Griffin Hosseinzadeh (University of Arizona)

Revealing CSM with Type II SNe

Arcus Community Meeting

2023-05-05 (MJD 60069.5)

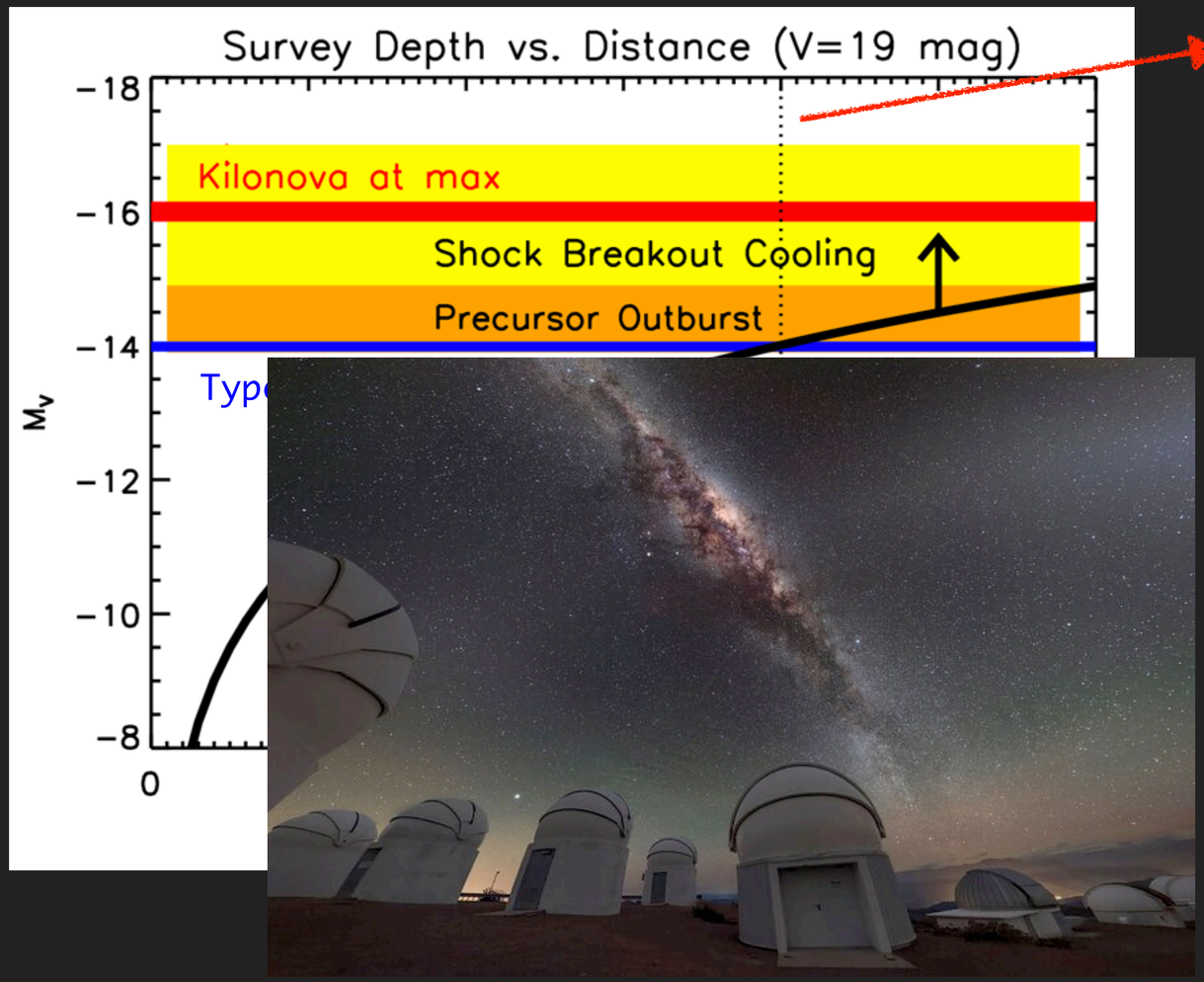
Why observe young supernovae?

NASA Ames

Supernovae teach us about stars!

- Very rarely can we observe a star during its lifetime AND watch it explode
- By observing the first hours to days after explosion, we can make inferences about the last months to years of a star's life
- These phases are almost never observed in the Milky Way, so they are very poorly understood

How else do we observe transients today: quality over quantity!



Distance Less Than 40 Mpc (DLT40) Survey

- Discovers ~10 supernovae per year, all within ~24 hours of explosion
- Each one gets a massive amount of follow-up and probes a previously unexplored region of parameter space
- Uses 40 cm telescopes!

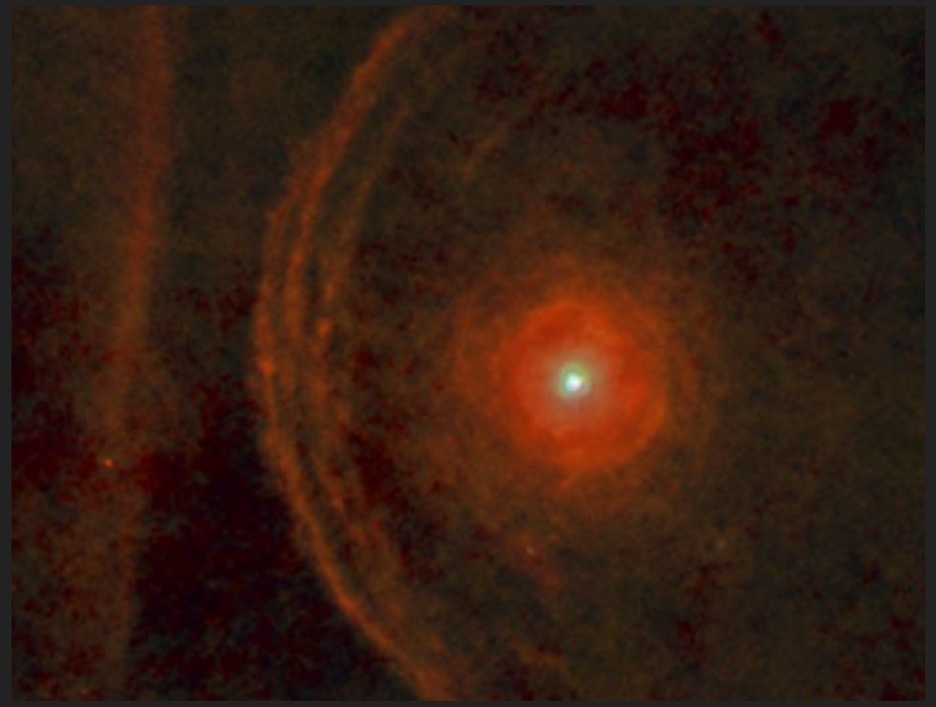
How else do we observe transients today: quality over quantity!

- Las Cumbres Observatory's Global Supernova Project & Swift provide immediate high-cadence optical-UV photometry
- Queue-based spectroscopy provides a classification spectrum (FLOYDS, MMT, SALT, SOAR)

Red Supergiant Mass Loss

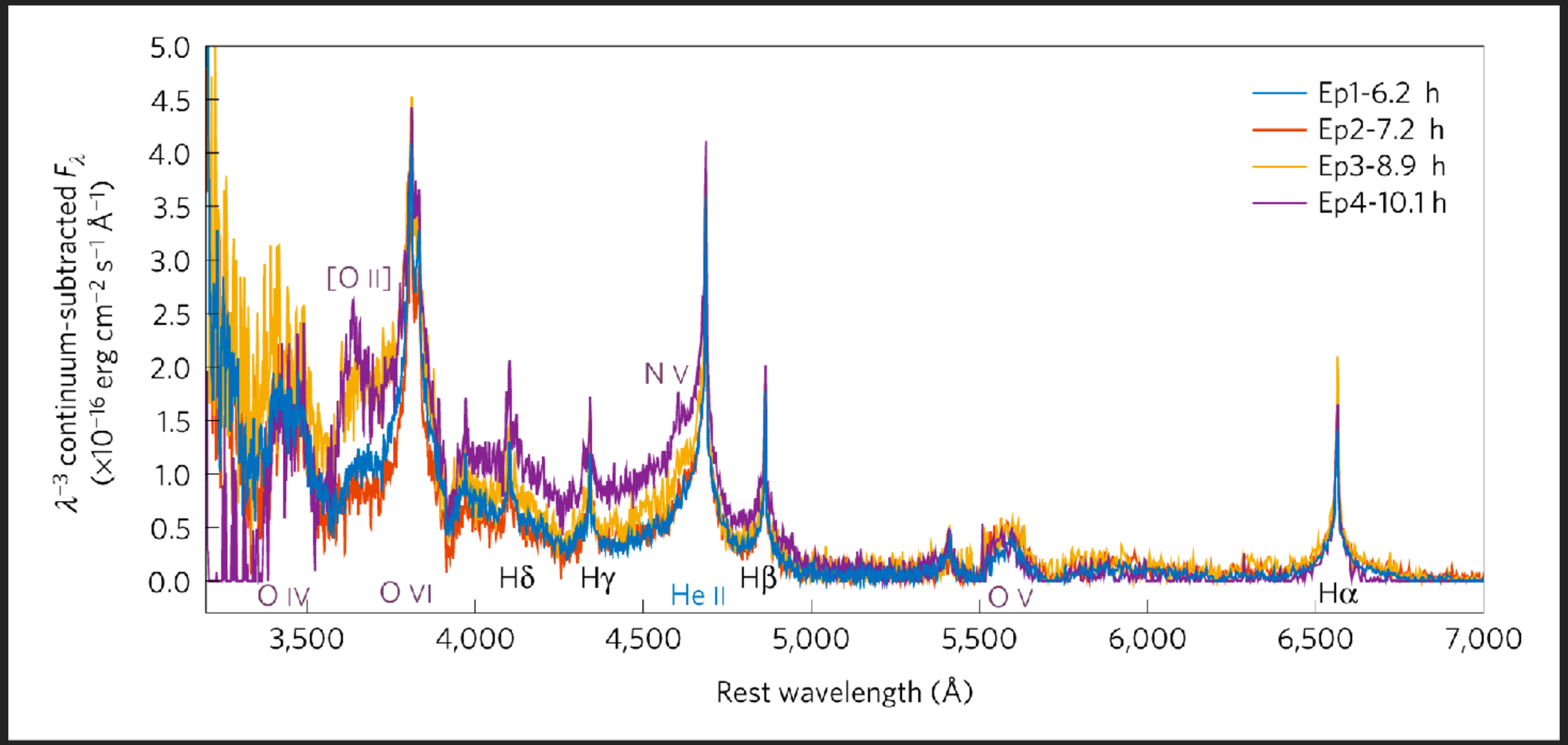
RSG Mass Loss

- Type II (hydrogen-rich) supernovae probe red supergiant mass loss
  - in greater numbers than MW/LMC/SMC
  - at the latest stages (years to months before explosion)



Betelgeuse (ESA/Herschel/PACS/L. Decin et al.)

What does nearby, confined CSM look like?



Yaron+17

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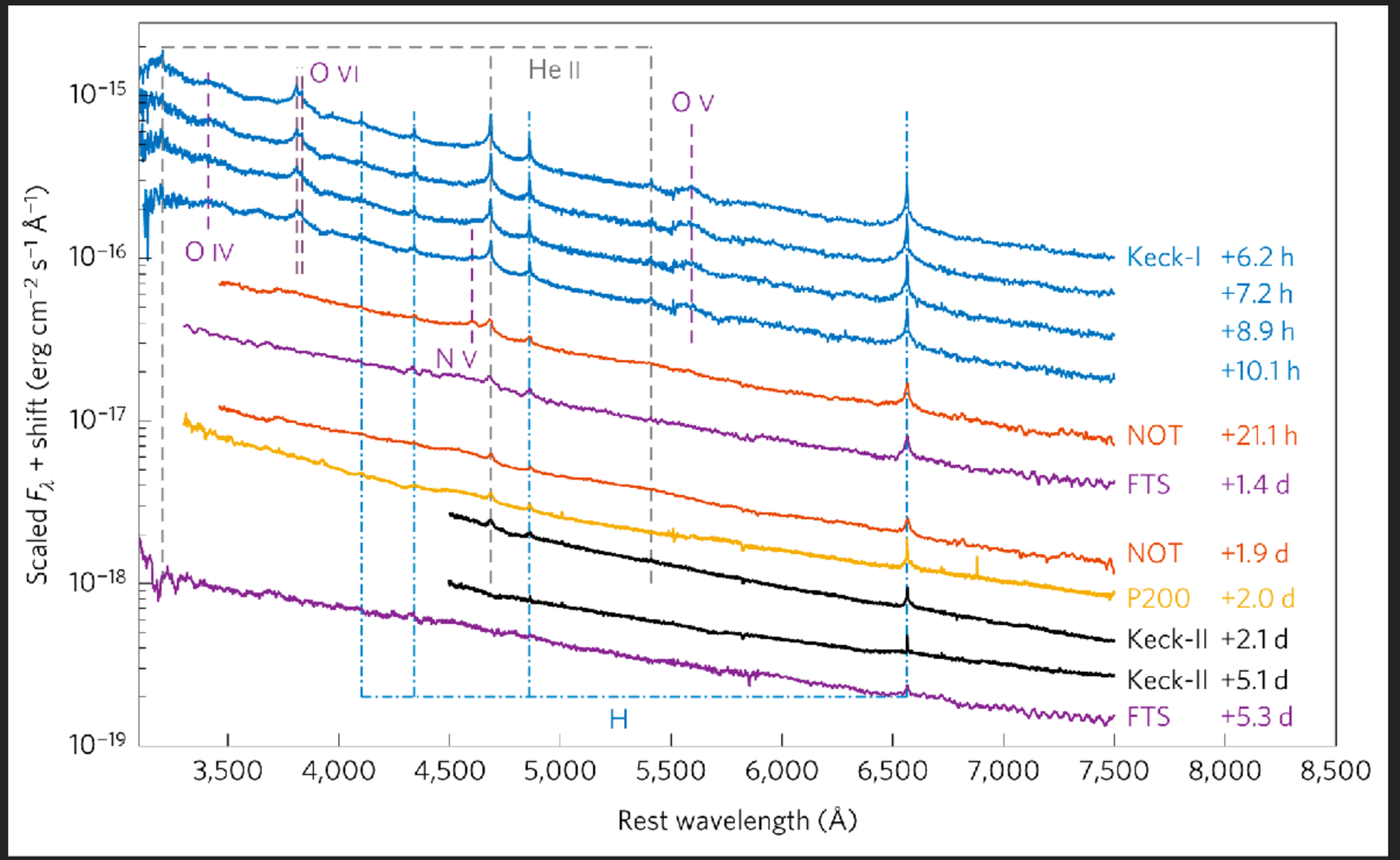

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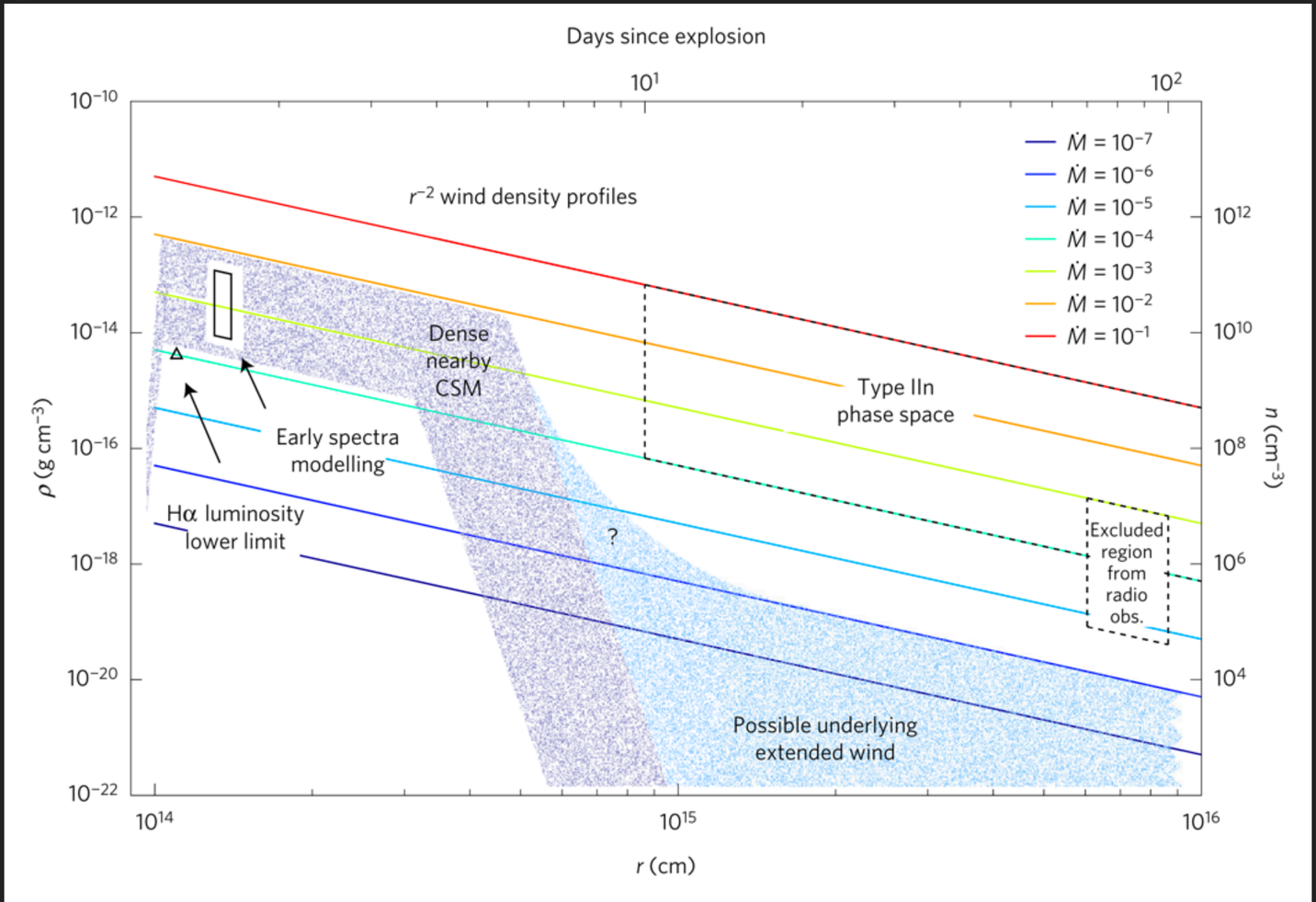

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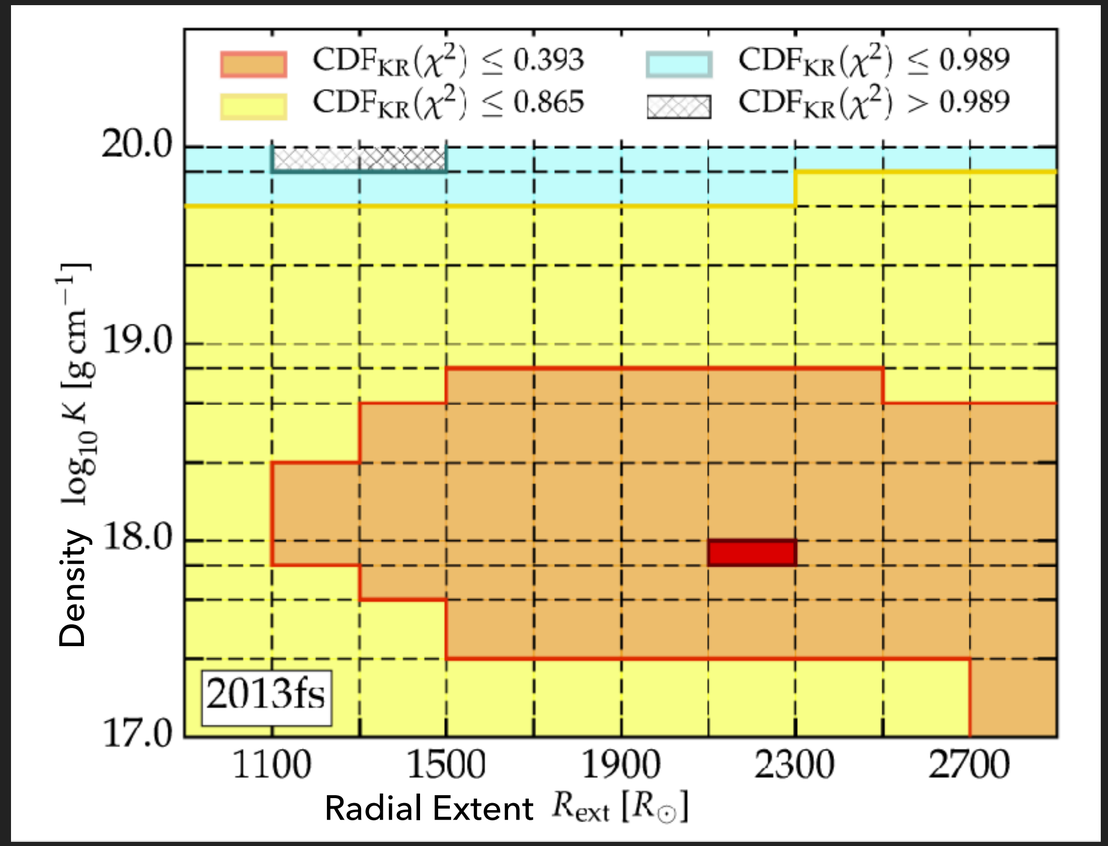
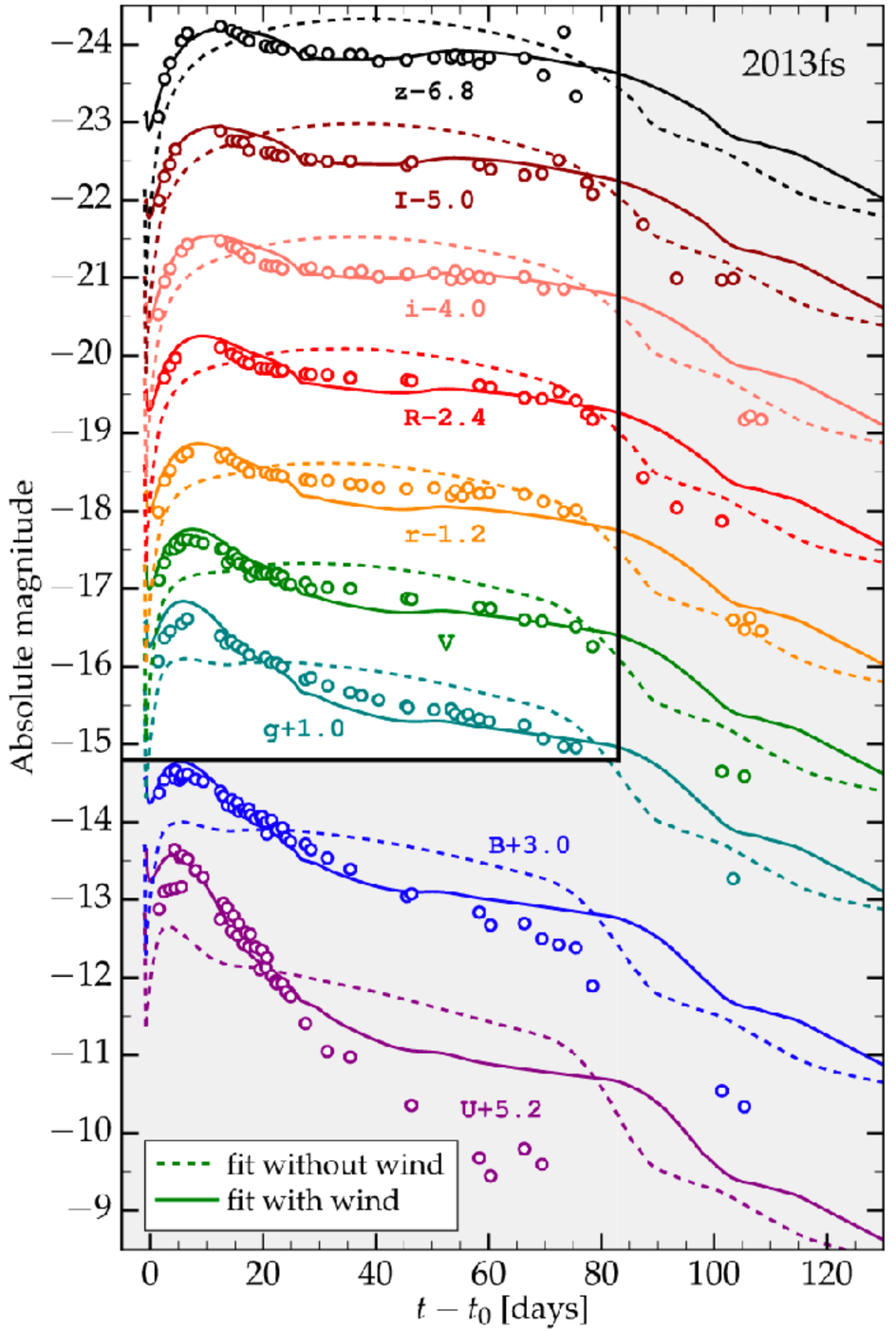


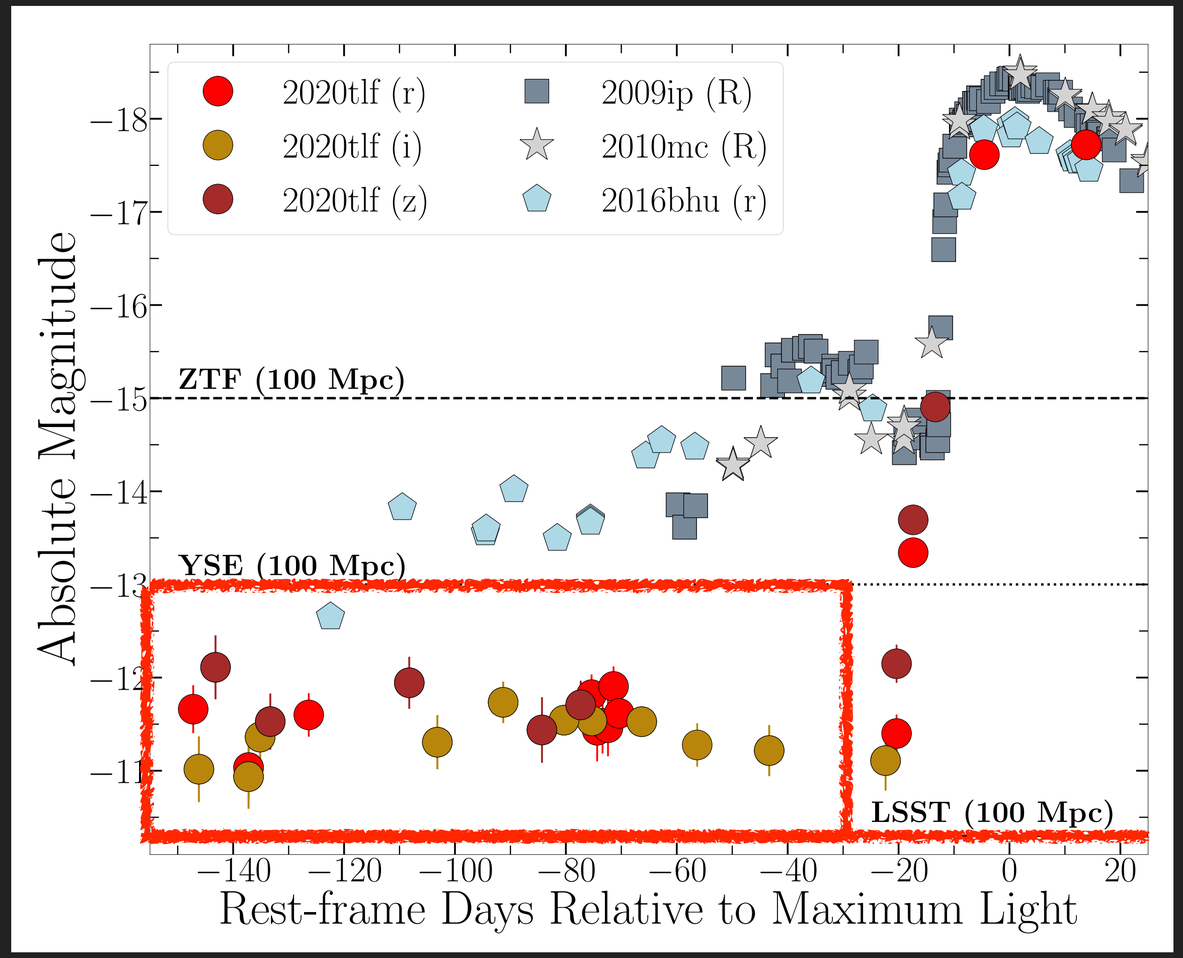
Morozova+17



Even direct evidence of activity!

- Red supergiants also experience **observable** pre-explosion eruptions
- **Lots** of these will be visible with LSST

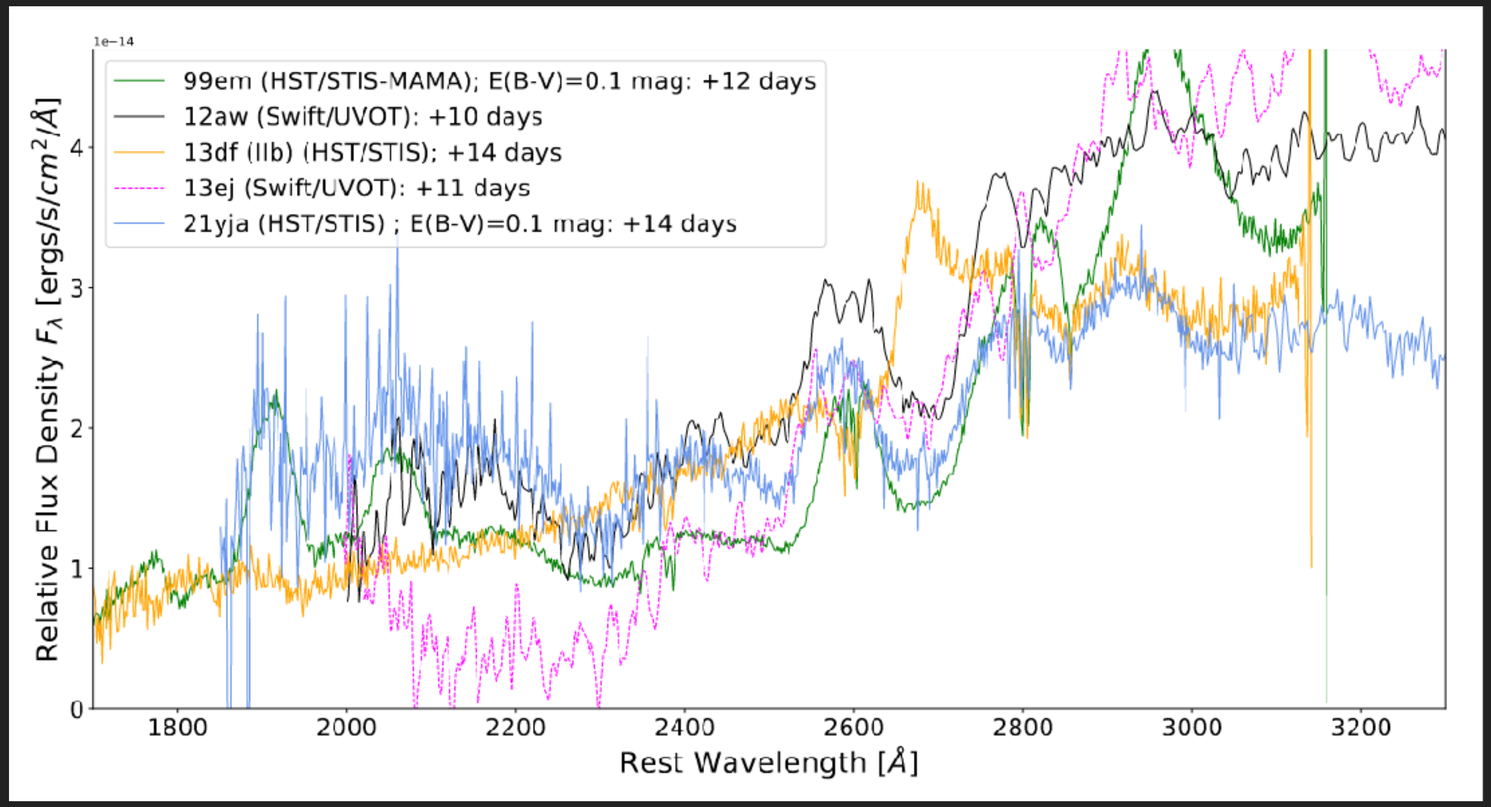
Jacobson-Galán+22



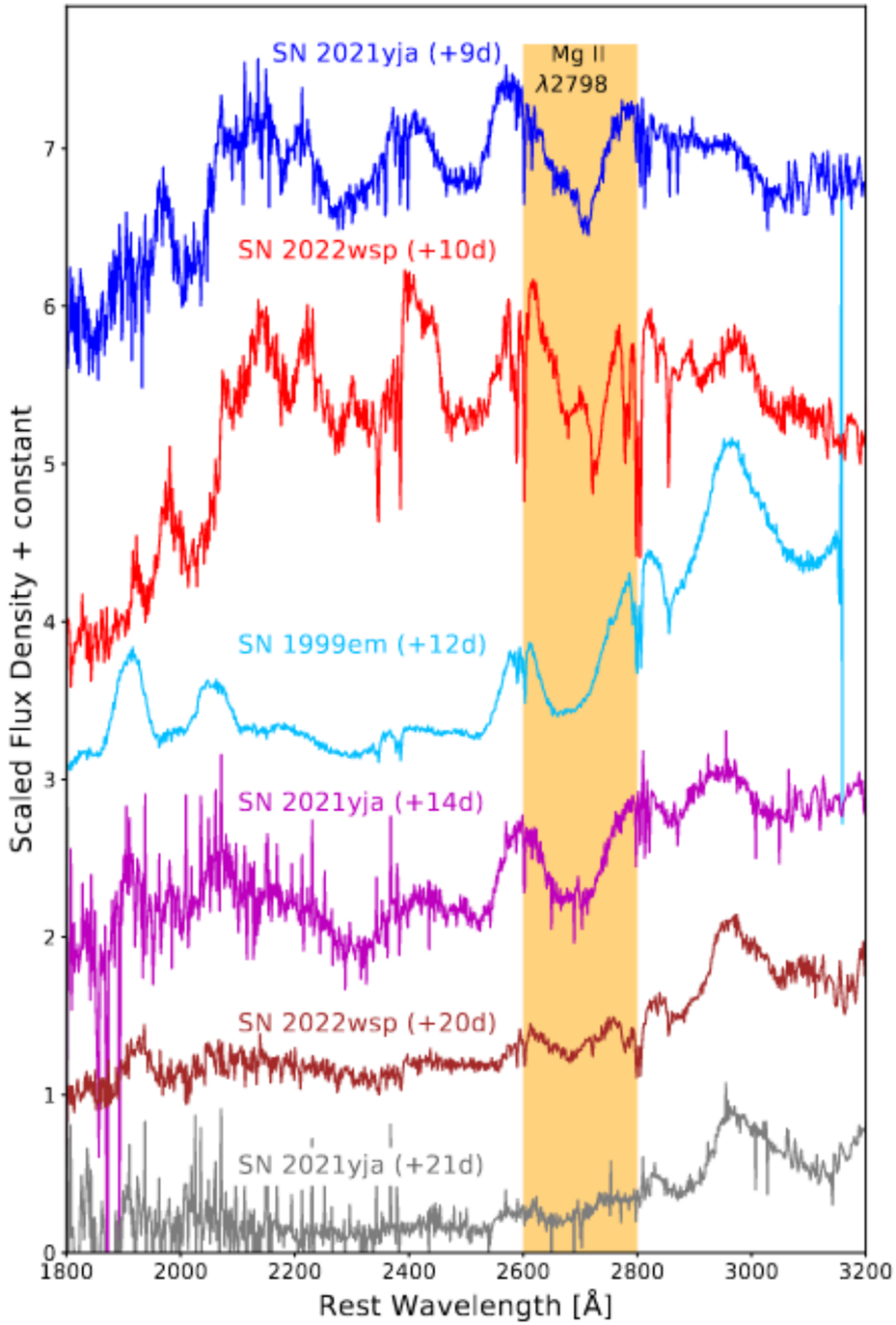
Ultraviolet Spectroscopy

(largely unexplored)

Near-UV Spectroscopy: Too Little, Too Late



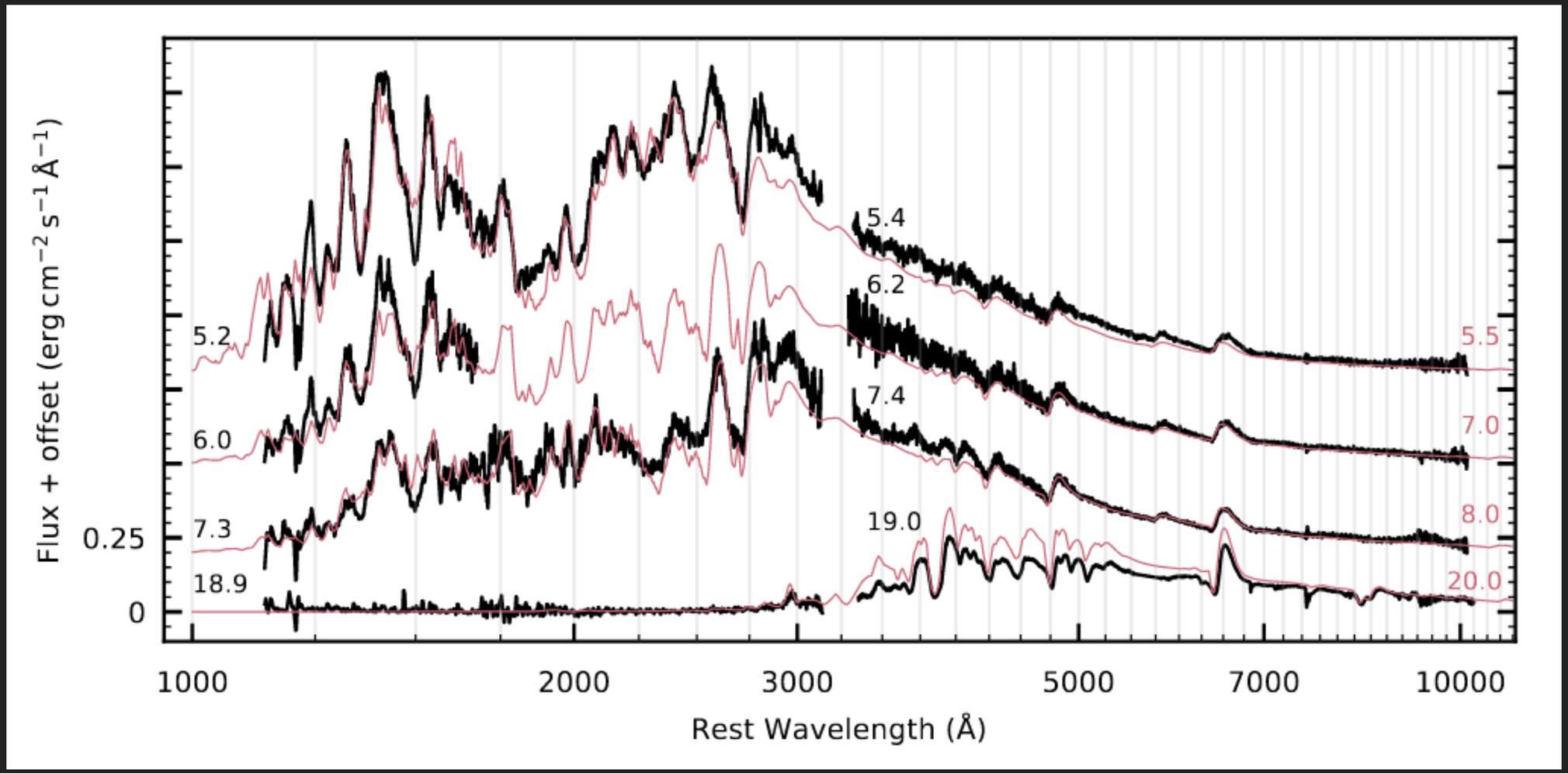
Vasylyev+22



Vasylyev+23

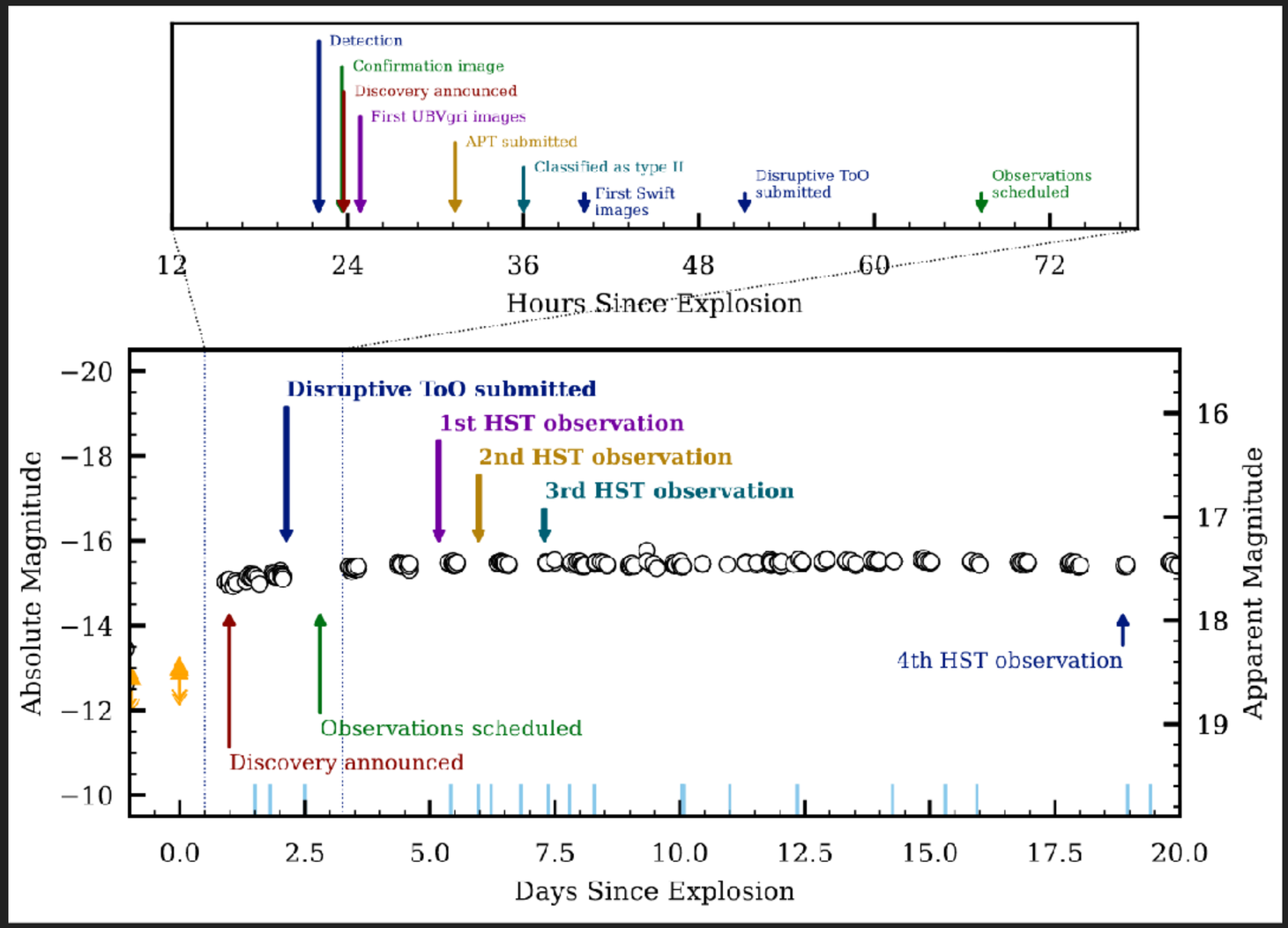
Far-UV Spectroscopy: Only 3 Spectra ≲1 Week After Explosion

Bostroem+23



Here's why this is hard...

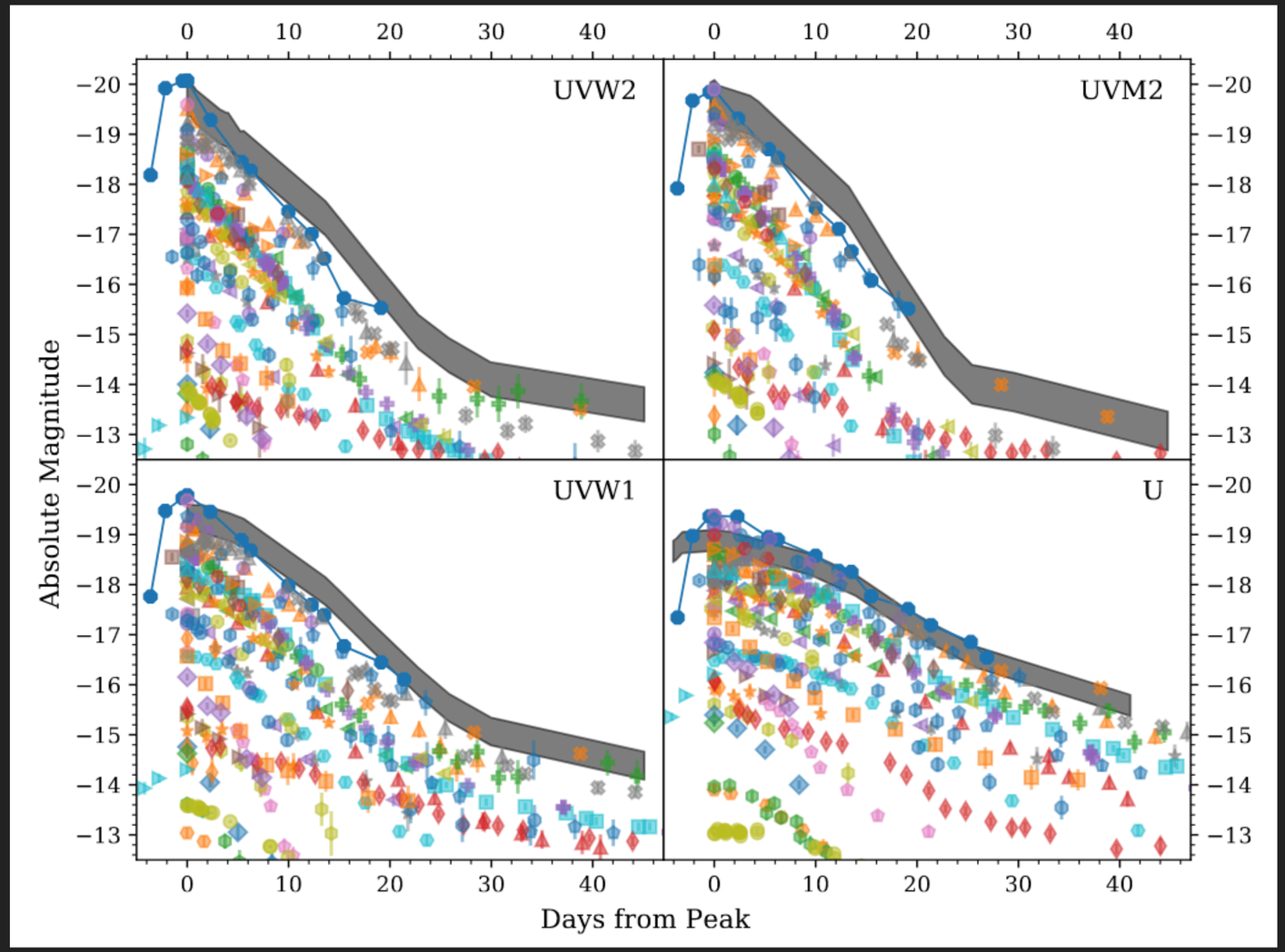
Bostroem+23



How Bright are Supernovae in the UV

- Wide range (partially depends on extinction)
- Brightest M_{NUV} ~ -20 mag (Vega) or -18 mag (AB)
- At ~40 Mpc (μ = 33 mag), this is m_{NUV} ~ 15 mag (AB)
- TAUS limiting magnitude in 100 ks ~ 18 mag (AB)

Hosseinzadeh+22b



Summary: Role of Arcus in Supernovae

- 4-hour ToO mode = perfect
- Wavelength coverage = good in combination with NUV spectra
- Wavelength resolution = way overkill (maybe some way to gain by binning?)
- Simultaneous x-ray coverage = helpful for some interacting supernovae
- Depth = better than most everything we have, but still small numbers

Thanks for listening!

griffin-h.github.io
griffin0@arizona.edu