Transitional Ia SNe SN2015bp And its early Carbon Absorption

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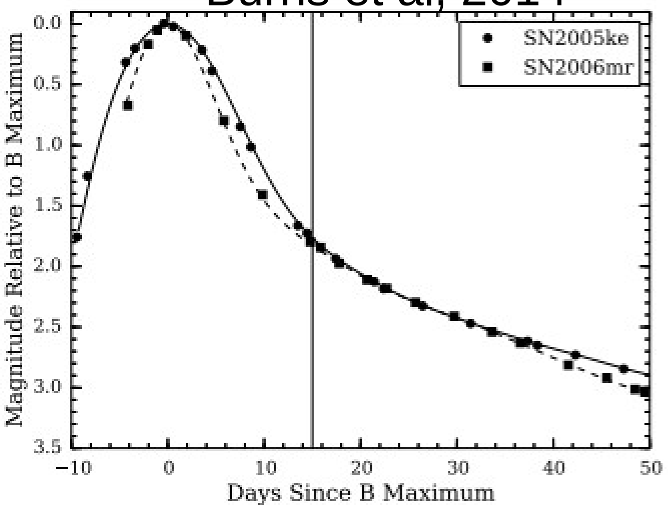
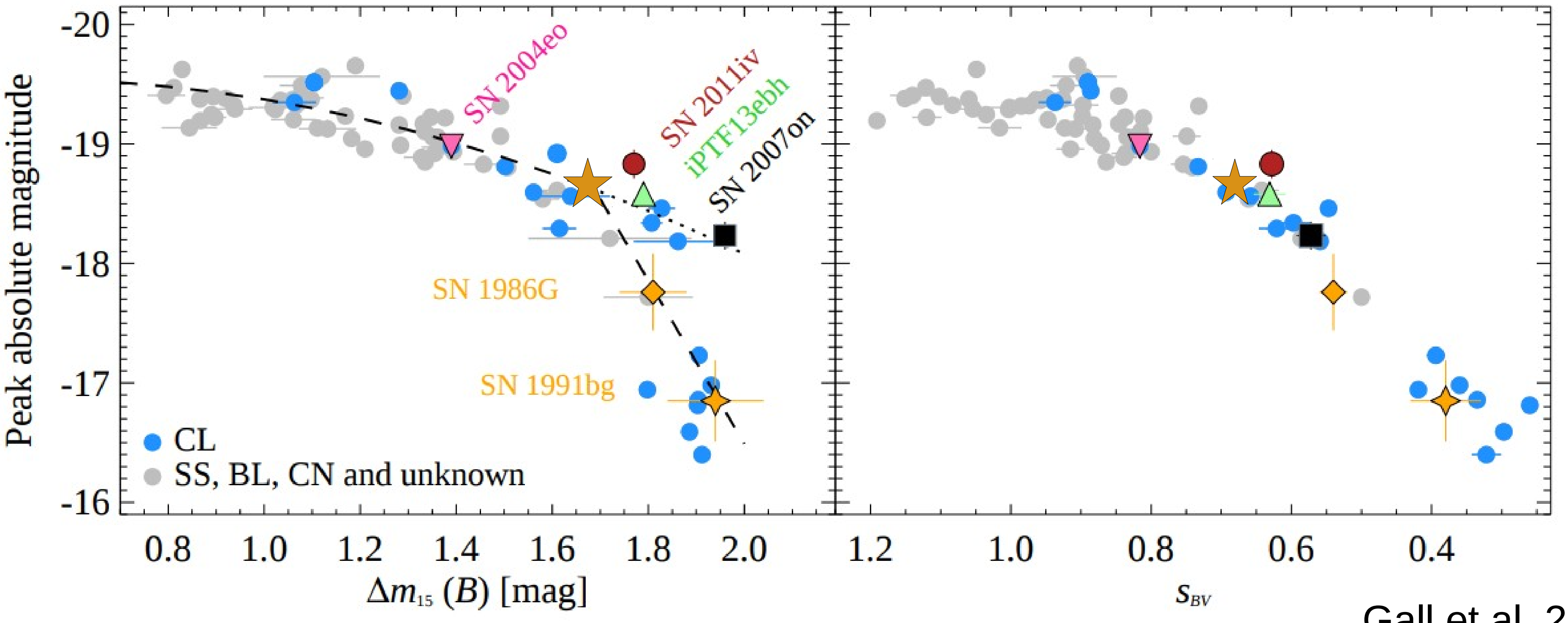
Transitional SNe Ia

- Fast-declining, sub-luminous SN Ia with NIR primary maximum peaking before B-band max (Hsiao et al, 2015)

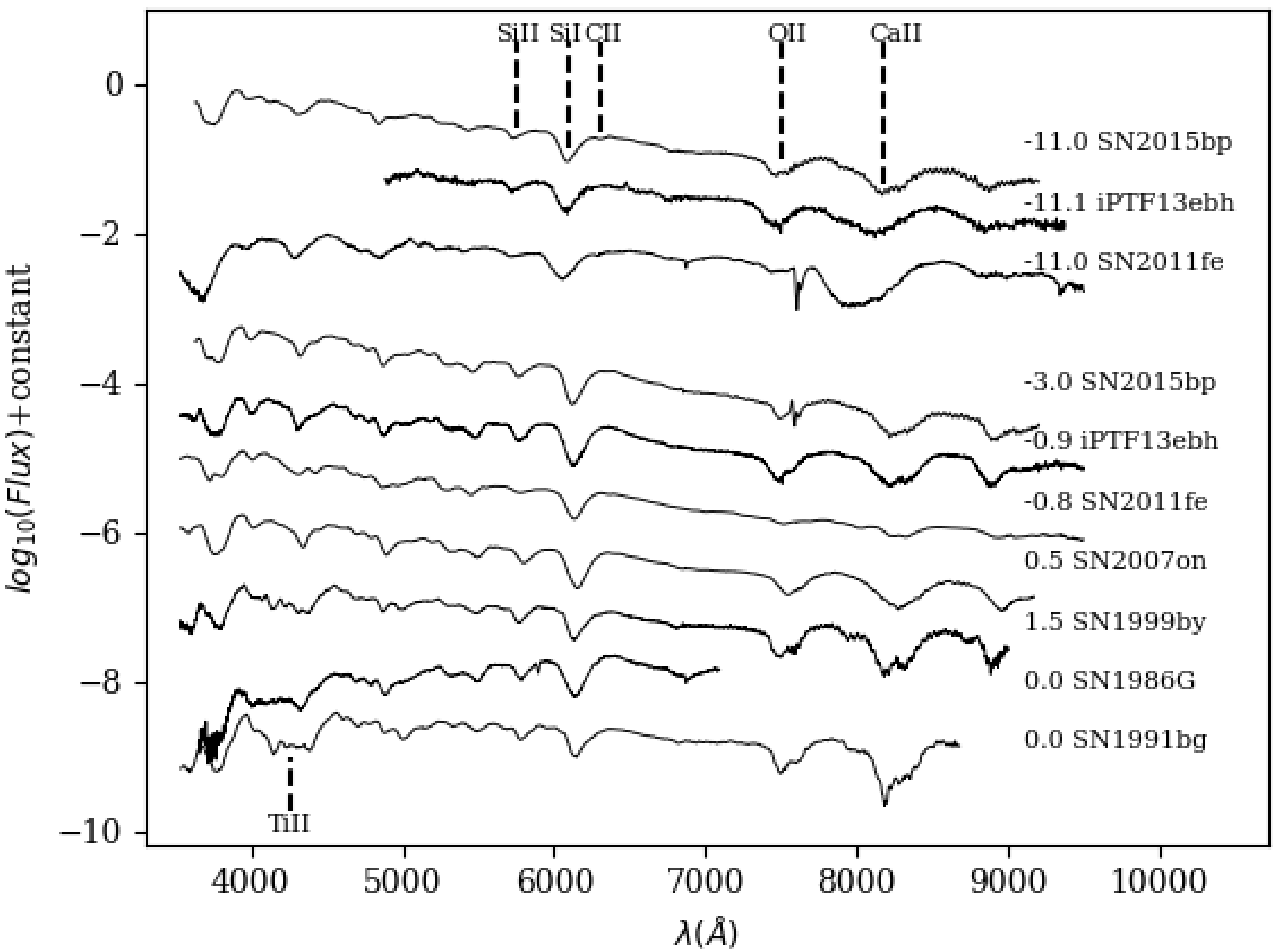
Burns et al, 2014





Gall et al, 2018

Peculiar/Transitional SNe Ia



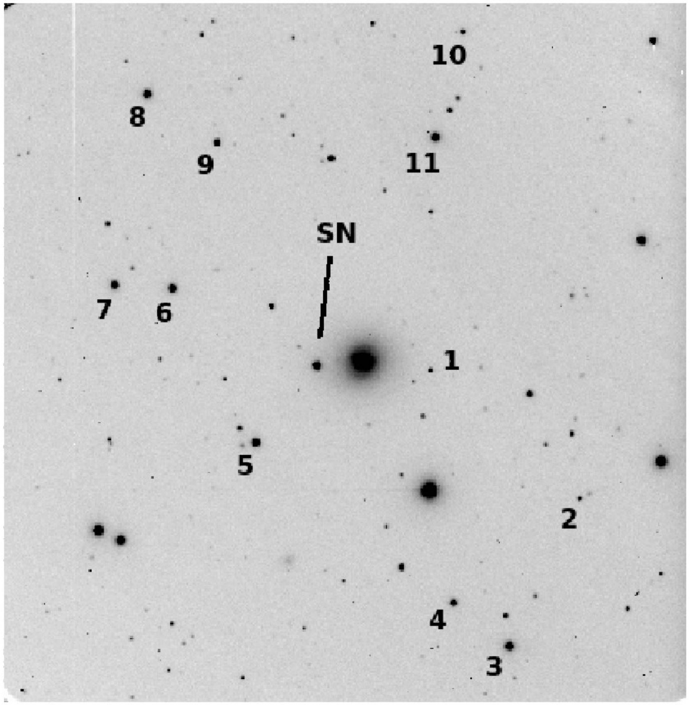
SN2015bp Wyatt et al, In Prep

- Discovered on 2015-03-16 by CRTS

Table 5. Basic properties of SN2015bp

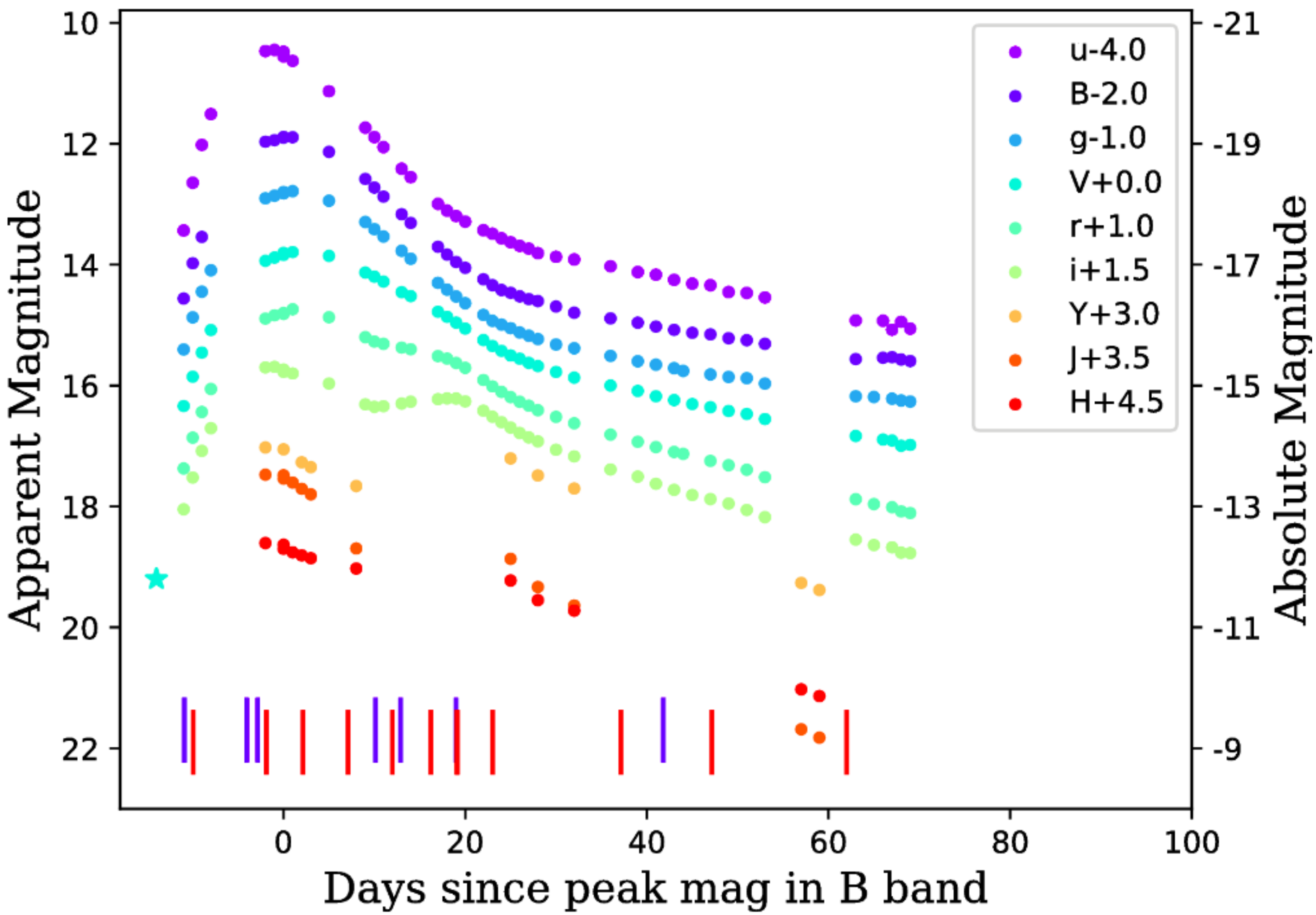
$RA(J2000)$	15 : 05 : 30.07
$DEC(J2000)$	+01 : 38 : 02.40
$JD^{a}_{explosion}$	2457093.64
$JD_{discovery}$	2457097.99
$JD_{max}(B)$	2457112.72
$B_{app}(max)$	13.69
$B_{abs}(max)^{b}$	-18.73
$\Delta m_{15}(B)$	1.56 ± 0.03
s_{BV}	0.671 ± 0.004
Host	NGC 5839
Heliocentric Redshift[c]	0.004
Distance Modulus[d]	32.15 ± 0.54
Distance Modulus[e]	32.426 ± 0.007
$E(B-V)_{MW}$	0.046

[a] Derived from the fit of the $v \approx t^{0.22}$ power law of Piro & Nakar (2013) to the Si ii λ6355Å velocity time evolution.
[b] Absolute magnitude calculated after taking into effect the extinction from Schlafly & Finkbeiner (2011) and using the distance modulus estimated from SNooPy Burns et al. (2014)
[c] Cappellari et al. (2011)
[d] Distance modulus estimated using the mean Tully Fisher Relation from Theureau et al. (2007)
[e] Distance modulus estimated using SNooPy Burns et al. (2014).



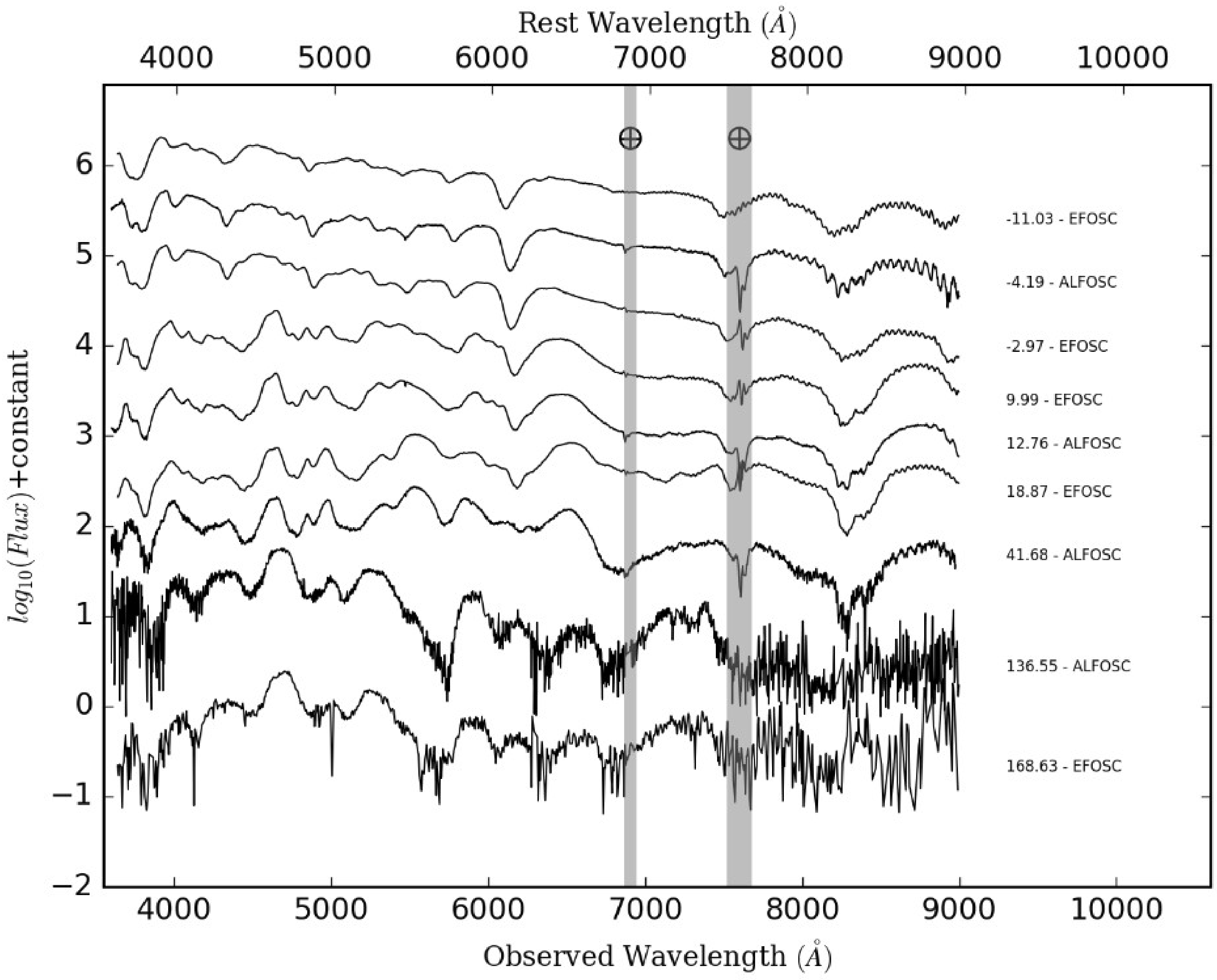
Srivastav et al, 2017

SN2015bp Wyatt et al, In Prep



Data from CSP

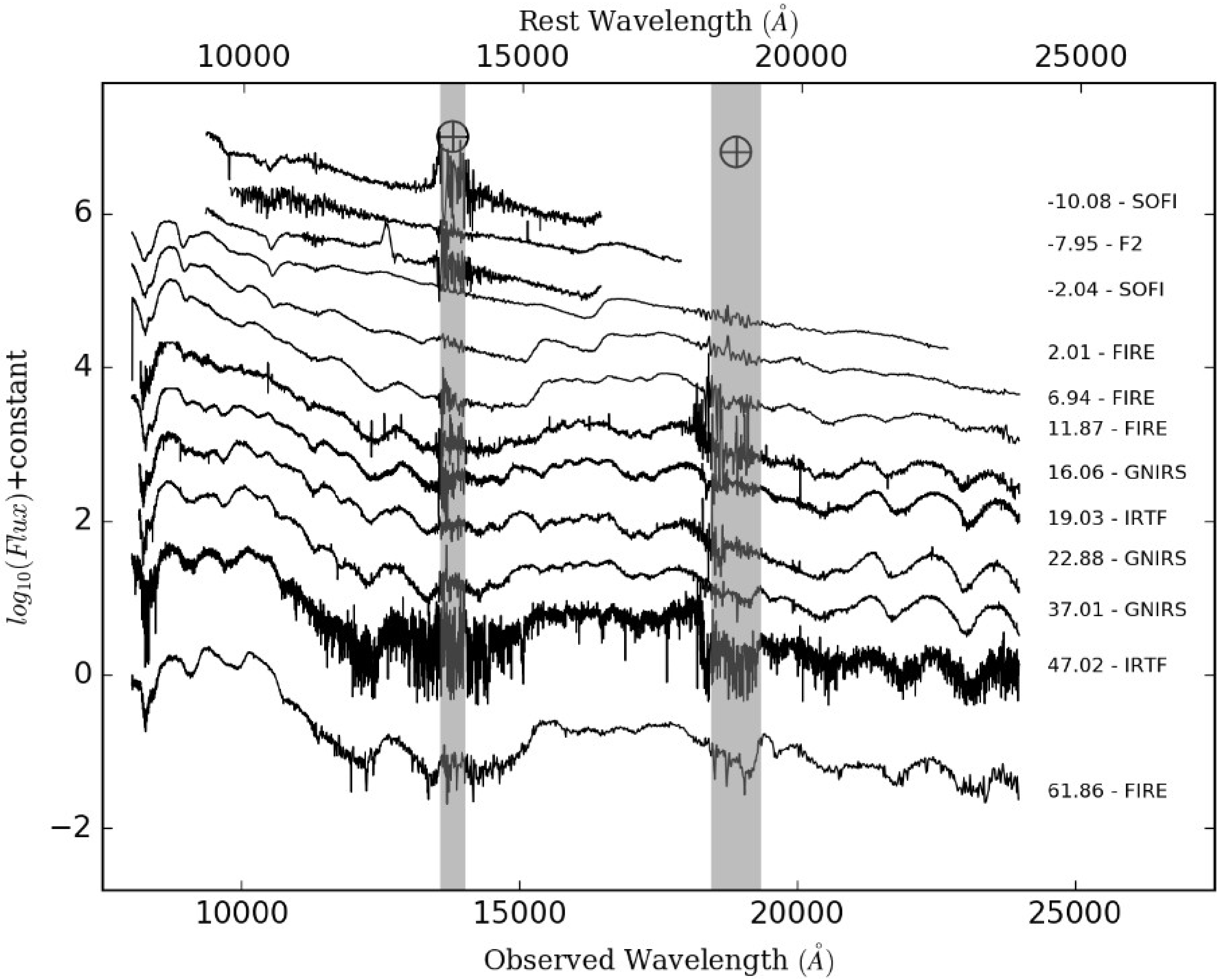
SN2015bp Wyatt et al, In Prep



EFOSC data from the PESSTO archive

SN2015bp

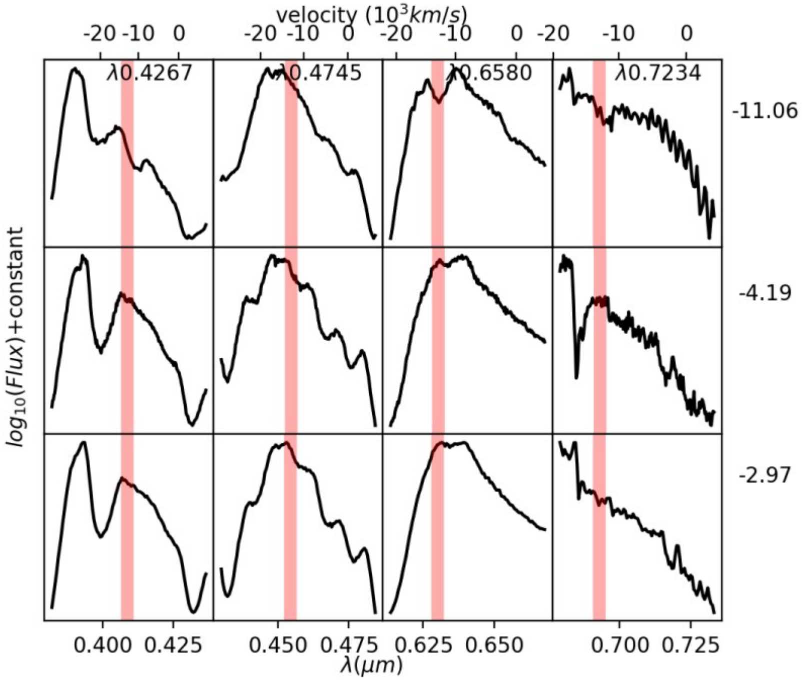
Wyatt et al, In Prep

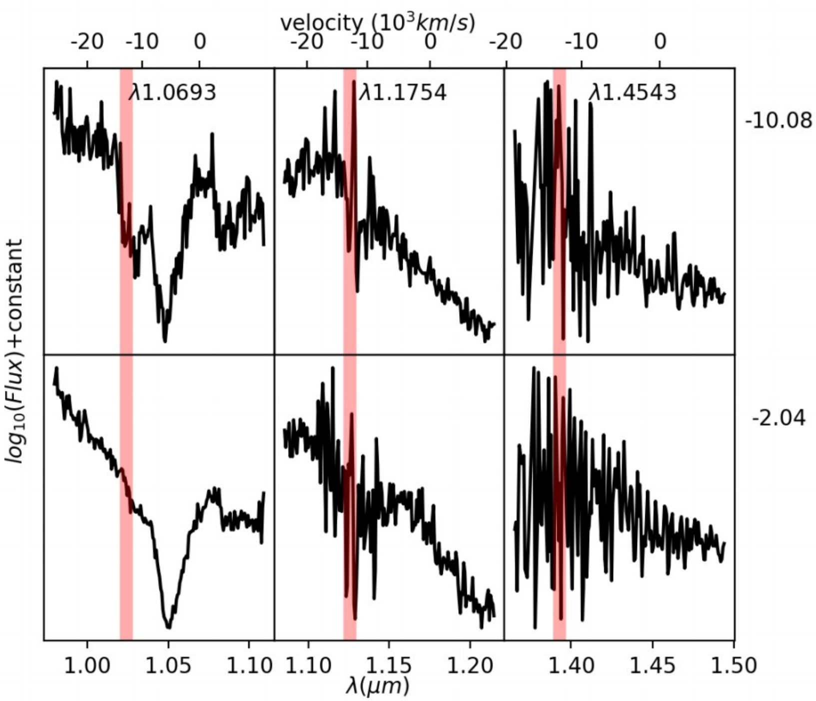


SOFI data from the PESSTO archive

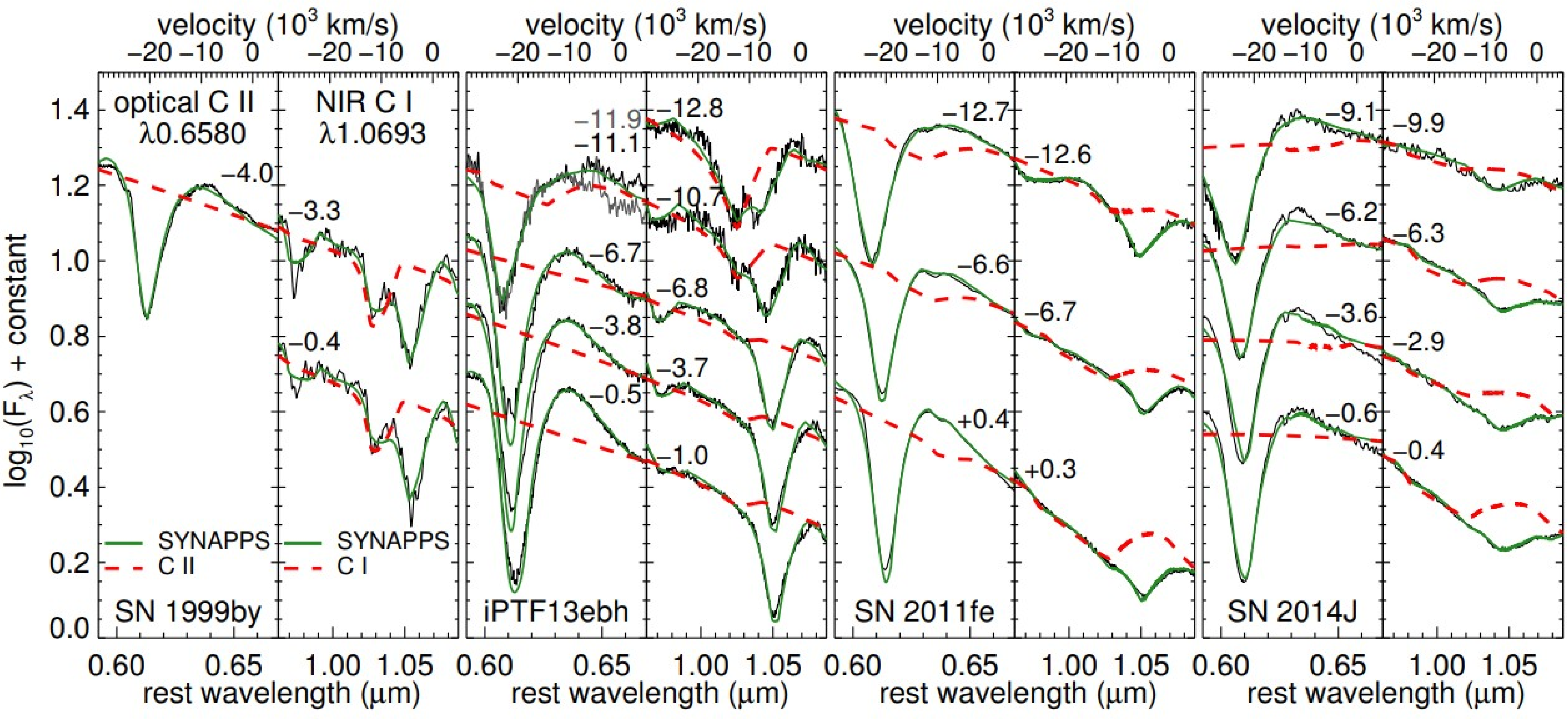
SN2015bp Wyatt et al, In Prep

- Both the NIR (1.0693) and Optical (0.6580) show evidence of unburnt carbon





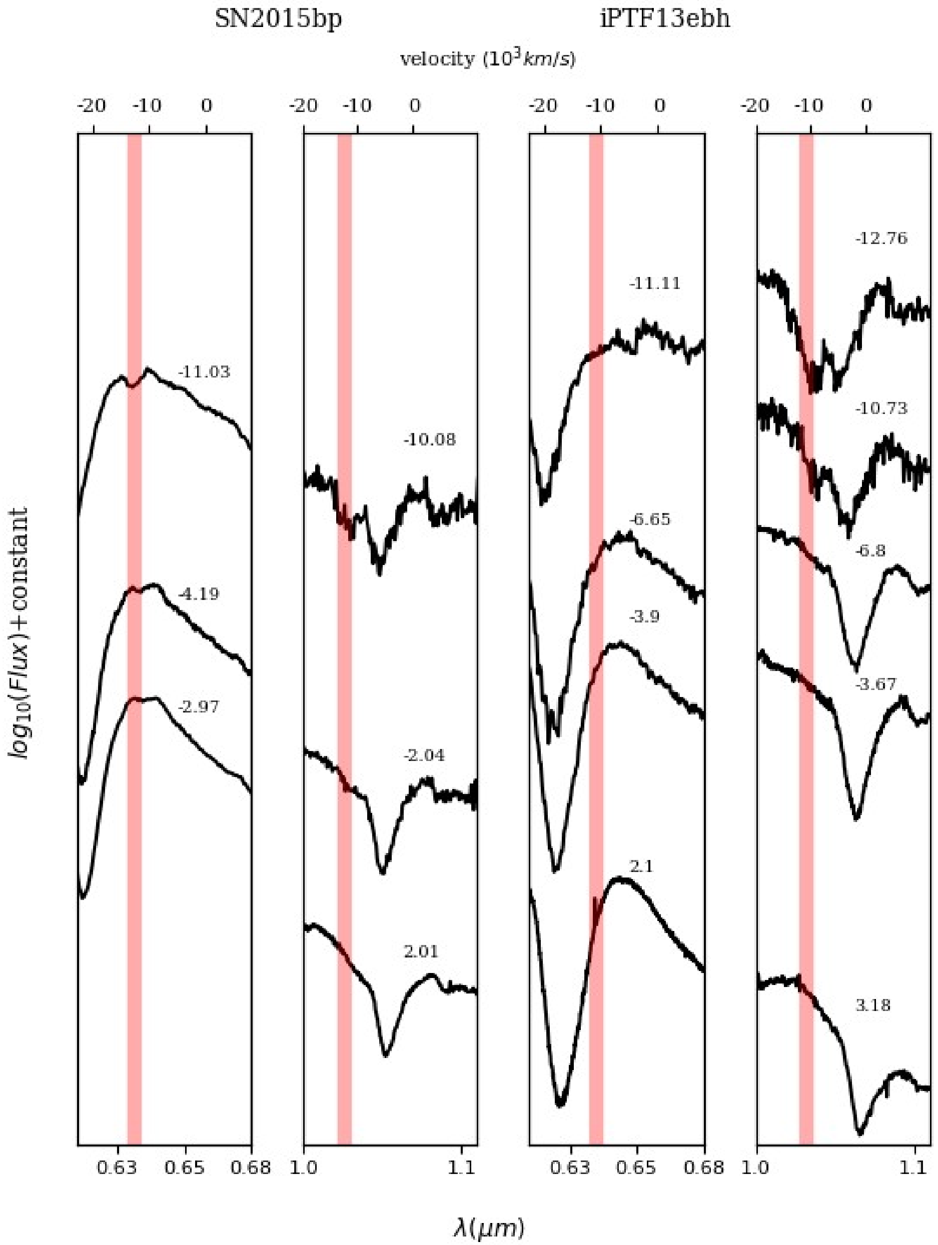
Carbon Detections in SNe Ia



Hsiao et al, 2015

Carbon Detections in SNe Ia

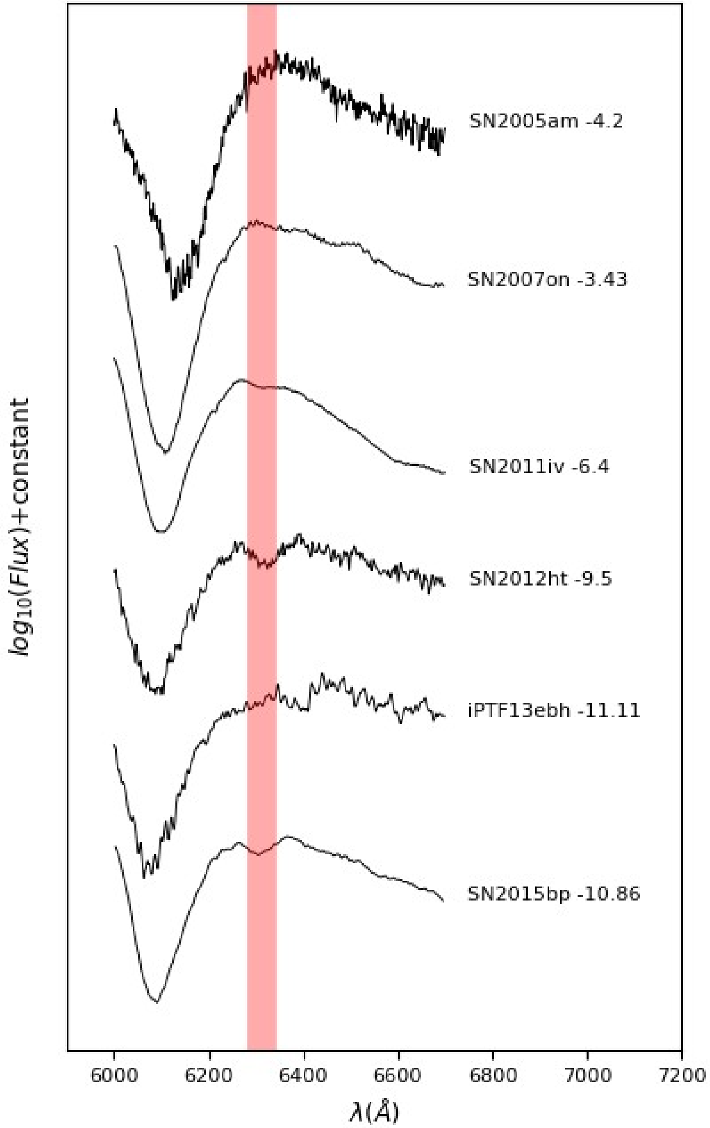
Wyatt et al, In Prep



- Comparison with iPTF13ebh (Hsiao et al, 2015)

Carbon Detections in SNe Ia

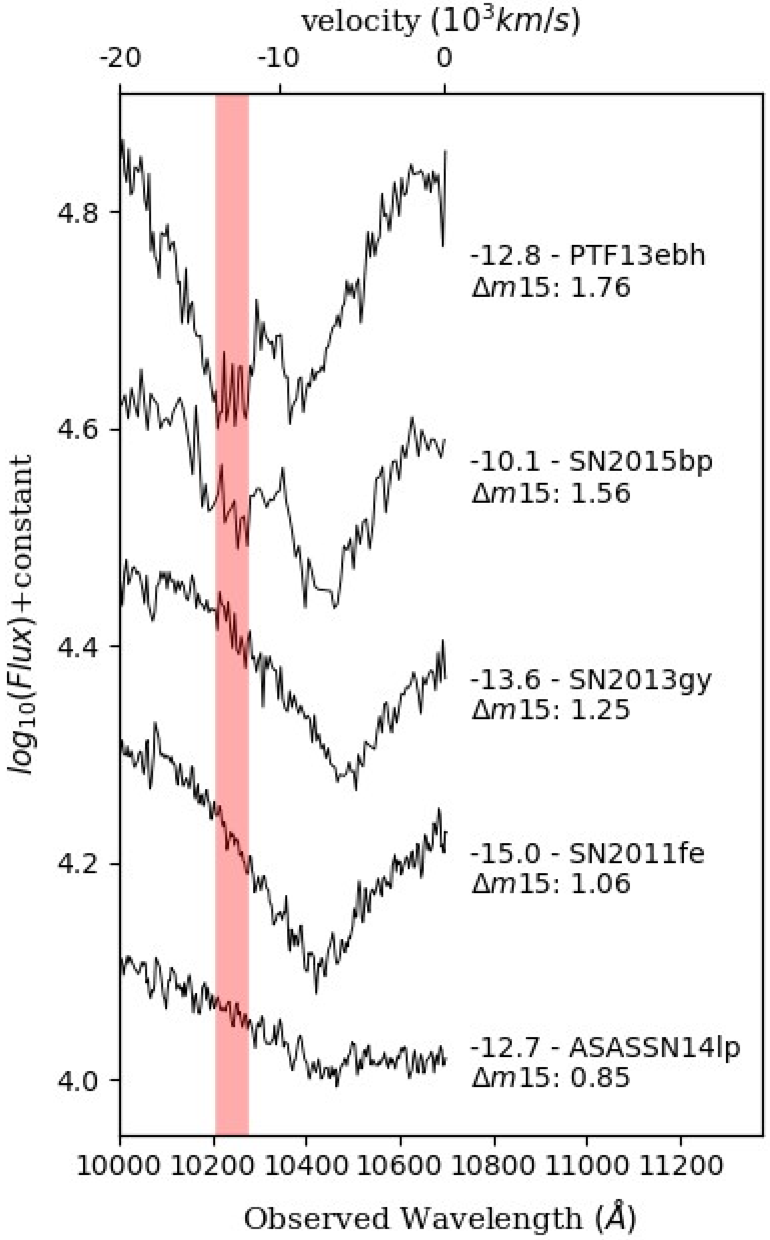
Wyatt et al, In Prep



- Optical CII compared to other Transitional SNe Ia at their earliest time

Carbon Detections in SNe Ia

Wyatt et al, In Prep



- Relationship of earliest NIR CI absorption and decline rate for SNe Ia

Carbon Implications

- Current explosion models suggest that there should be a unitary ratio of C to O from SNe Ia.
- Oxygen absorption is a very prominent feature, but carbon very rarely shows itself as a feature except in the early stages after explosion
- NIR CI and CII do show themselves heavily in the early spectra, but diminish at roughly the same timescales.

Progenitor Scenario

- Unburned Carbon from the progenitor C-O white dwarf provides strong constraints on the possible explosion trigger
- It is not expected to survive the explosion of sub-CH mass white dwarfs via the helium double detonation mechanism and predicts that NIR C I (10693) is misidentified HV Helium 10830 (Boyle et al, 2017)
- The coincident optical and NIR detections suggest that this is in fact unburned carbon
- Suggests Deflagration → Detonation

fin

- Thank you

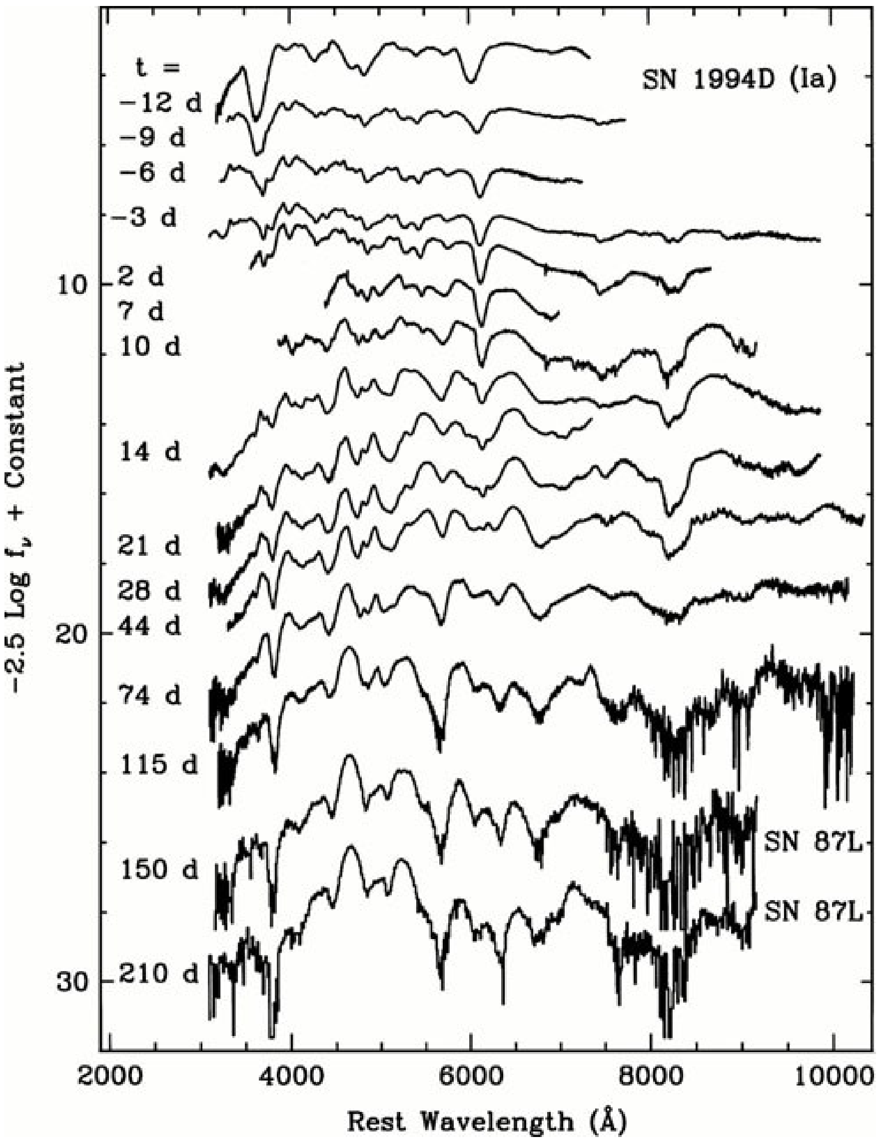
TODO

- Science that is done with SNe Ia x
  - Cosmology I guess x
- Transition into transitional SNe ::)) x
  - “on this edition of ‘Hey that’s different, time for a new subclass’.” x
  - How they fall on the Luminosity-Width relation, and other ways they are different x
- SN2015bp
  - Its data x
  - How it compares to other transitional SNe x
  - Woah look at that carbon x
  - What does that mean/implications x

SNe Ia

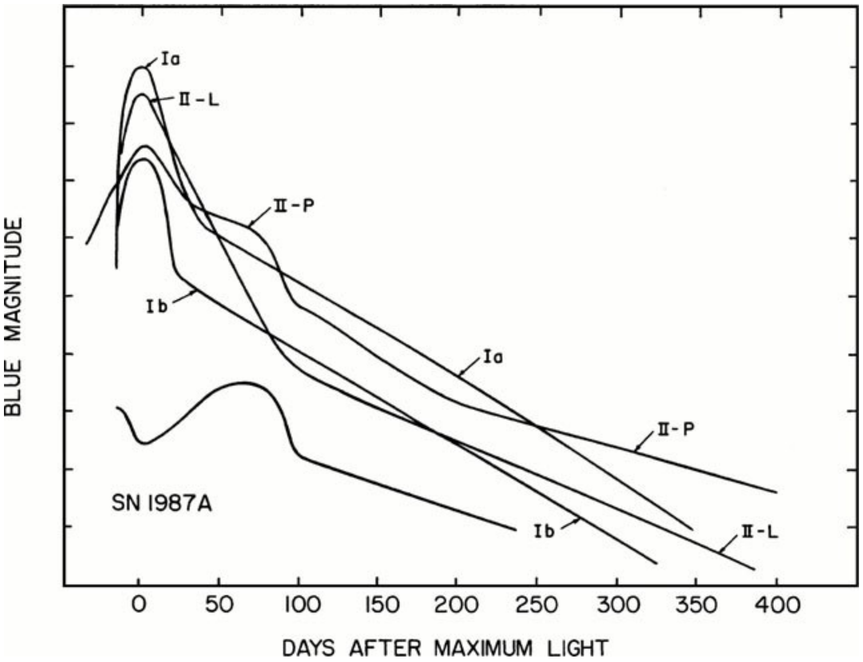
- Occur in all galaxies. More frequently in spiral galaxies
- At early times spectral signatures come from neutral and singly ionized elements (O, Mg, S, Si, Ca) with the strongest being the *lovely* Si II absorption at $\lambda 6355$
- Optical Carbon (C II $\sim\lambda 6580$) found in ~30% of early time spectra

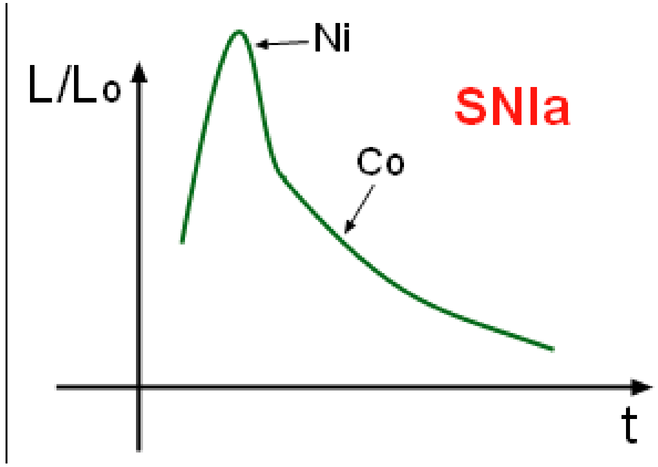
SNe Ia Spectra



SNe Ia Light Curve

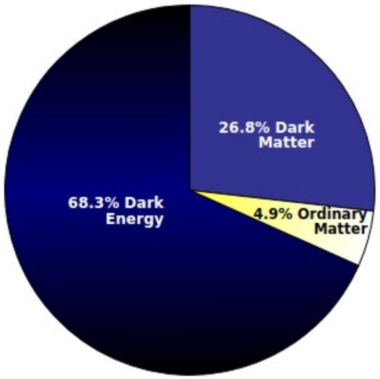
- Compared with other SNe types





SNe Ia Relevance

- Uses as standard candles
  - Cosmological distance indicators
    - Accelerated expansion (with respective redshifts) ~ Dark Energy
    - Hubble Constant precision

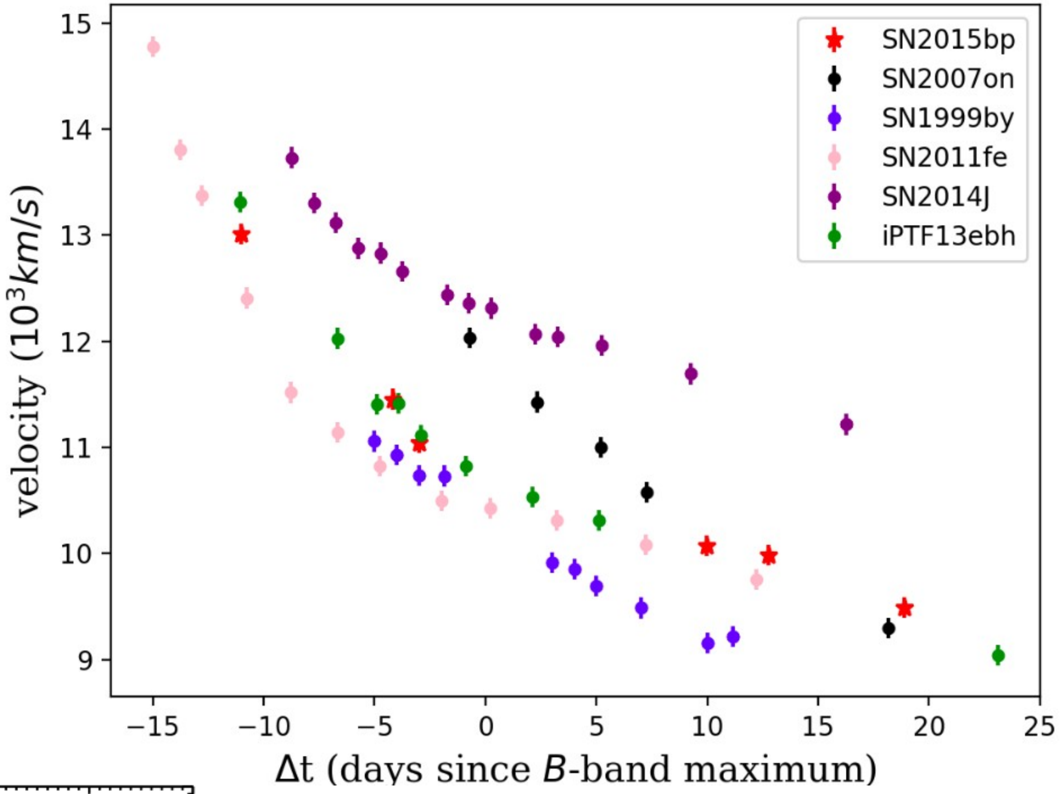


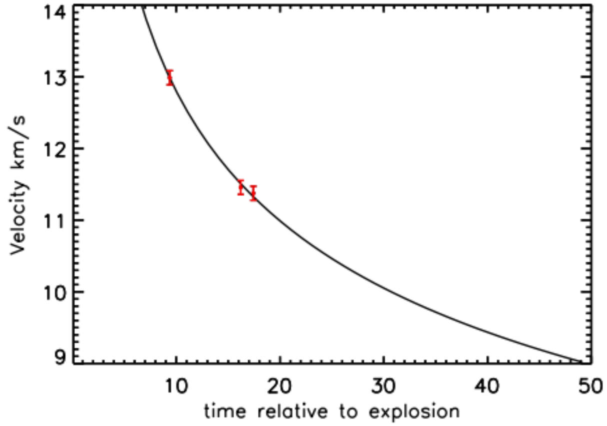
Supernovae

- Two avenues at which a star's life can dramatically end
  - Core Collapse ~ II's - yes hydrogen
  - Binary ~ Ia's – no hydrogen
    - Mass accretion
    - In-spiral merger event (maybe indicative of a tertiary companion as well)

SN2015bp

Wyatt et al, In Prep





- Measured Si II (λ6355) velocities compared to other SNe Ia
  → Inferred to be Normal Velocity subclass
- Able to infer an upper limit on the possible dark phase ~4.3 days before detection (19.08 before B band max)

Piro et al, 2013