

# Searching Past the Confusion: Stokes V Imaging of the Transient Sky

Marin M. Anderson (Caltech)

G. Hallinan, S. Bourke, M. Eastwood, R. Monroe, H. Vedantham,  
D. Wang, D. Woody, and the OVRO-LWA collaboration

Science at Low Frequencies II  
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# Searching Past the Confusion: Stokes V Imaging of the Transient Sky

- I. Target transients
- II. The Owens Valley Long Wavelength Array
- III. Stokes V imaging
- IV. OVRO-LWA pilot survey

# The target low frequency sky – short-duration, coherent transients

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1

## Extrasolar space weather

- Stellar flares and CMEs
- Exoplanet magnetospheric emission

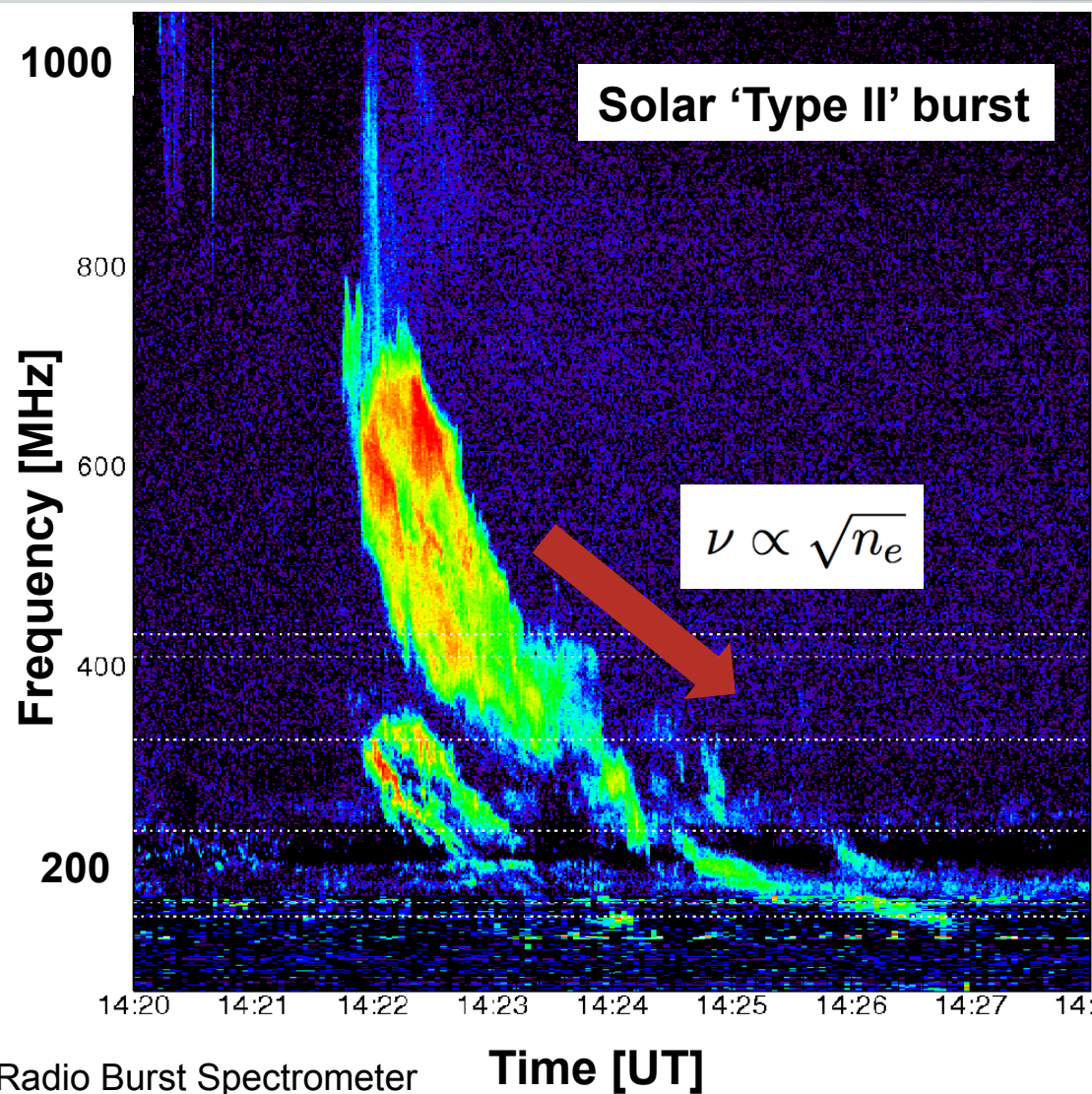
...events indicative of stellar magnetic activity and their impact on planetary companions.



Image: C. Carter and G. Hallinan

1

# The low frequency (<100 MHz) sky is the ideal place for monitoring extrasolar space weather events

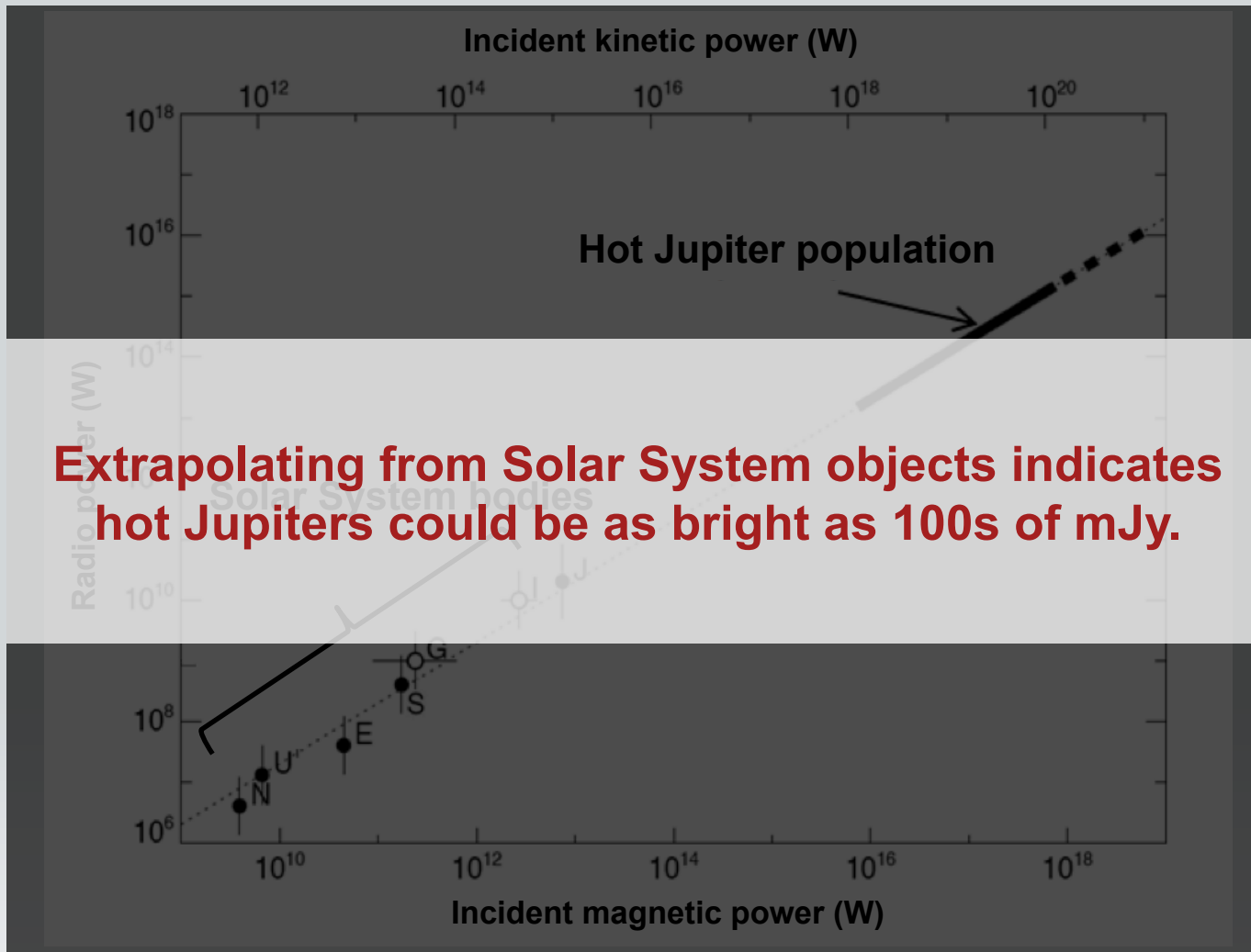


Stephen White

Green Bank Solar Radio Burst Spectrometer

1

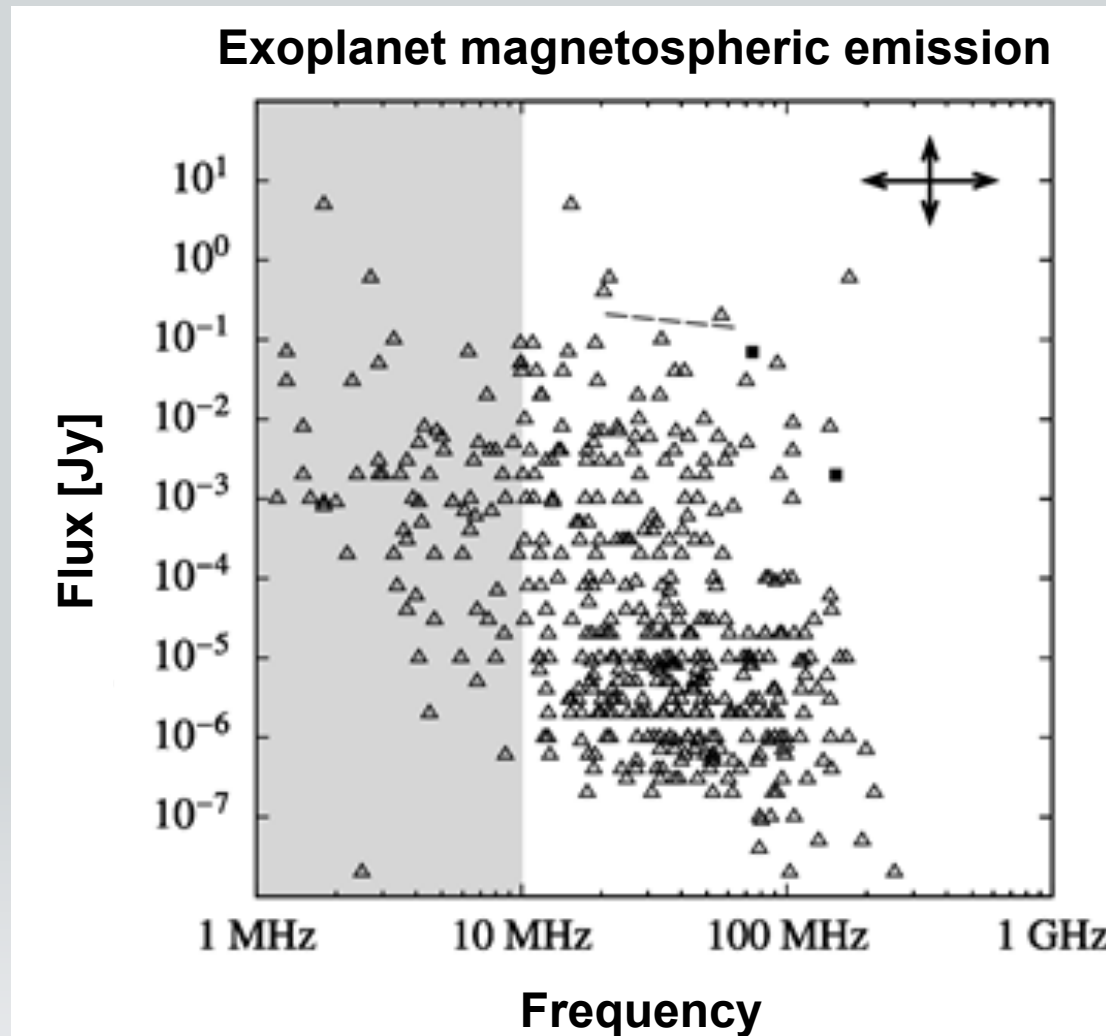
# The low frequency (<100 MHz) sky is the ideal place for monitoring extrasolar space weather events



Adapted from Zarka et al. 2001, *Ap&SS*

1

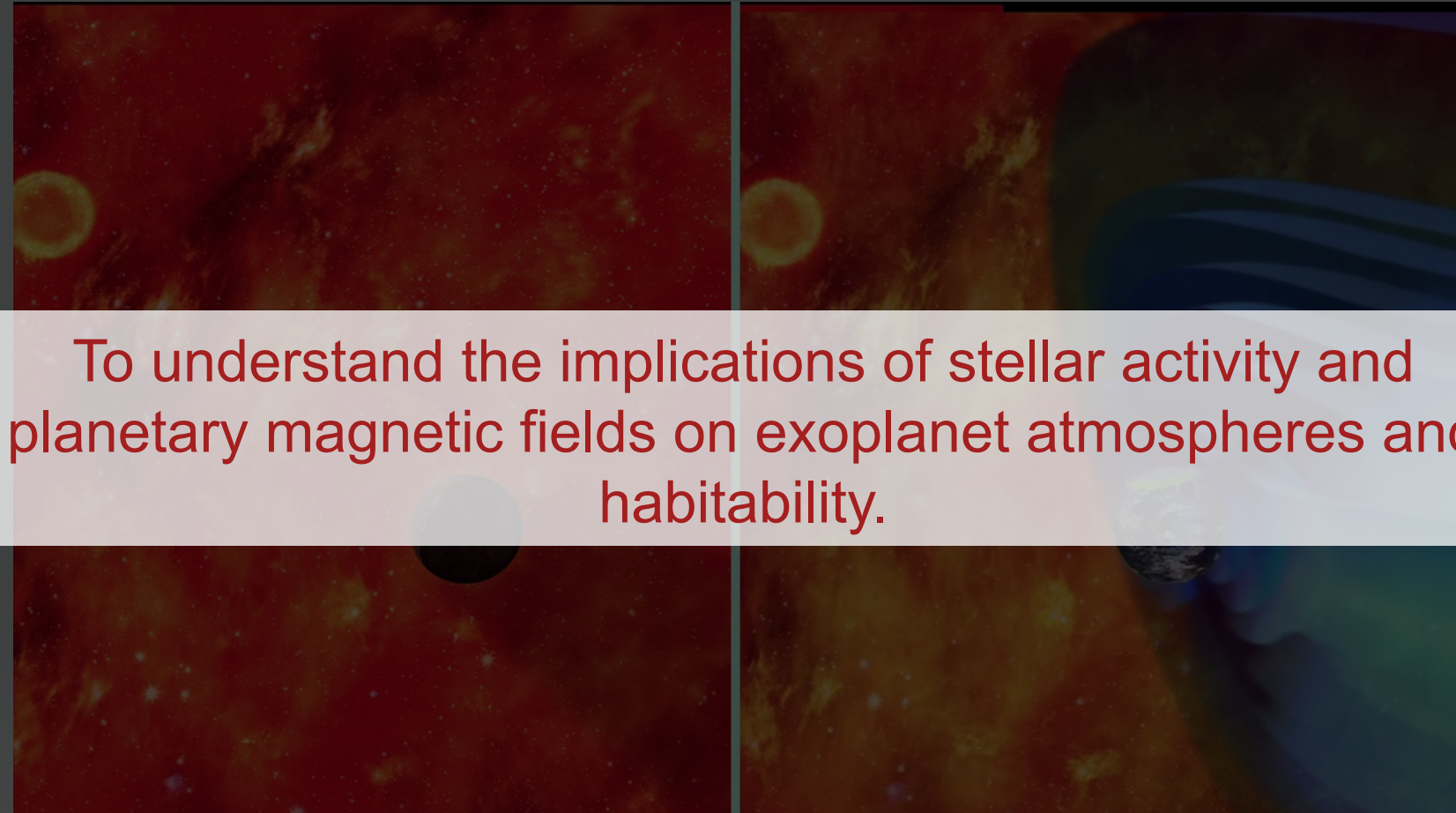
## The low frequency (<100 MHz) sky is the ideal place for monitoring extrasolar space weather events



Grißmeier et al. 2011, *RaSc*

# 1 Why monitor the low frequency sky for extrasolar space weather events?

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To understand the implications of stellar activity and planetary magnetic fields on exoplanet atmospheres and habitability.

# The target low frequency sky – short-duration, coherent transients

1

**Extrasolar  
space weather**

- Stellar flares and CMEs
- Exoplanet magnetospheric emission

...events indicative of stellar magnetic activity and their impact on planetary companions.

2

**GCRT**

As yet unidentified, bright, pulsing transient in the Galactic center – 100% circularly polarized.

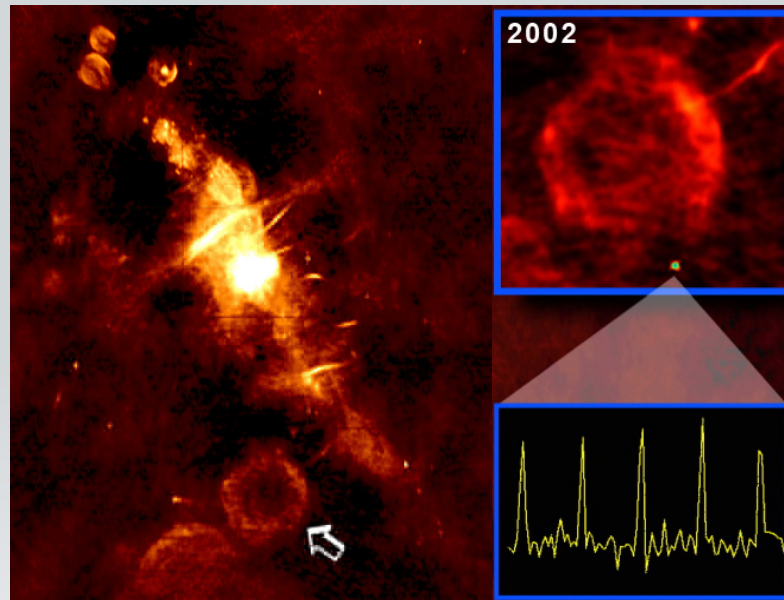


Figure: G. Hallinan



# The target low frequency sky – short-duration, coherent transients

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1

## Extrasolar space weather

- Stellar flares and CMEs
- Exoplanet magnetospheric emission

...events indicative of stellar magnetic activity and their impact on planetary companions.

2

## GCRT

As yet unidentified, bright, pulsing transient in the Galactic center – 100% circularly polarized.

3

## Binary neutron star mergers

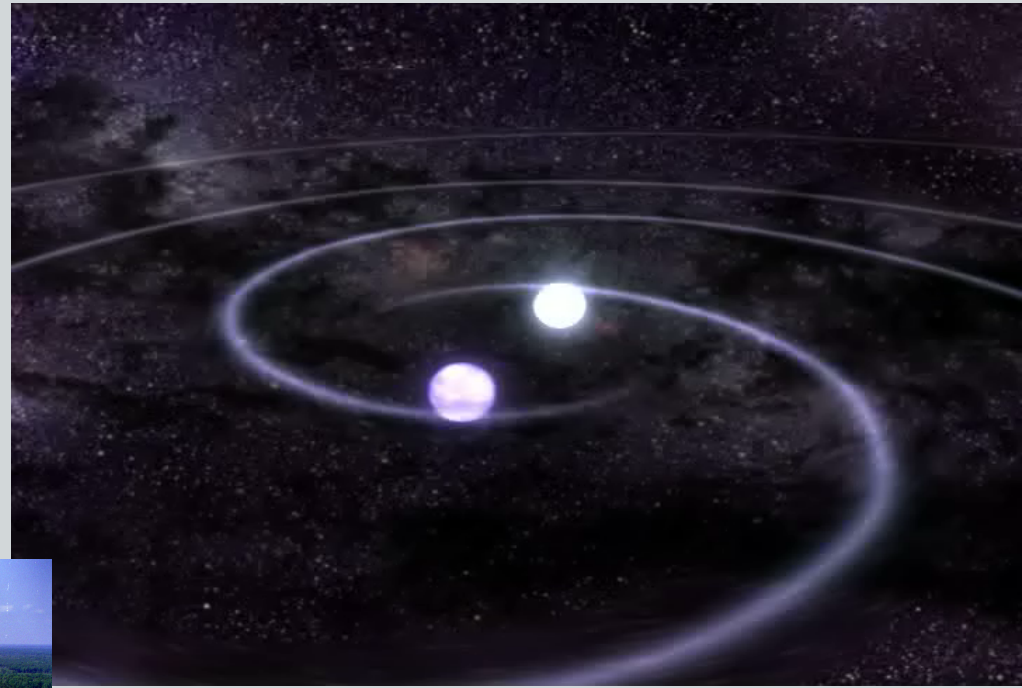
Theoretically predicted, coherent low frequency counterpart to GW event.

3

## Binary neutron star mergers

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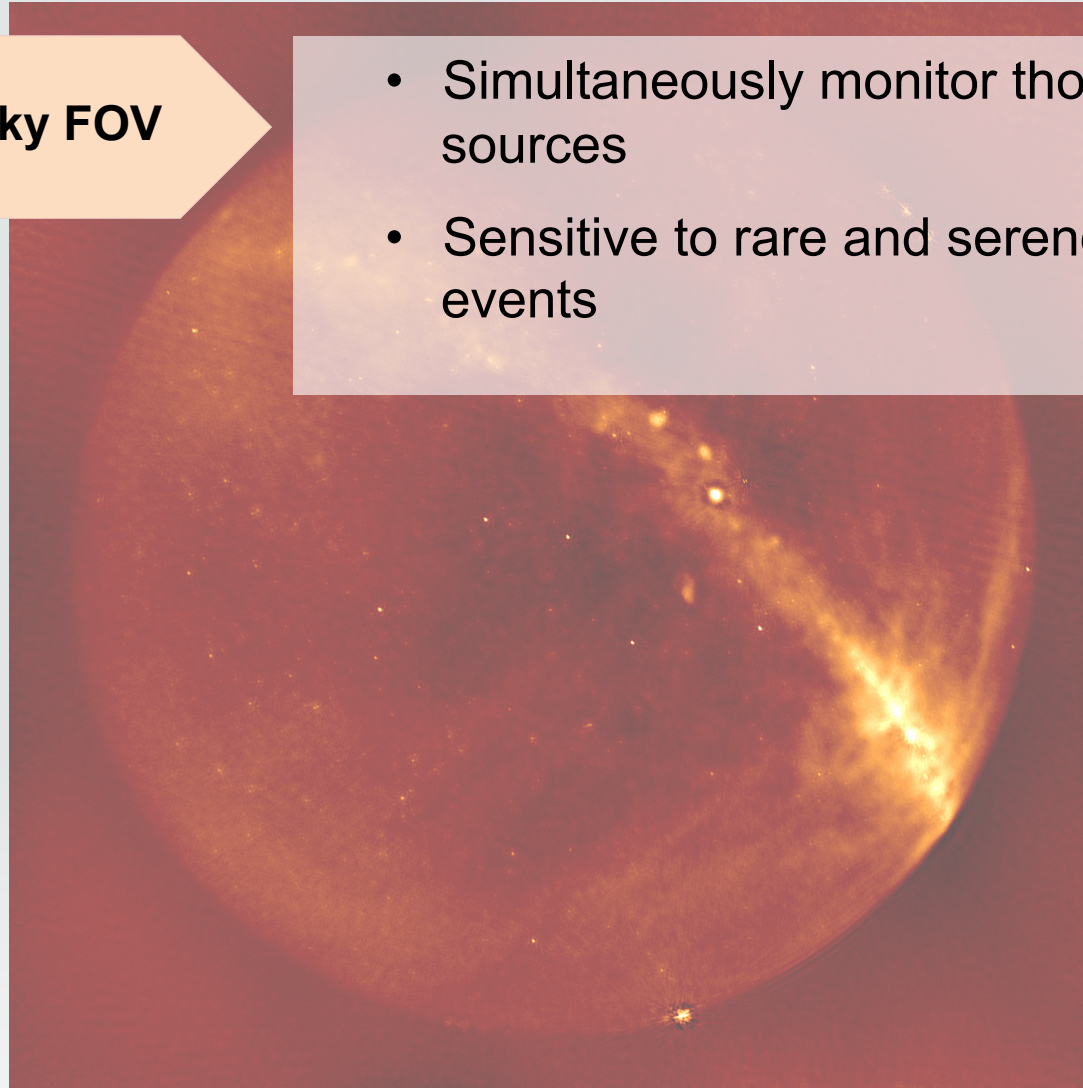
Prompt, coherent low frequency radio emission detectable following GW or GRB trigger.



# OVRO-LWA – a transient machine!

All-sky FOV

- Simultaneously monitor thousands of sources
- Sensitive to rare and serendipitous events

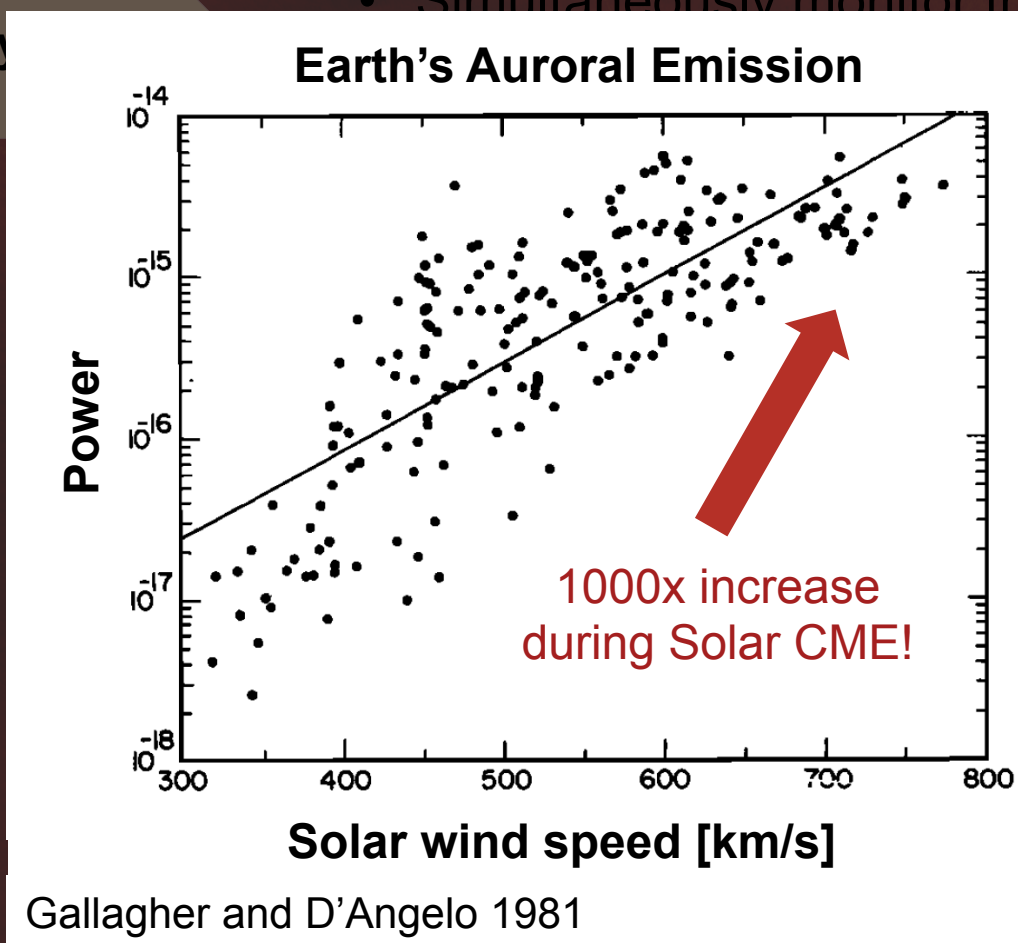


# OVRO-LWA – a transient machine!

All-sky

- Simultaneously monitor thousands of

ndipitous



# OVRO-LWA – a transient machine!

## All-sky FOV

- Simultaneously monitor thousands of sources
- Sensitive to rare and serendipitous events

## Stokes V imaging

- Extrasolar space weather and GCRT-like events circularly polarized
- Get down below confusion noise...

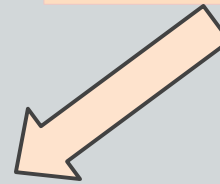
# Transients in Stokes V – a search down Easy Street.

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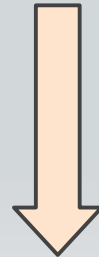
Not confusion-limited!



Sky is empty of sources!



Immediately identify transients!



Make grand scientific discoveries!

# Transients in Stokes V – a search down Easy Street.

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Not-so-

## Antenna beam

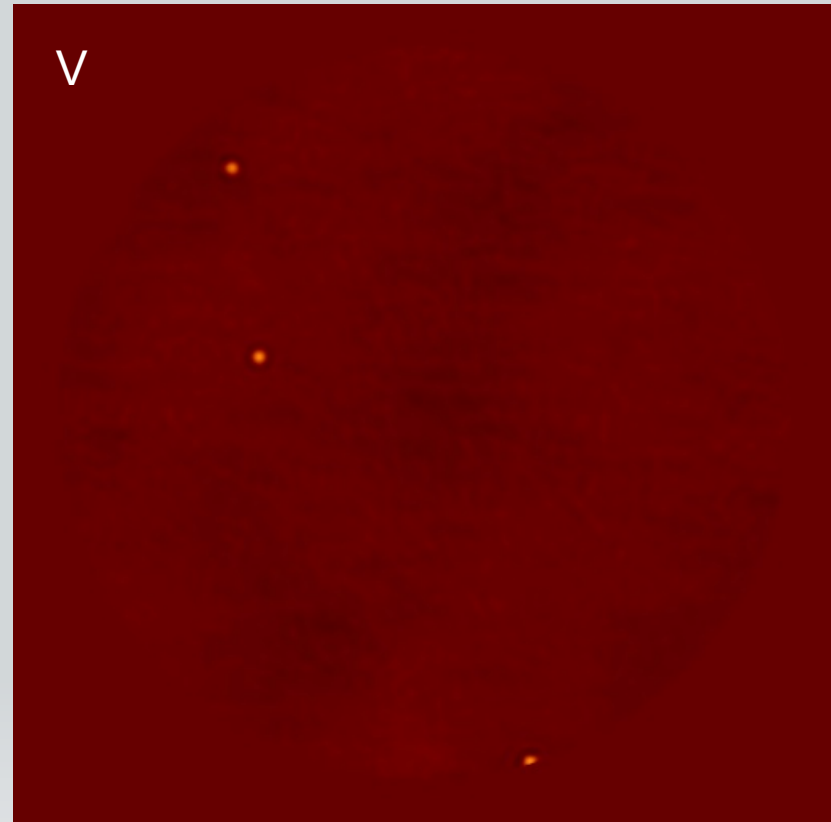
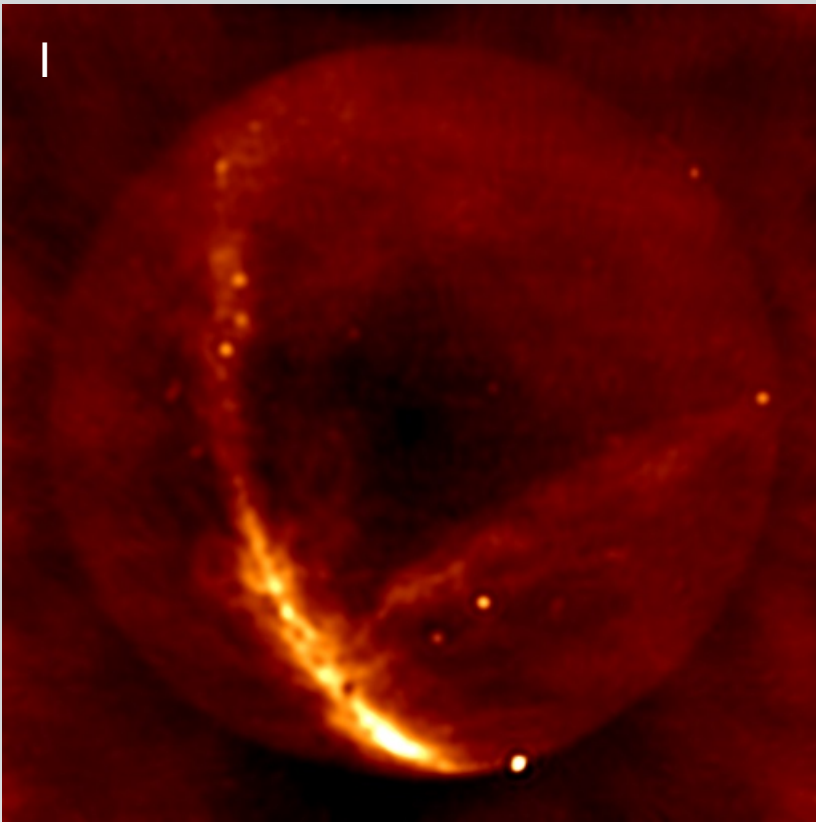
Need to understand antenna beam pattern to high degree of accuracy, including polarization orthogonality between crossed dipoles.

## Polarized calibrator

Requires strongly polarized source whose emission dominates the flux in the beam for a given integration.

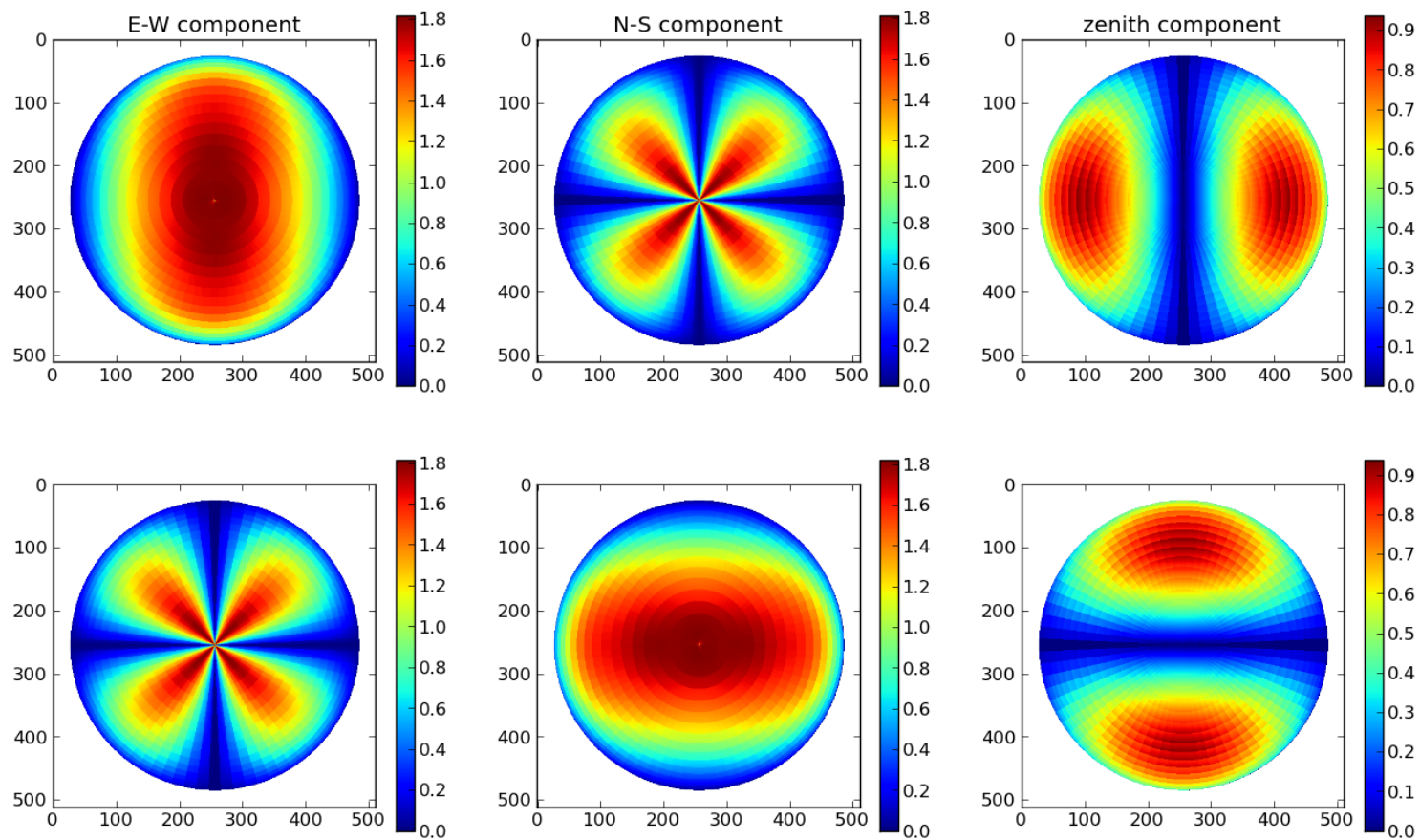
## Stokes – Geometric correction

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# Calculation of LWA dipole beam

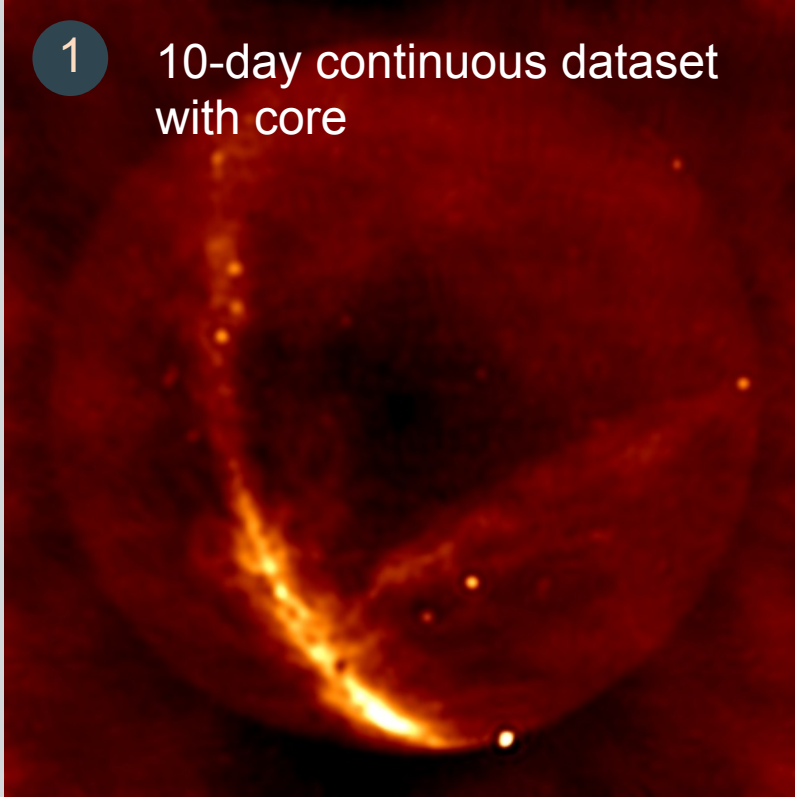


Antenna modeling by Dave Woody

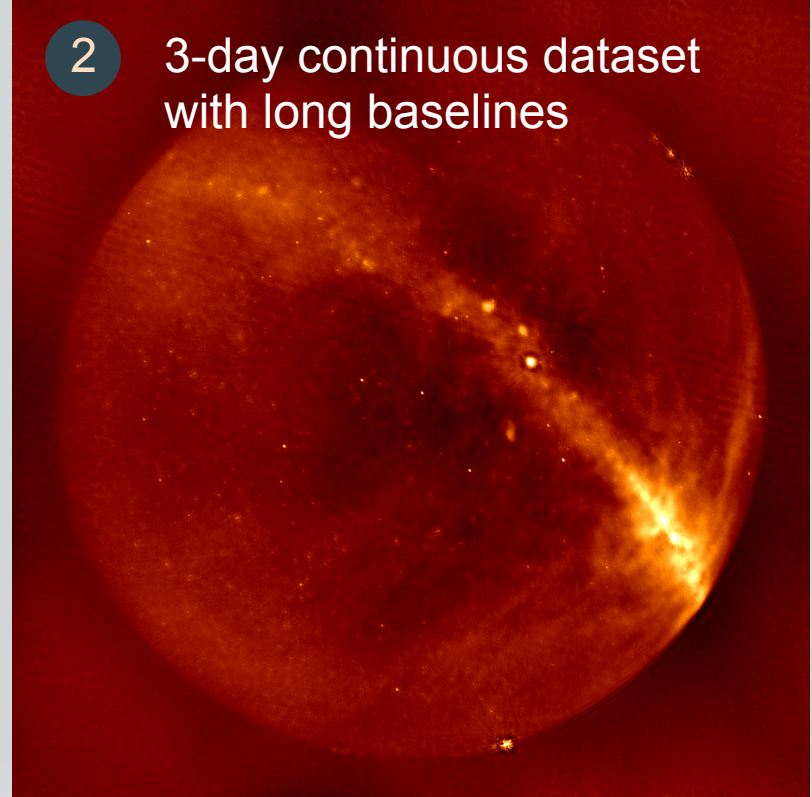
## Three Modes of Operation

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1 10-day continuous dataset  
with core



2 3-day continuous dataset  
with long baselines



3 7-day continuous 'buffer mode'  
- respond to GW triggers

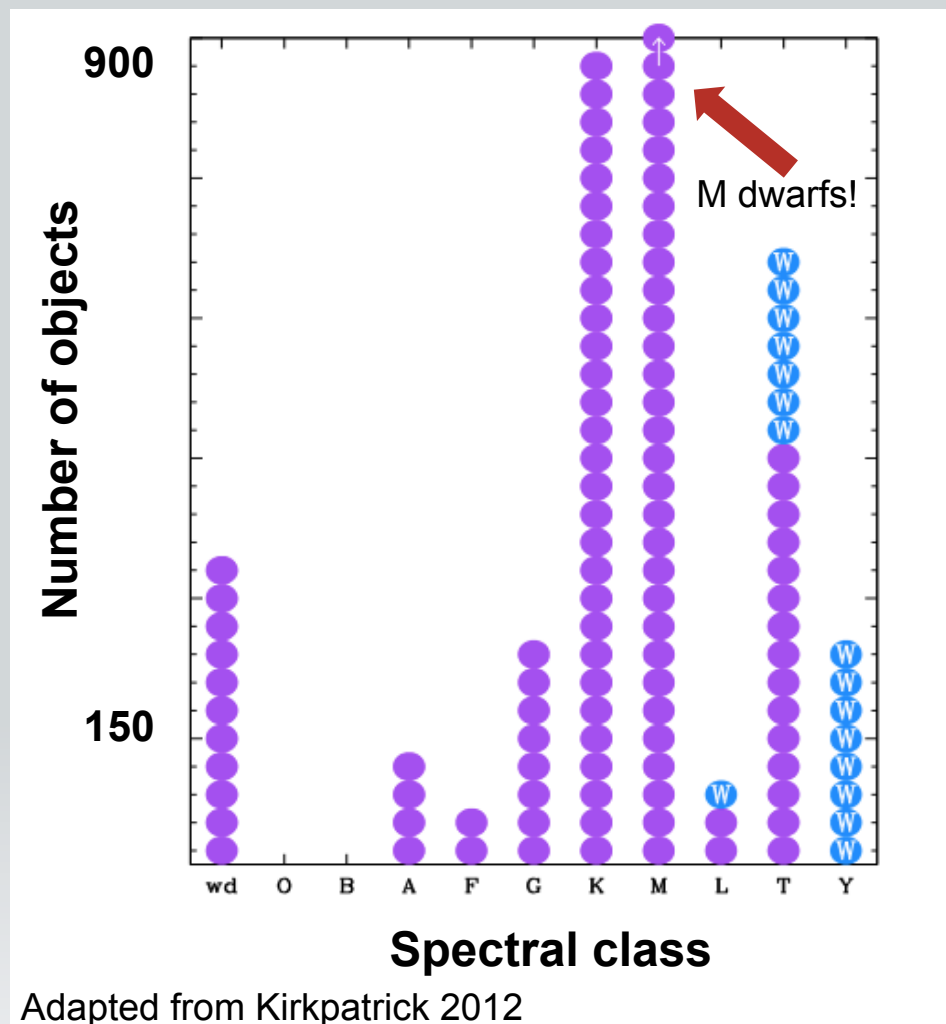
# OVRO-LWA Pilot Survey

## 25-pc catalog

- >2000 objects out to 25 pc
- Light curves in Stokes I,V for every source

## Non-targeted transients

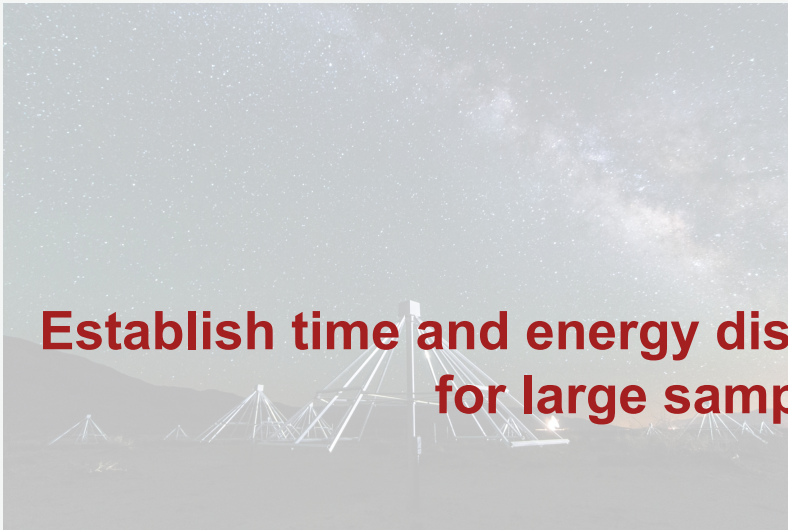
- Identify sources not in VLSSr
- Anything in Stokes V!



# Simultaneous radio and optical monitoring of ~1000 nearby stellar systems.

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LWA



All-sky radio

Evryscope



All-sky optical

**Establish time and energy distribution of flares and CME events for large sample of nearby stars!**

# Summary

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## OVRO-LWA

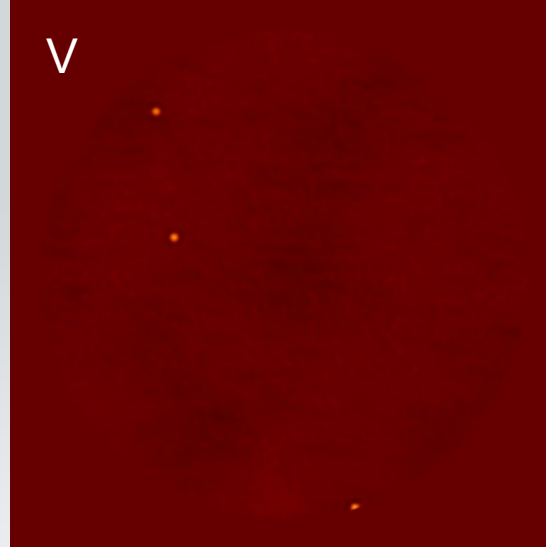
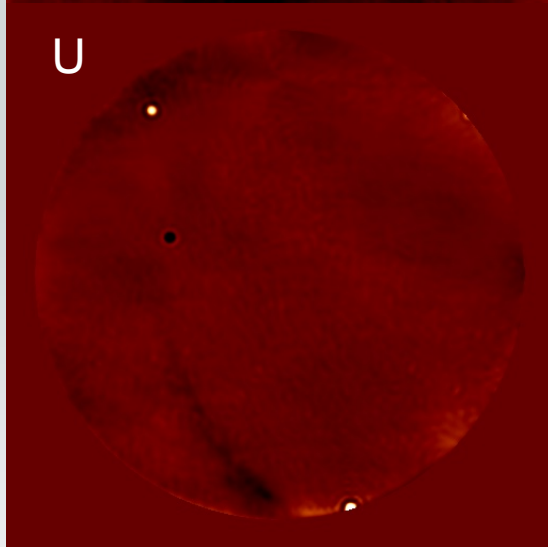
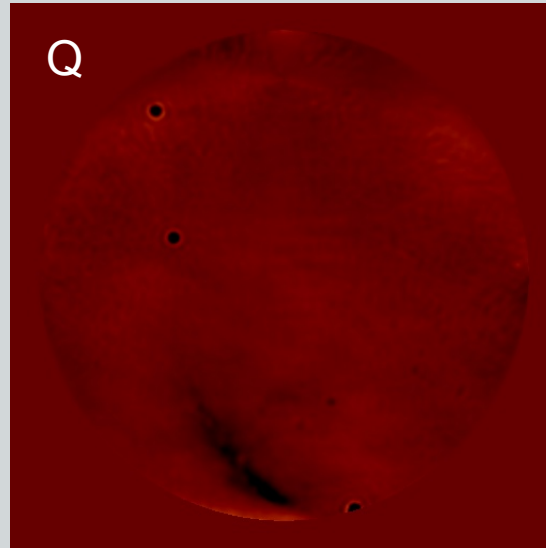
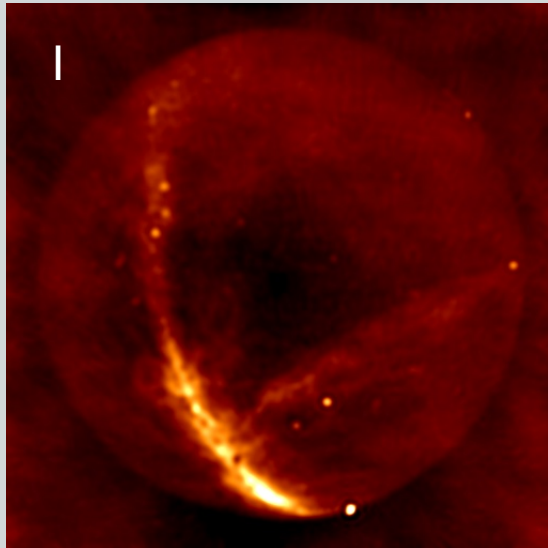
- Low frequency (20-80 MHz), all-sky, in Stokes I,V
- Pilot survey – monitoring thousands of nearby sources – soon underway

## Stokes V Imaging

- Next step – Jupiter? Sun? to calibrate X,Y phase
- Further improvements using astronomical sources to characterize beam

# Full Stokes

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I. Low frequency transient sky II. OVRO-LWA III. Stokes V imaging IV. Pilot transient survey