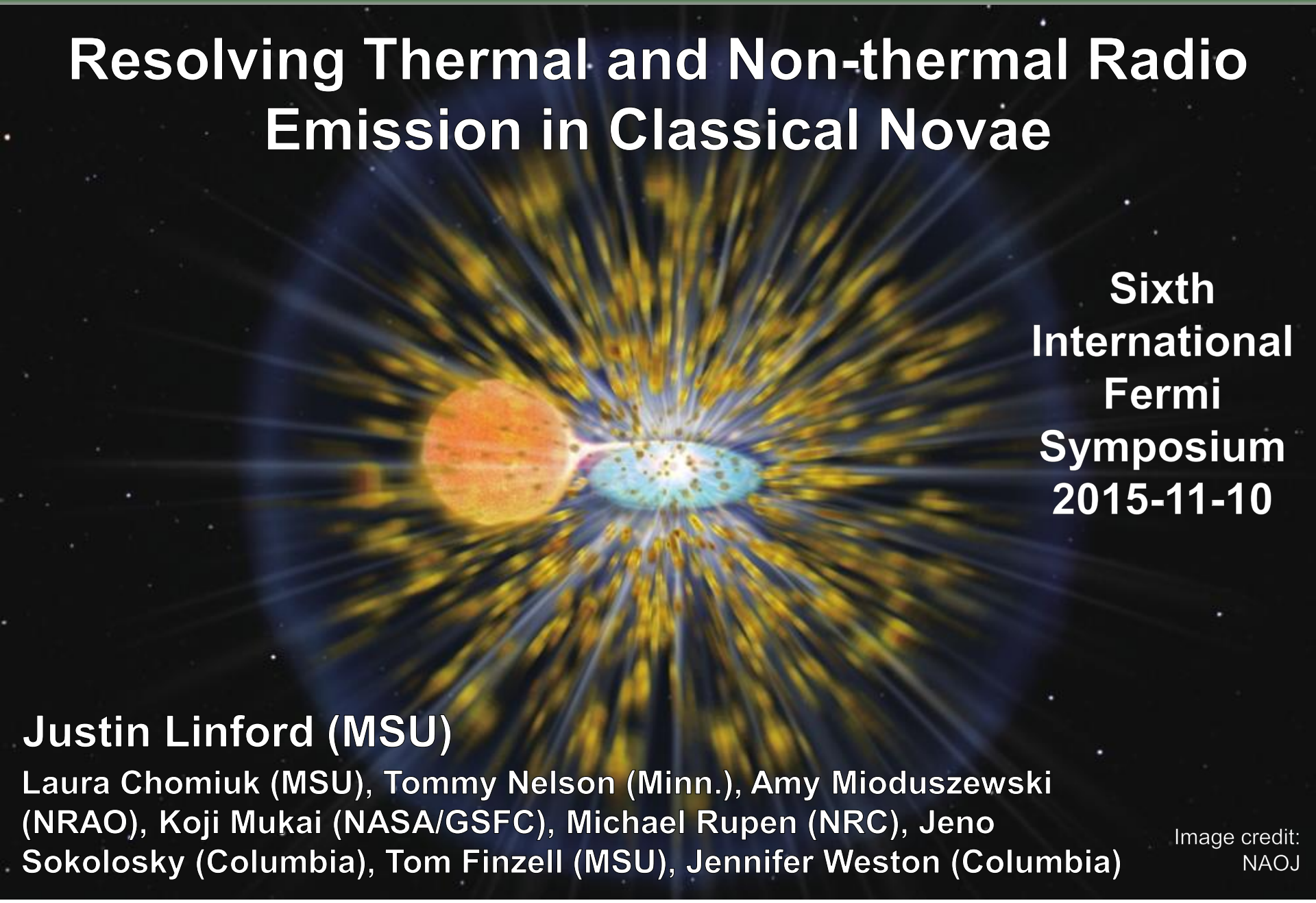
MICHIGAN STATE UNIVERSITY

Resolving Thermal and Non-thermal Radio Emission in Classical Novae



Sixth International Fermi Symposium 2015-11-10

Justin Linford (MSU)

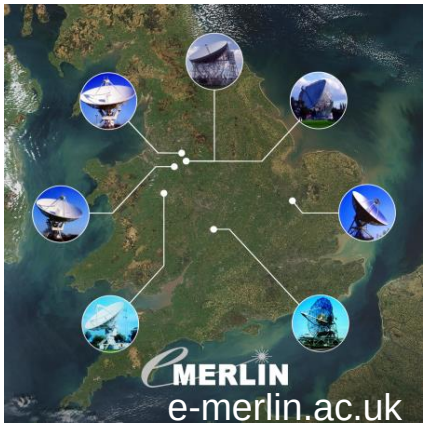
Laura Chomiuk (MSU), Tommy Nelson (Minn.), Amy Mioduszewski (NRAO), Koji Mukai (NASA/GSFC), Michael Rupen (NRC), Jeno Sokolosky (Columbia), Tom Finzell (MSU), Jennifer Weston (Columbia)

Image credit: NAOJ

Radio Observations of Novae

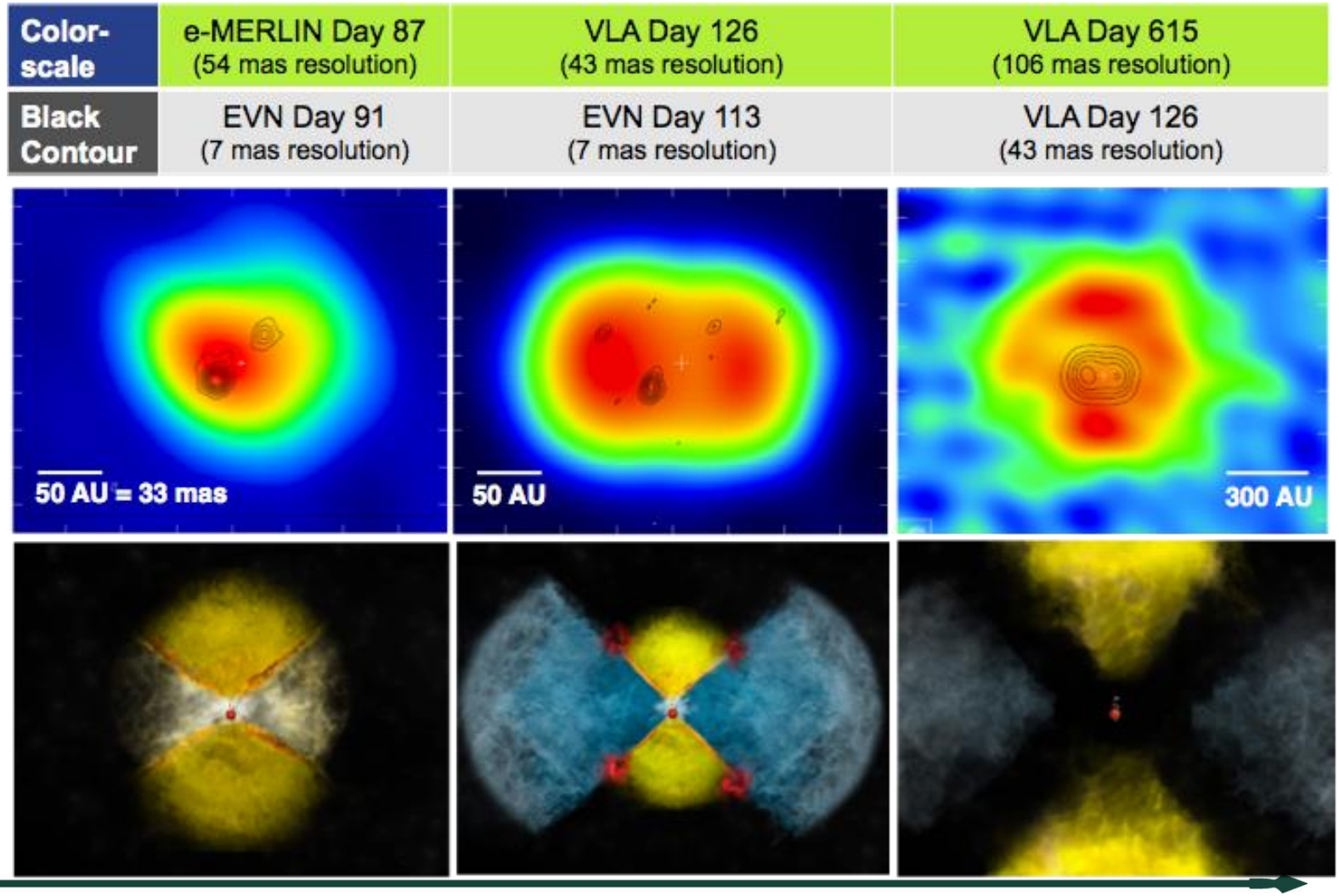
- E-Nova team: monitors novae in the radio at several wavelengths (21 cm to about 0.8 cm)
- We use radio telescopes all over the world
- Sensitive to both thermal (un-shocked) and synchrotron (shocks) emission

NRAO/AUI



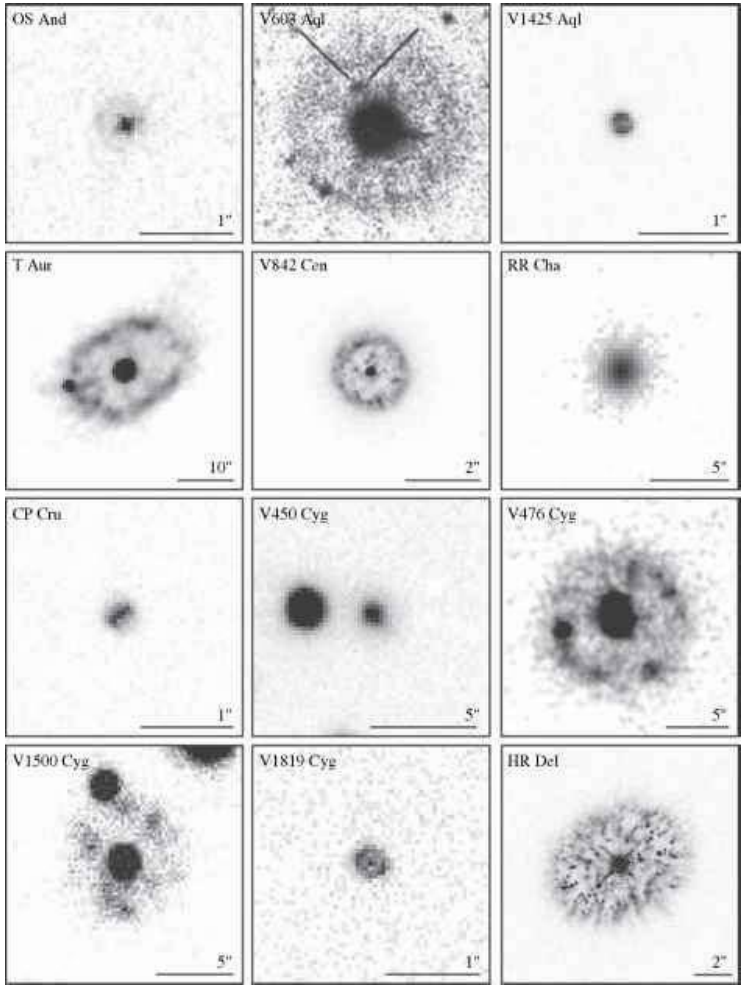
Current Understanding of Novae

V959 Mon

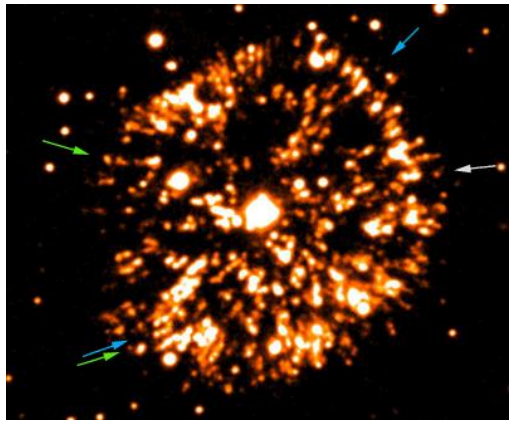


From Chomiuk et al. 2014

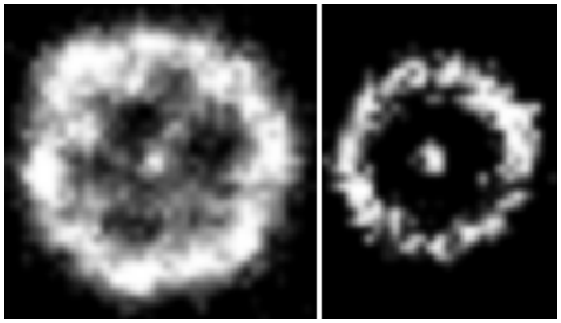
Does This Model Work for Other Novae?



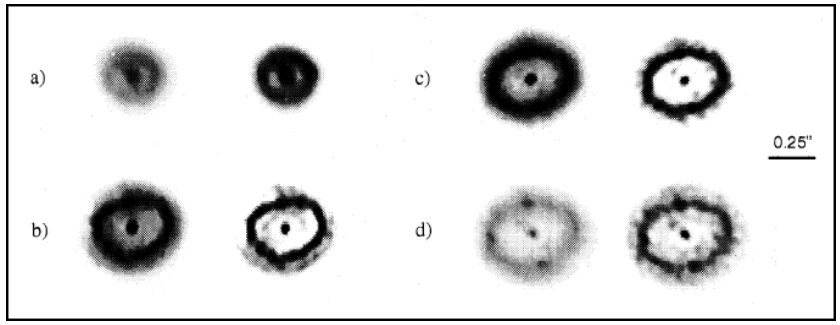
From O'Brien & Bode 2008
(Ch. 12 in Bode & Evans 2008)



GK Per (Hα + [NIII], Romano Corradi)

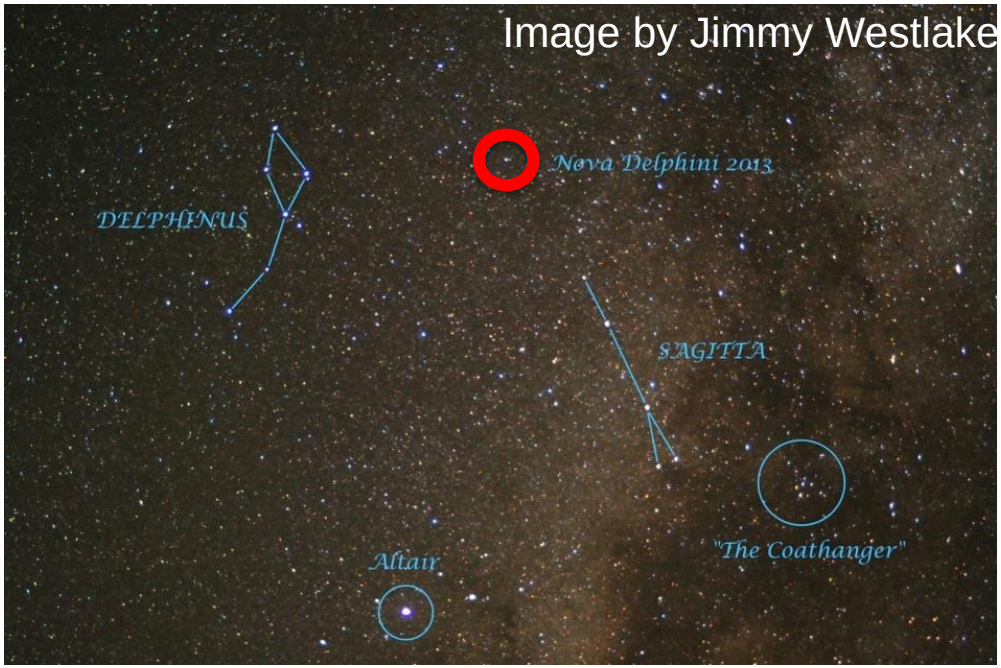


QU Vul V351 Pup
(HST, Ringwald)



V1974 Cyg (HST, from Paresce et al. 1995)

V339 Del (2013)

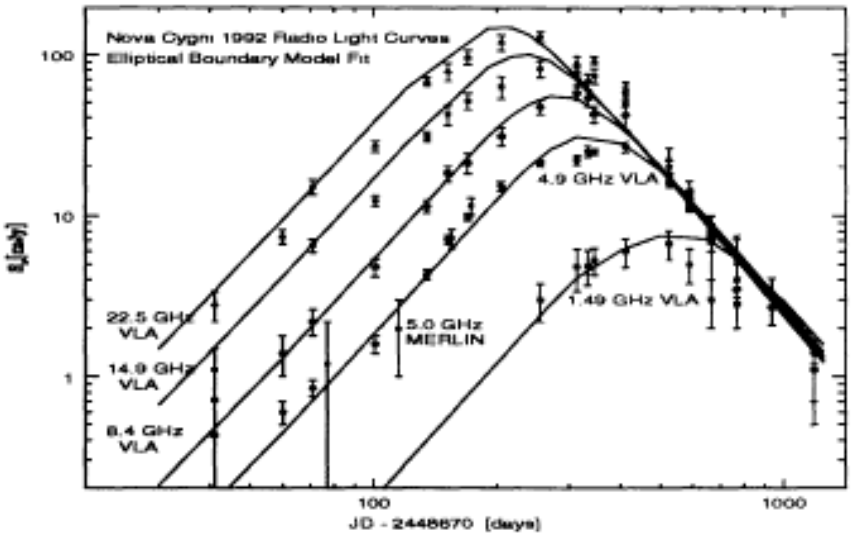


- Peak optical (V) magnitude ~4.3
- Detected by Fermi for 27 days (Ackermann et al. 2014)*
- IR interferometry during the first ~50 days indicated a “ring + core” structure (Schaefer et al. 2014)

*Only 9 detections $\geq 3\sigma$, most points after Day 12 are upper limits

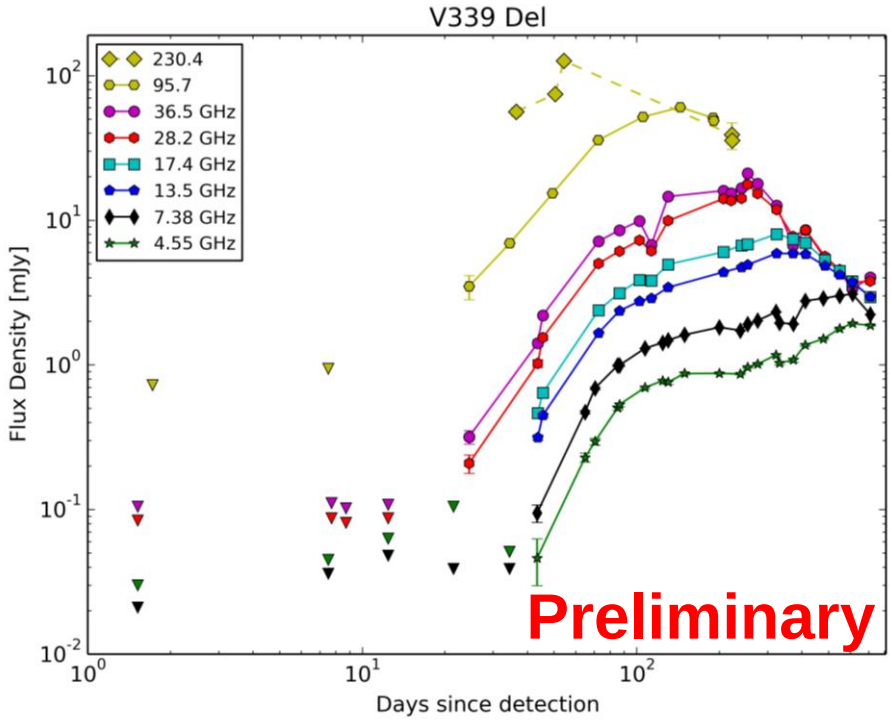
V339 Del: Thermal Ejecta

What the radio light curve is supposed to look like



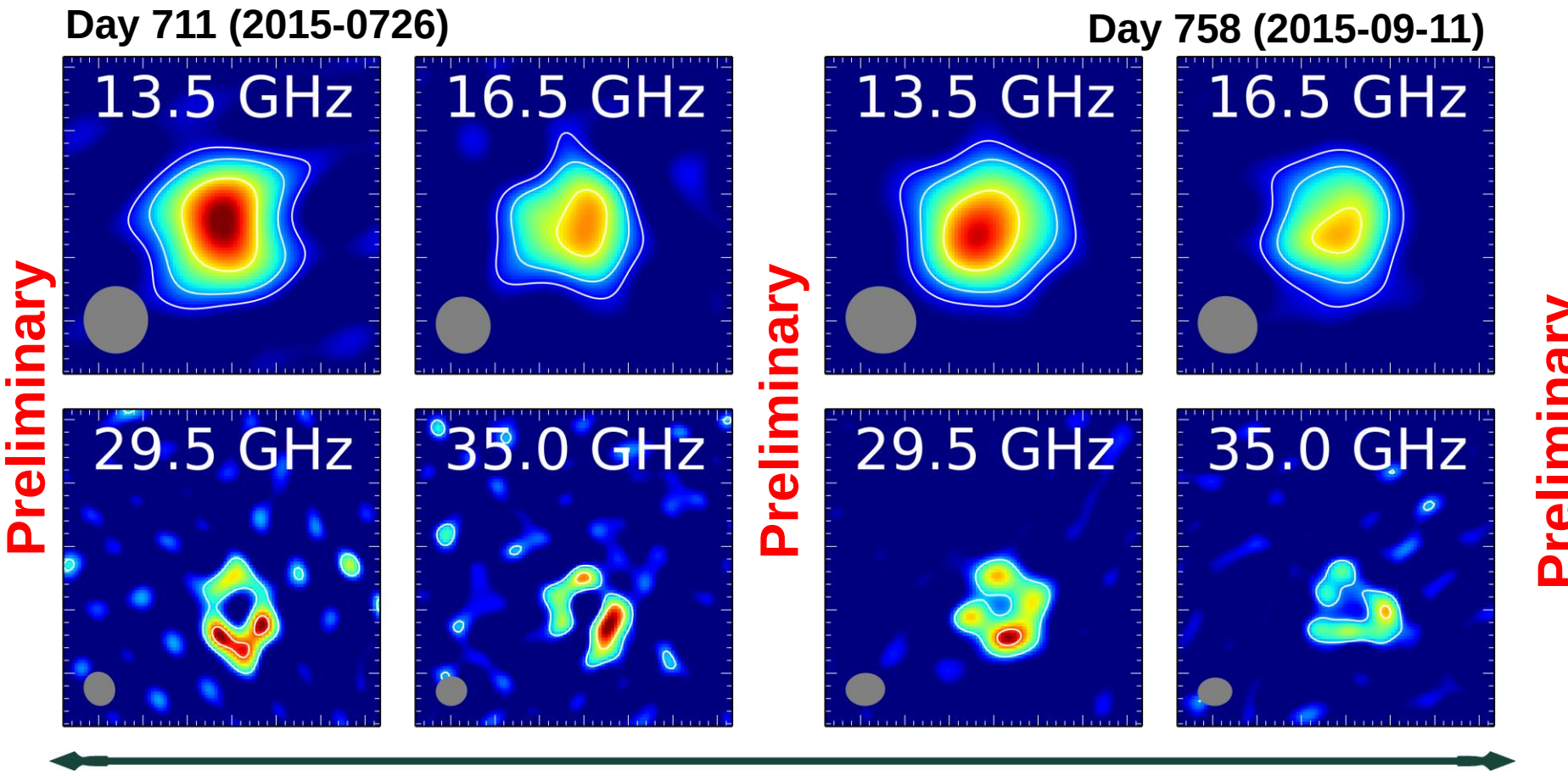
V1974 Cyg (from Hjellming 1996)

V339 Del's radio light curve



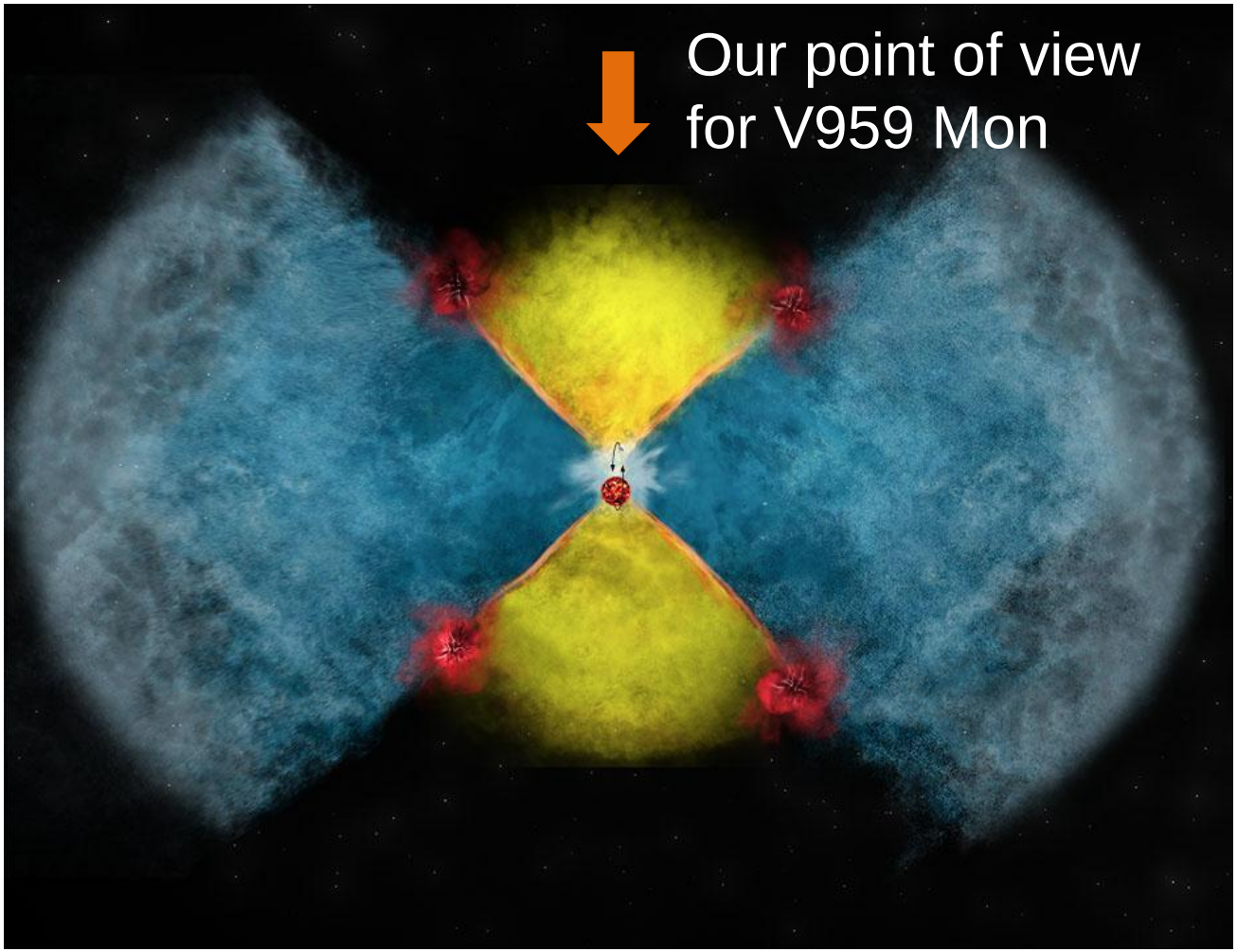
V339 Del: Resolved Ejecta

VLA, A-configuration images



Hypothesis

Our point of view for V339 Del



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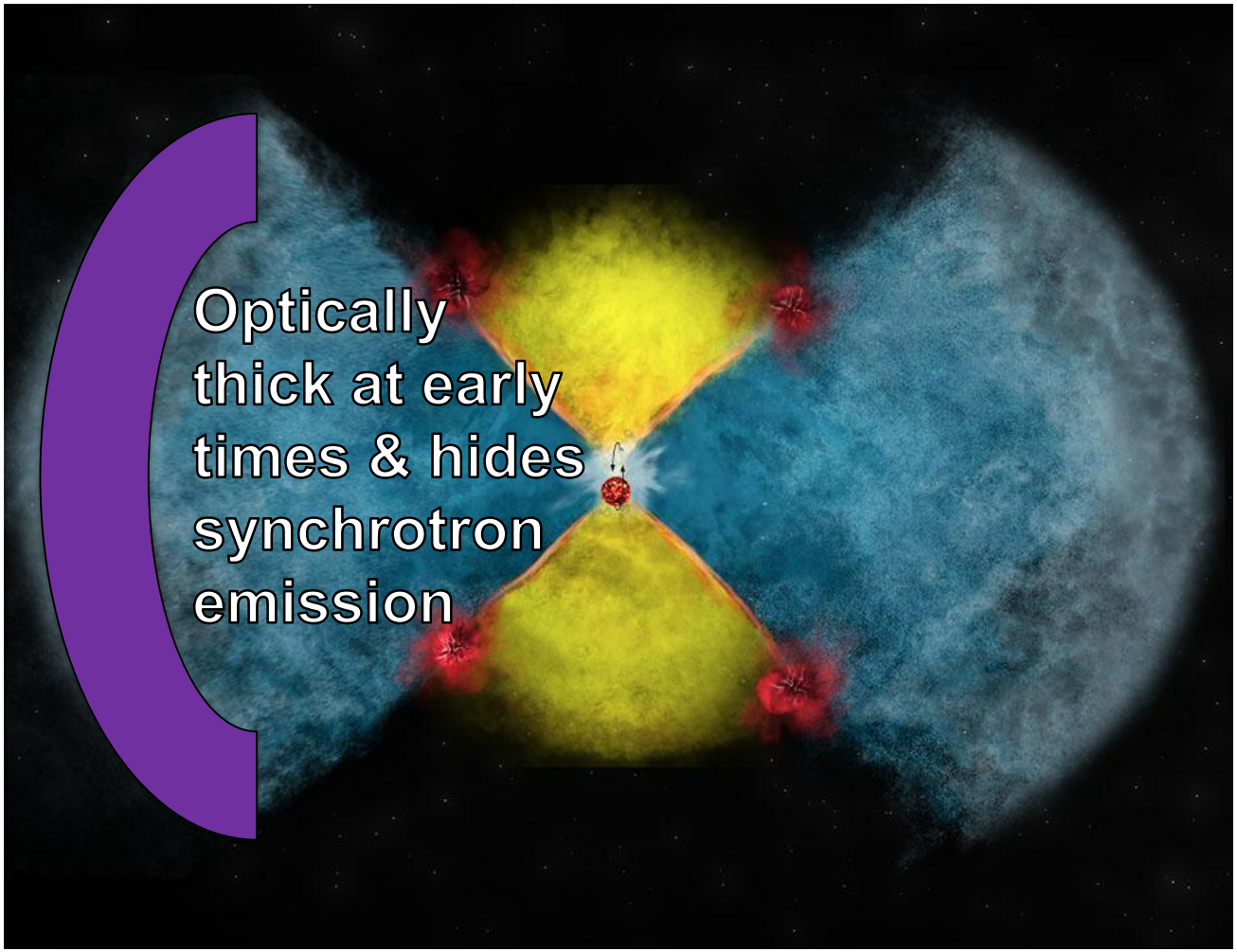

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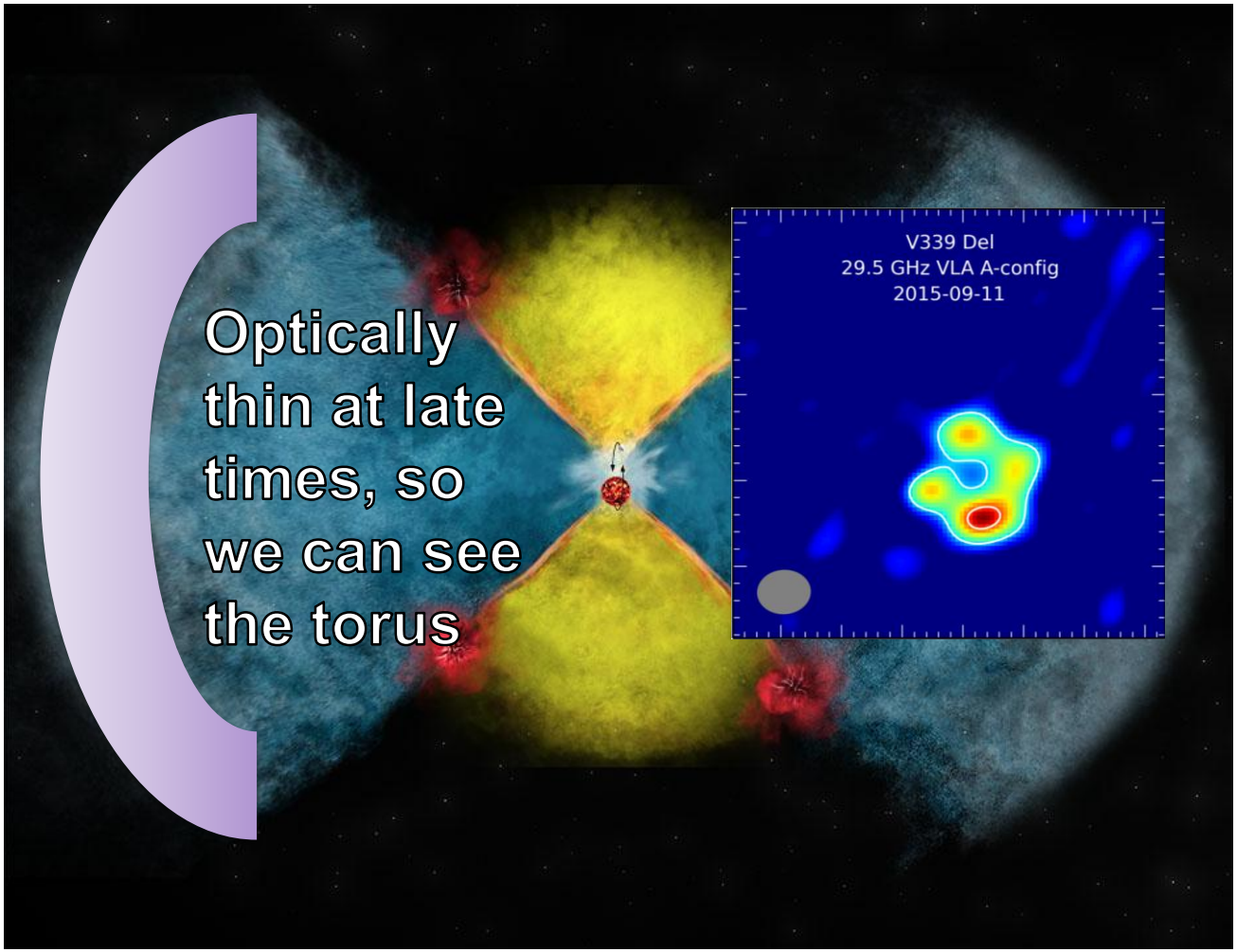

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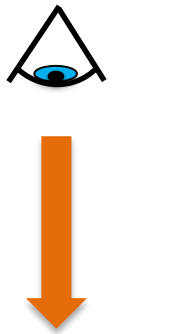

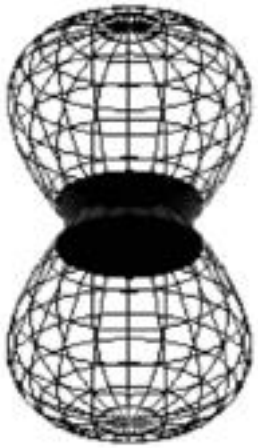

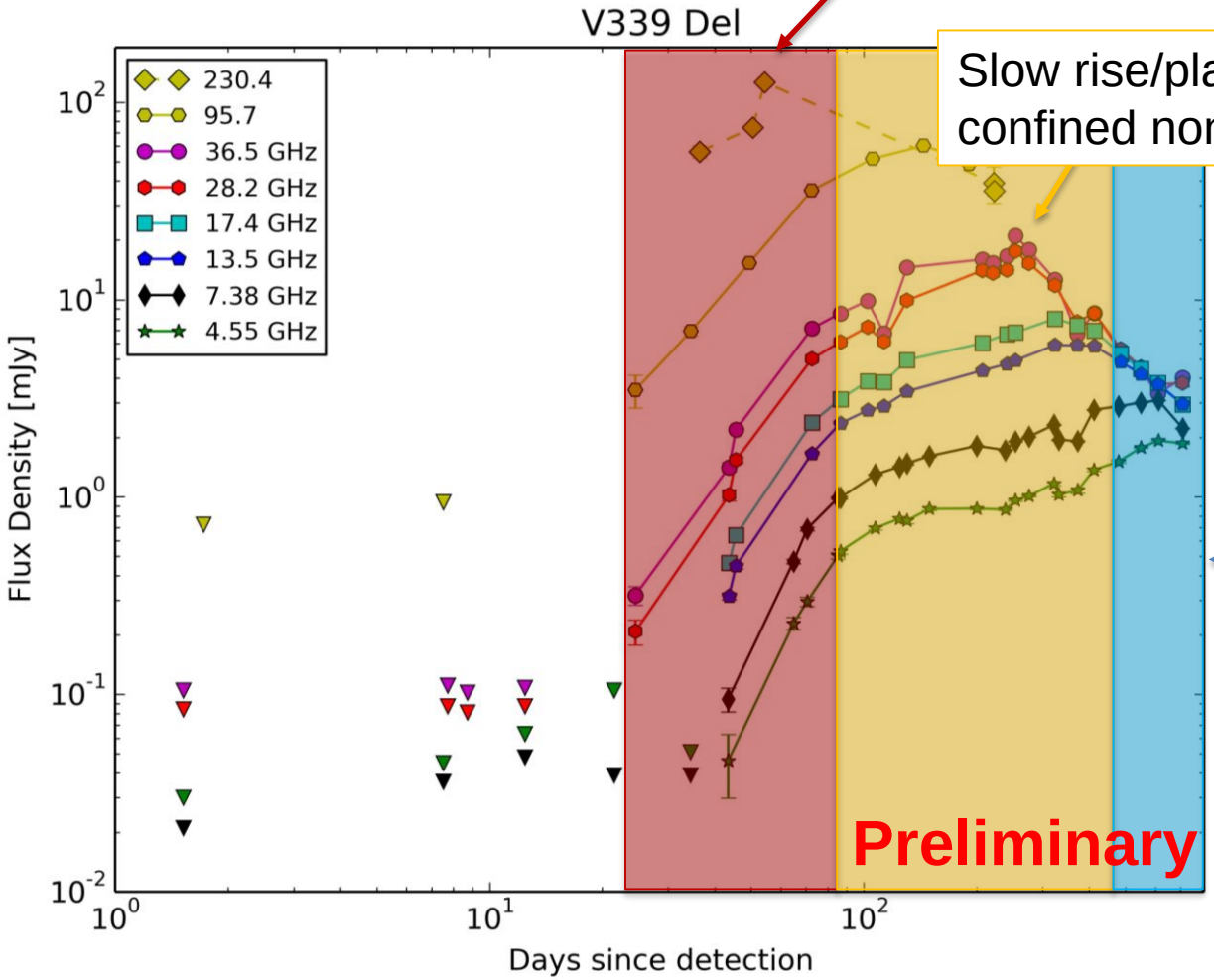

Fast rise after initial common envelope phase

Slow rise/plateau due to confined non-spherical flow

Ejecta becomes optically thin

Why Aren't All Novae Detected By Fermi?

- Luminosity range
  - V959 Mon: $L_\gamma \sim 0.6 \times 10^{35}$ erg s^{-1} (Linford et al. 2015)
  - V1324 Sco: $L_\gamma \geq 18 \times 10^{35}$ erg s^{-1} (Finzell et al. 2015)
- What can lead to the luminosity range?
  - Ejecta velocity range
  - White dwarf mass range
  - Accretion rate range
  - Some novae are embedded in red giant wind which leads to stronger shocks (e.g., V407 Cyg & V745 Sco)

The Other Post-2012 Fermi-Detected Novae

- V1369 Cen (2013, peak V mag ~ 3.3)
  - Limited data due to its declination of -59°
  - Some ATCA observations
- V745 Sco (2014, peak V mag ~ 9.0)
  - VLA and VLBA observations
  - X-ray observations with multiple instruments
- V5668 Sgr (2015, peak V mag ~ 4.0)
  - VLA observations ongoing
  - X-ray observations with Swift and Chandra ongoing

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Recurrent nova with red giant companion

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