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# Chasing Low Frequency Radio Bursts from Magnetically Active Stars

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+ MWA Transients Collaboration**



THE UNIVERSITY OF  
**SYDNEY**



**MWA**  
MURCHISON  
WIDFIELD  
ARRAY

Flaring is a common characteristic of magnetically active stars.

Observations tell us about:

Stellar magnetic properties

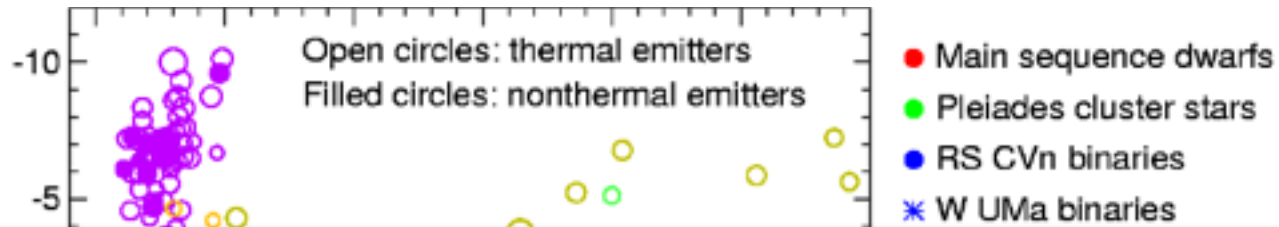
Solar - Stellar connection

Habitability of discovered exoplanets



<https://blogs.stsci.edu/universe/2015/11/15/follow-the-photons-to-understand-the-effects-of-stellar-flares/>

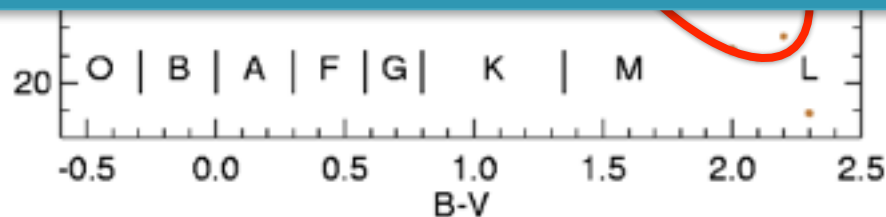
# Radio H-R Diagram



Dominant stars in the Galaxy (~70%)

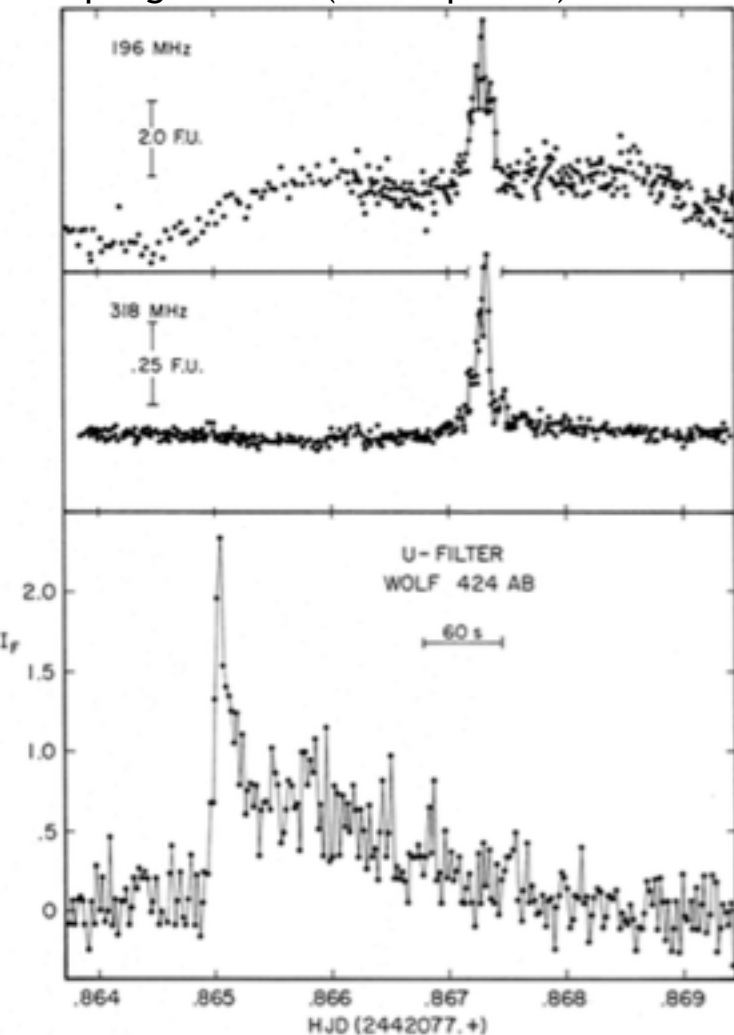
Extreme magnetic activity + strong (kG) fields covering large fraction of surface

Nearest (habitable?) exoplanets orbiting M dwarfs



# Previous low frequency detections

Spangler et al. (1976 ApJ 203)



Early single dish observations  
(1960's - 80's) :

High flare rates (up to 0.8 per hour)

Bright ( $>0.8$  Jy)

High fractional circular polarisation  
( $>70\%$ )

Total number of sources with MHz  
emission = 11

Non-detections in long-duration, widefield surveys for transients:

**Tingay et al. (2016 ApJ 152):** Kepler K2 field, 5.9 hours,  $5\sigma \sim 0.5$  Jy

**Rowlinson et al. (2016 MNRAS 458):** 100 hrs of MWA EoR field,  $5\sigma \sim 0.235$  Jy

**Where are all the flare stars?**

**Try targeted observations to assess behaviour**

# Targeting GJ 65 AB

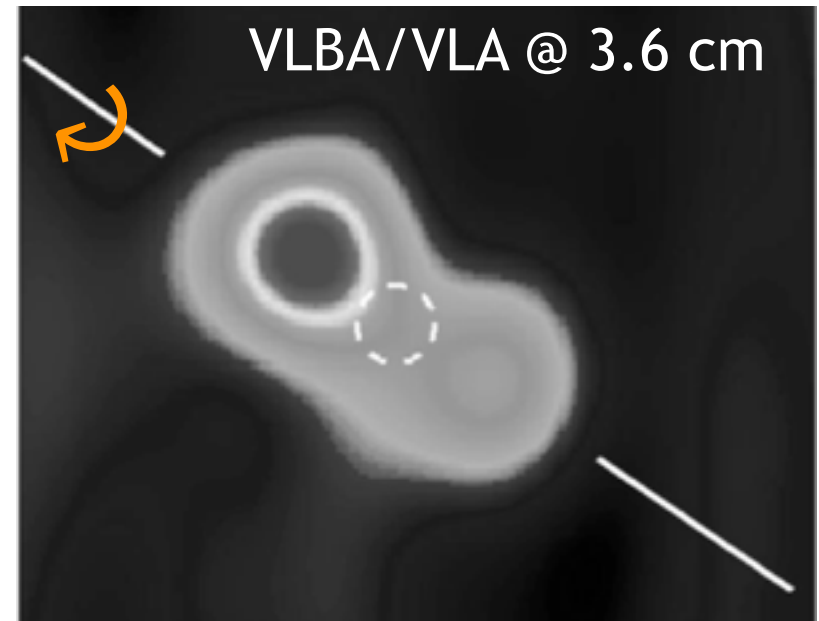
Binary system w/ 26 yr period  
Spectral types = M5.5 (BL Cet)  
+ M6 (UV Cet)

Rotational periods:

BL Cet,  $P = 5.86$  hr

UV Cet,  $P = 5.45$  hr

Benz et al. 1998



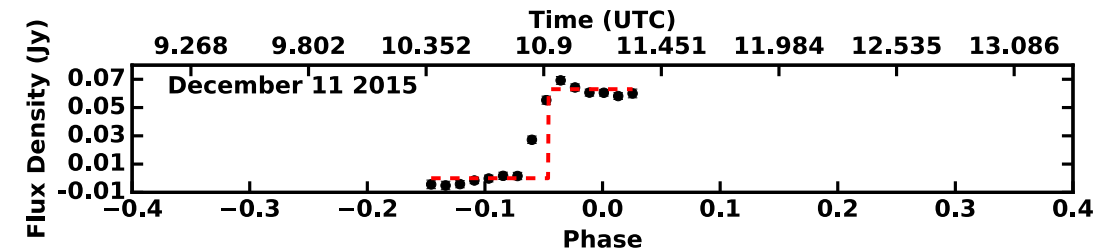
MWA Observations @ 154 MHz:

8.8 hours – split over 4 days in Dec 2015

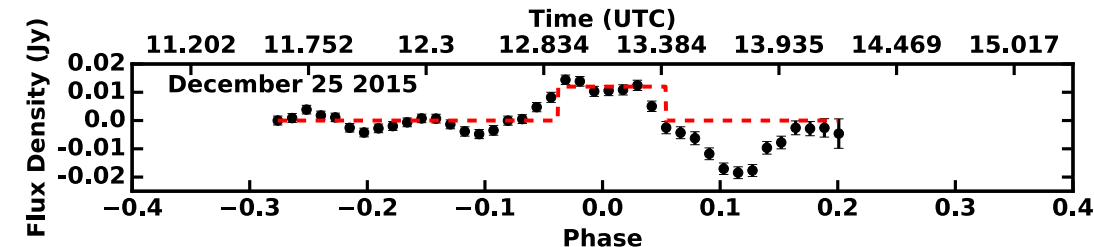
Focus in Stokes V (circular polarisation)

# Detections of GJ 65 AB

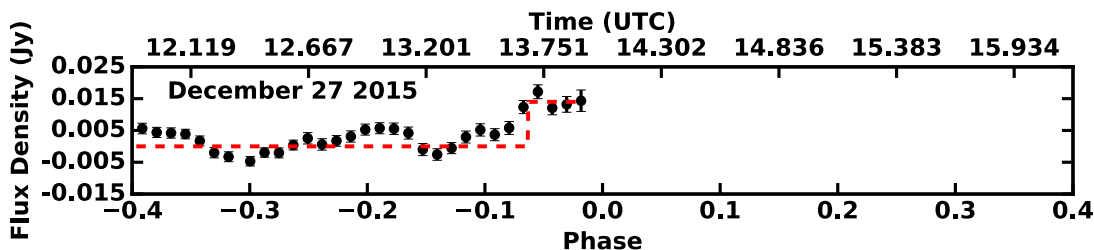
STOKES V (pos = RH, neg = LH)



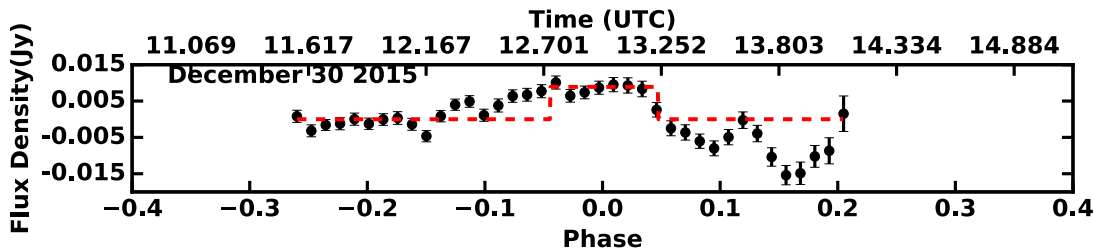
Only detected in CP



Linear polarisation detected in brightest flare – indicates ECM



P ~ 5.45 hrs (95% confidence)



Lynch et al. (2017 ApJL 836)

# Follow up observations:

**Dec 2016: 13.7 hrs (Hex)**

$5\sigma \sim 0.1$  Jy

Single bright (440 mJy), short burst

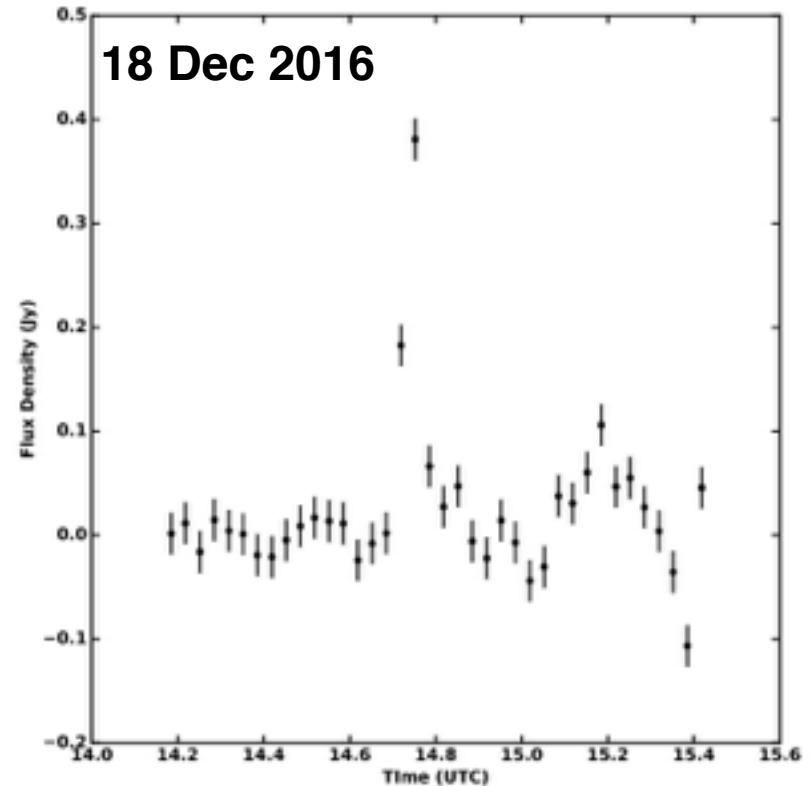
**Oct 2017: 18 hrs (extended)**

$5\sigma \sim 0.03$  Jy

Single dim (35 mJy), short

No periodic long-duration signal

Observations on-going (80 hours total)





YZ CMi:

11.1 hours Jan 2016;  $5\sigma \sim 0.03$  Jy

CN Leo:

7.4 hours (Hex) Feb 2017;  $5\sigma \sim 0.1$  Jy

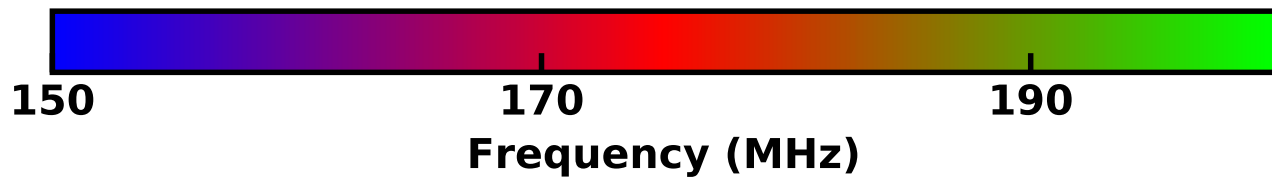
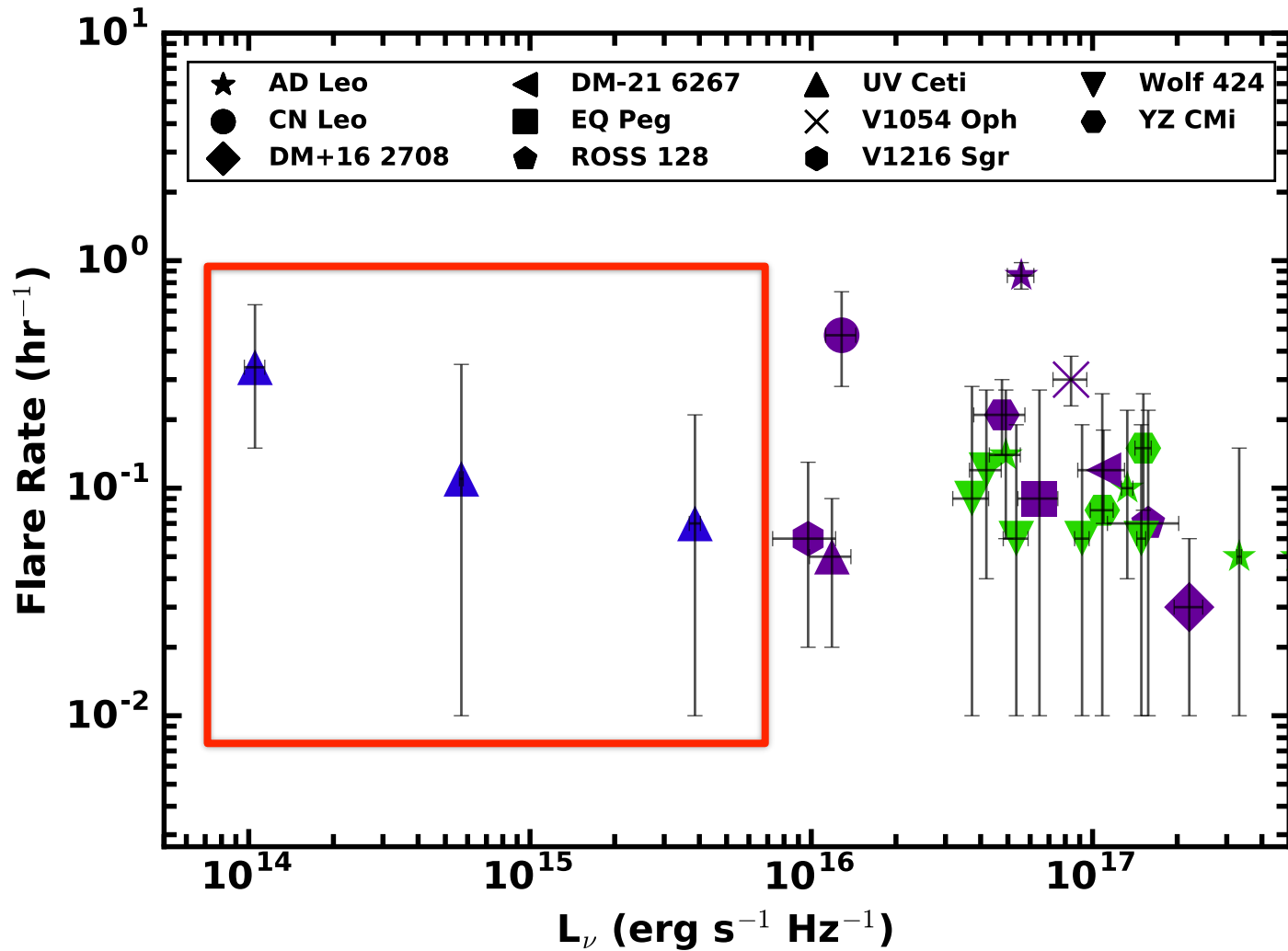
17 hours (extended) to be observed (End of Dec 2017)

DM-21 6267:

10.7 hours (extended) Oct 2017;  $5\sigma \sim 0.03$  Jy

6 hours (extended) Nov 2017 still to be reduced & imaged

## Do Not Despair!



# Summary:

**Low frequency stellar flares** expected to be common – blind surveys do not reveal these events.

**Circularly polarised imaging** achieves best MWA sensitivities and can detect dim flares.

**UV Ceti:** Two types of flares detected but no clear connection.

**Flare distribution not well constrained** due to uncertainties – need more detections.