The Symbiotic Recurrent Nova V745 Sco at Radio Wavelengths

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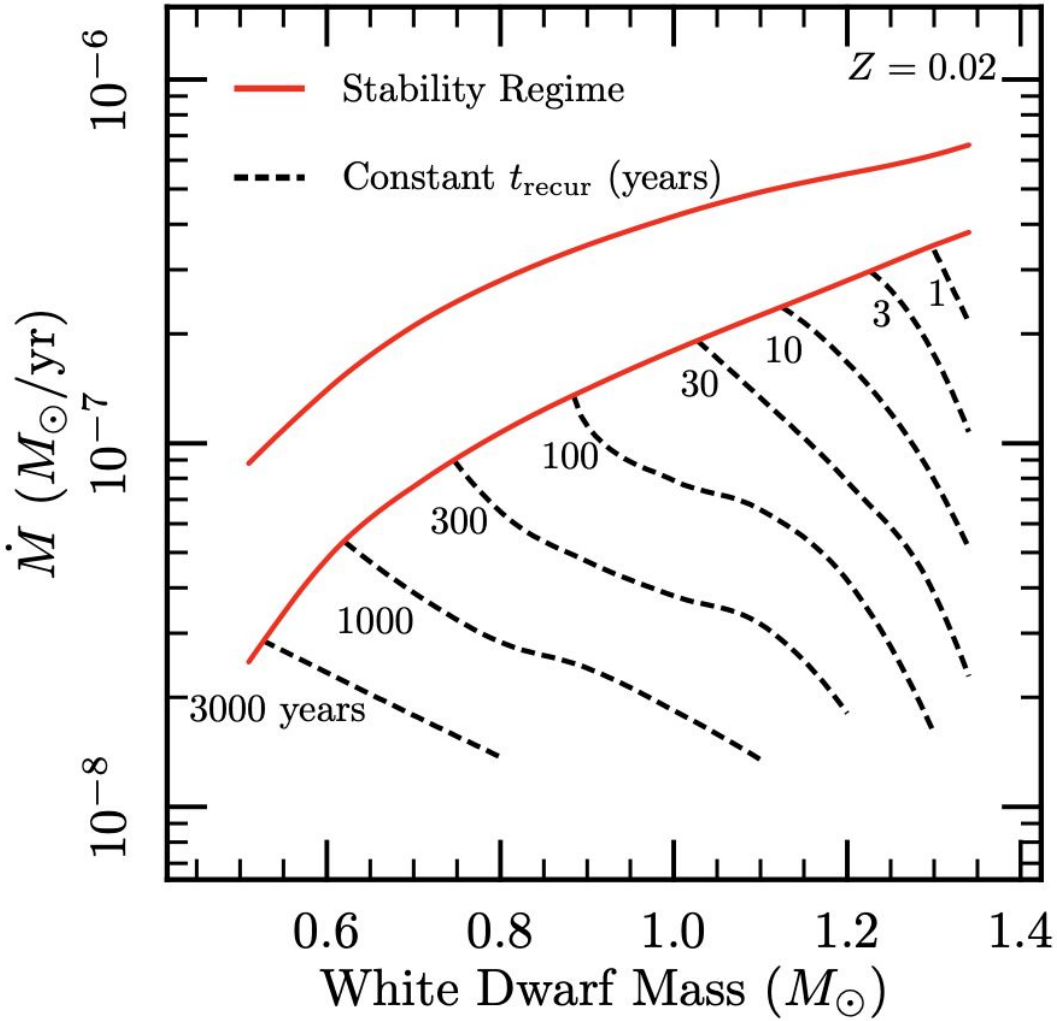
Recurrent Nova V745 Sco

- **Symbiotic binary - white dwarf and a red giant companion**
- **Nova outbursts observed in 1937, 1989, and 2014**
- **10 known recurrent novae in the Milky Way, and only 4 have giant companions**

Image Credit: Credit: S. O'Connor (OCN, St. Georges, Bermuda)

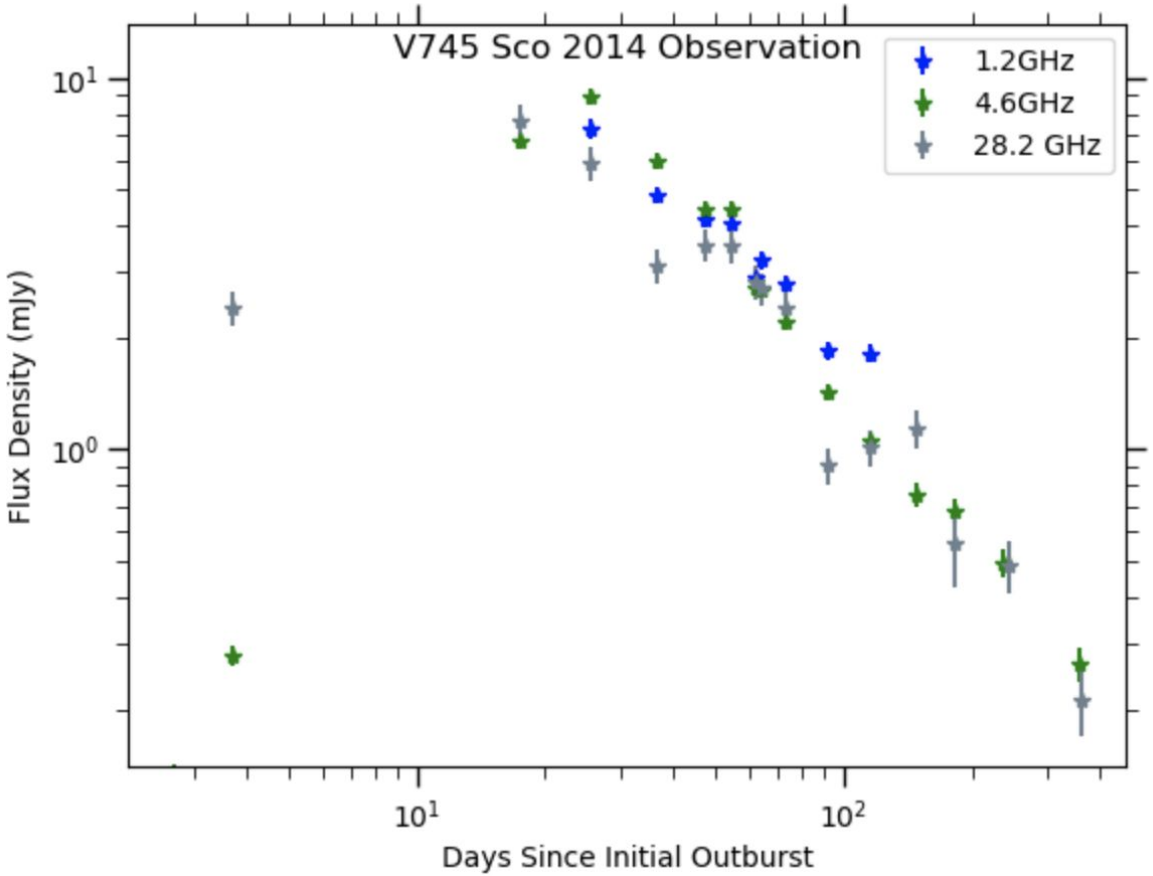


Wolf et al. 2013

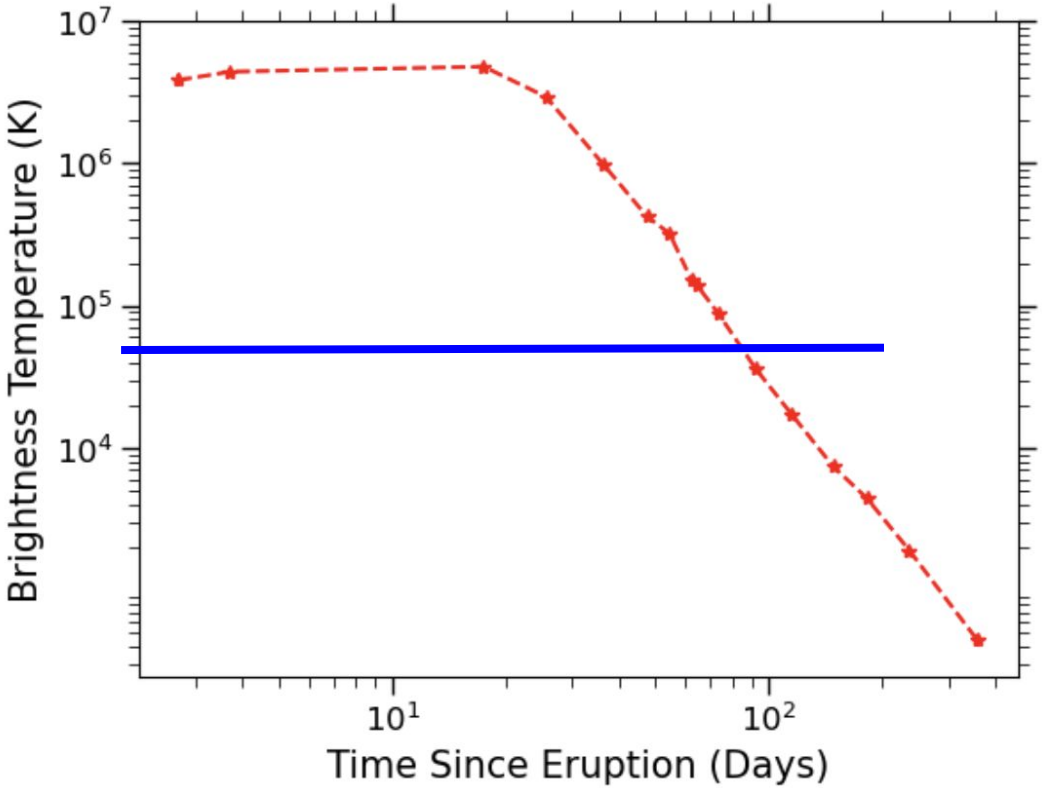
VLA Observations of 2014 Outburst

- **Outburst Feb. 6, 2014**
- **Monitored V745 Sco with the Jansky VLA from Feb. 8, 2014 to Feb. 1, 2015**
- **Receiver bands used: L, C, Ku, and Ka**

Molina et al. 2024



Brightness Temperature



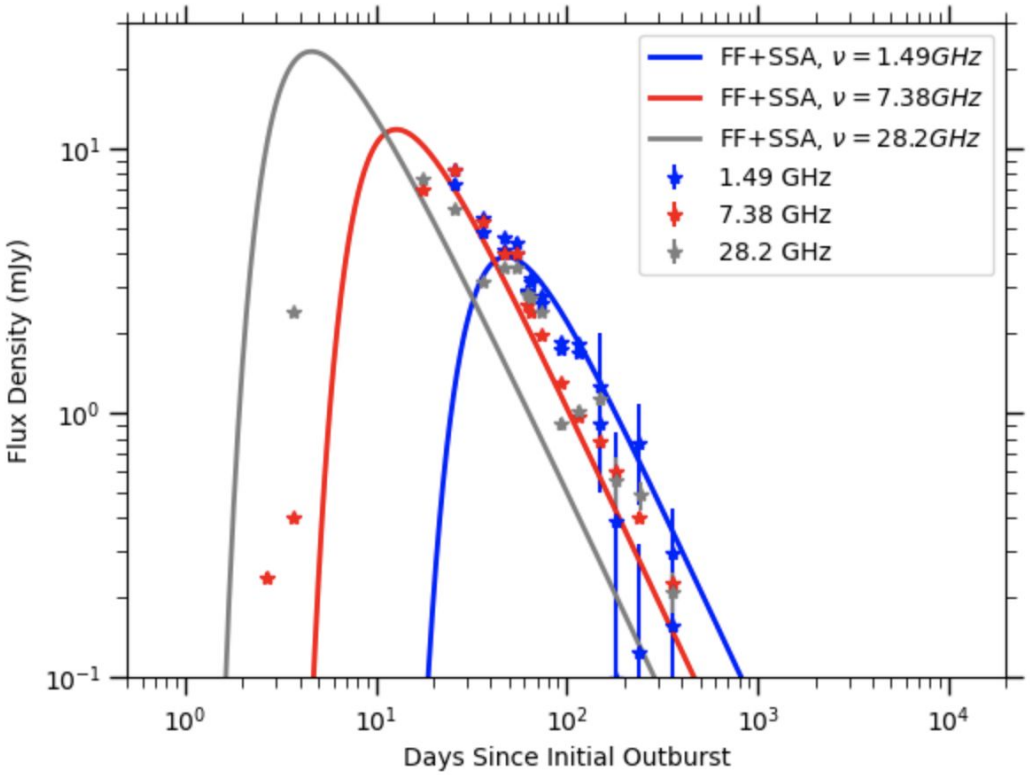
- **Useful for distinguishing thermal from non-thermal emission**
- **A brightness temperature > 5 x 10^4 K is greater than expected for a photo-ionized gas, must be synchrotron dominated**

Molina et al. 2024

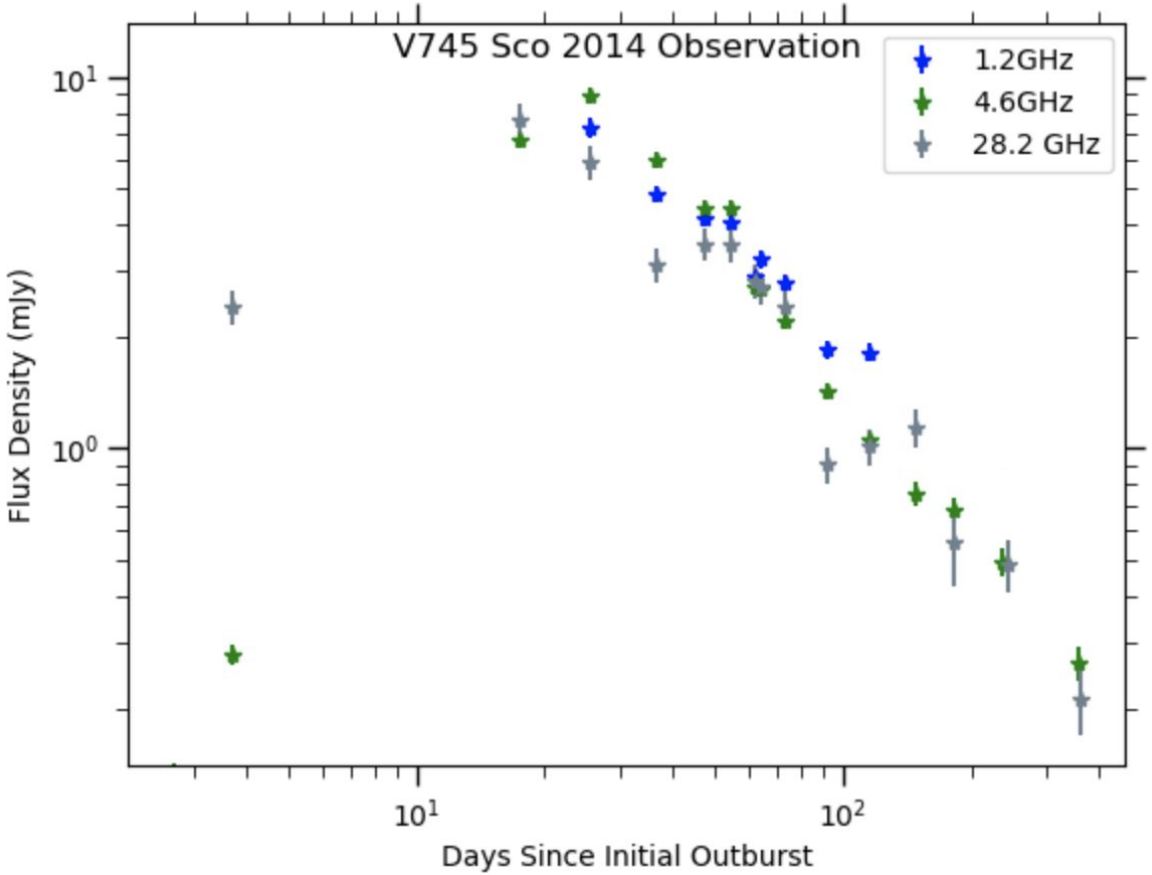
Modeling Synchrotron Emission

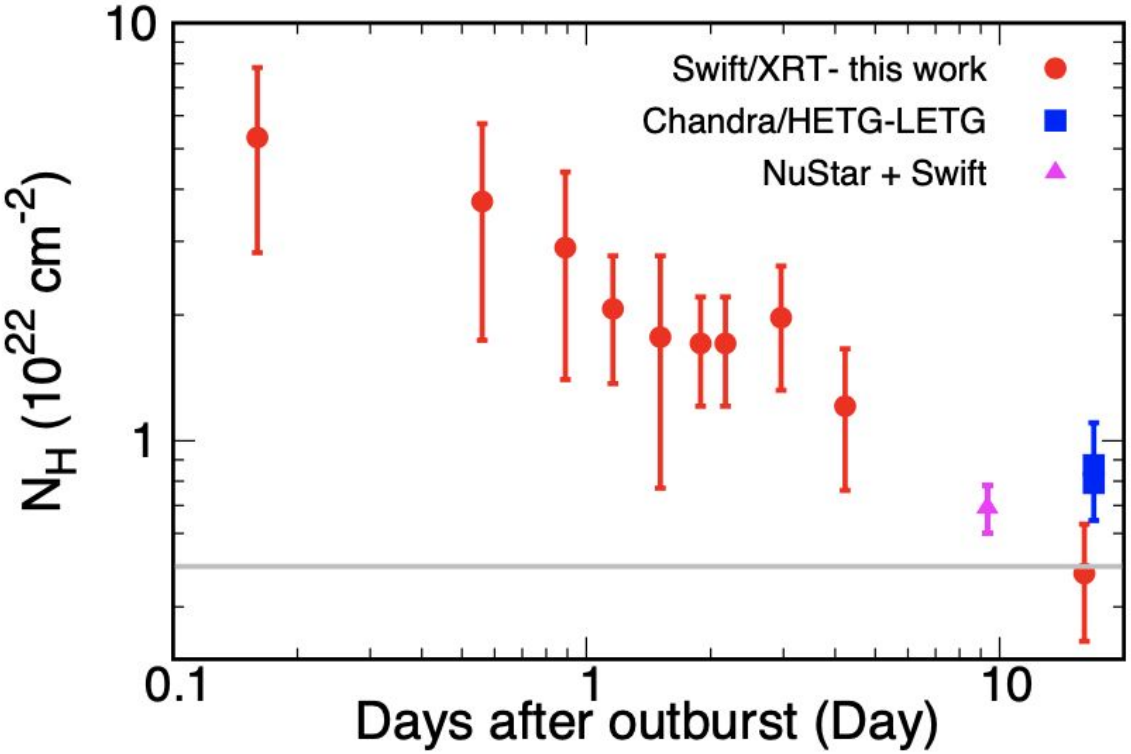
- **Simple model for synchrotron emission**
- **Model peaks at earlier times for different frequencies**
- **Does not match radio behavior we see from the light curve.**

$$\rho_{\mathrm{CSM}} = \frac{\dot{M}}{4\pi v_{\mathrm{wind}}} r^{-2}$$

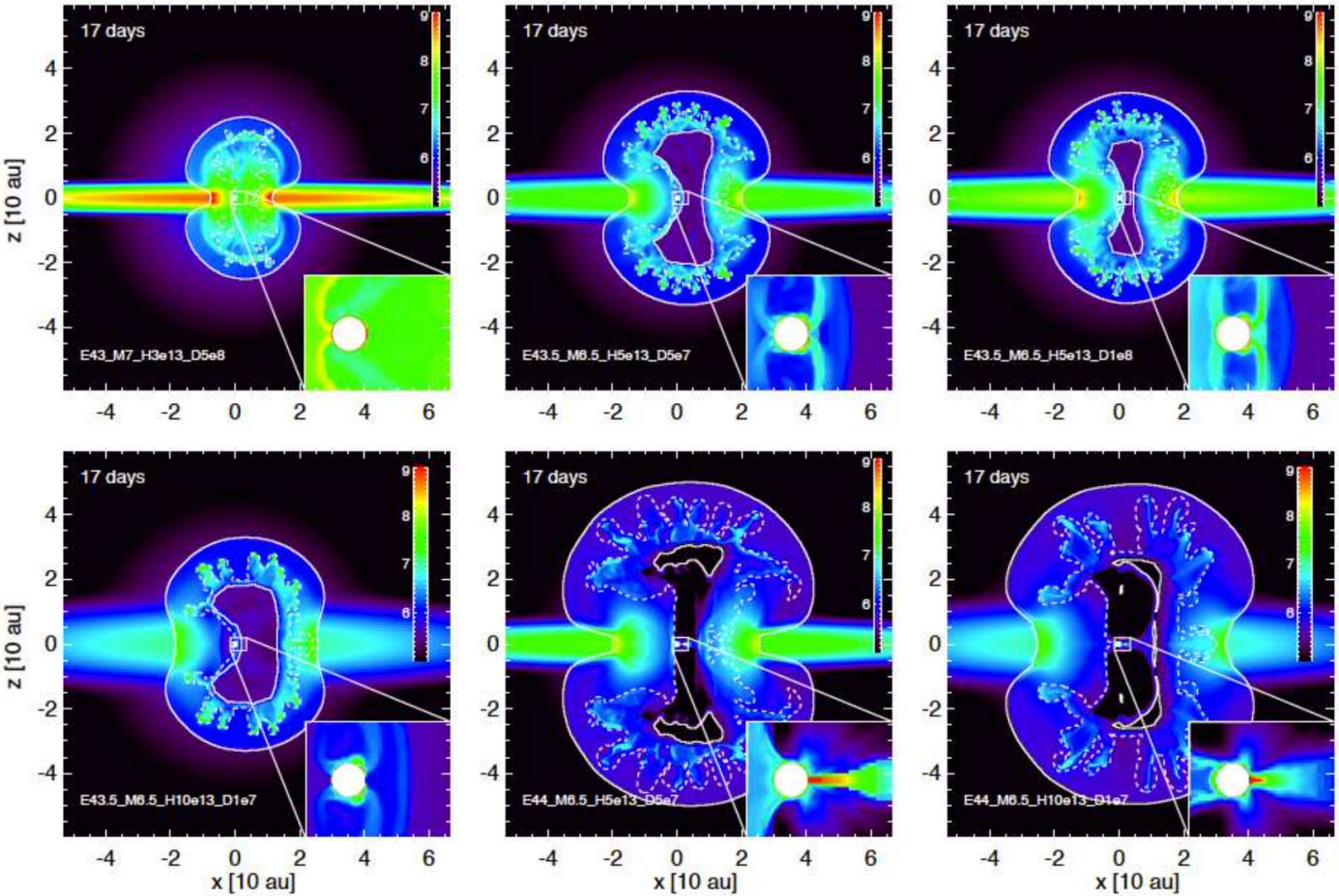


Molina et al. 2024


V745 Sco 2014 Observation
1.2GHz
4.6GHz
28.2 GHz
Flux Density (mJy)
10^1
10^0
10^1
10^2
Days Since Initial Outburst

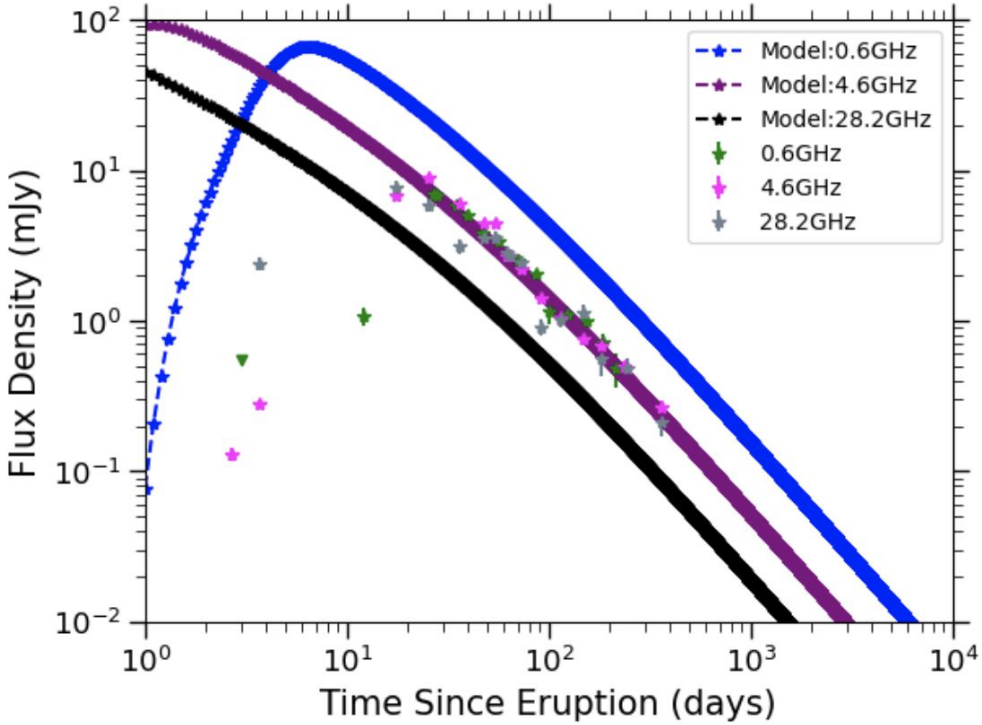


Delgado and Hernanz 2019



Orlando, Drake & Miceli 2016

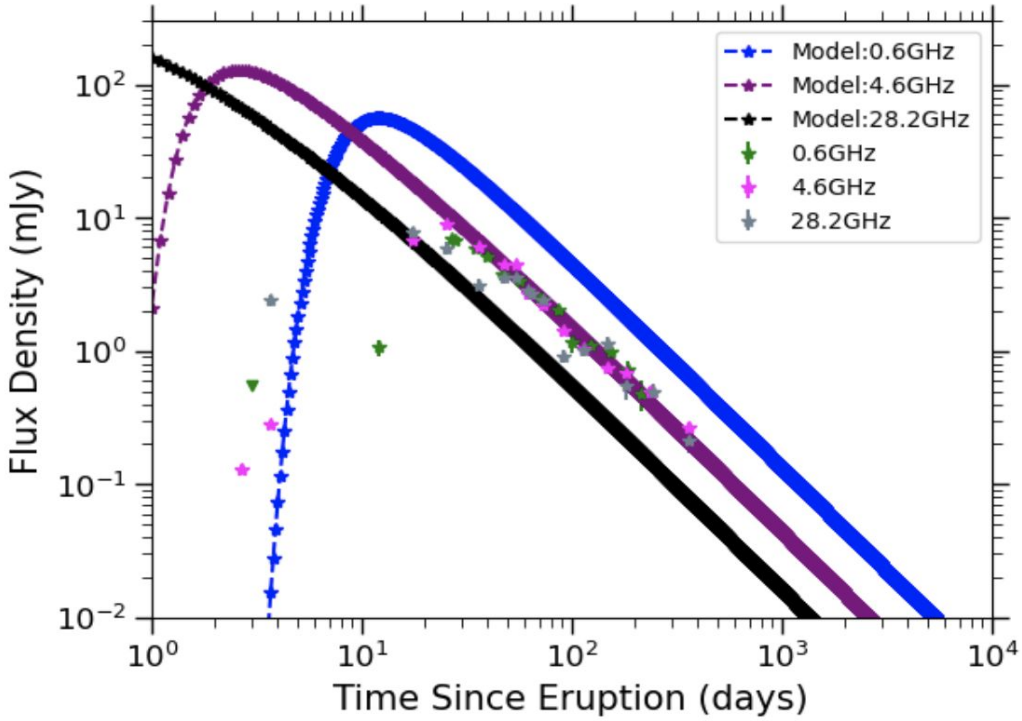
What if V745 Sco goes SN Ia?



- KE = 5 x 10^{42} erg
- $M_{ejecta} = 10^{-7} M_{\odot}$
- $\dot{M} = 9 \times 10^{-10} M_{\odot}\ yr^{-1}$
- $\varepsilon_B = 0.1$
- $V_{wind} = 10\ km\ s^{-1}$

What if V745 Sco goes SN Ia?

- $\dot{M} = 7 \times 10^{-9}\ M_{\odot}\ yr^{-1}$
- $\varepsilon_B = 0.01$



What if V745 Sco goes SN Ia?

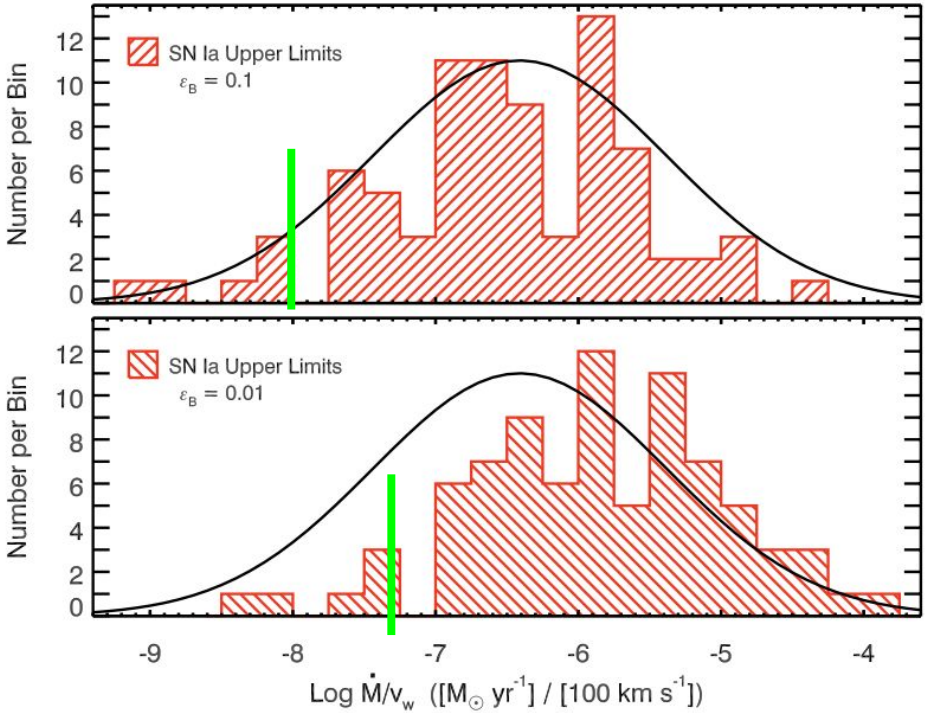
Chomiuk et al. 2016

- **We can compare the CSM properties of V745 Sco with constraints on CSM for SNe Ia**

- **Radio constraints on SNe Ia can't rule out a wind of**

  $\dot{M} = 9 \times 10^{-10}\ M_\odot\ yr^{-1}$ ($\varepsilon_B = 0.1$) and

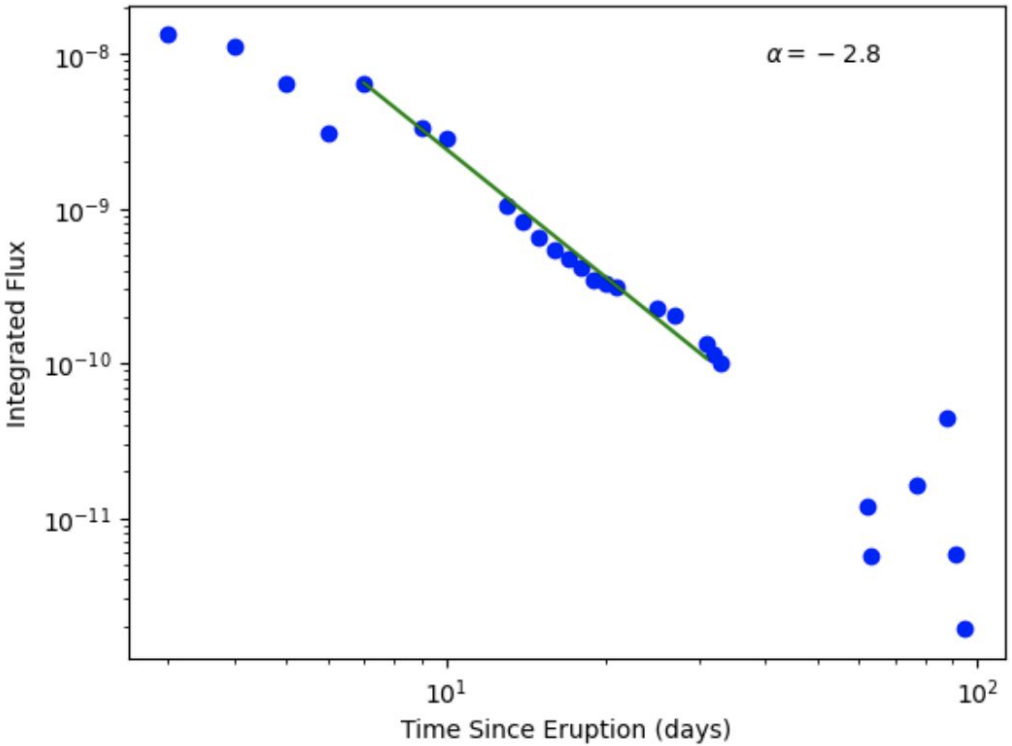
  $\dot{M} = 7 \times 10^{-9}\ M_\odot\ yr^{-1}$ ($\varepsilon_B = 0.01$)



SUMMARY

- **V745 Sco's radio light curve is synchrotron dominated, as we can see from the brightness temperature**
- **V745 Sco has an inner dense CSM and an outer lower density CSM**
- **For most Type Ia SN we can't rule out V745 Sco as a progenitor, based on CSM properties alone**
- **We are working with Orlando and Drake on extending their simulations into the radio.**

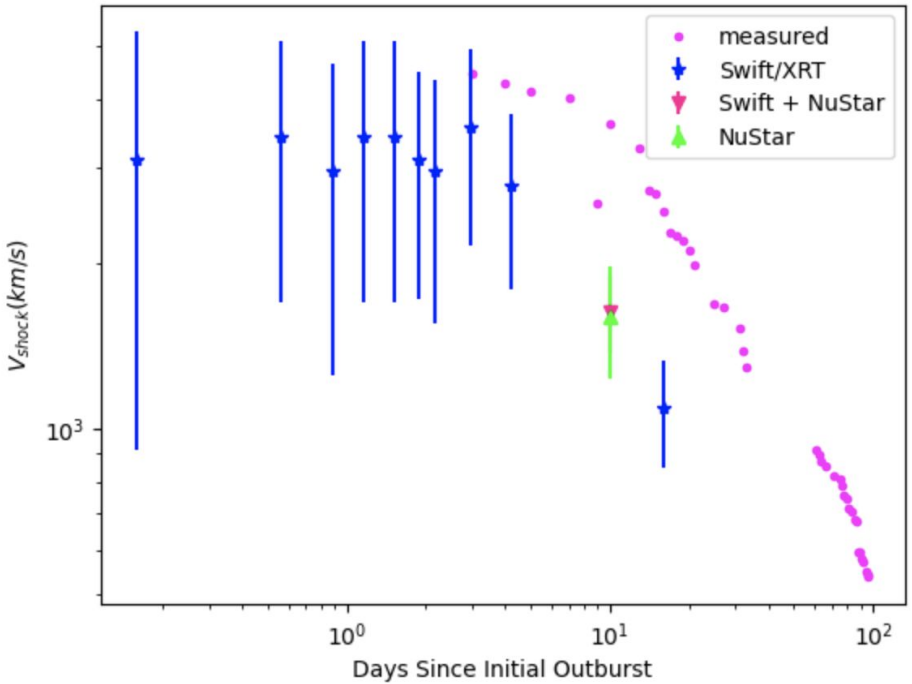
FWZI and the Blast Wave

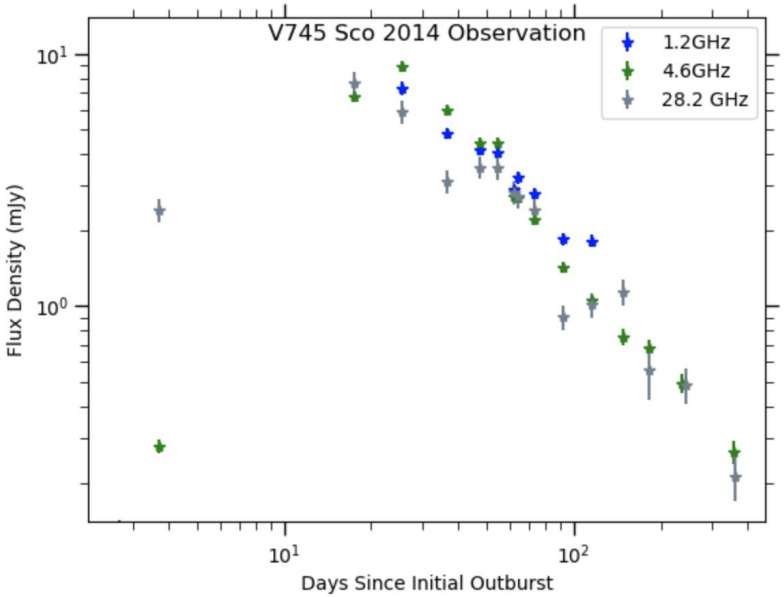


- **Flux calibrated the spectra data**
- **The calibrated data was then analyzed**
- **Integrated flux declines steeply around day 10**
- **This slope is close to t^-3, what is expected for recombining optically thin gas (Munari et al. 2018)**

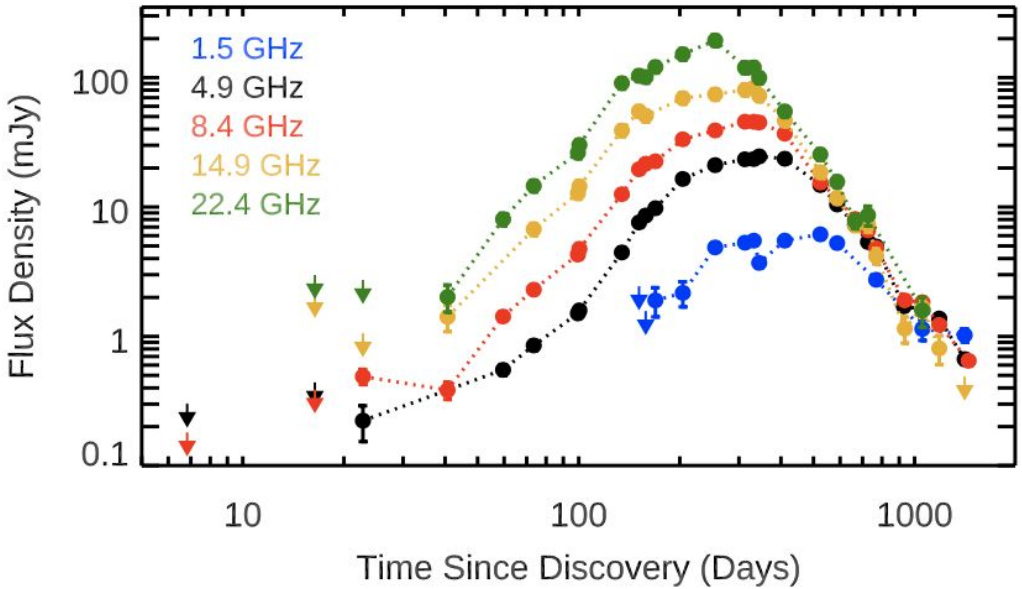
Temperature and Velocity

- **Plasma temperature measurements from Swift and NuStar were used to get velocity**
- **This also shows a very steep decline, slope = -0.7**
- **Hard to explain by changing the CSM density profile**



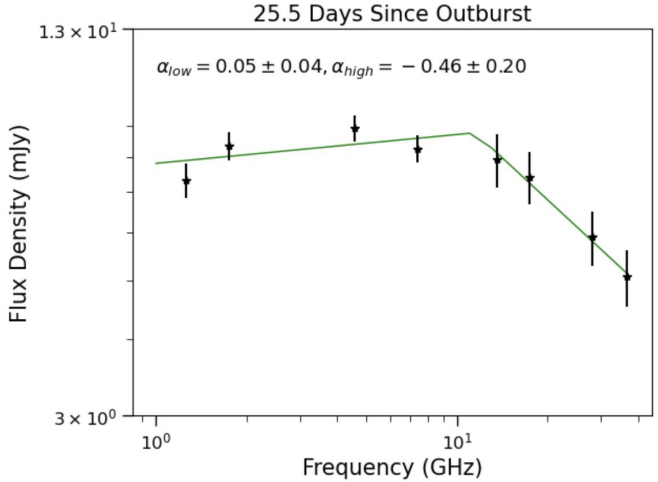


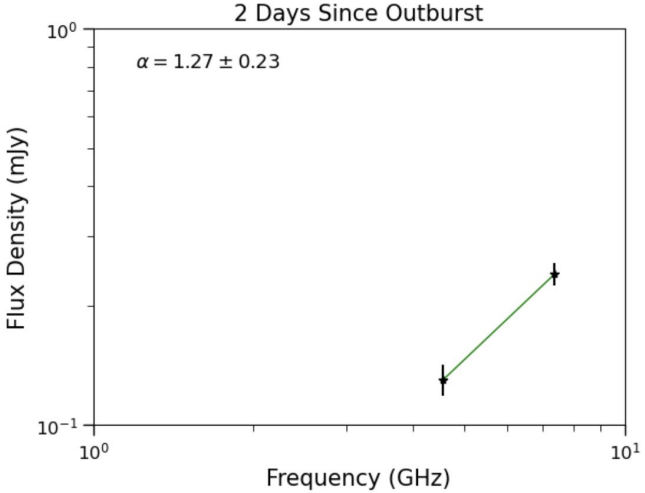
V1974 Cyg Observations

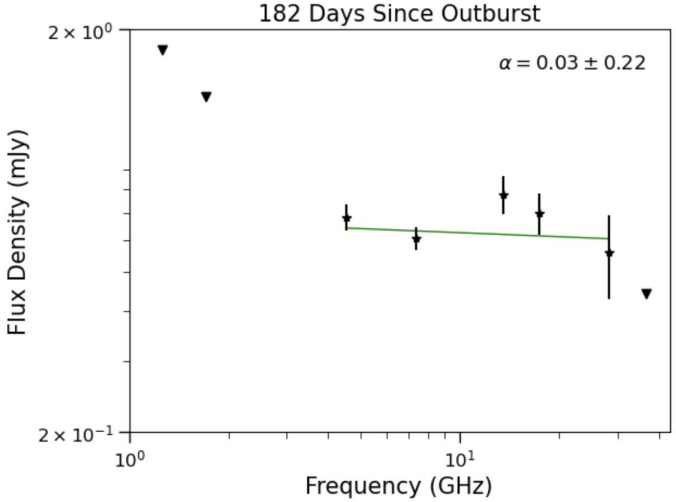


Chomiuk et al. 2021

$$S_\nu \propto \nu^\alpha$$

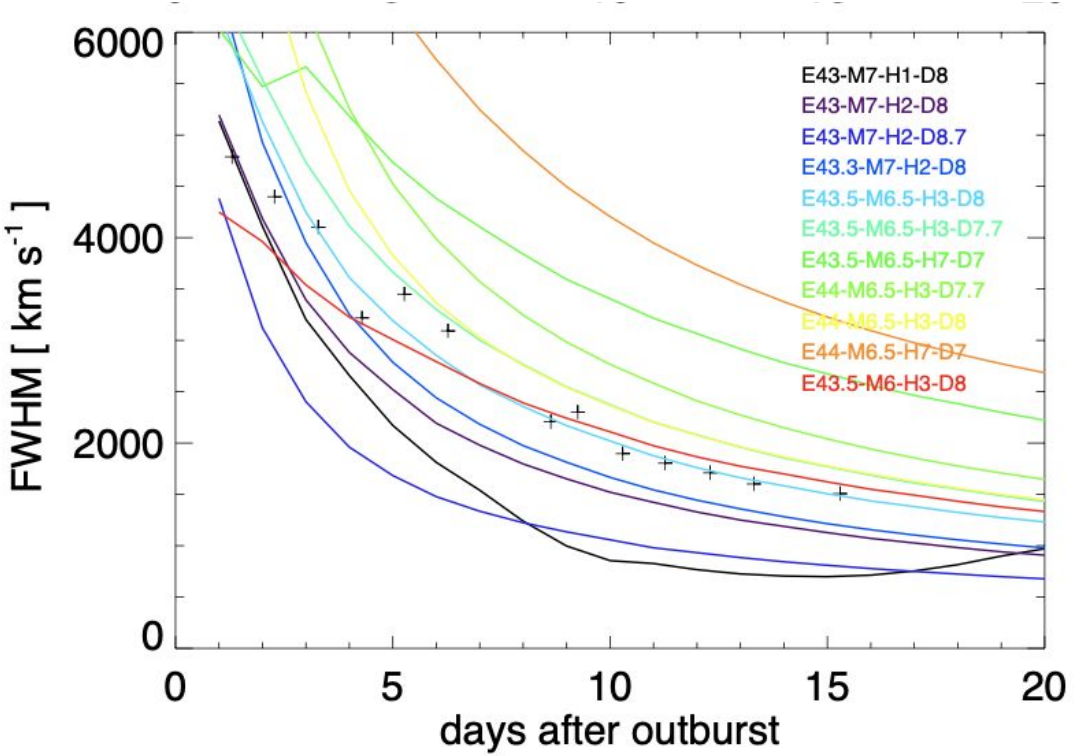






Simulation Results

- **They check their results with X-ray observations.**
- **Each line is a different model.**
- **We hope to do the same in the radio!**



Orlando, Drake & Miceli 2016