SN 2013fc: the big brother of SN 1998S

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Type II SNe

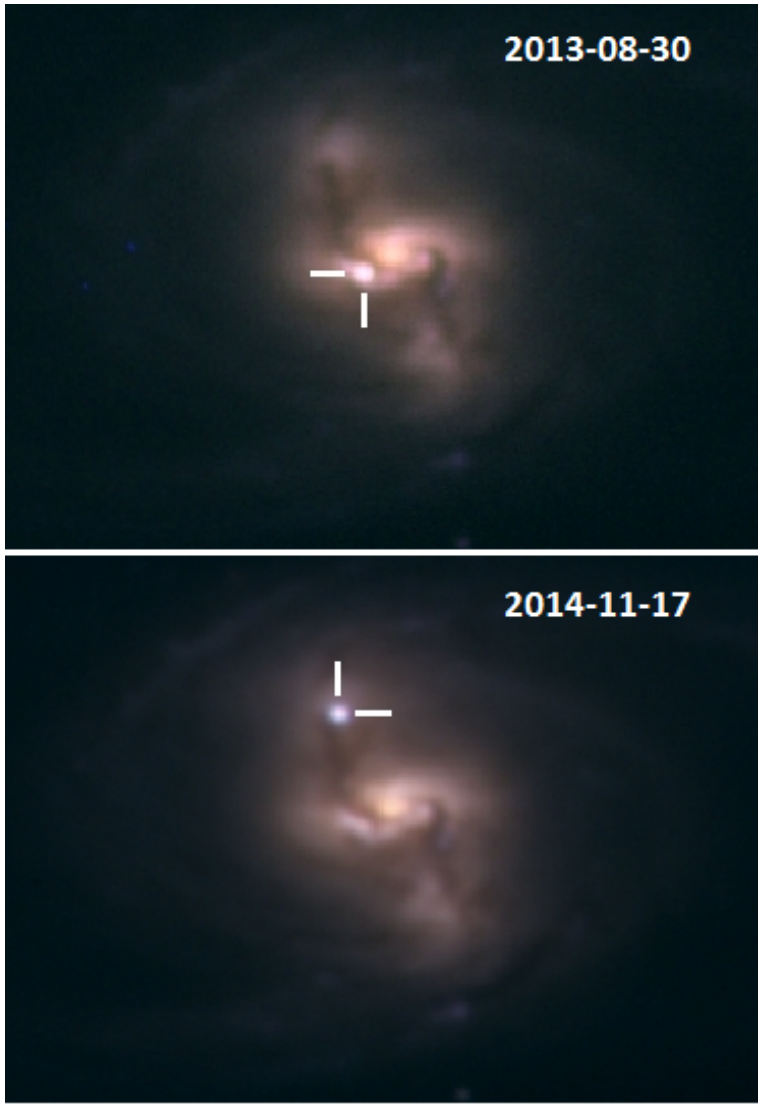
- Main CCSN types: type Ib/c (no H), type II (H); divided into subtypes
- II-P (plateau), II-L (linear), IIn (narrow lines), IIb (turns into Ib)
- Historical division between II-P and II-L, but continuum between subtypes(?)
- Lower H envelope mass $\rightarrow$ shorter plateau, few truly linear events
- CSM interaction involved in some II-L

SN 1998S

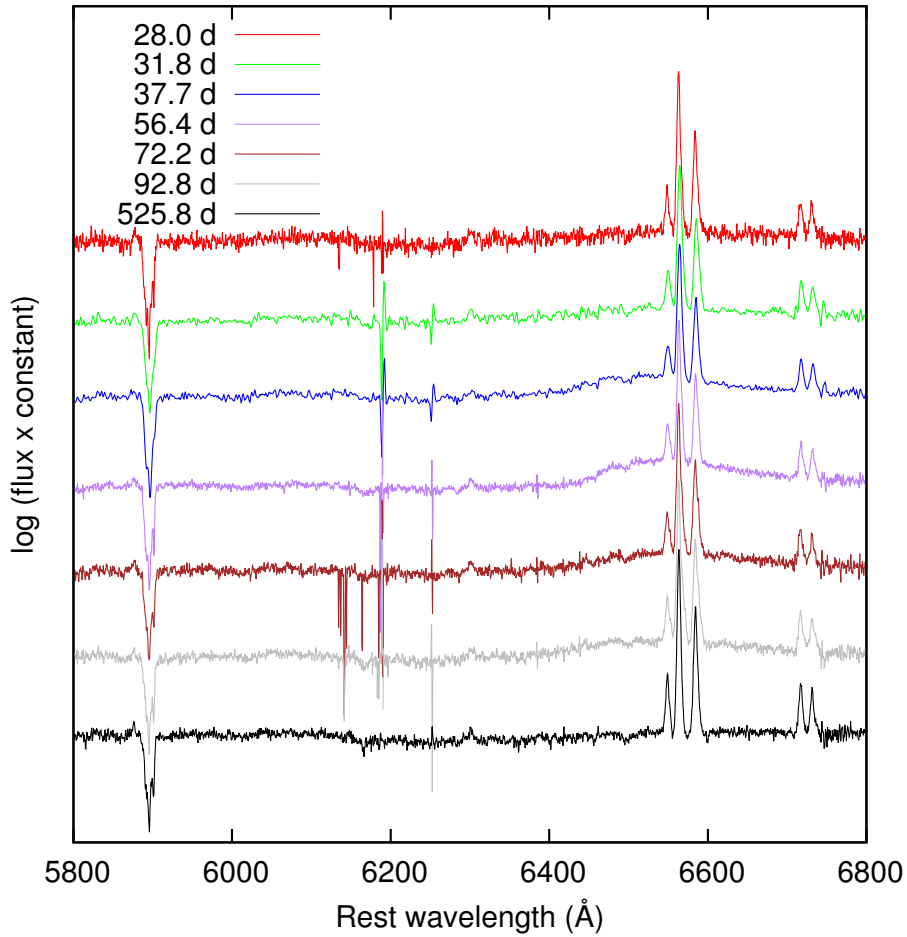
- One of the brightest and best-studied IIn events
- II-L-like: fast linear decline, short plateau
- Long-lasting IR emission from dust (mostly pre-existing?)
- Fassia+ 2000 & 2001: significant CSM interaction due to high recent mass loss
- Mauerhan+ 2012: RSG progenitor, mass loss due to wind
- Similar events: 1979C, 2008fq...

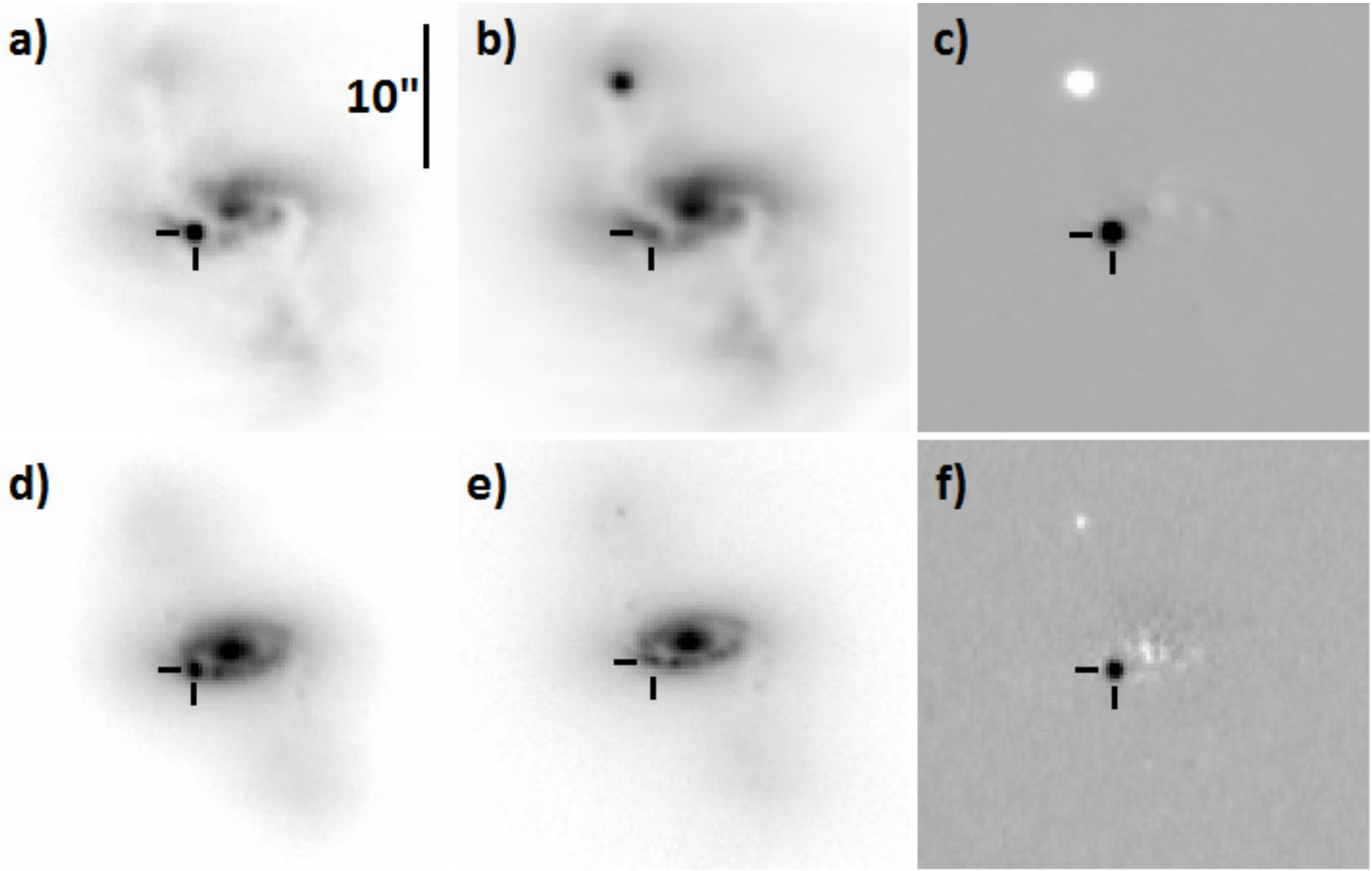
Observations of 2013fc

- Discovered by CHASE on 2013-08-20 in ESO 154-G10
- Follow-up as part of PESSTO with SALT, NTT, ANU 2.3m, LCOGT + smaller telescopes until March 2014
- Template images and IFU spectrum of the galaxy taken later due to tricky location

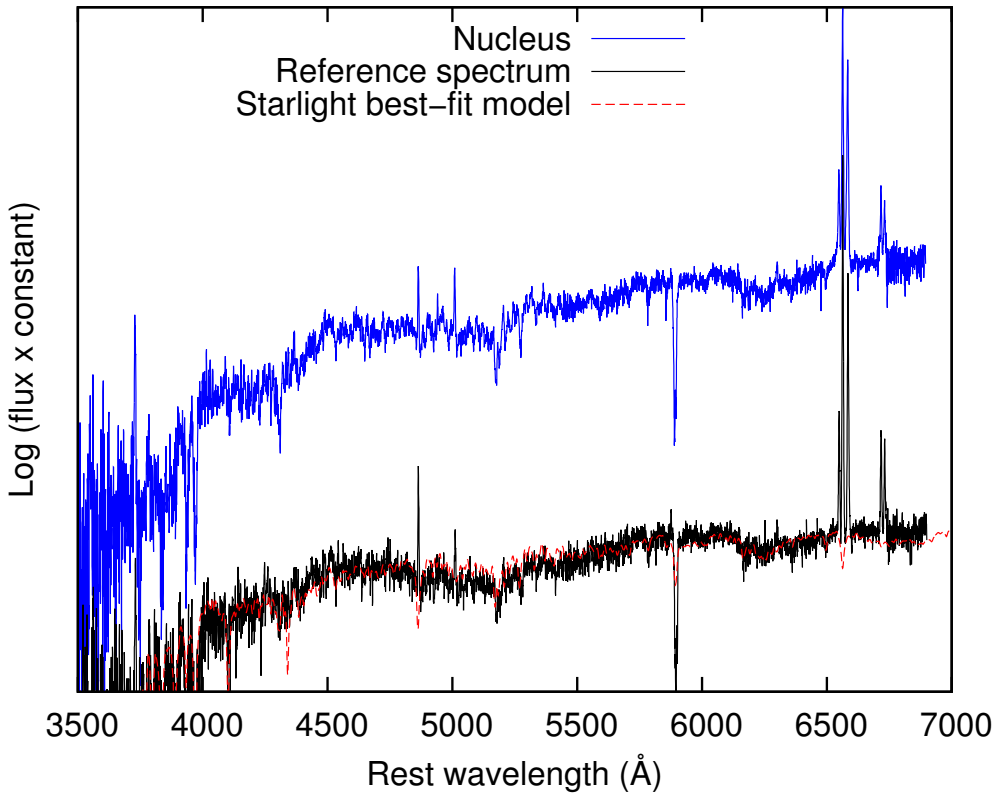


- Narrow lines from the start, but include forbidden lines and don't change → galaxy contamination
- Na I D: high extinction

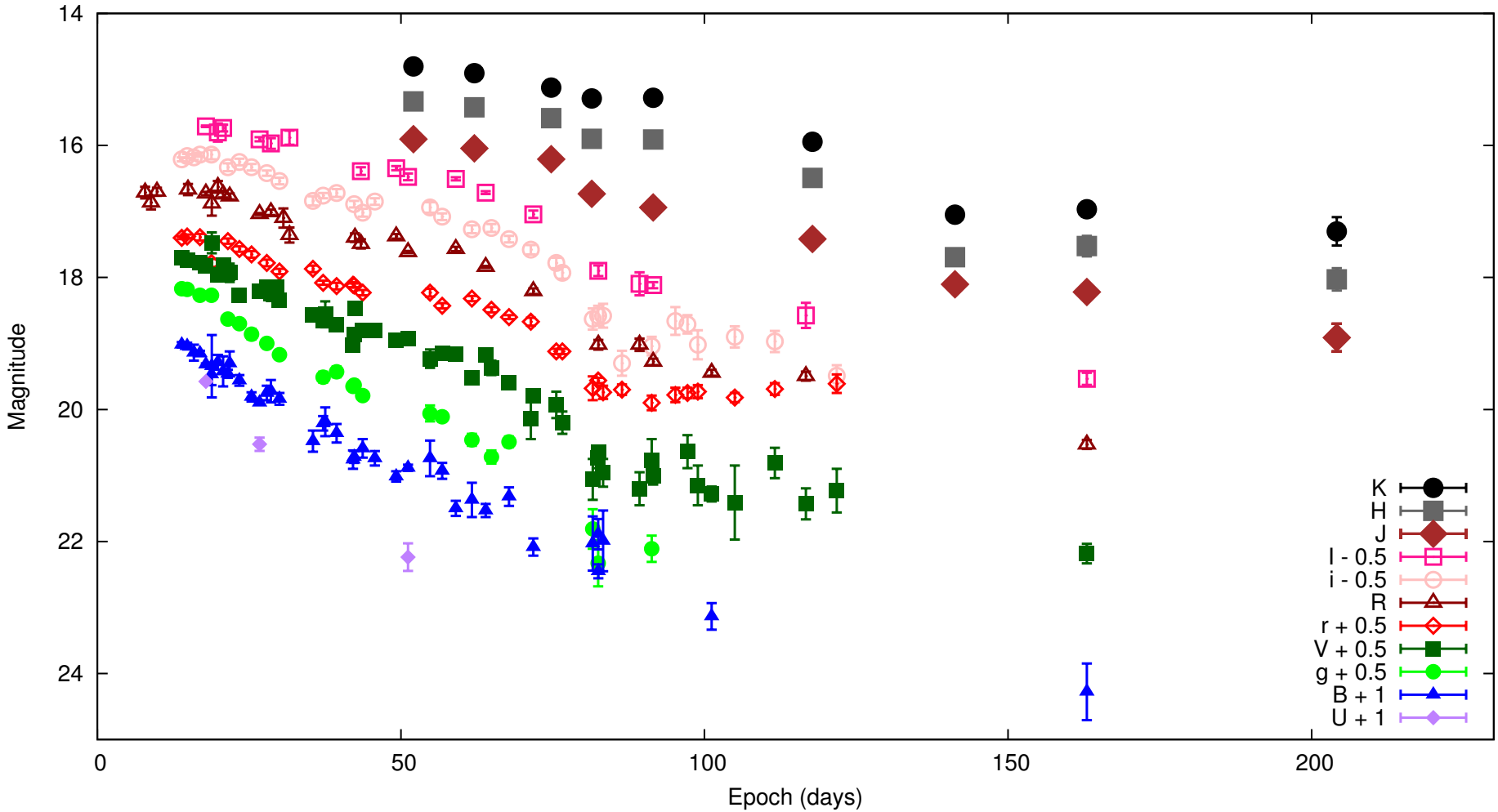



a)
10"
b)
c)
d)
e)
f)

- ESO 154-G010 barely a LIRG
- Narrow lines not narrow enough for a normal H II region: LIRG outflow or AGN?
- Core spectrum inconsistent with AGN (Kewley+ 2006)
- Stellar population fit to background spectrum: mix of $\sim$10 Myr and much older populations
- Balmer decrement after fit subtraction: $A_V \sim 2.9$



LC and spectra of 2013fc



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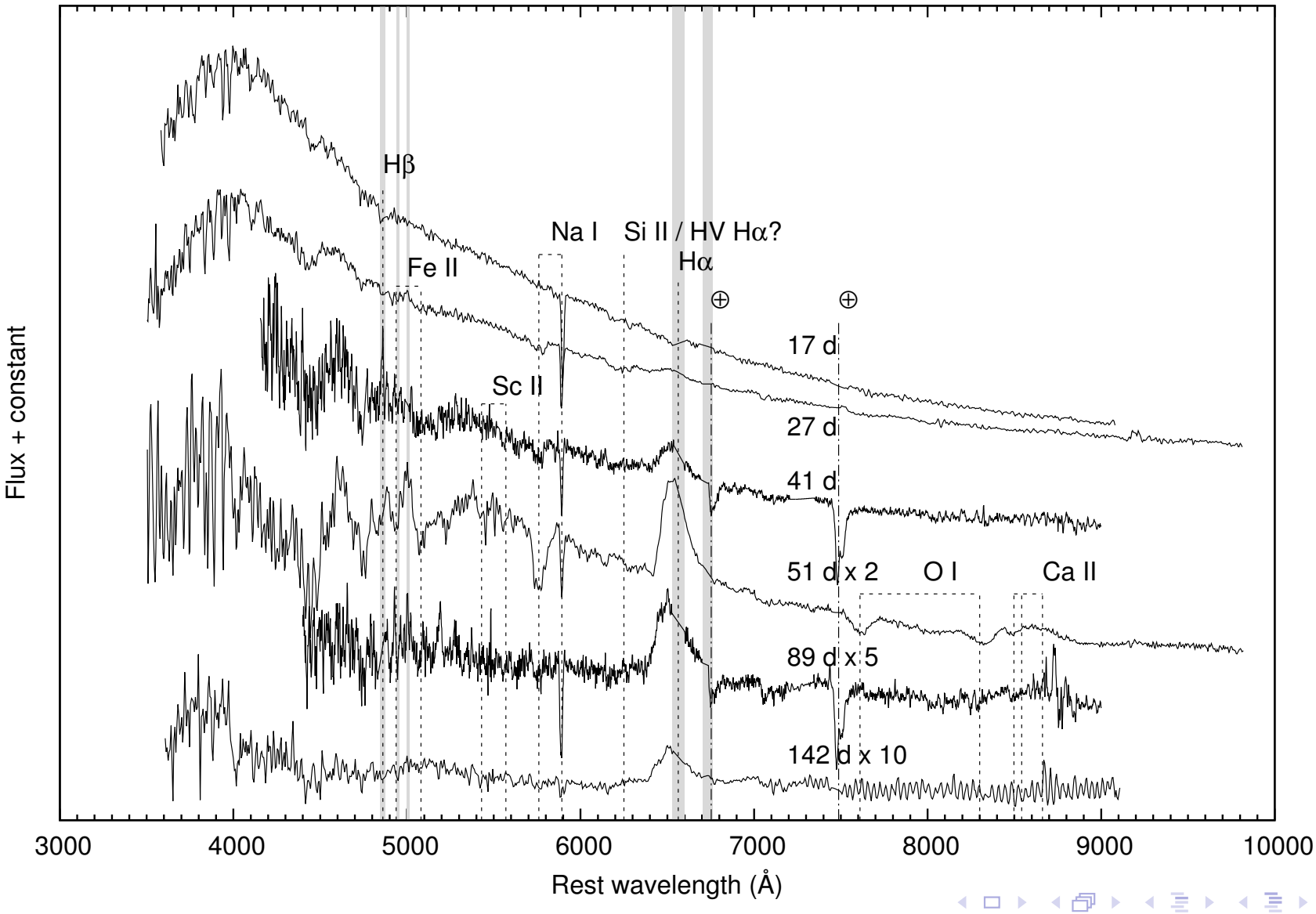
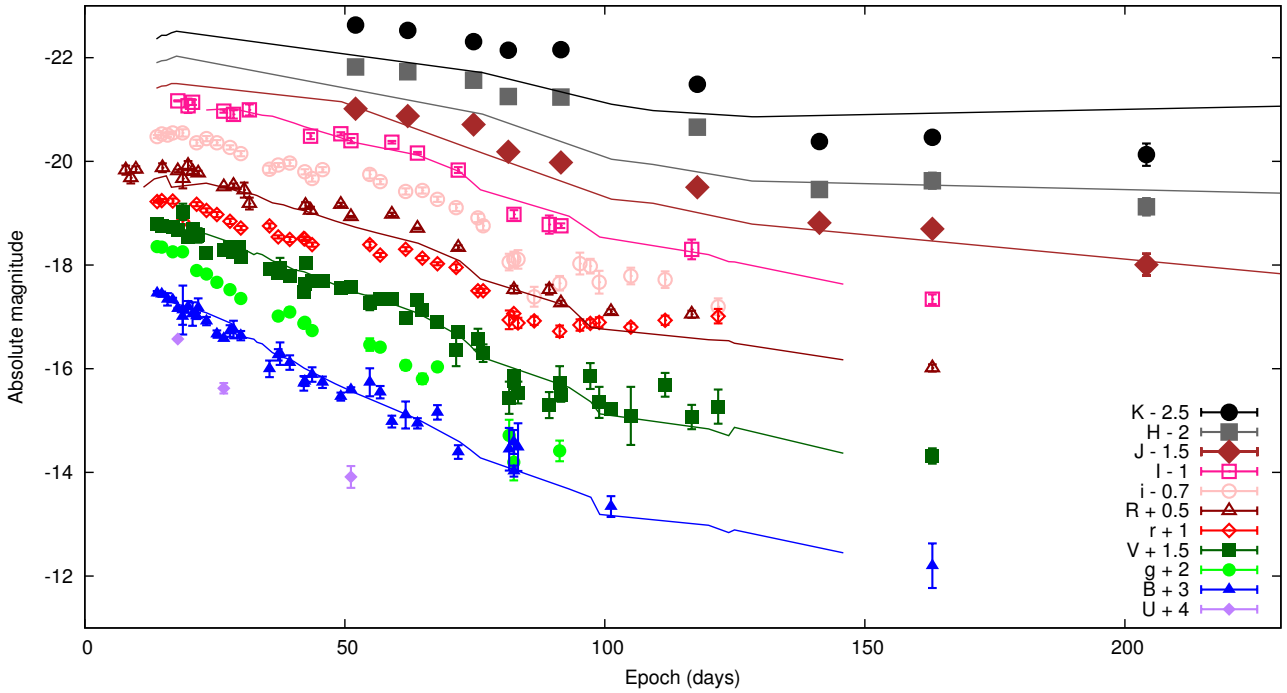
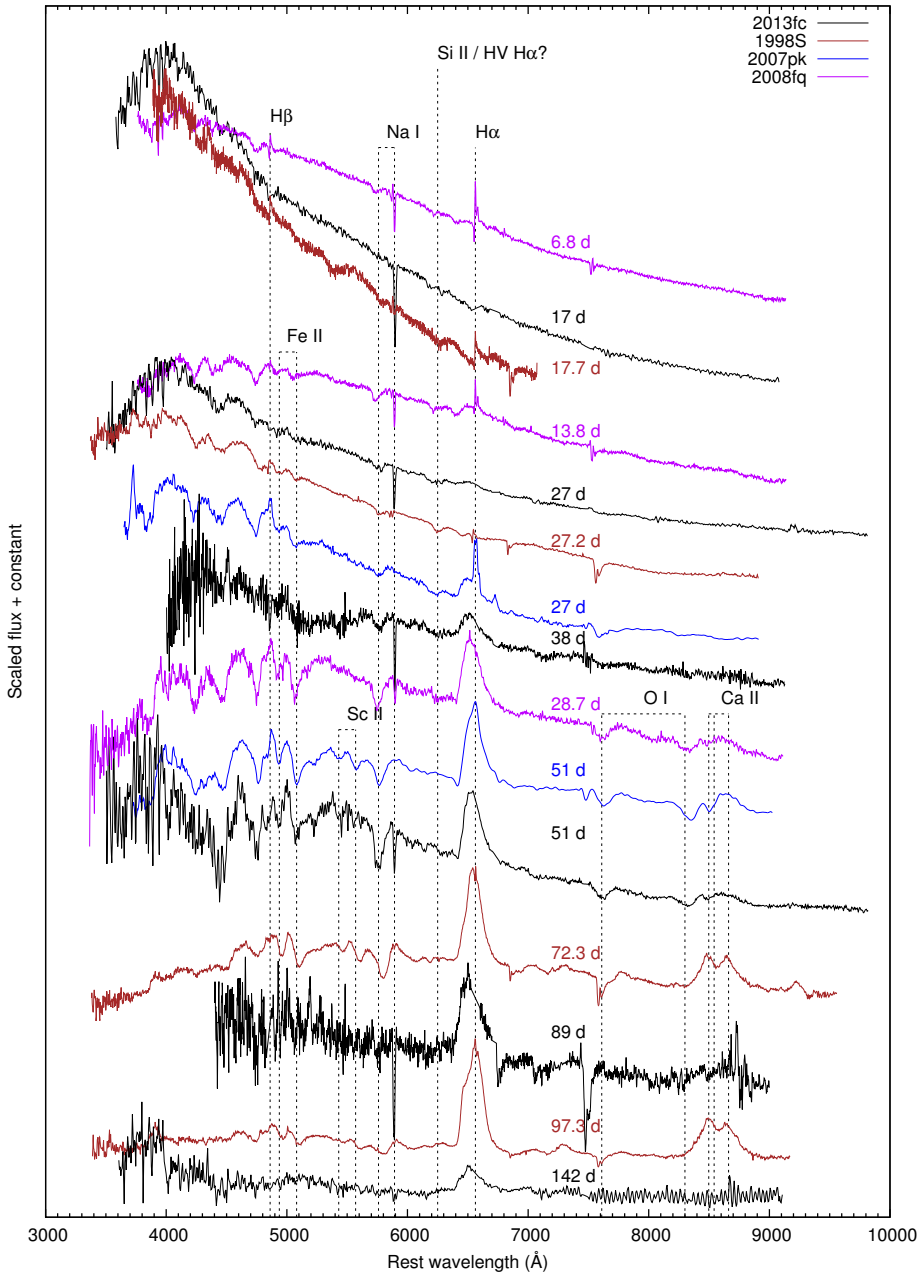




- Assuming $A_V \sim 2.9$, the optical light curve shape matches 1998S
- -0.9 mag brightness offset
- Bigger difference in NIR

- Spectroscopic similarity to 1998S-like SNe



So what was it?

- Directly detected II-L progenitor $\sim 16 M_{\odot}$ (Smartt 2015: upper mass limit for most CCSNe at $\sim 18 M_{\odot}$?)
- Similarity between II-L and 98S-like: similar mass range?
- Population fitting to the cluster of 1979C (van Dyk+ 1999): progenitor 17 – 18 $\pm 3 M_{\odot}$
- 98S evolution (Mauerhan+ 2012): RSG progenitor

- No late or very early spectra of 2013fc, but in-between very 98S-like
- Peak $B = \sim$-20.5
- CSM-ejecta interaction (brightness; featureless spectra; hot dust)
- Clump stellar population fit: $\sim$10 Myr $\rightarrow$ massive RSG, like 79C and 98S?
- Test case for SN observations against nuclei and bright/dusty regions

Thank you!