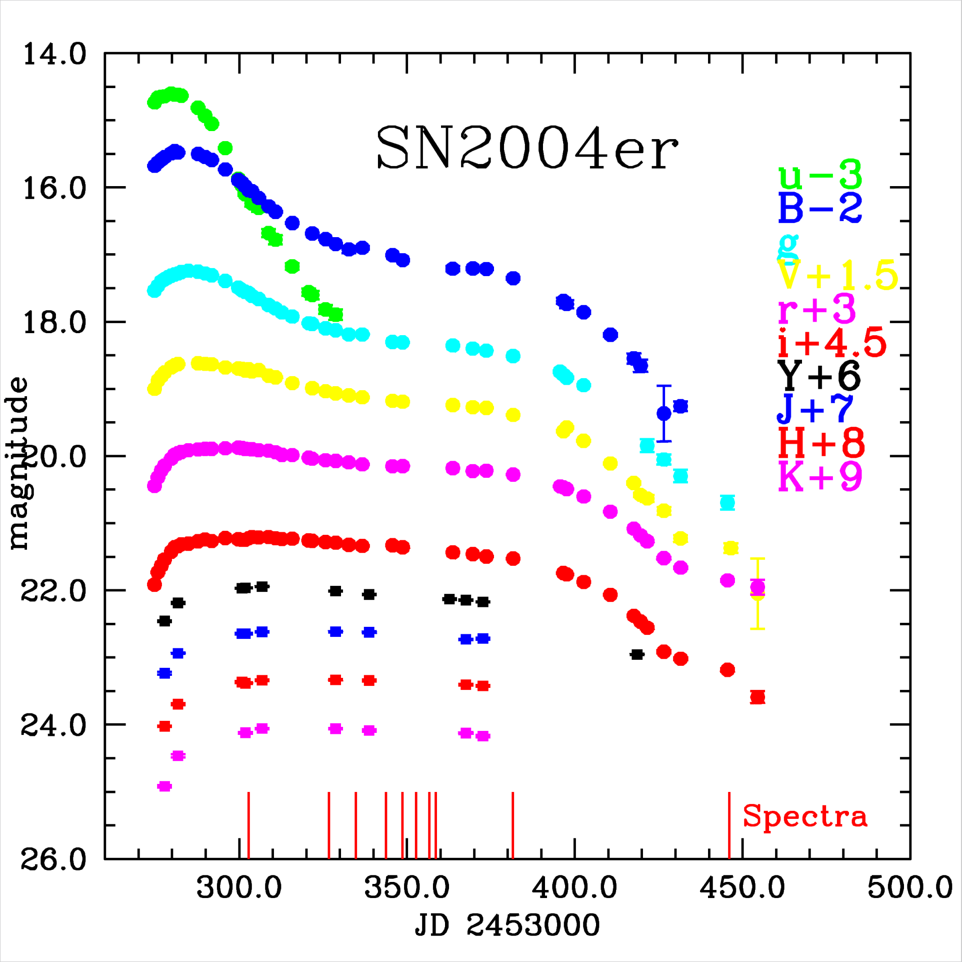
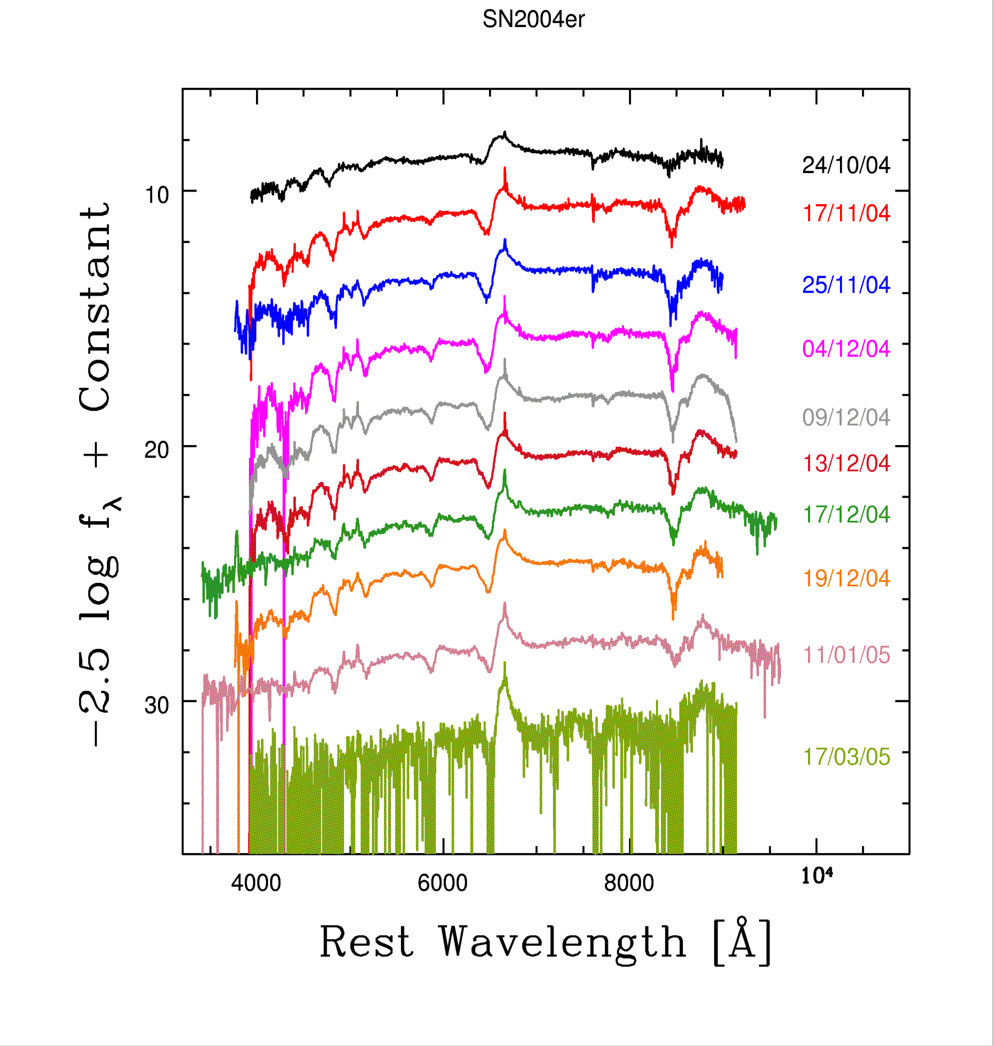
Photometric and spectral correlations of supernovae type II

Joe Anderson (U. de Chile, MCSS)





Overview

- **Observables -> explosions -> progenitors**
- **'Normal' Type II SNe**
  - SNIIn and SNIIb not included
- **Samples of high quality optical photometry and spectra**
  - Carnegie Type II Supernova Survey *(CATS)*: **46 SNe**
  - Carnegie Supernova Project I *(CSPI)*: **71 SNe**
- **Initial light-curve analysis** *(J. Anderson):* **focus on *V*-band**
  - best matched to bolometric light-curve
  - one of best sampled bands
- **Initial spectral analysis** *(C. Gutierrez):* **focus on Hα**
  - most prominent feature in optical spectra

Observations, explosion/progenitor properties

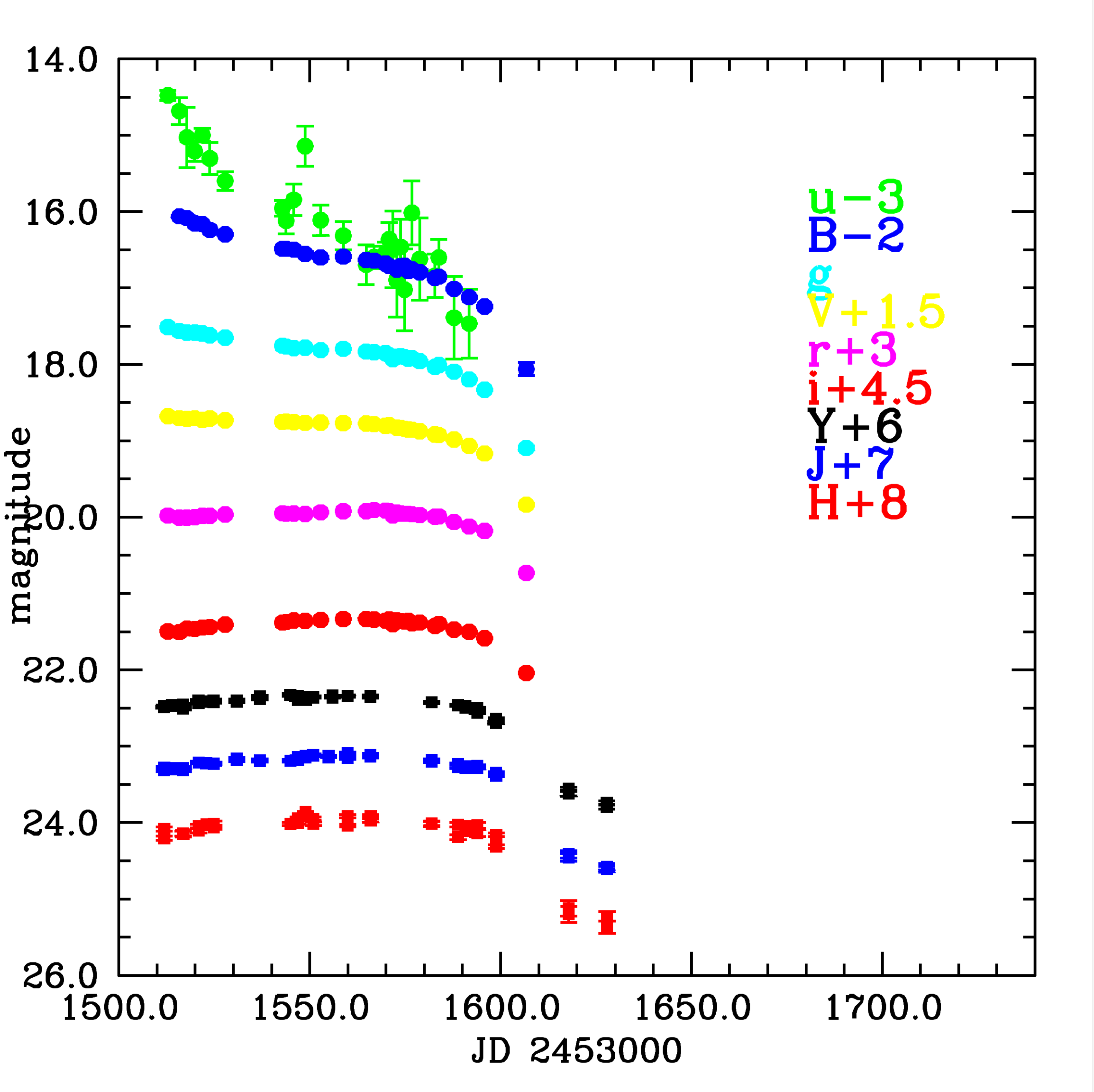
- **Observables**
  - magnitudes, decline rates, colours
  - velocities, line strengths, line appearance
- **Explosion properties**
  - energy, temperature, radius, extent of H envelope, +?
- **Progenitor properties**
  - mass, metallicity, binarity, rotation, +?

- **Overall goal to map observables to explosion properties and progenitor characteristics**

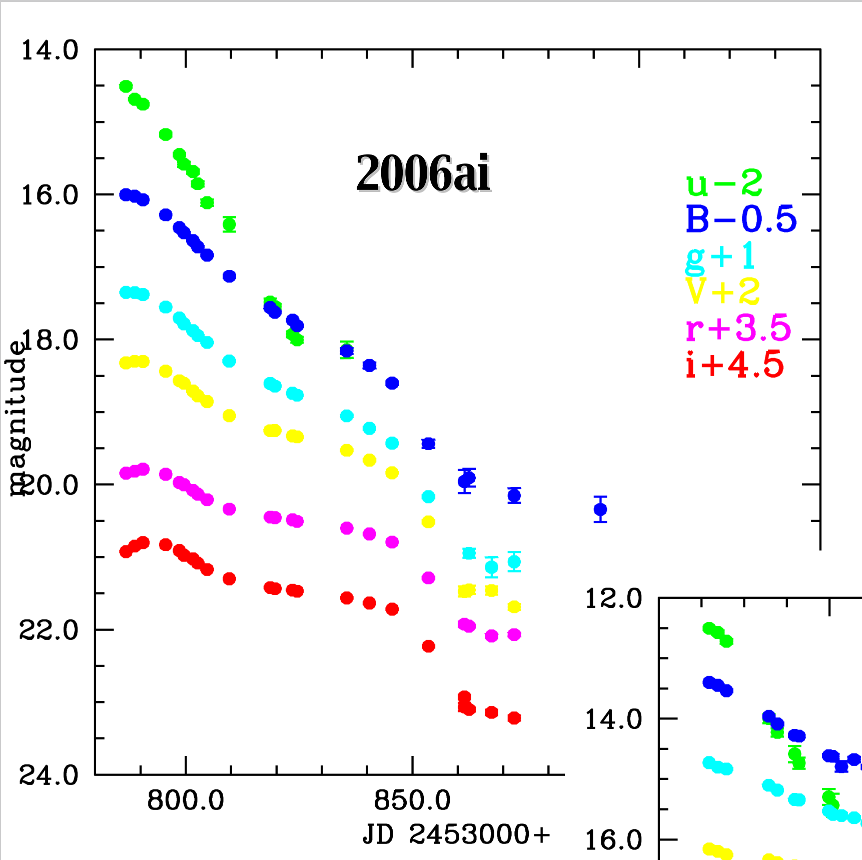
Example light-curves

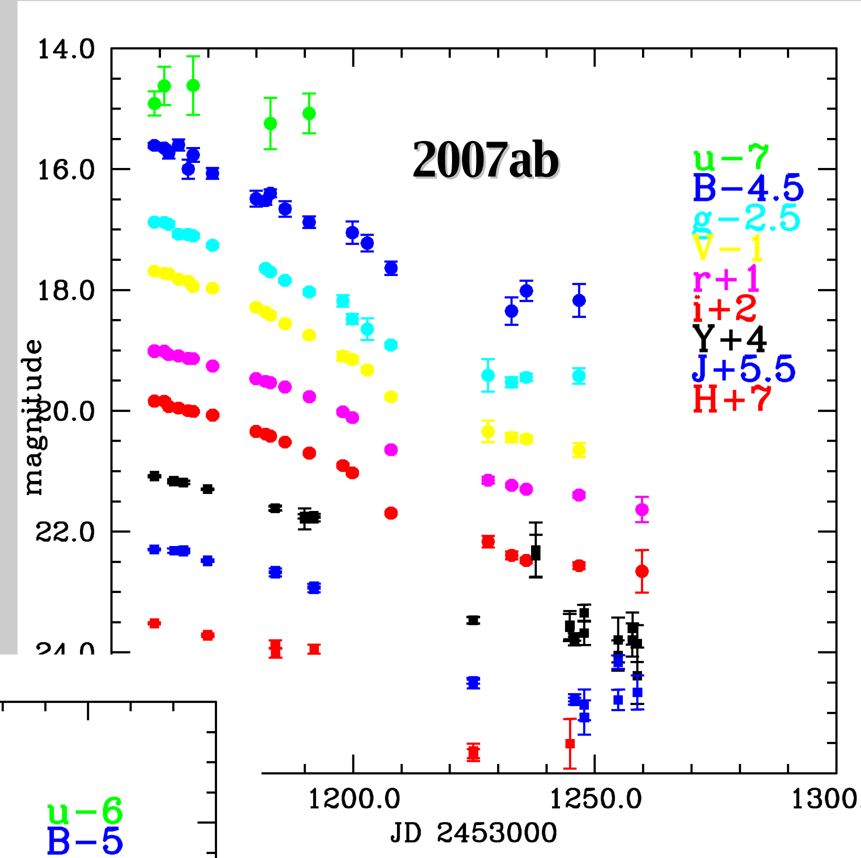
- CSPI: ***ugriBV*** **+** ***YJH****(K)* (CATS: *UBVRI*)

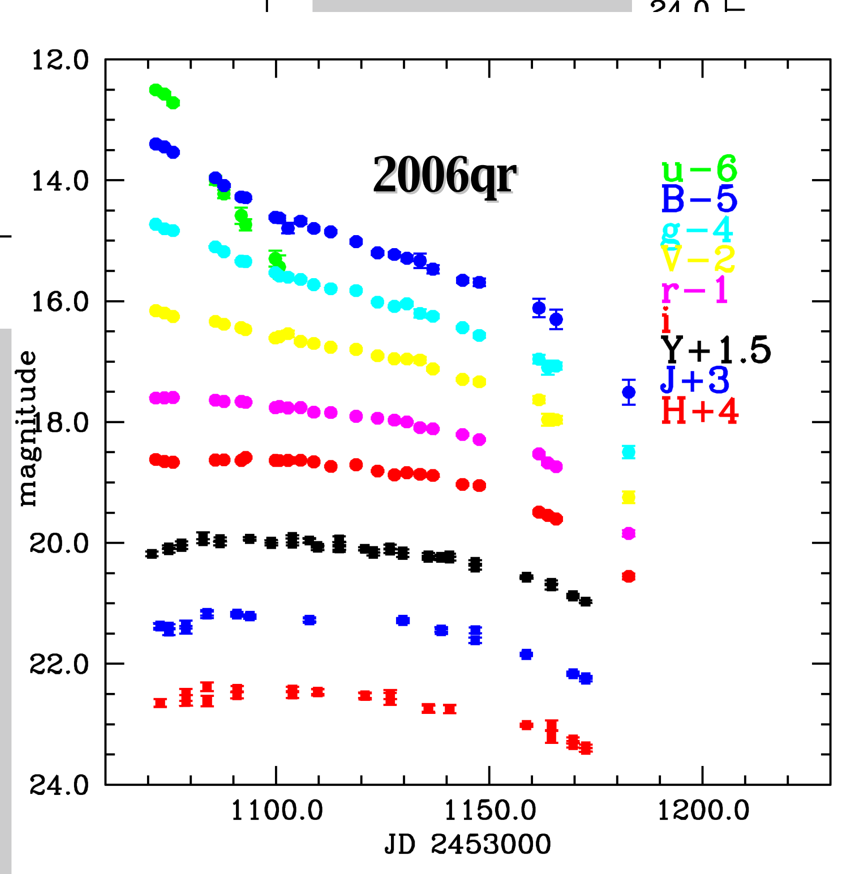
- **SN2008ag: a typical(?) plateau type SN (SNIIP)**
- **How many SNII behave in this textbook way?**



Example light-curves







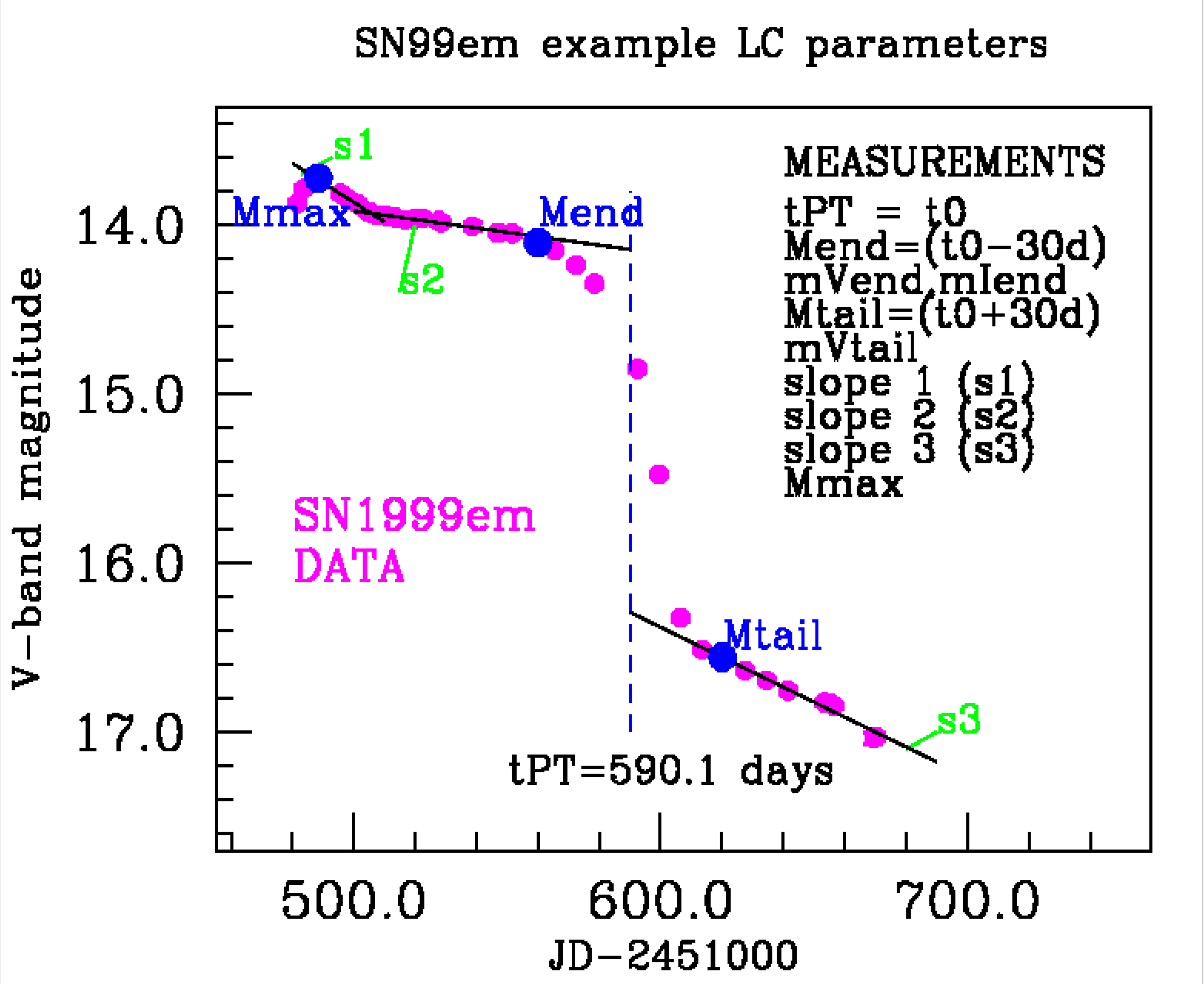
Photometric measurements

- Define 3 magnitudes, 3 decline rates, plus 2 epochs:

- M_{max} = peak
- M_{end} = end of P
- M_{tail} = start of tail

- s1 = initial decline
- s2 = 'P' decline
- s3 = radioactive tail

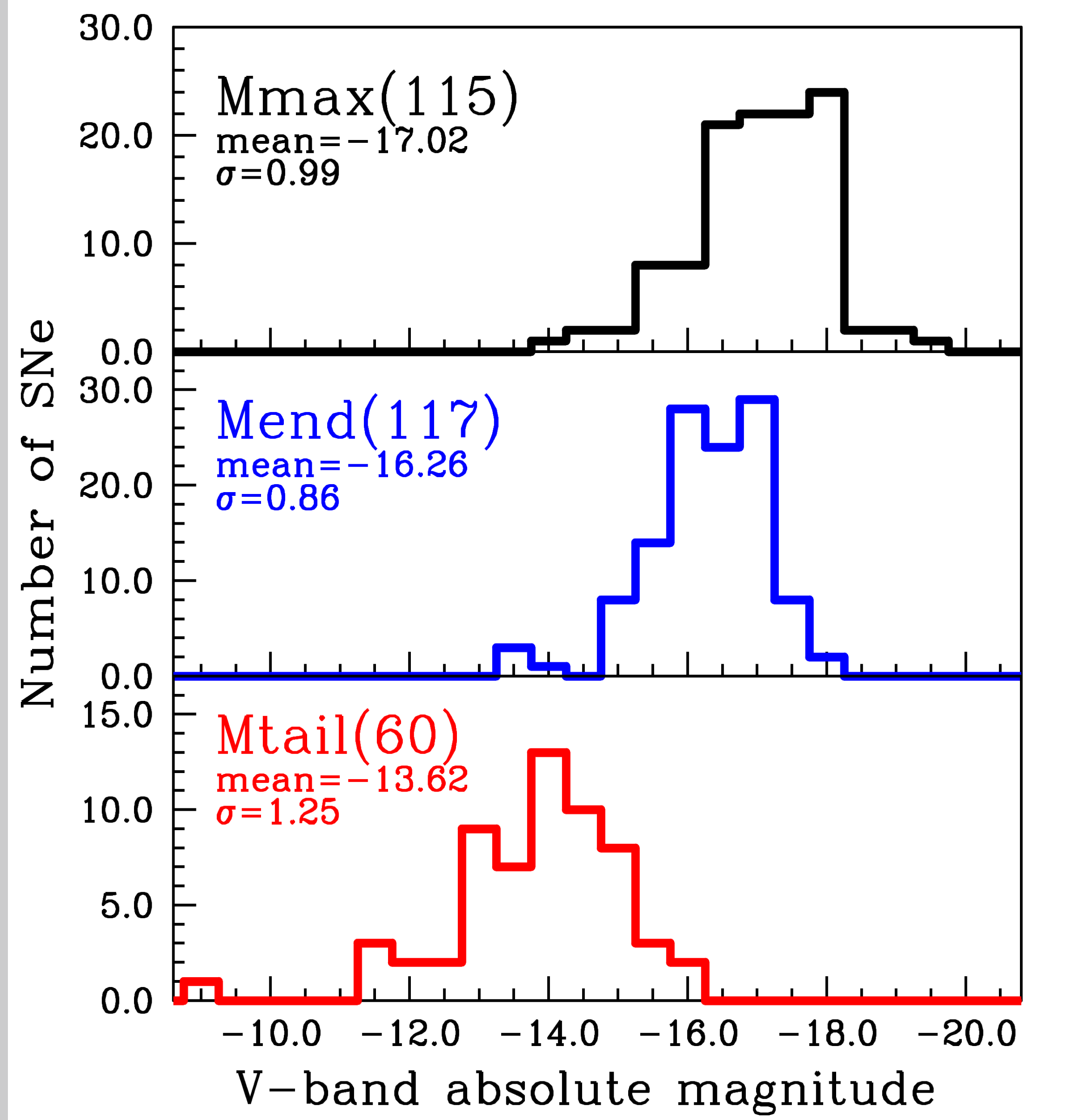
- Epoch 'tPT'
- Epoch 'B-inflec.'



V-band absolute magnitudes

- Magnitudes corrected for host extinction using NaD EWs

- Low luminosity tail to SNII distributions
- Dispersion is smallest at the end of the 'plateau'

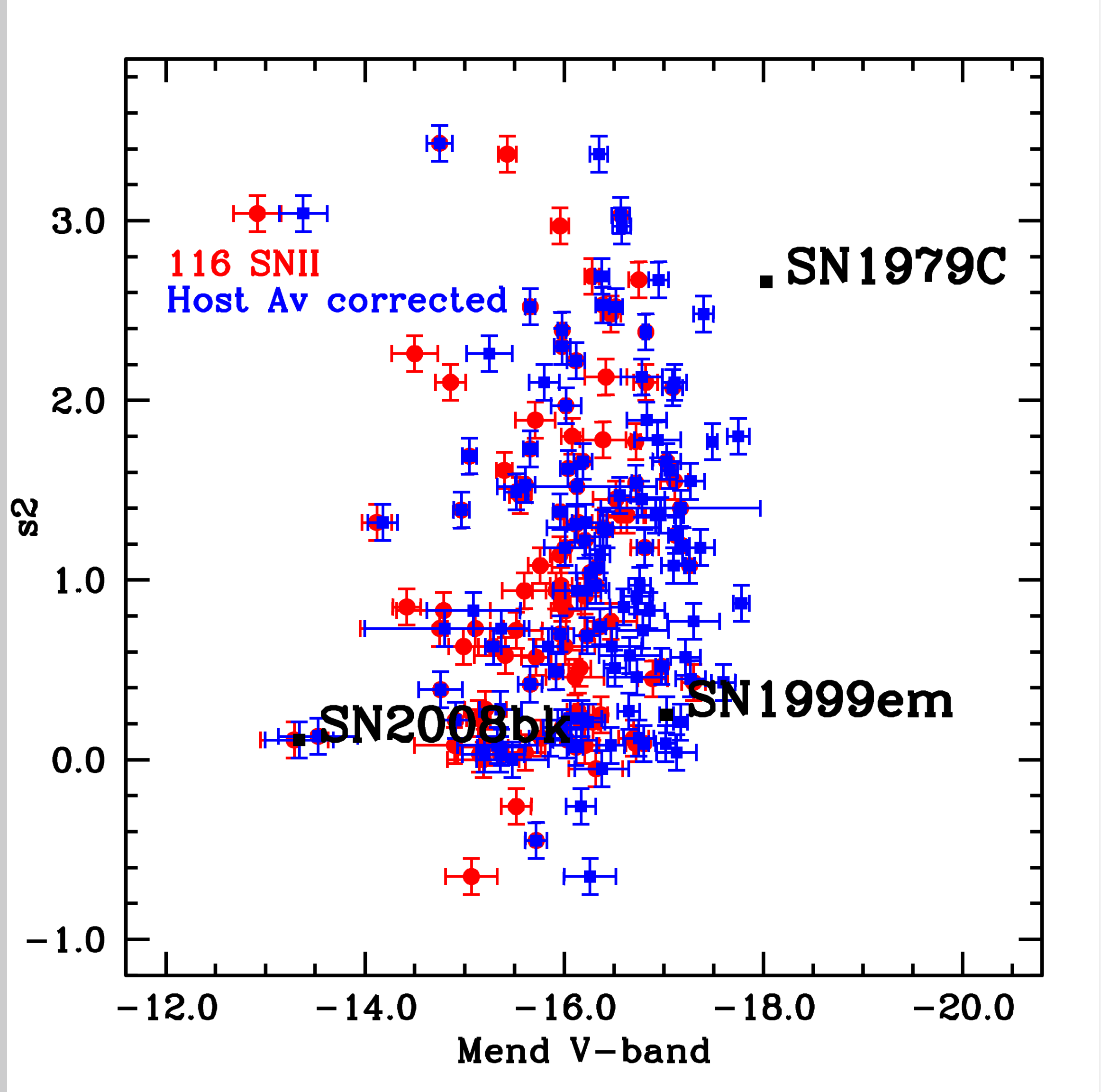


Photometric correlations

- M_{max} is difficult to observe and measure...

- -> end of 'plateau', M_{end} is what people measure
- BUT no correlation with decline rates...

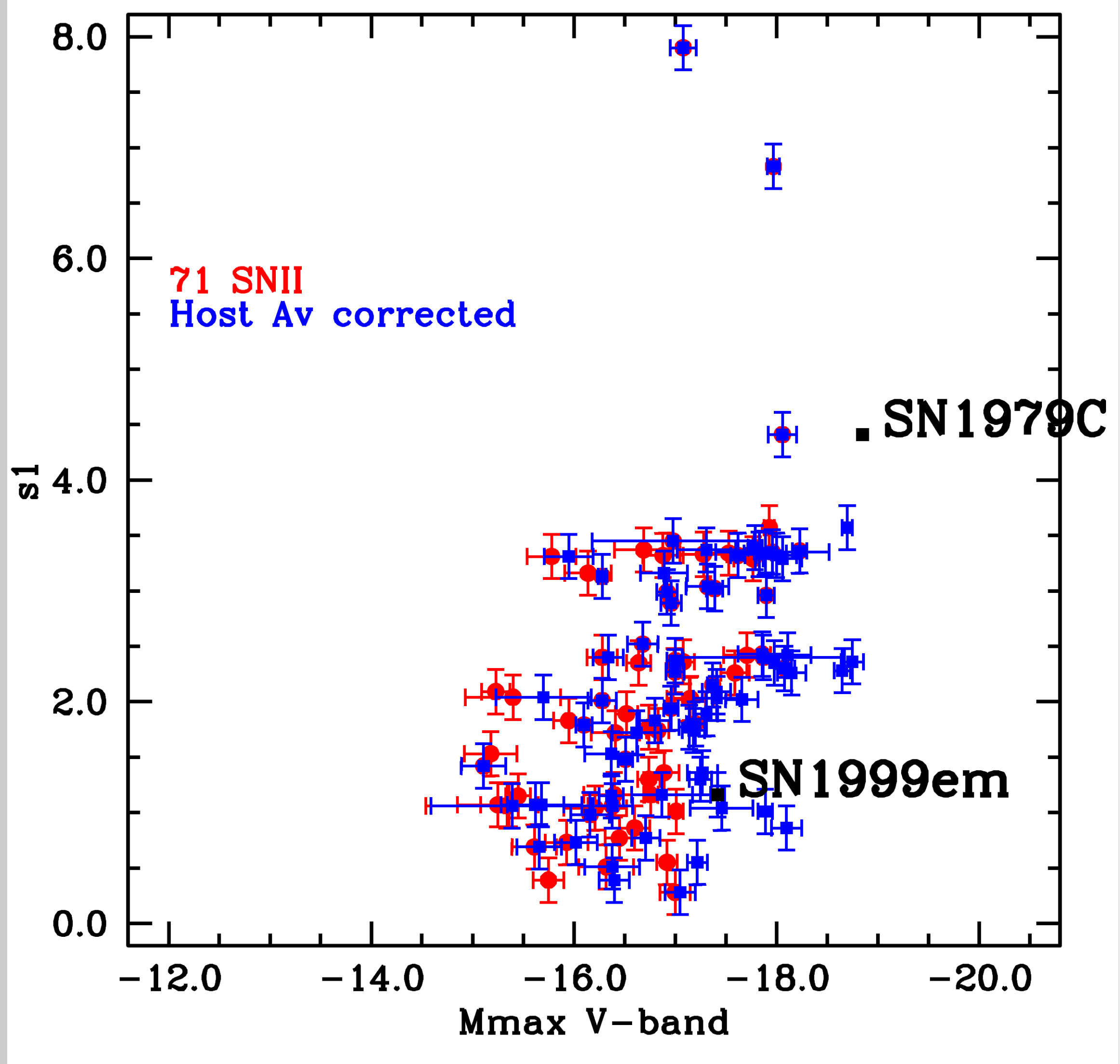
- SN1979C prototype IIL
- However, most extreme SN in most parameters!



Photometric correlations

- Does M_{max} correlate with decline rates?
- Correlation: M_{max} and s1?

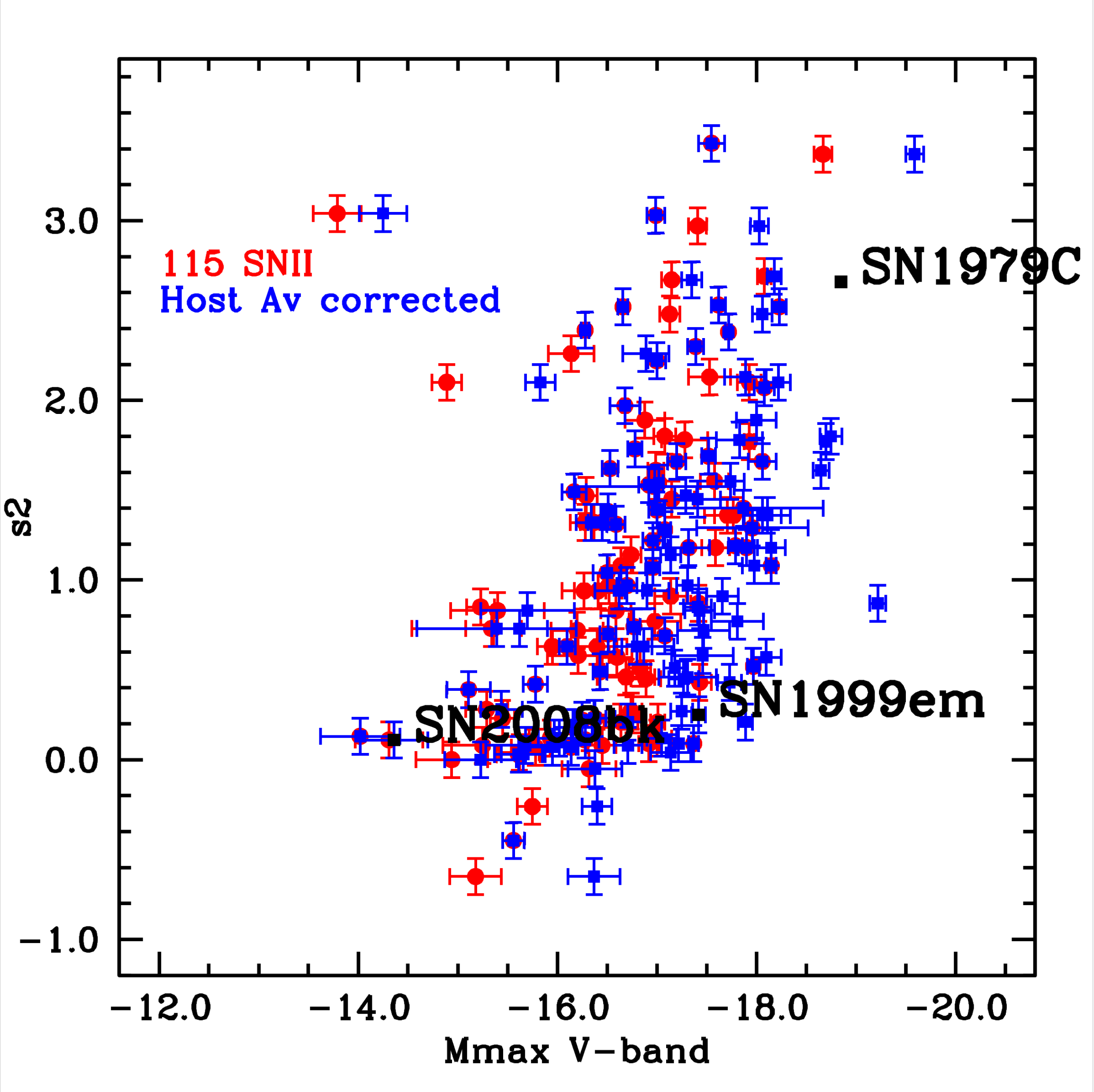
- Often not possible to measure s1
- Often poorly sampled
- 2 SNe with v. fast s1



Photometric correlations

- Brighter SNe (M_{max}) decline more quickly on 'plateau' (s2)

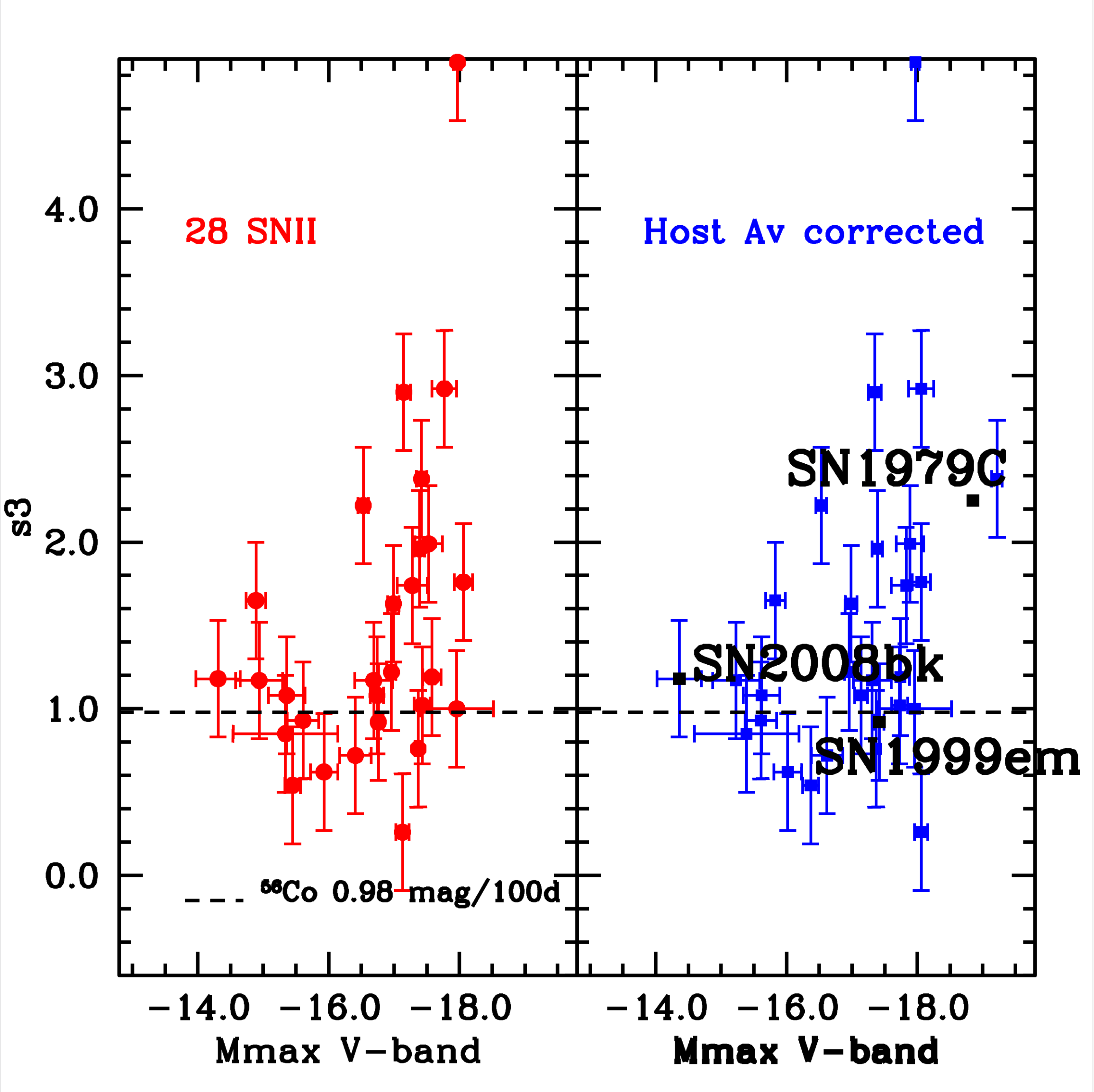
- M_{max} more important for describing diversity
- Bulk of SNII population decline faster on 'plateau' than SN1999em!



Photometric correlations

- s3 should follow ^{56}Co decline rate if full trapping...

- Higher M_{max} faster s3?
- More luminous SNe have less massive ejecta and hence no full trapping?



Photometric summary

- Brighter objects at maximum evolve more quickly
- M_{max} more important than M_{end} for diversity
- SN1999em not so typical in terms of decline rate?

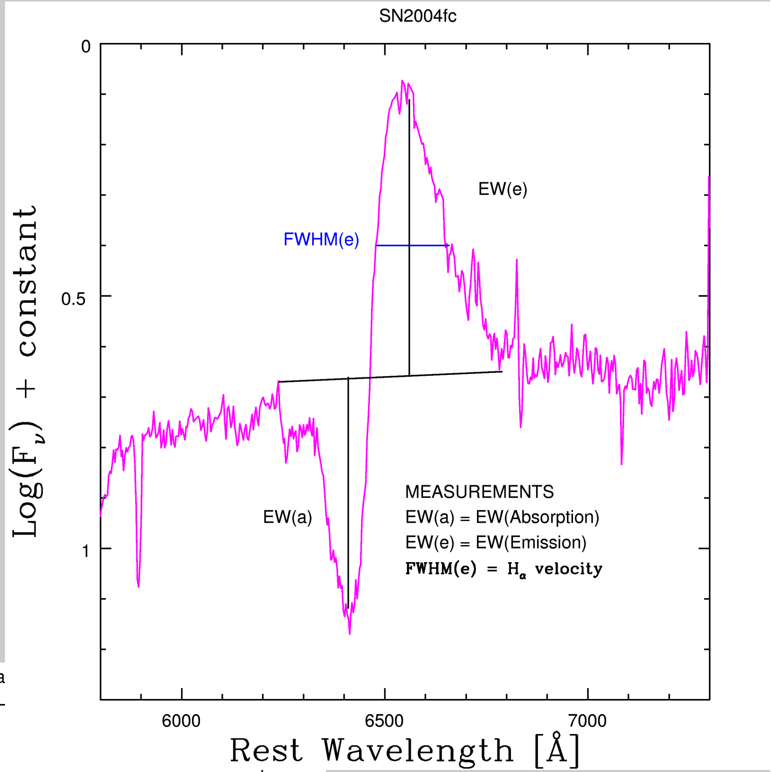
- What are dominant explosion properties controlling these?
  - energy?
  - radius?
  - temperature?
  - +?

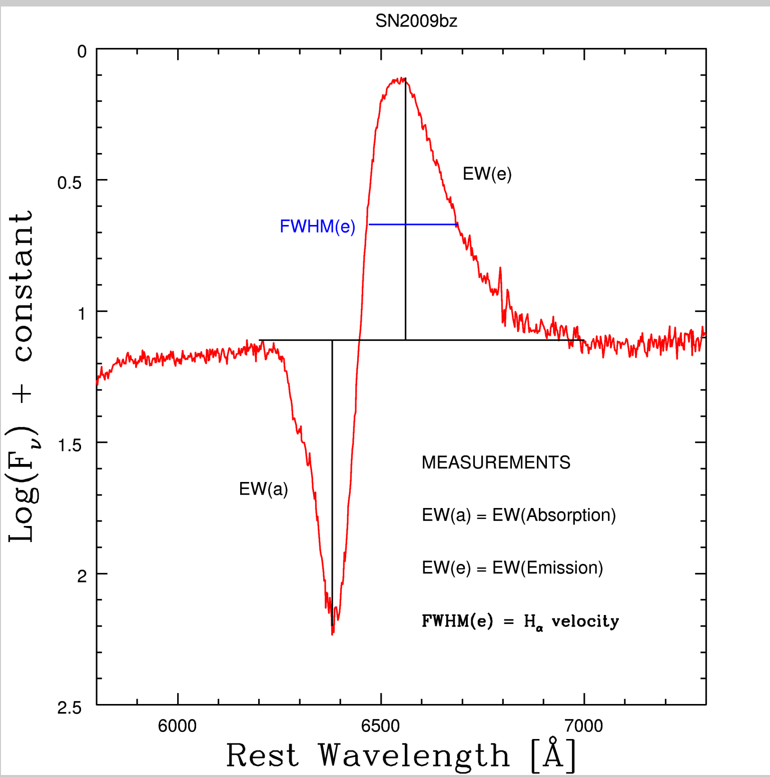
- How are these related to progenitor properties?

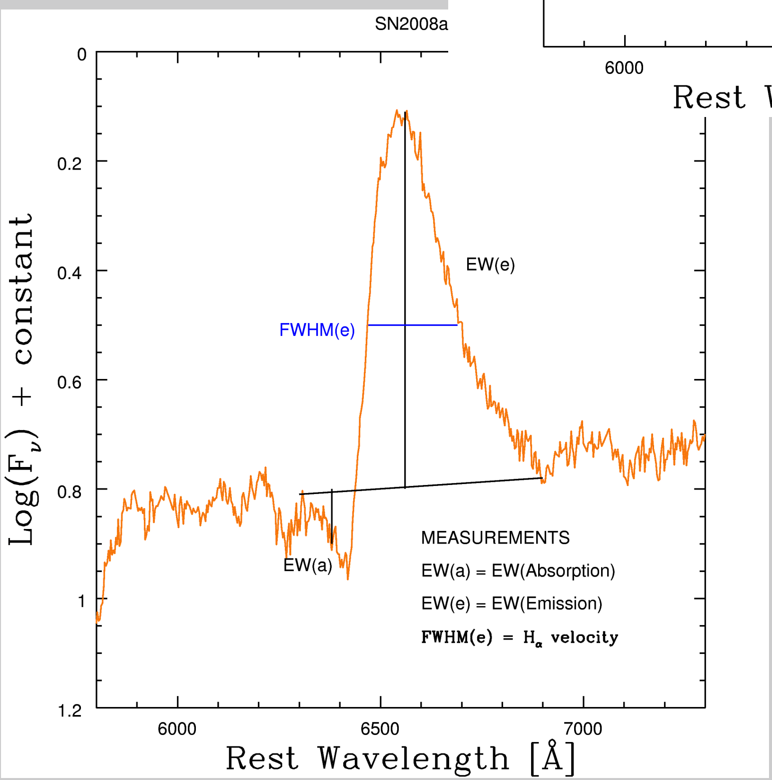
Measured spectral properties

(Claudia Gutierrez)

- **2 Hα measurements defined:**
  - velocity: FWHM of emission
  - EW of absorption/emission





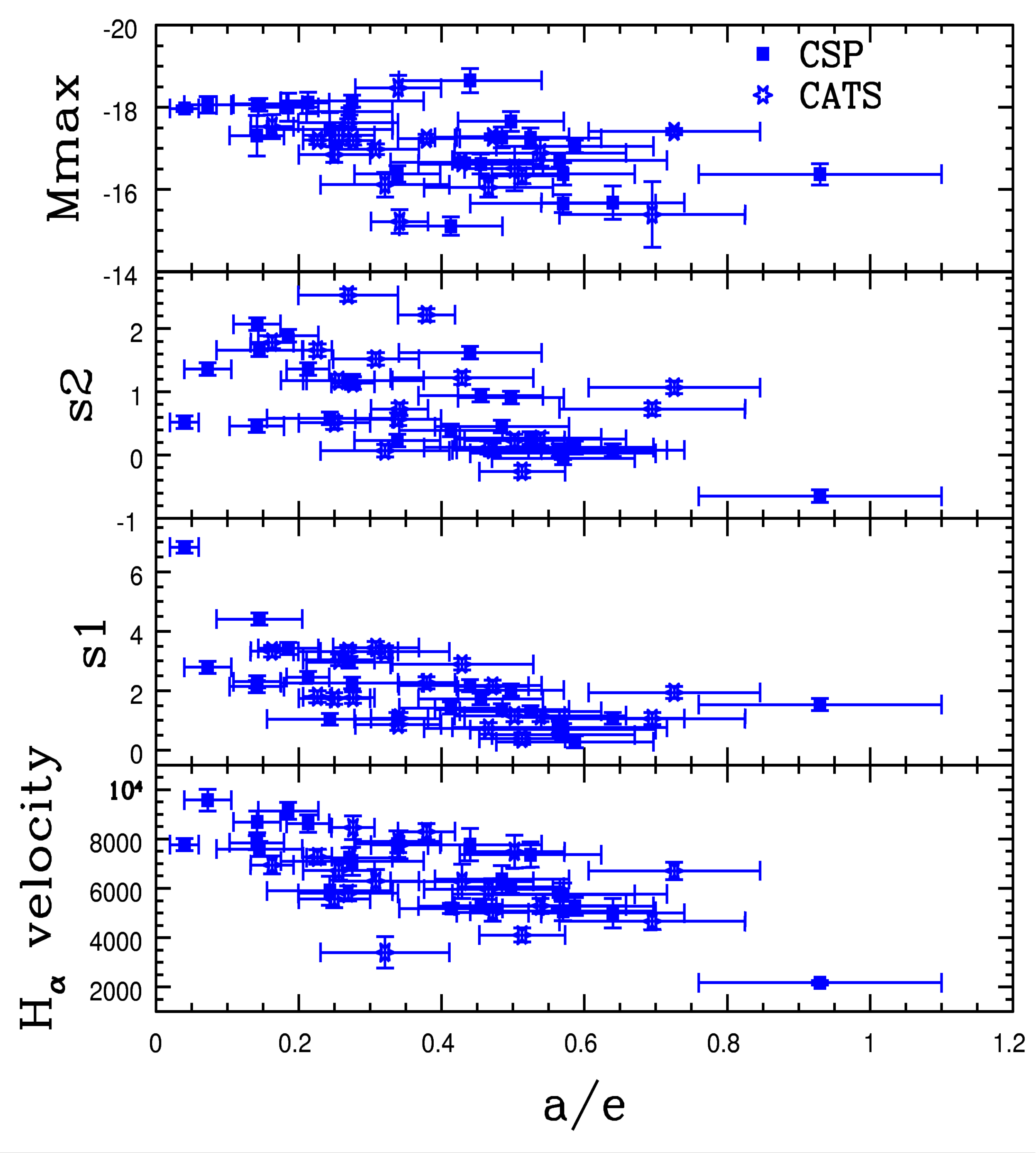


Photometric and spectral correlations

(Claudia Gutierrez)

- SNe with less a to e decline more quickly; have brighter peak mags. and higher ejecta velocities

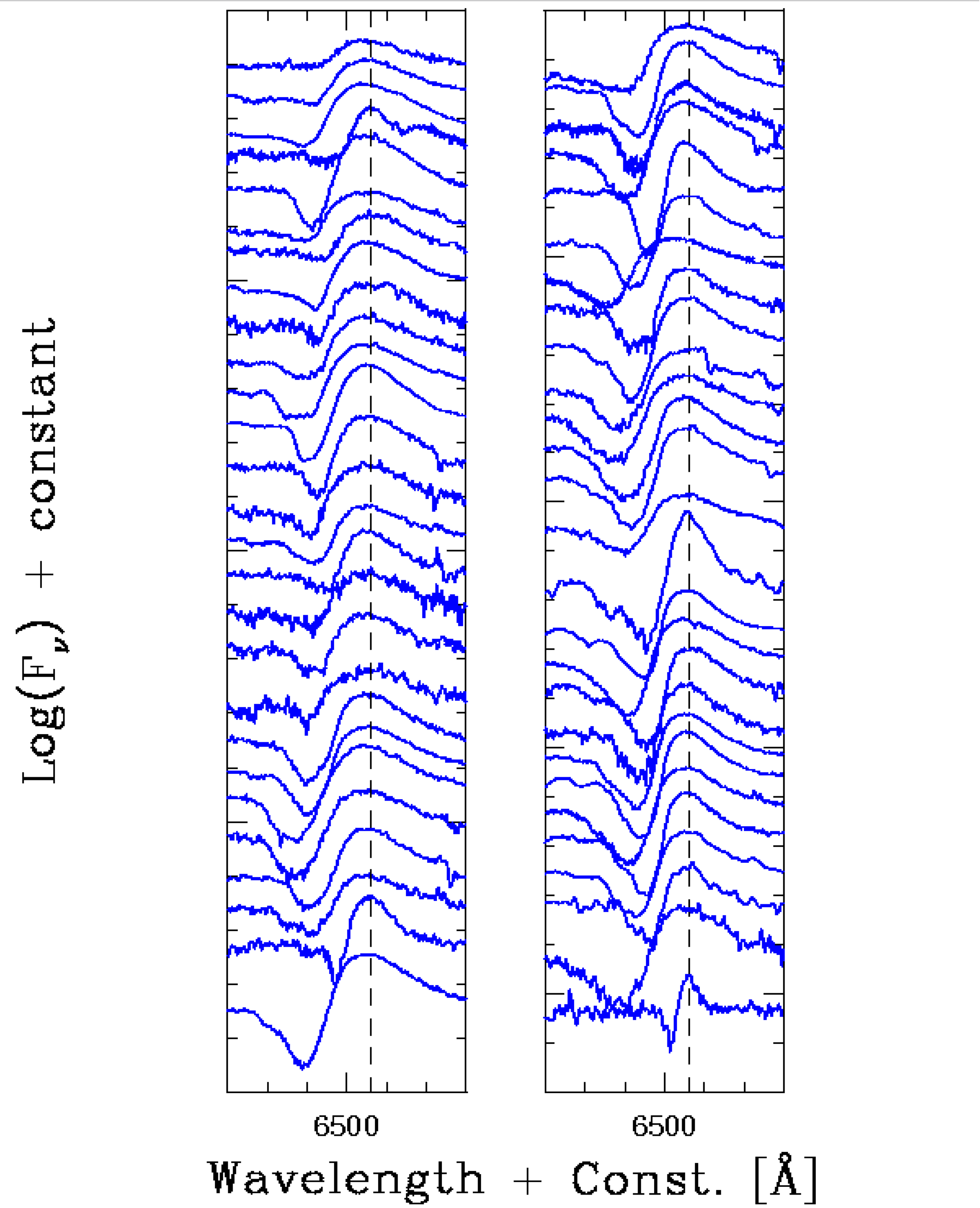
- How to explain these through physical properties?



Photometric and spectral correlations

(Claudia Gutierrez)

- Hα profiles, ordered in increasing a/e
- Some order: correlation with velocities
- BUT, large range in line profiles...



Summary/conclusions?

- **First steps to characterise common properties of SNII**
- **Brighter SNe decline more quickly**
- **Spectral properties also show correlations with light-curves**

- **Can we relate these to common explosion properties and progenitor scenarios?**

- **One possible scenario...**

  - higher mass progenitors -> more energetic explosions
  - higher mass progenitors -> smaller ejecta masses, smaller radii
  - THERFORE(?) -> higher velocities, lower a/e
    -> faster light-curves, at all times...

Where to go next?

- **Multi-colour light-curve analysis**
- **Other spectral features and time evolution**
  - PCA analysis with Eric?
- **Cosmology with SNII**
- **'Wierdos'**
- **Detailed studies of individual objects**

- **Key to tie down the physical origin of correlations**
- **Light-curve modeling: collaborate with IPMU!**
- **Spectral modeling: collaboration with Luc Dessart**