Hydrogen in SNe Ib

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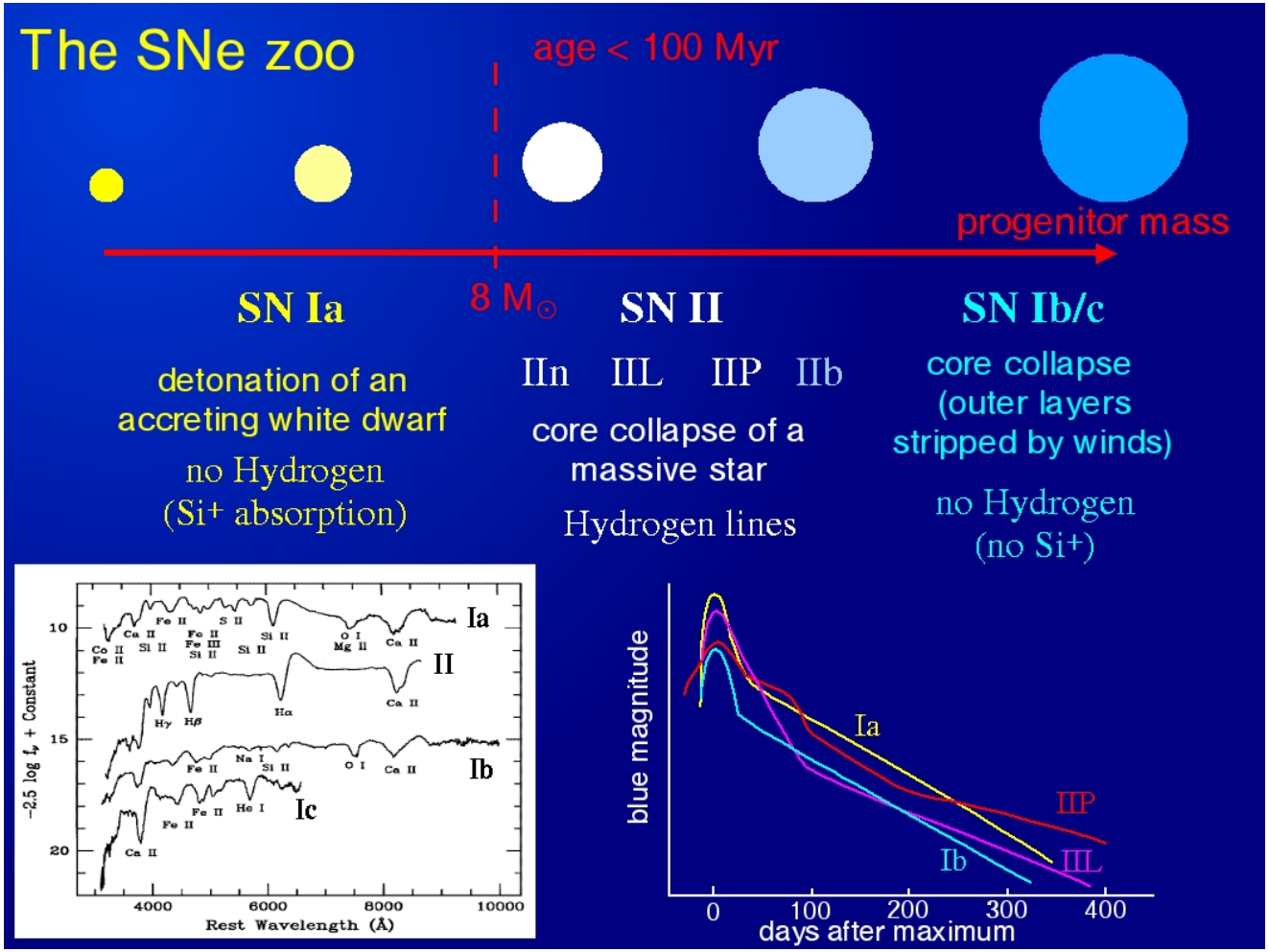
Collaborators

- Usual Suspects
  - David Branch
  - Peter Hauschildt
- Good Undergraduates
  - Wesley Ketchum
  - Spencer James

SN Taxonomy

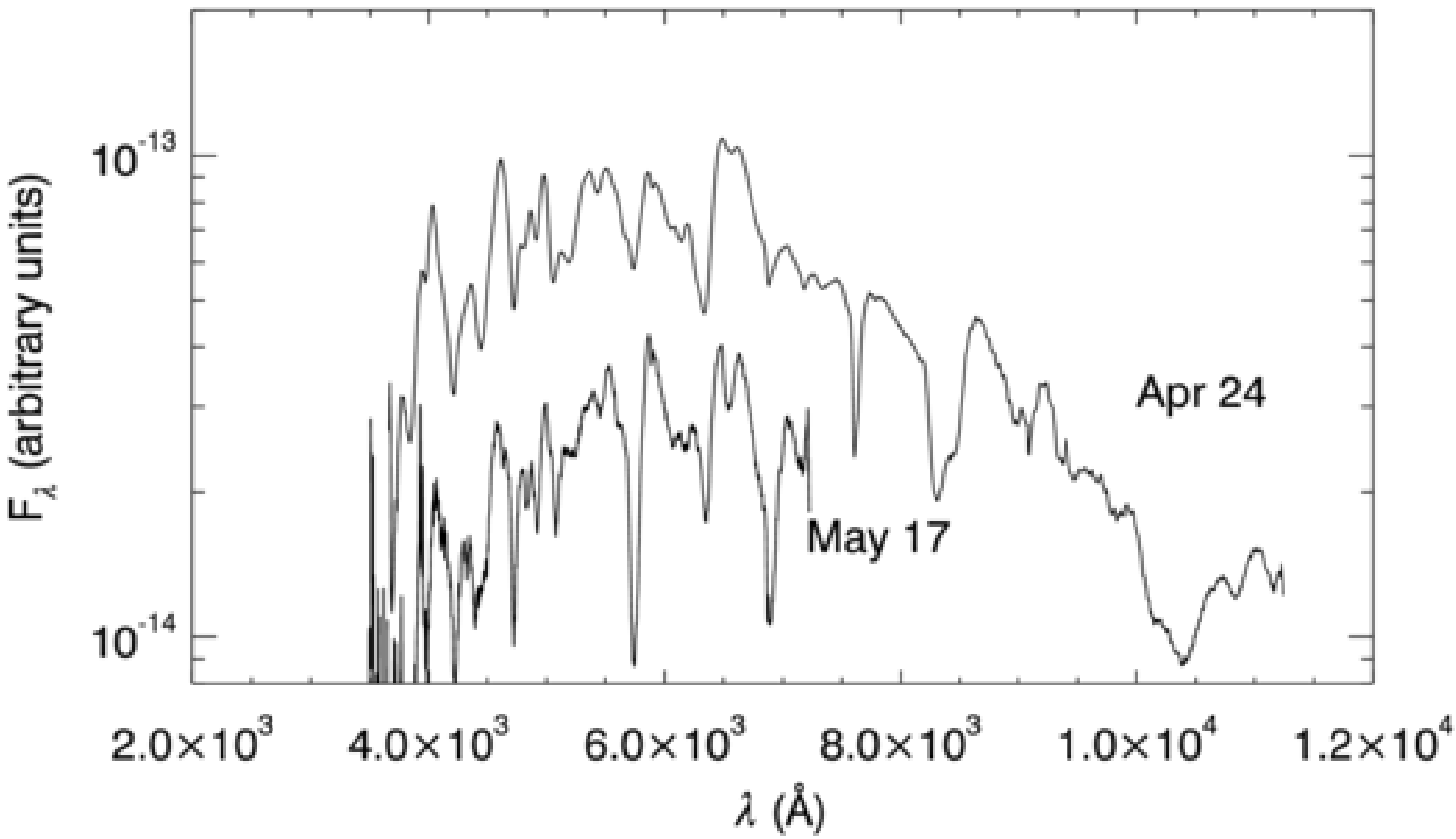

The SNe zoo
age < 100 Myr
progenitor mass
8 M⊙
SN Ia
detonation of an accreting white dwarf
no Hydrogen (Si+ absorption)
SN II
IIn IIL IIP IIb
core collapse of a massive star
Hydrogen lines
SN Ib/c
core collapse (outer layers stripped by winds)
no Hydrogen (no Si+)
Ia
II
Ib
Ic
−2.5 log f_λ + Constant
Rest Wavelength (Å)
blue magnitude
days after maximum
IIP
IIL

3 Classes of Ixb SNe

- Most if not all in Binary Systems
- SNe IIb $M_H \sim 0.3\ \mathrm{M}_\odot$
  - Progenitor: Stable Case C, Critical mass $\sim 0.3\ \mathrm{M}_\odot$ Roche lobe shrinks
- Hydrogen Rich Ib $M_H \sim 0.1\ \mathrm{M}_\odot$
  - Progenitor: Stable Case C, followed by wind loss? (Posiadlowski et al.)
- Hydrogen Poor Ib $M_H \sim 0.001\ \mathrm{M}_\odot$
  - Progenitor: UnStable Case C, Common Envelope Formation (Posiadlowski et al.)
  - Progenitor: Rotation + Nonconservative Case A or B, Followed by Wind loss (Yoon et al.)

SN IIb

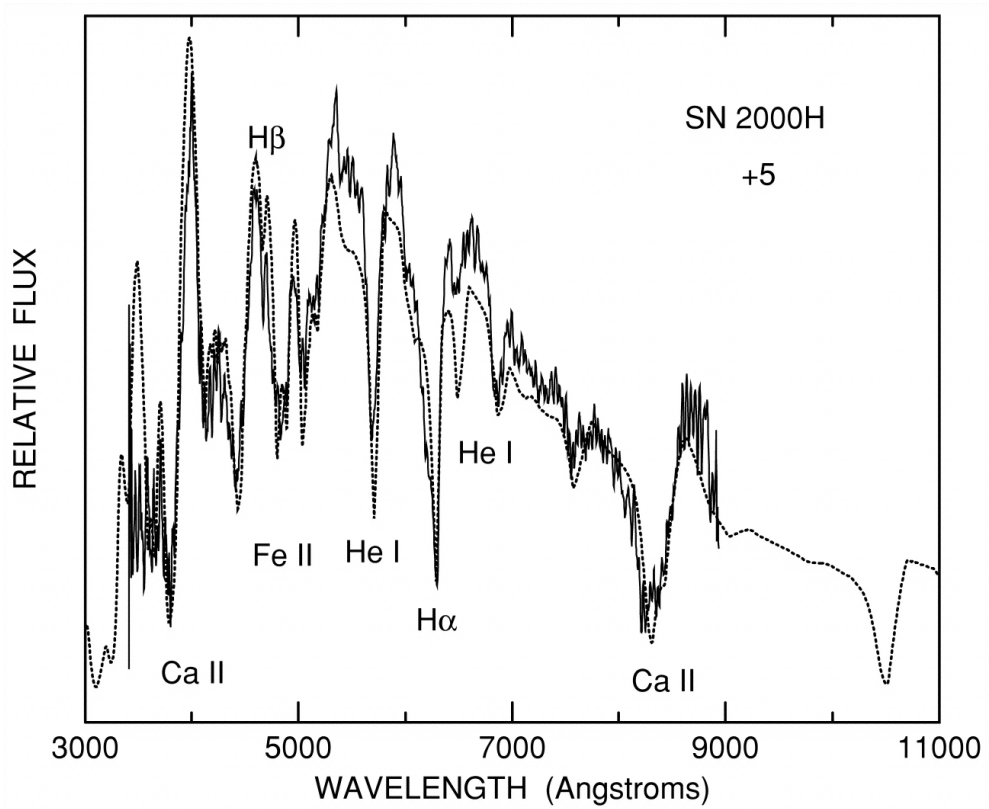
SN 1993J: Days +25, 48



SYNOW Analyses

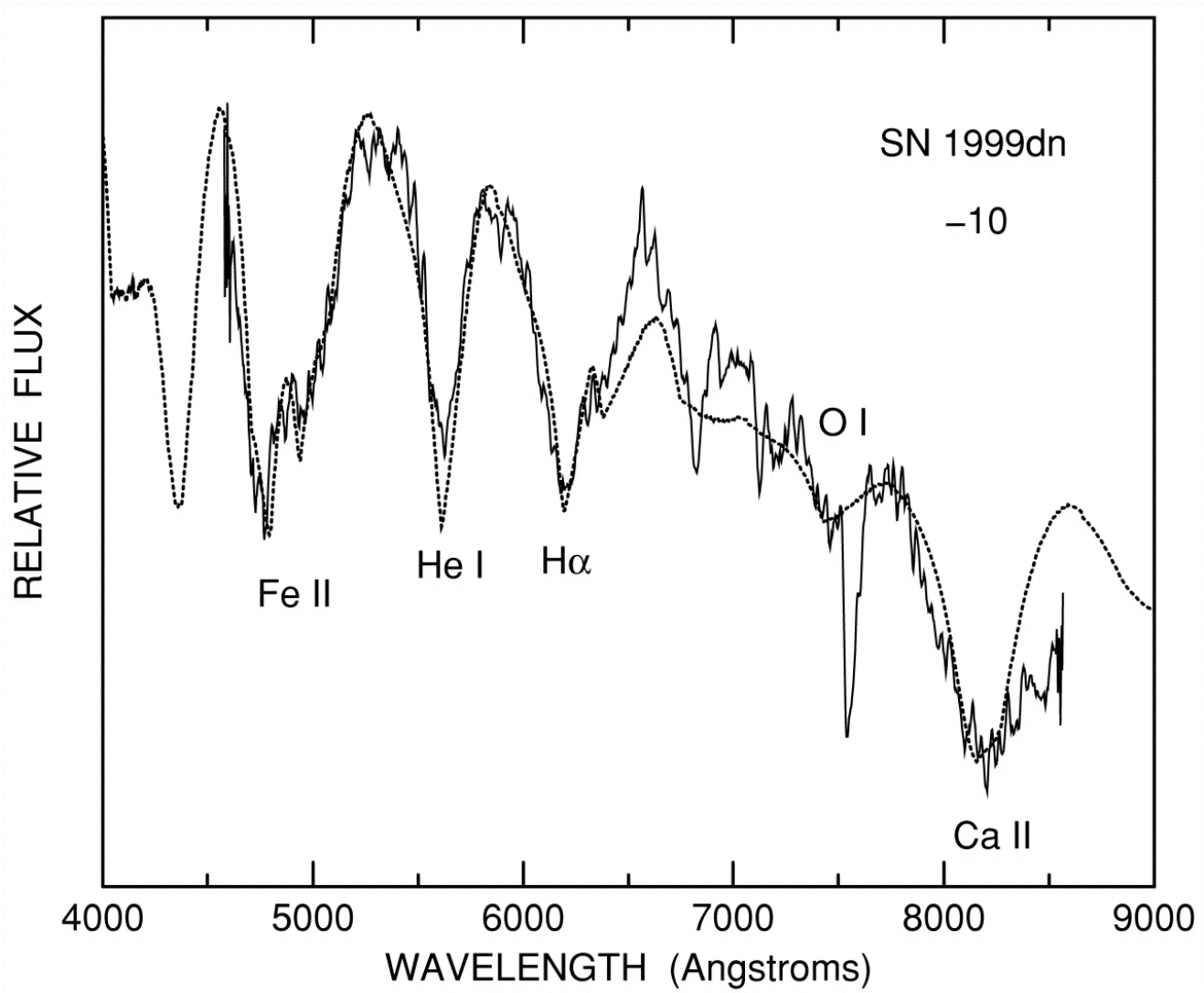
- Highly parametrized
- Good for line IDs
- Can’t determine abundances or masses

Hydrogen Rich SN Ib
SN 2000H



Hydrogen in Typical SN Ib?

SN 1999dn



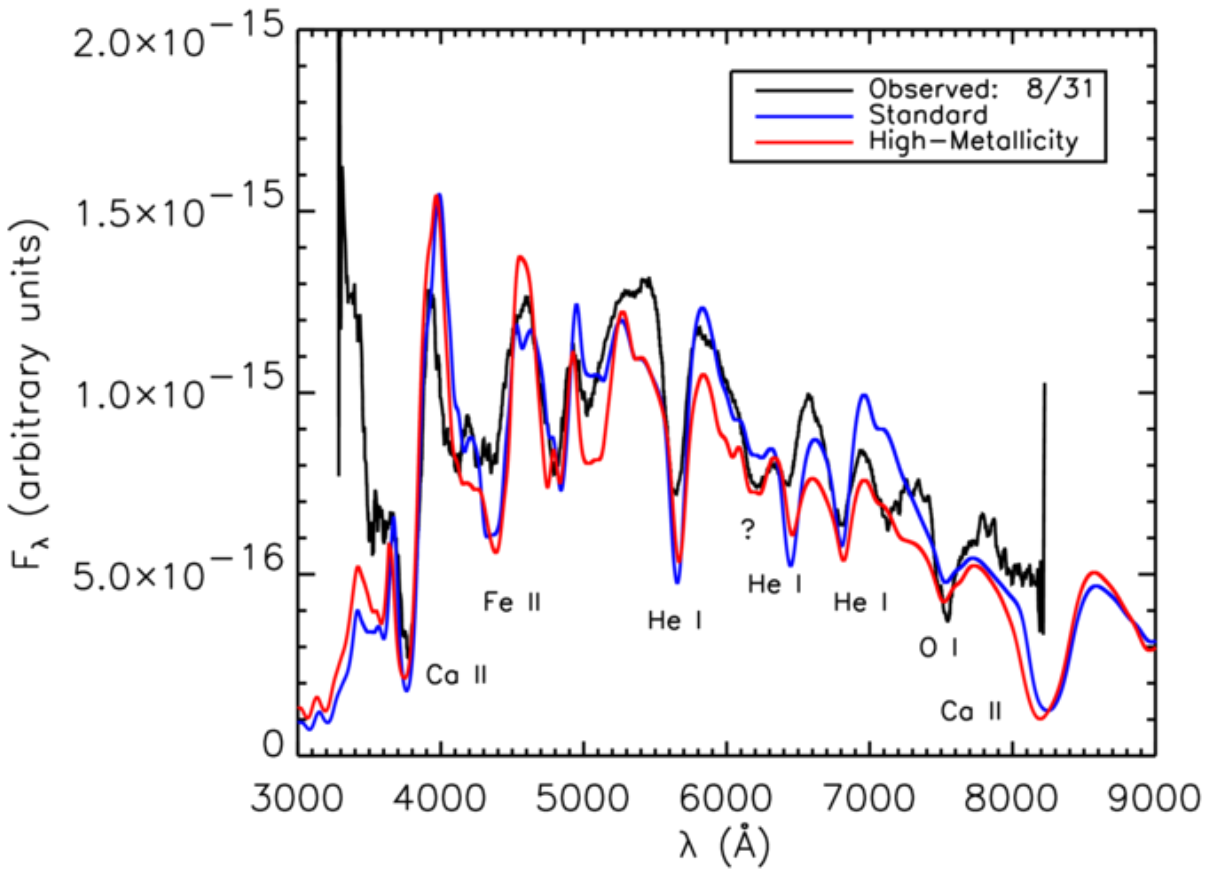
PHOENIX Analysis

- PHOENIX: Generalized Stellar Atmospheres Code
- Try to use “best phyics”

Hydrogen Free Models

- Parametrized Model
- Powerlaw Density
- Helium Core
- Vary Metallicity

SN 1999dn
Maximum Light

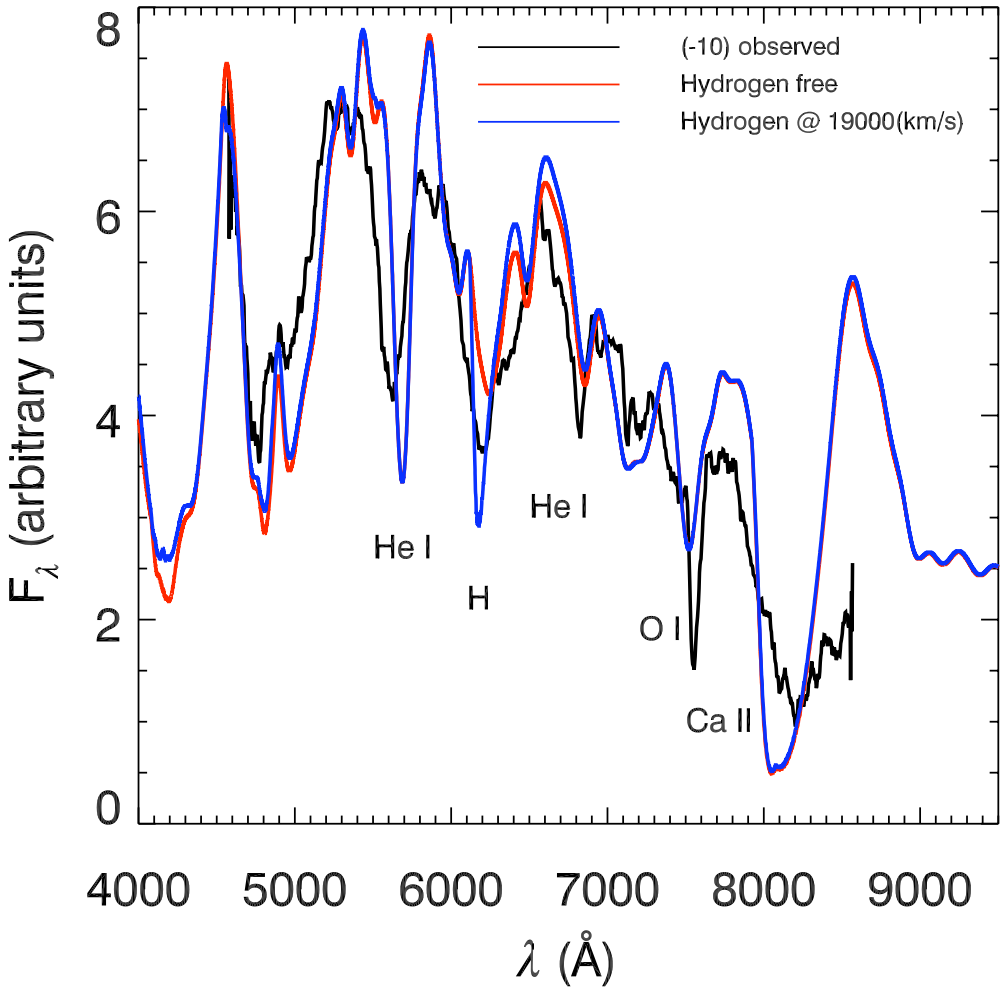


Hydrogen Skin Models

- Parametrized Model
- Solar Compositions
- Powerlaw Density
- Helium Core with hydrogen (solar) skin
- Self-consistent

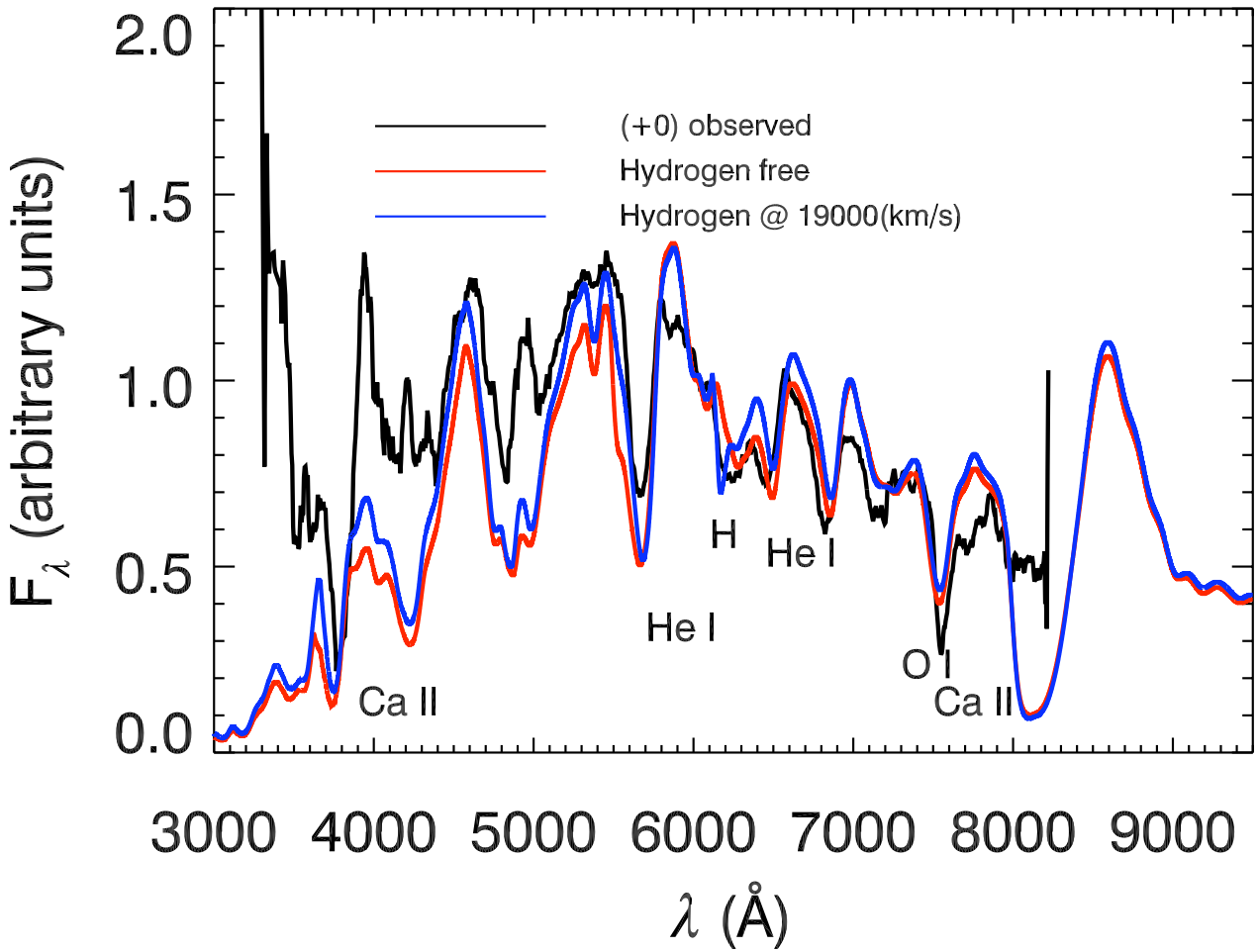
SN 1999dn

Day -10

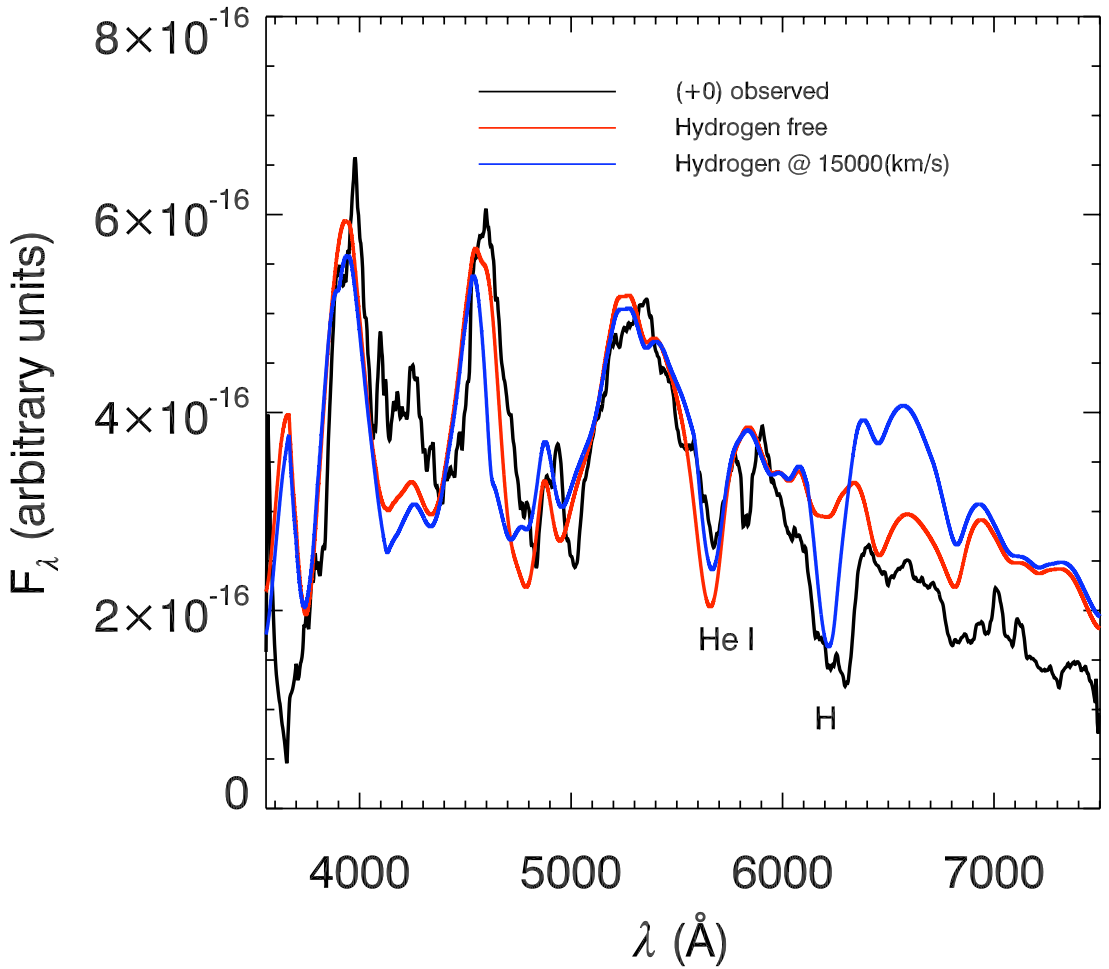


SN 1999dn

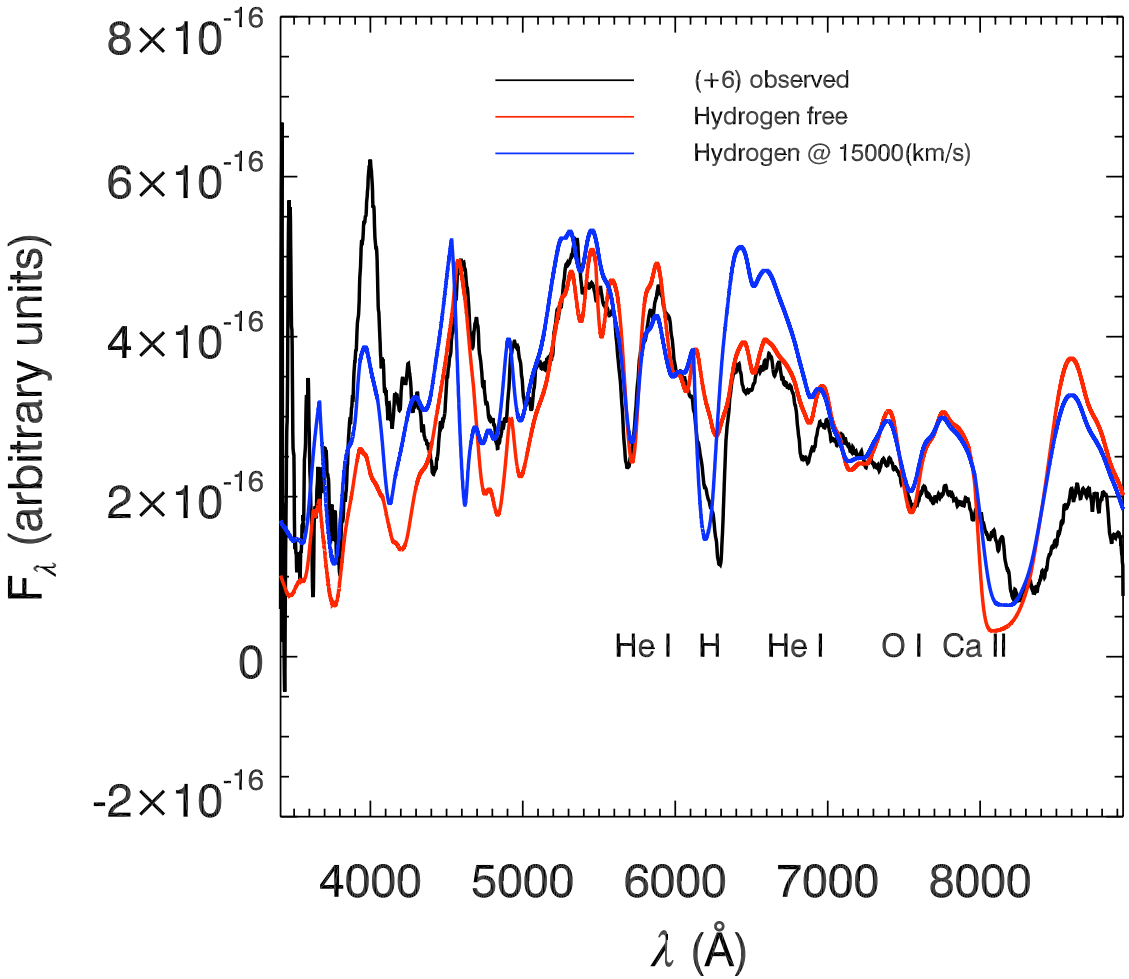
Day 0



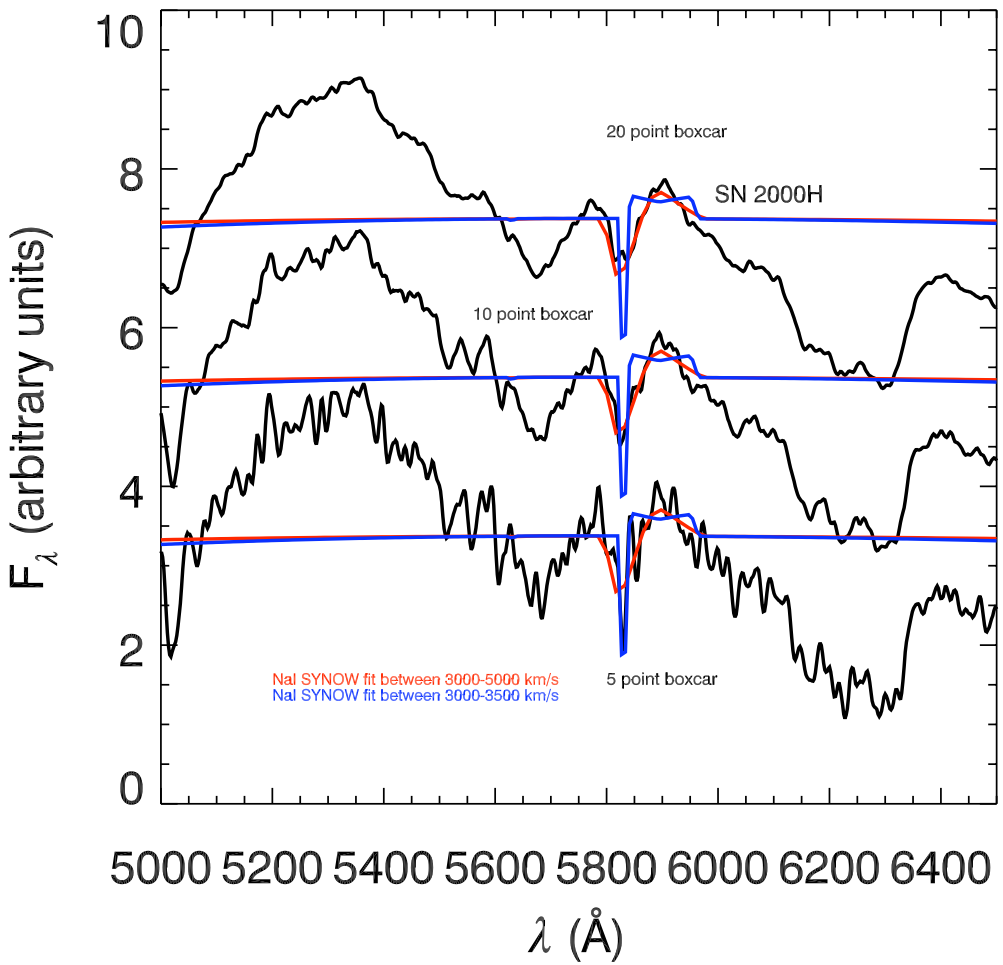
SN 2000H
Day 0



SN 2000H
Day 6



SN 2000H CSM


10
8
6
4
2
0
F_λ (arbitrary units)
20 point boxcar
SN 2000H
10 point boxcar
NaI SYNOW fit between 3000-5000 km/s
NaI SYNOW fit between 3000-3500 km/s
5 point boxcar
5000 5200 5400 5600 5800 6000 6200 6400
λ (Å)

Conclusions

- Hydrogen is common in SNe Ib
- May be two classes of SNe Ib
  - Class I: Closely Related to SNe IIb
  - Class II: Very thin hydrogen envelope
  - Class III: Hydrogen free?