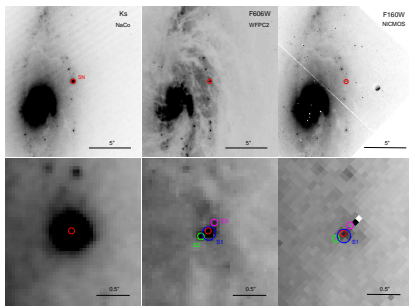


# Supernova 2010as and Flat-Velocity Type IIb SNe

Gastón Folatelli

Kavli IPMU, University of Tokyo

June 29, 2014



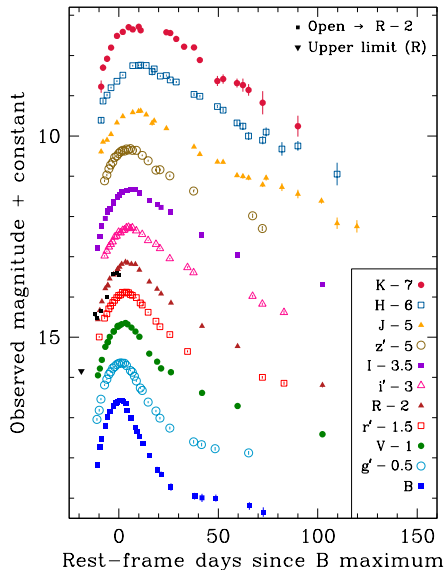
# Supernova 2010as

## Facts

- Host: NGC 6000, starburst
- Distance  $\approx 27$  Mpc
- $< 500$  pc from nucleus
- Type Ib/c “transitional”
- Early spectroscopy by MCSS/CSP
- *HST* archival imaging

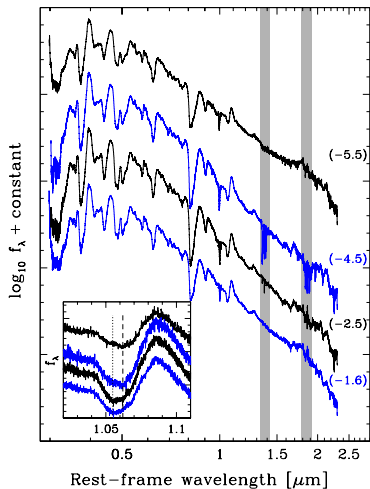
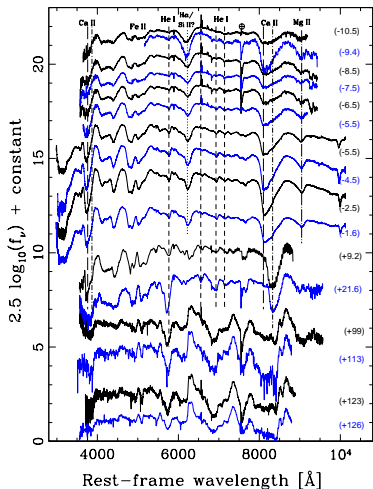
## Photometry

- PROMPT *BVRI, g'r'i'z'*
- GROND *JHK*
- 7 d from last non-detection



# Supernova 2010as – Spectra

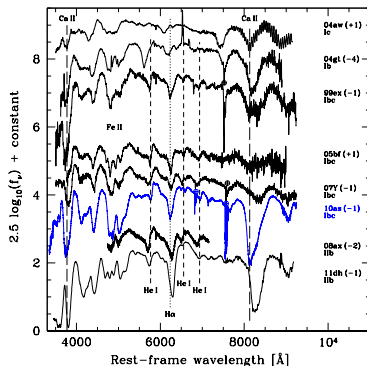
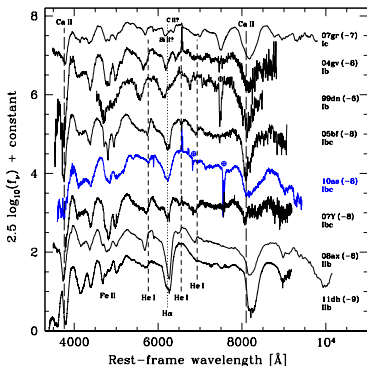
- Optical every night  $[-11:-1]$  d; NIR from X-Shooter; Nebular



# Supernova 2010as – Spectroscopic Classification

## Transitional Ic $\rightarrow$ Ib SN?

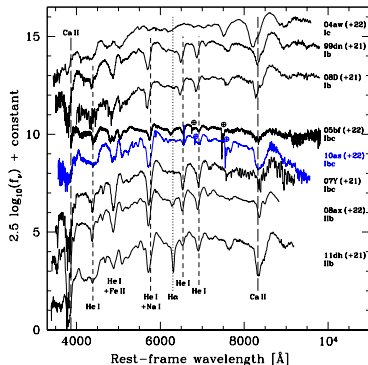
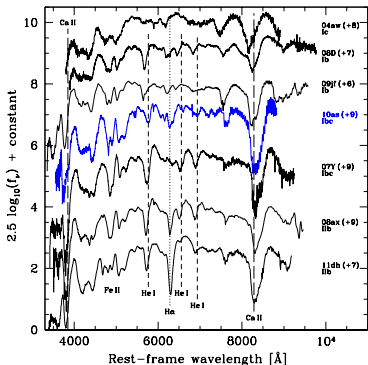
- Similarities with “transitional Ib/c” SNe
- Weak He – Hydrogen – HV Ca II Fe II
- SNe 1999ex, 2005bf, 2007Y – But very different photometrically



# Supernova 2010as – Spectroscopic Classification

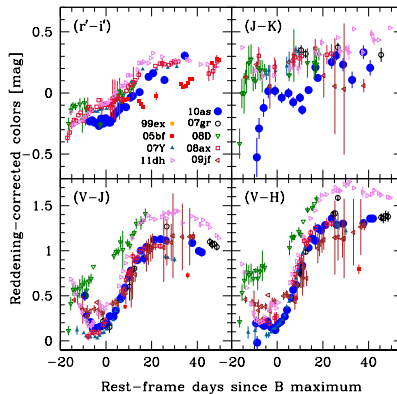
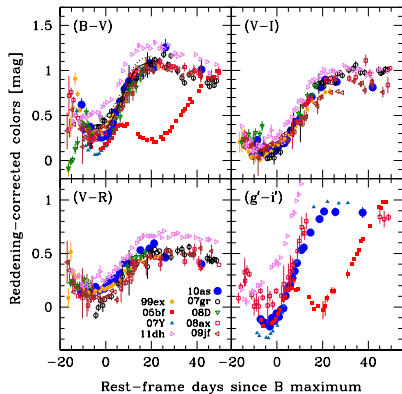
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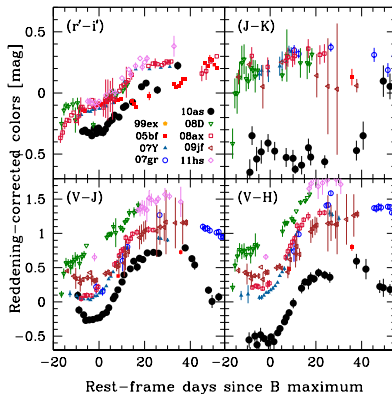
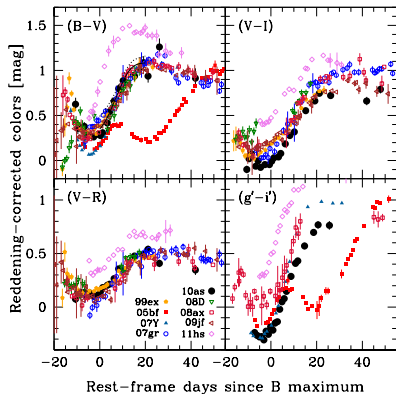
# Supernova 2010as – Color and Reddening

- Reddening from Francesco's  $(B - V)_0$  on CSP sample
- $E(B - V)_{\text{host}} = 0.42$  mag; verified with Balmer decrement
- Reddening-law parameter  $R_V \approx 1.5$



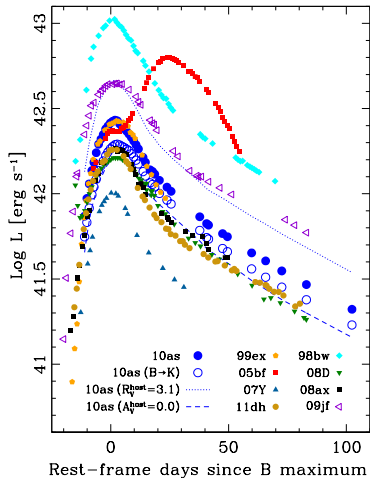
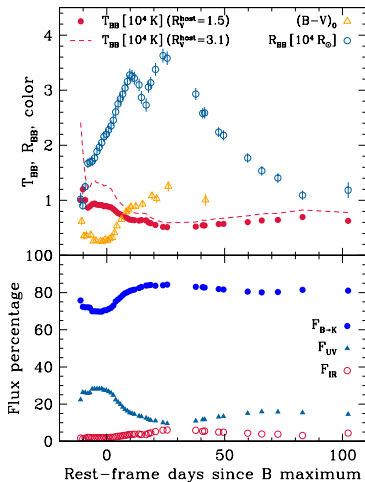
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# Supernova 2010as – Bolometric Light Curve

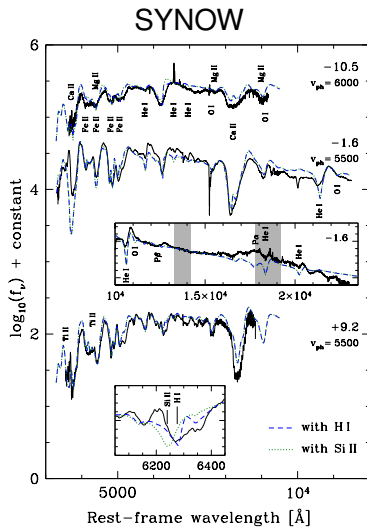
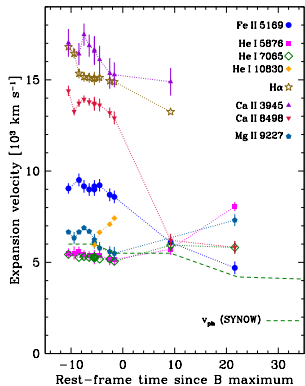
- Integrated  $B \rightarrow K$  ( $>70\%$ ) + UV and IR extrapolations





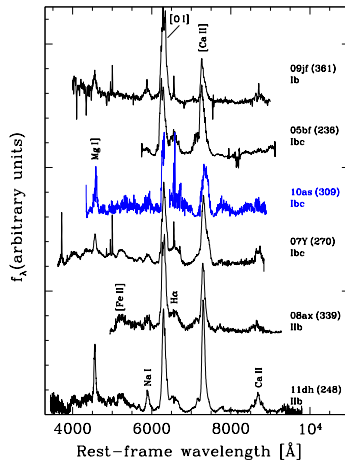
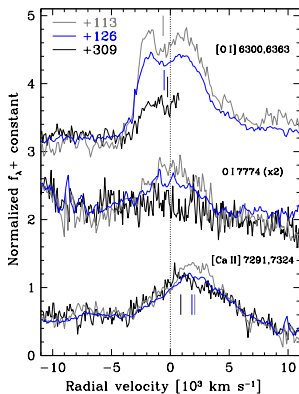
# Supernova 2010as – Spectroscopic peculiarities

- Very weak He early-on, hydrogen
- High-vel. Ca II, Fe II, H I
- Low photospheric velocity



# Supernova 2010as – Nebular Phase

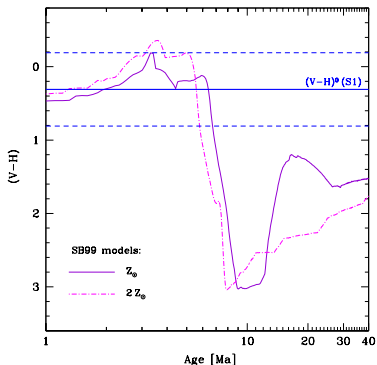
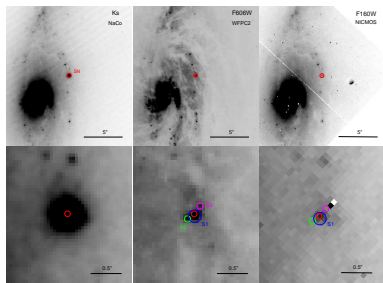
- Split [O II] line
- Redshift of [Ca II]
- Hydrogen dubious unlike 07Y, 05bf



# Supernova 2010as – Progenitor

## Pre-SN object from HST

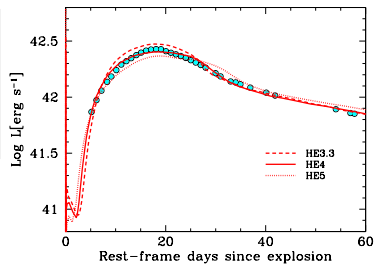
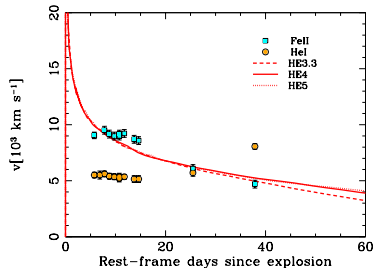
- HST F606W and F160W
- Triple source at SN location
- SPP models – Age – ZAMS mass
- Single star burst  $M_{\text{ZAMS}} > 28 M_{\odot}$
- Compatible with WR



# Supernova 2010as – Progenitor

## Hydro models (Bersten+'11)

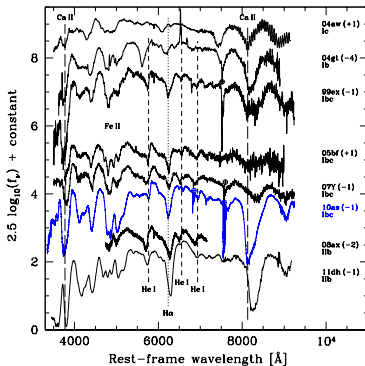
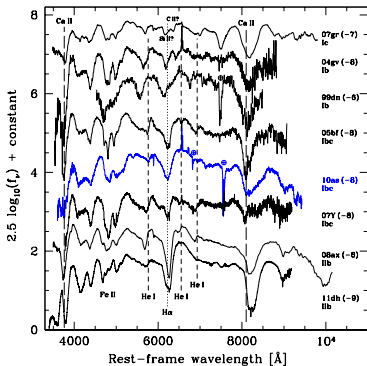
- 1-D Hydro explosion of He stars
- LC is fit by low mass ( $4 M_{\odot}$ )
- Velocities appear too low



- Incompatible with single, massive (e.g. WR) star.
- Binary progenitor may reconcile with young age

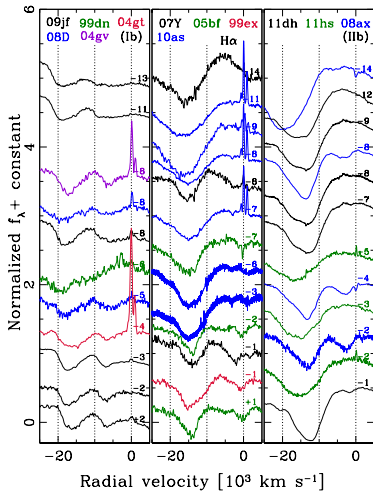
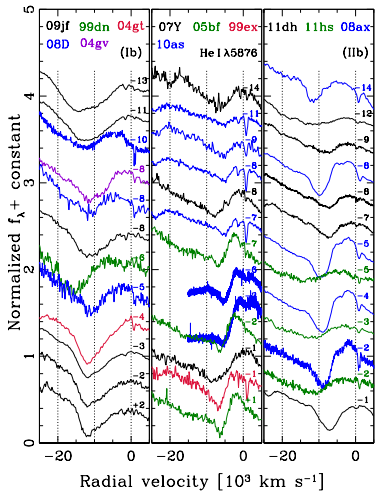
# Peculiar Type IIb SNe

- Transitional Ib/c are Type IIb with peculiar He-line evolution



# Peculiar Type IIb SNe

- Transitional Ib/c are Type IIb with peculiar He-line evolution



# Flat-Velocity Type IIb SNe

- He I velocities are low and flat
- Dense shell?
- Correlated with luminosity?
- RMS  $\approx 0.3$  mag T.B.C.

