Insights into the Local SN Population from ASAS-SN

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Supernova Remnants II
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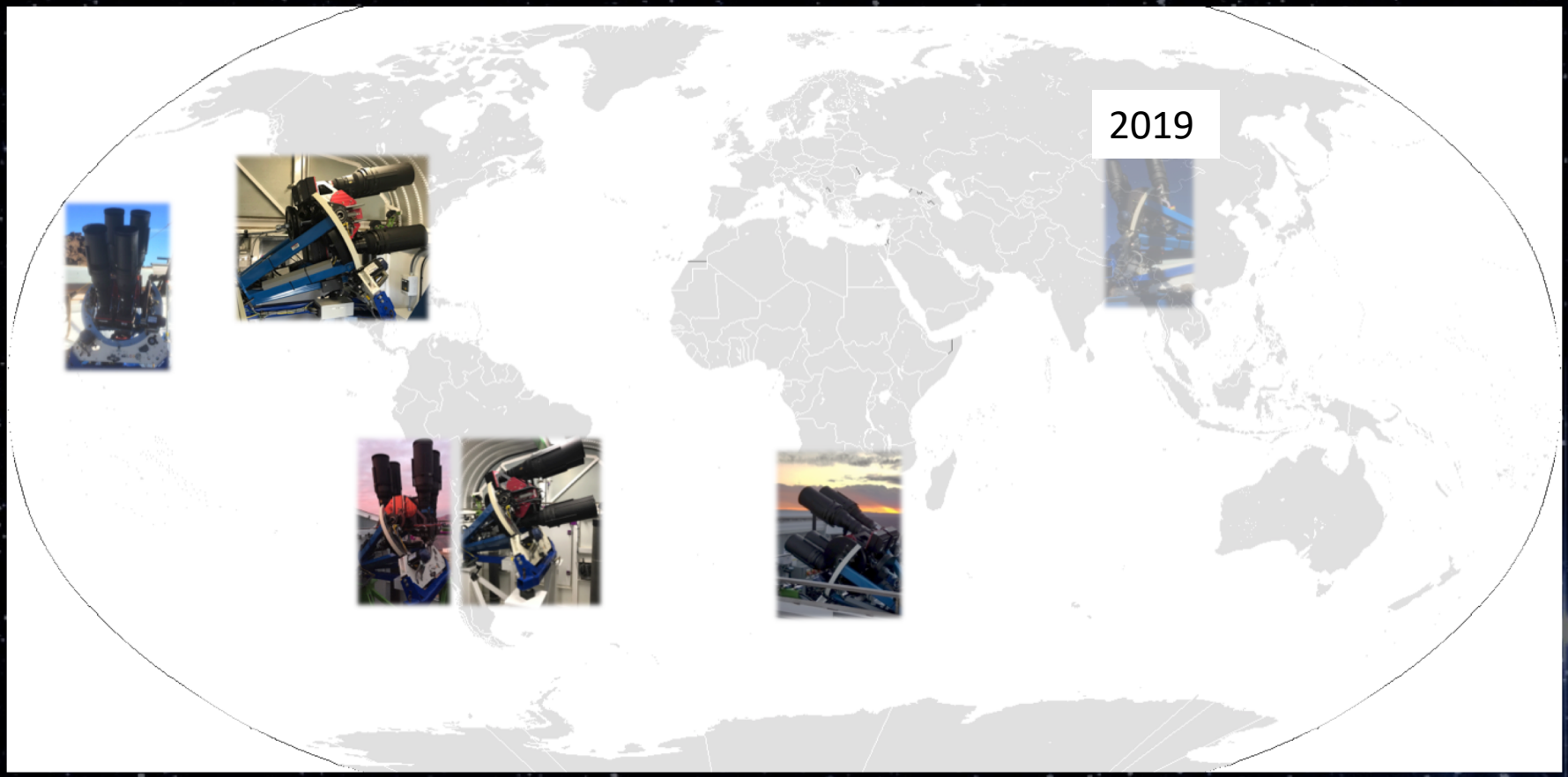
ASAS-SN

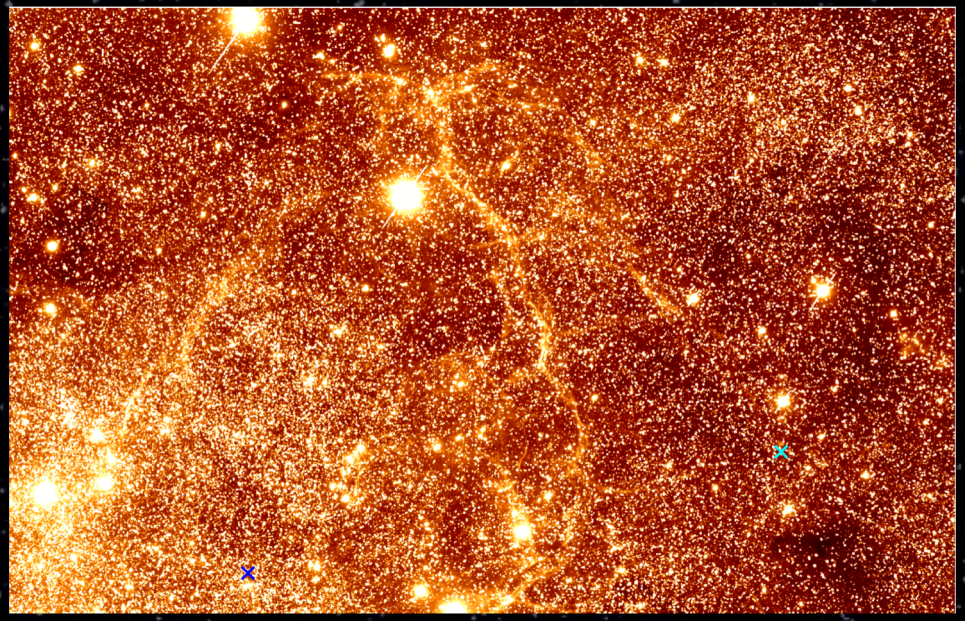


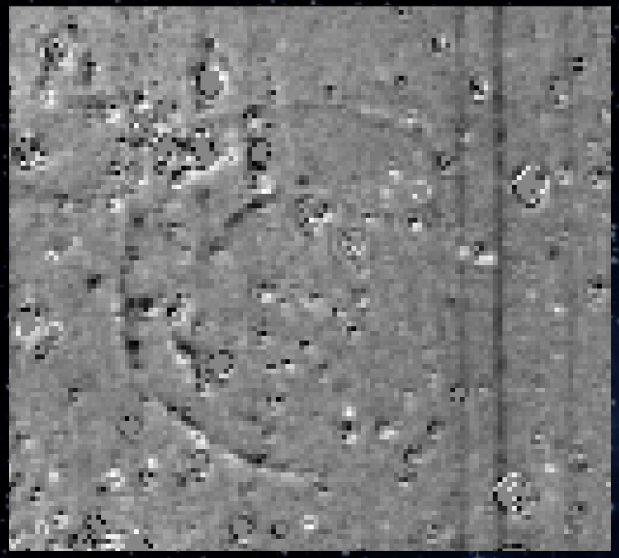
ASAS-SN

- Survey began in 2013, focus on “best and brightest”
- Current: 5 units (20 telescopes), ~6500 images per night, ~40,000 sq. degrees per night
- Limiting mag of g~18.5, saturation at g ~12
- Fully automated data reduction pipeline
- Discoveries announced publicly
- Public light curve tool: https://asas-sn.osu.edu//
- Variable Star DB: https://asas-sn.osu.edu/variables

ASAS-SN Light Echoes and SNRs

- Stack long-term ASAS-SN imaging data
- Limiting surface brightness of 24-28 mag/arcsec^2
- Subtract sub-stacks to detect light echoes





Type Ia “Progenitor Problem”

Single Degenerate (SD): WD accretes from MS or RG companion to reach Chandrasekhar Mass

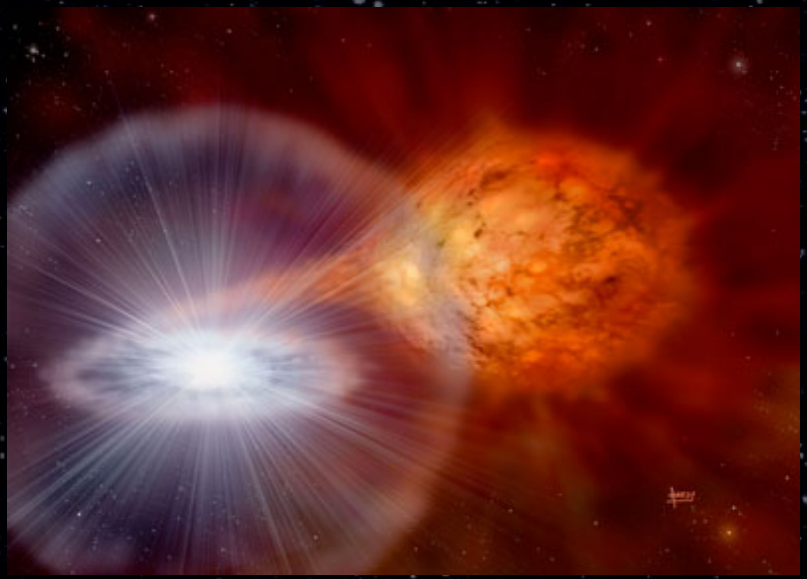


Image credit: STFC/Dave Hardy

Double Degenerate (DD): WD-WD merger after angular momentum loss through gravitational waves

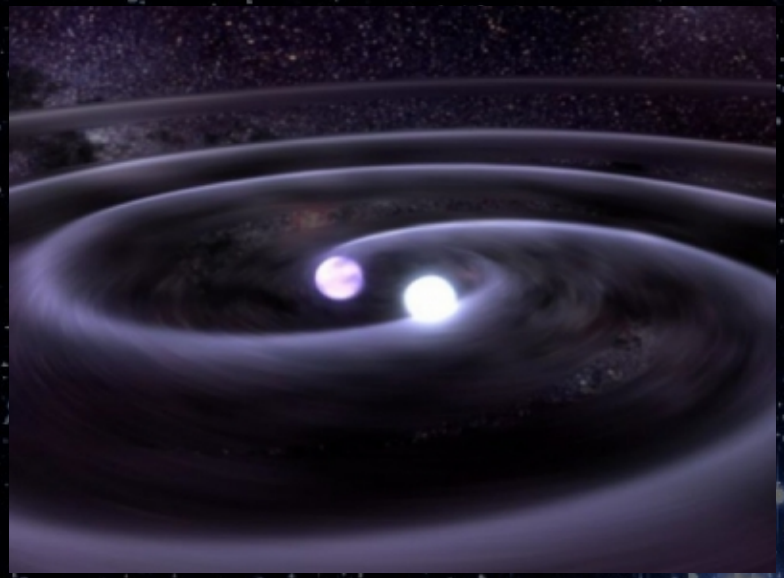
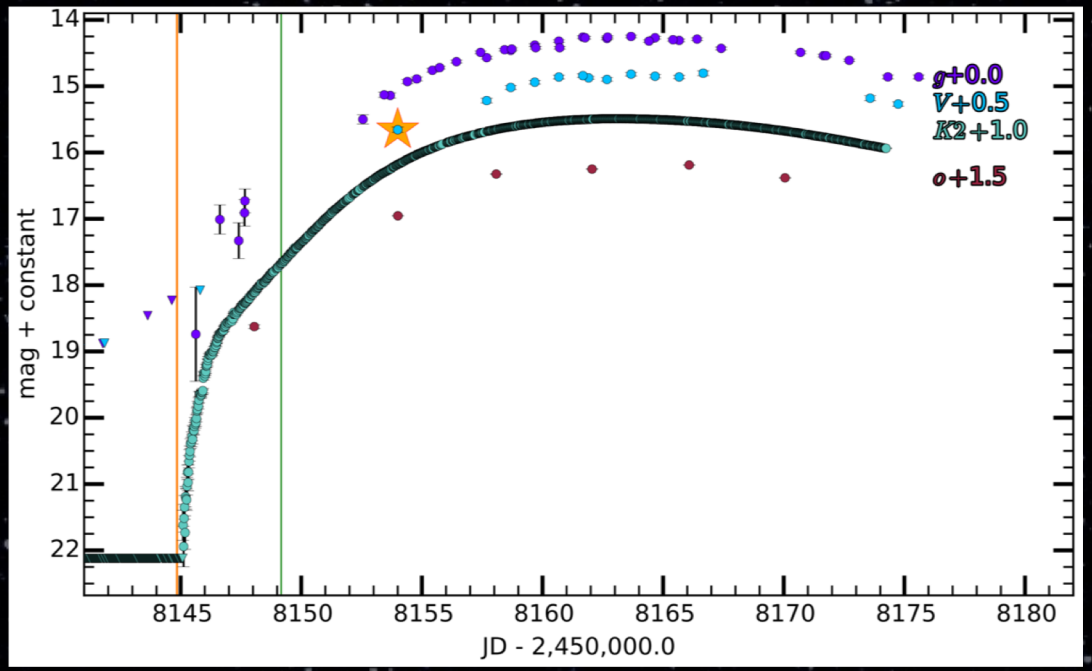
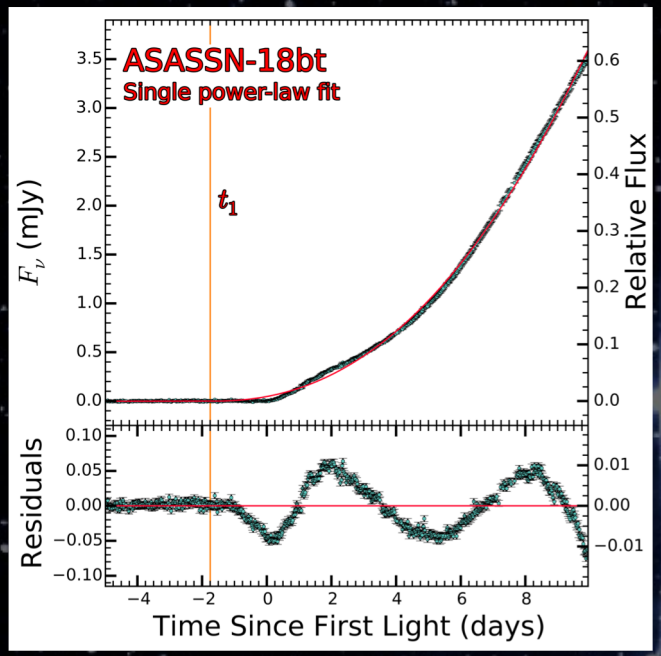


Image credit: GSFC/Dana Berry

ASASSN-18bt/SN 2018oh

- Discovered by ASAS-SN on 2018-02-04
- First K2 detection ~ 8 days prior
- B_{max}=14.31, d=47.7 Mpc

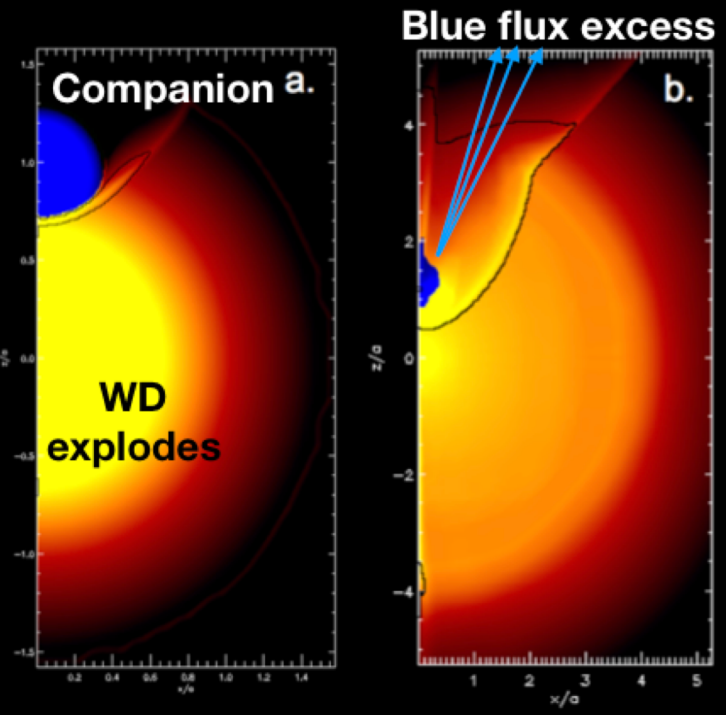


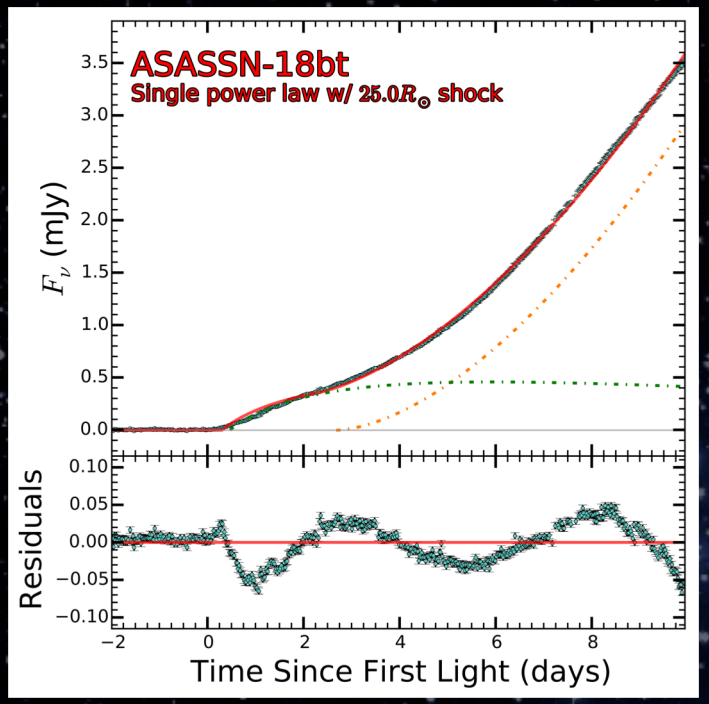


Shappee, Holoien et al. (2019)

Flux Excess: SD Companion Interaction

- Shock-interaction between SN ejecta and non-degenerate companion generates excess flux (Kasen 2010)
- Best fit to 10-25 R_{Sun}

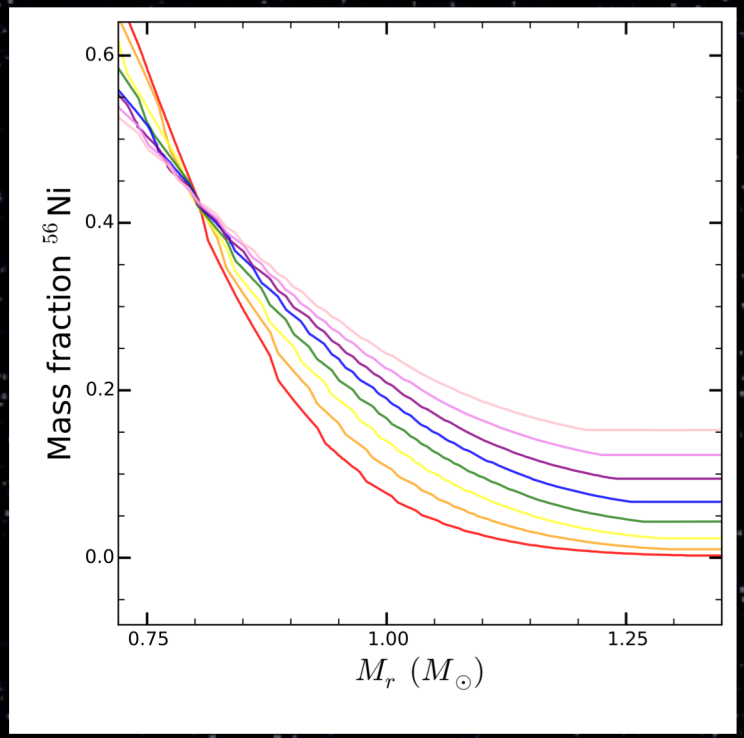




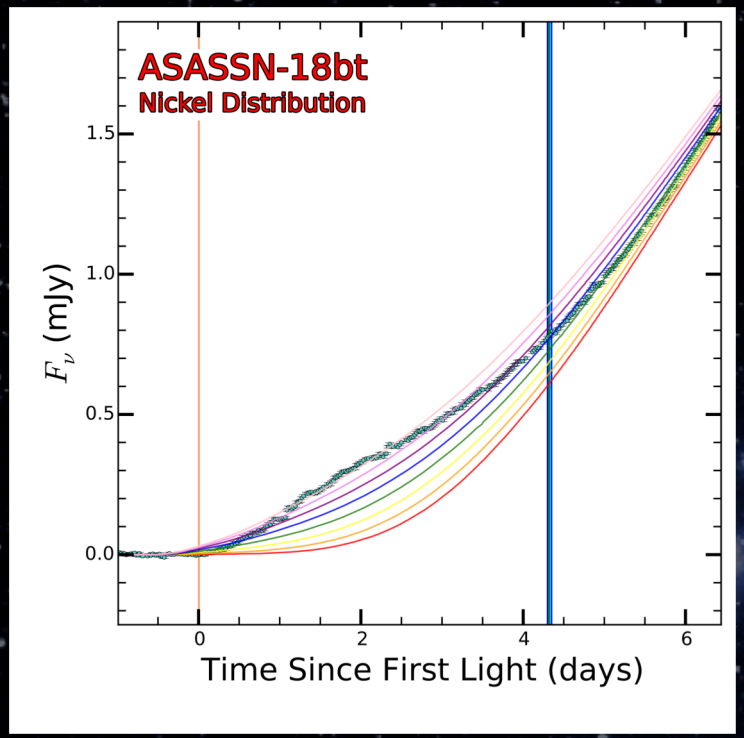
Shappee, Holoien et al. (2019)

Flux Excess: Off-Center Nickel Distribution

- If nickel is mixed into the outer layers of the ejecta it can generate excess flux (Piro & Morozova 2016, Contreras 2018)
- Requires non-smooth distribution, highly concentrated at surface



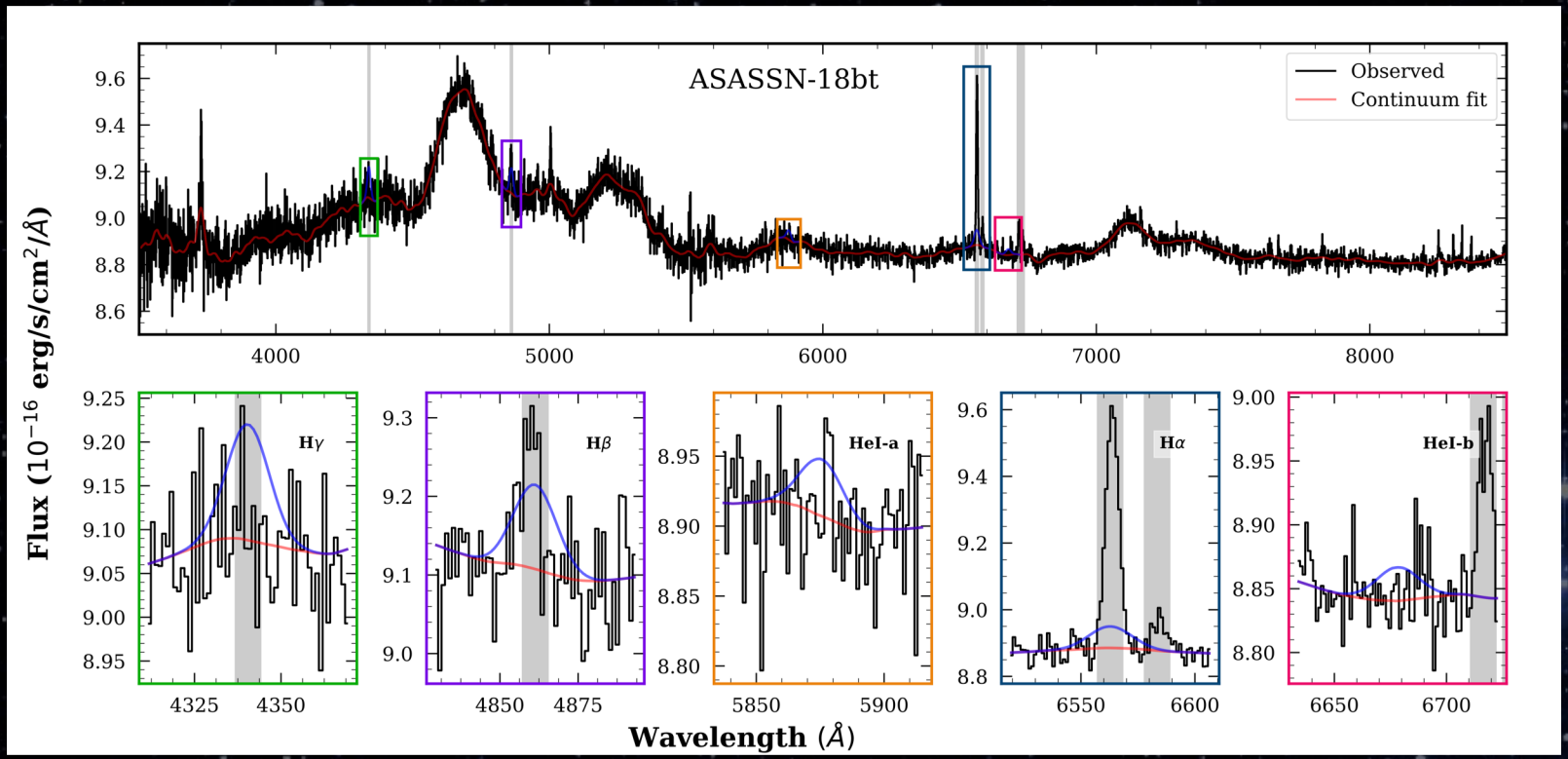
Contreras et al. (2018)



Shappee, Holoien et al. (2019)

ASASSN-18bt: Nebular Phase Spectra

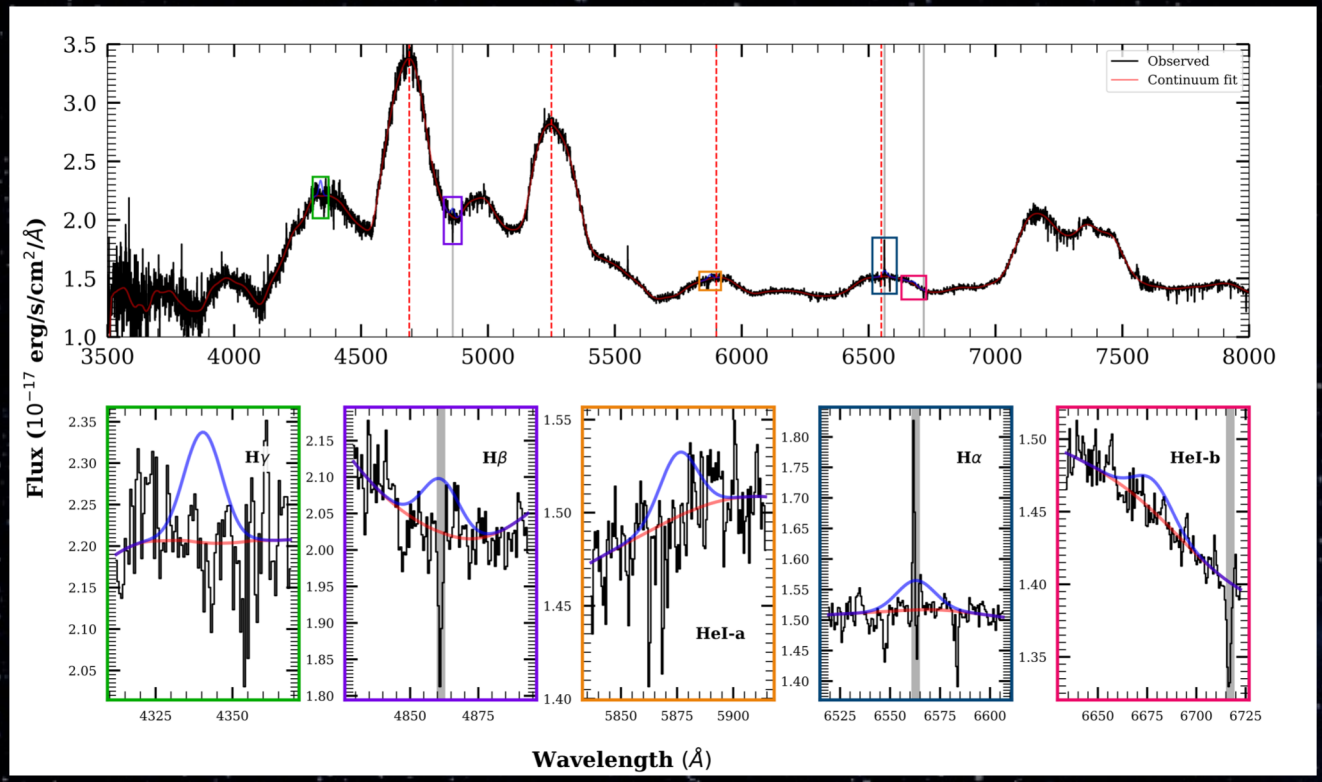
- Nebular phase spectra can show evidence of stripped material
- No Halpha limit -> M<0.006 Msun of H-rich material



Tucker et al. (2018)

Nebular Phase Population Study

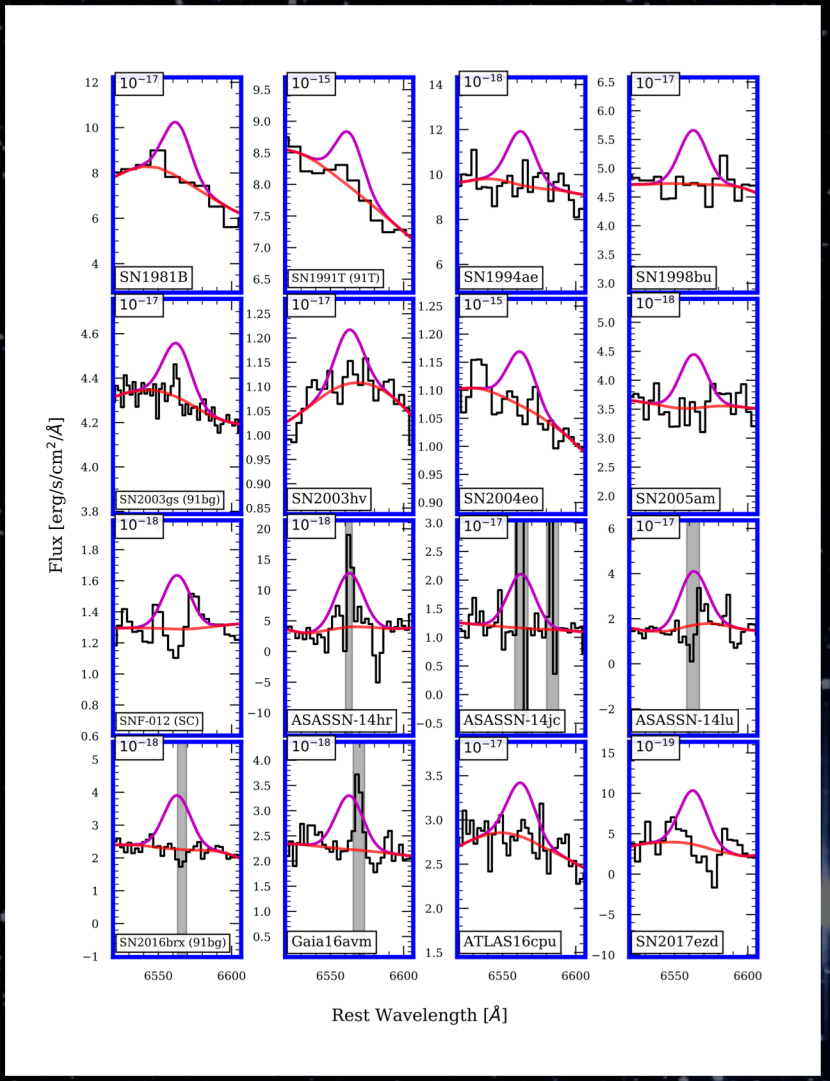
- Over 200 nebular phase spectra of 110 SNe Ia
- Same examination as ASASN-18bt



Tucker et al. (Incl. Holoien) (2019)

Nebular Phase Study

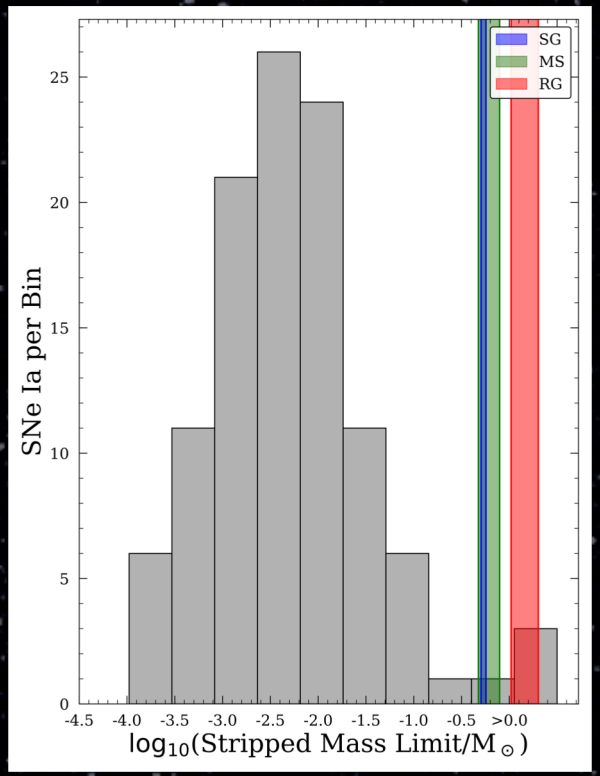
- No detections of stripped material
- Calculate flux limits for all objects

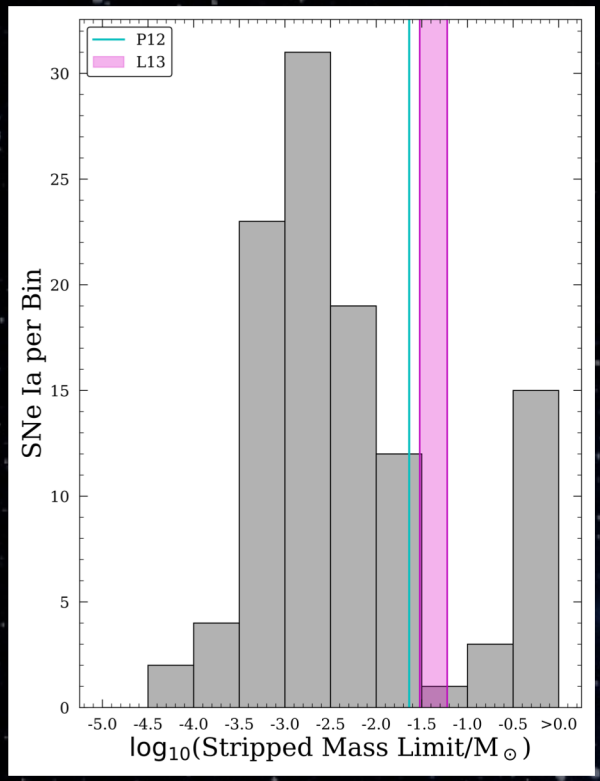


Tucker et al. (Incl. Holoien) (2019)

Nebular Phase Study

- Few are consistent with models
- Limit on fraction of SNe Ia produced through SD scenario: <5.6% (H-rich companion), <6.1% (He-rich companion)





Tucker et al. (Incl. Holoien) (2019)

Summary

- ASAS-SN is the leading professional survey for bright, nearby transients
- Type Ia SN discoveries coupled with space telescope data allow the study of early-time flux to look for signatures of the progenitor system
- Late-time studies suggest DD scenario is dominant progenitor channel for SNe Ia
- Additional work: specific SN Ia rate is higher in lower-mass host galaxies (Brown, Stanek, Holoien et al. 2018), future work will look at specific rates with SFR and metallicity and the general nearby SN rates.

Thank You

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