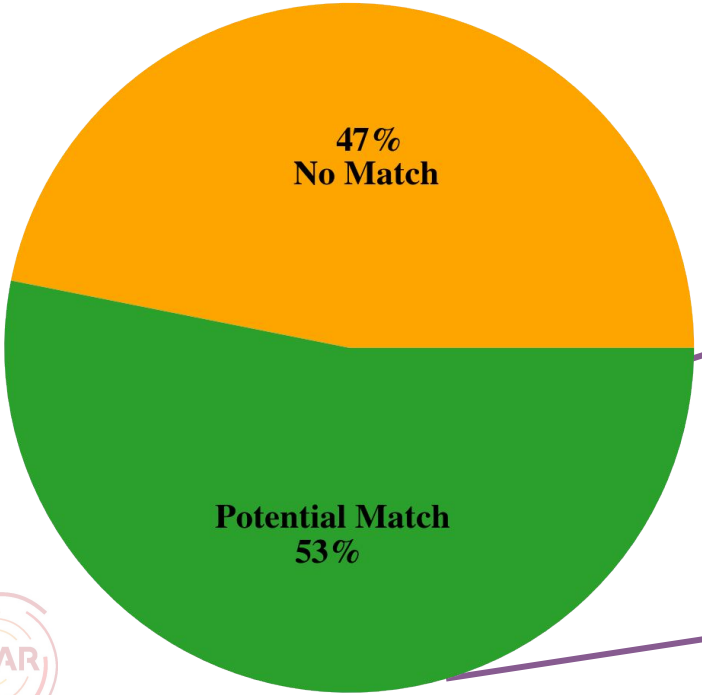
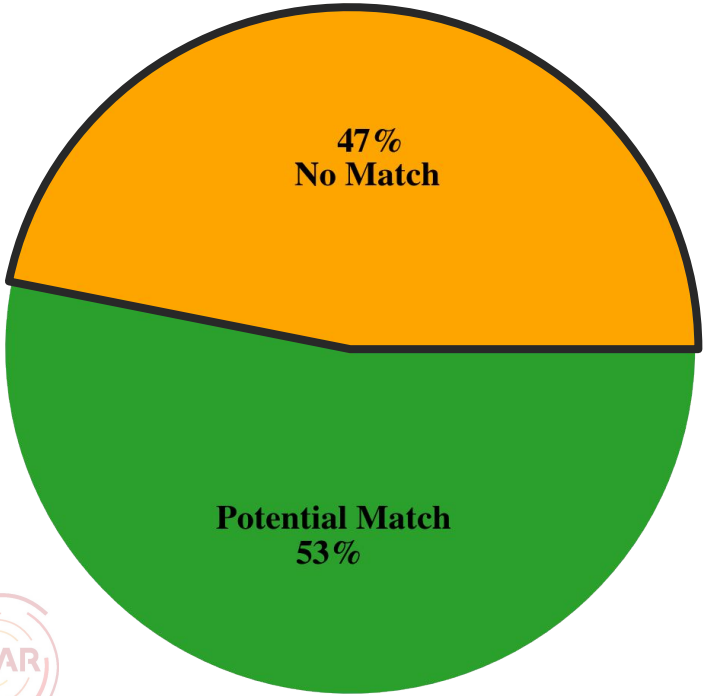


- First identify features in MWA IPS observations and see if those features were matched in the previous analysis

- 7 CMEs
- 6 SIRs
- 4 both

Transient Events

IPS -> Catalogues



- First identify features in MWA IPS observations and see if those features were matched in the previous analysis
- Majority of “no match” features were out of the ecliptic plane
  - Would not be recorded by STEREO which makes up most of matches

Transient Events

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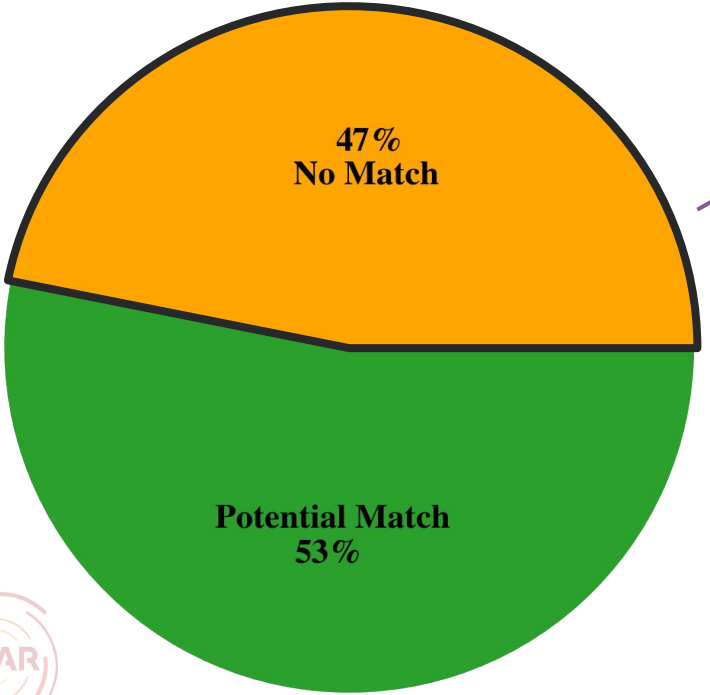
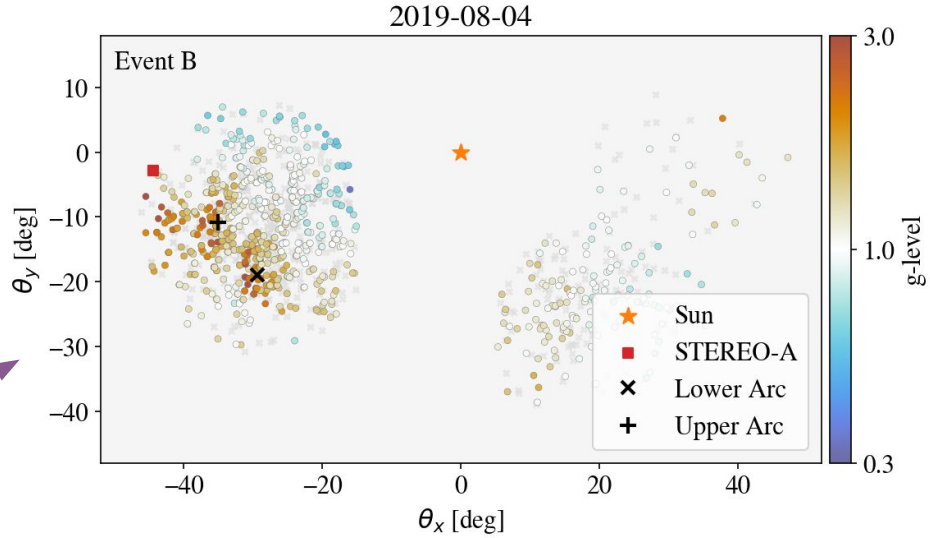
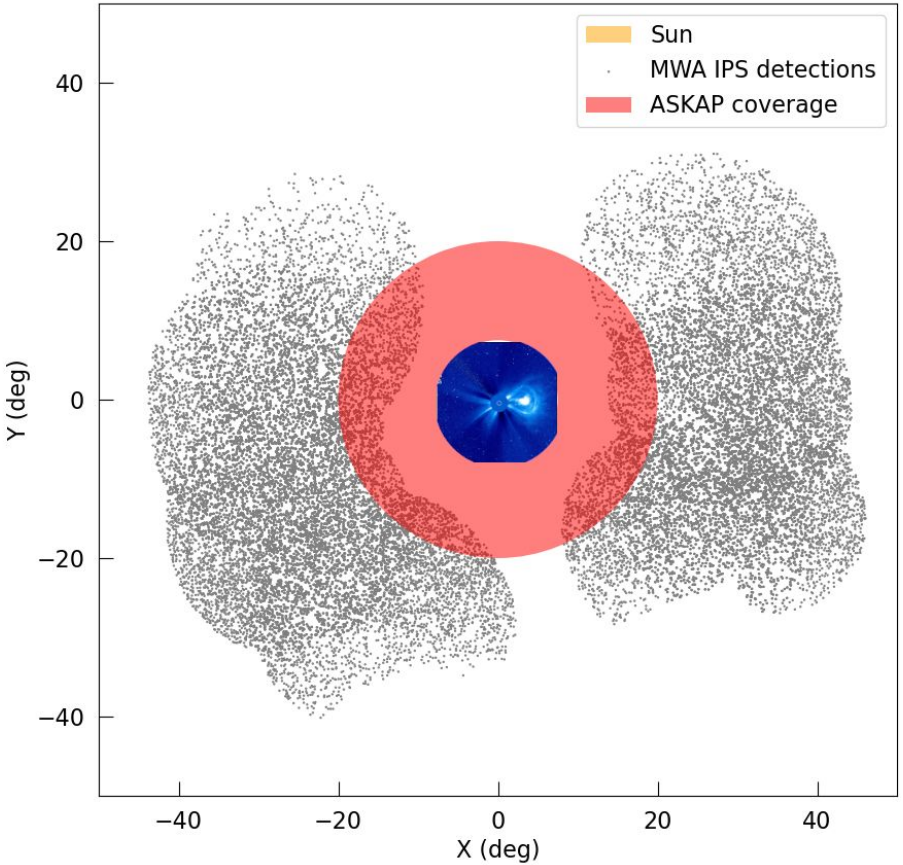




- IPS is privy to heliospheric events that commonly-used techniques
- With the MWA's FOV and source density we see features in unprecedented detail

Looking to the future!

- MWA
  - Keep processing data
  - Look at true solar maximum and ramp-down phase
- ASKAP
  - Chhetri+ 2022 showed that we can capture IPS at higher frequencies
  - Increases IPS monitoring from C3 FoV to MWA
  - High density of sources
- SKA
  - Increase in collecting area will let us go much fainter by factor of ~10
  - More lines of sight = higher degree-level accuracy



Questions?

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