Stripped-Envelope SN Progenitors

Fifty-one Erg 2019

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Stripped-envelope supernovae

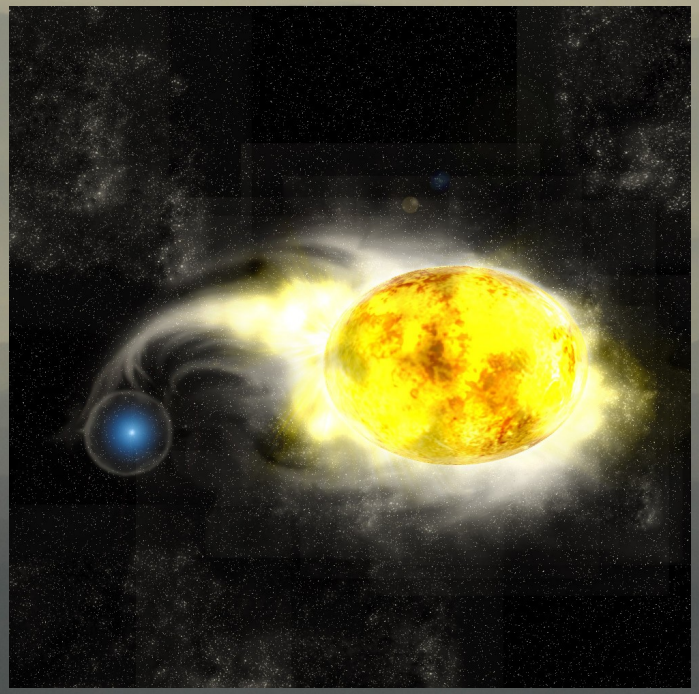
A good number of CC SNe are H-free (Types Ib, Ic) or H-poor (Type IIb)

How do massive stars lose their envelopes?

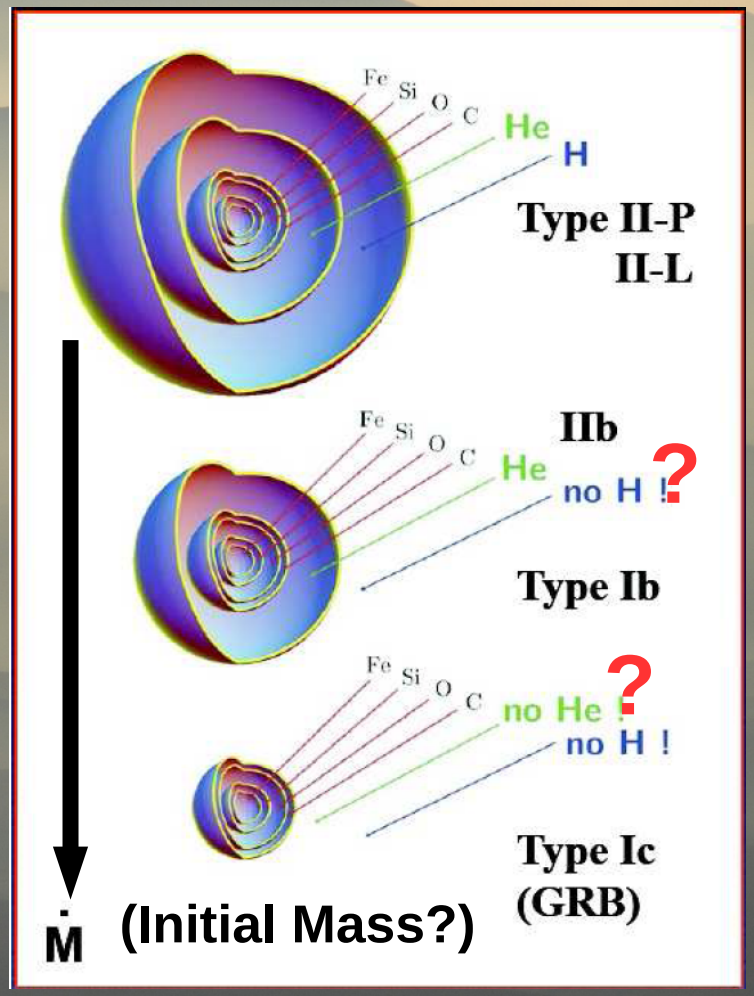
Map SN Types back onto stellar types?

Binary interaction plays a key role

What is the shape and origin of the CSM?



Binary mass transfer

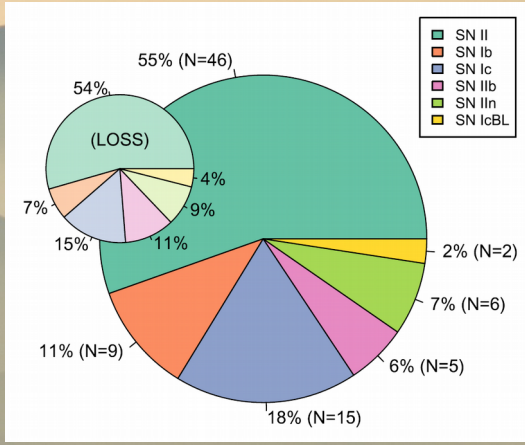


Schematic stellar structures
(Credit: M. Modjaz)

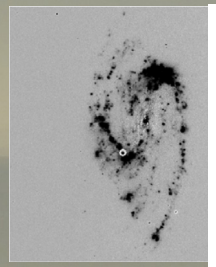
Progenitor characterization

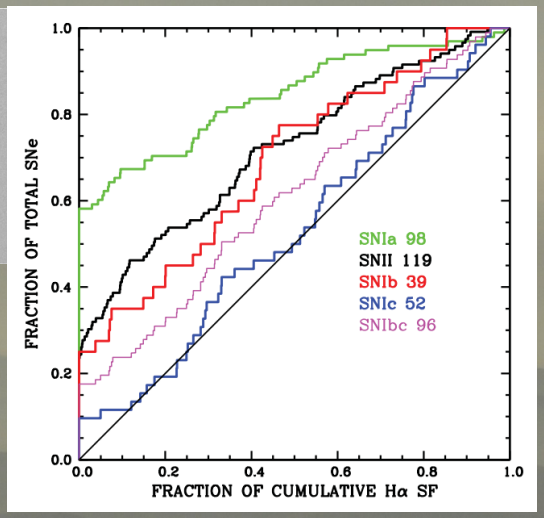
- Fractions and rates of each SN Type
- Associated stellar populations
- Light curves and spectra
- Very early observations
- Direct detections

Observed Type fractions
(Shivvers+'17,Kuncarayakti+'18)

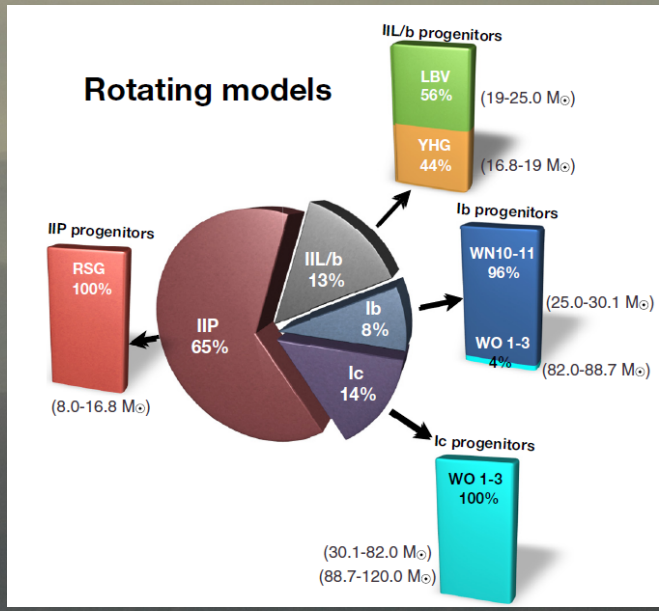


Association with
Hα emission
Anderson+'12,'15

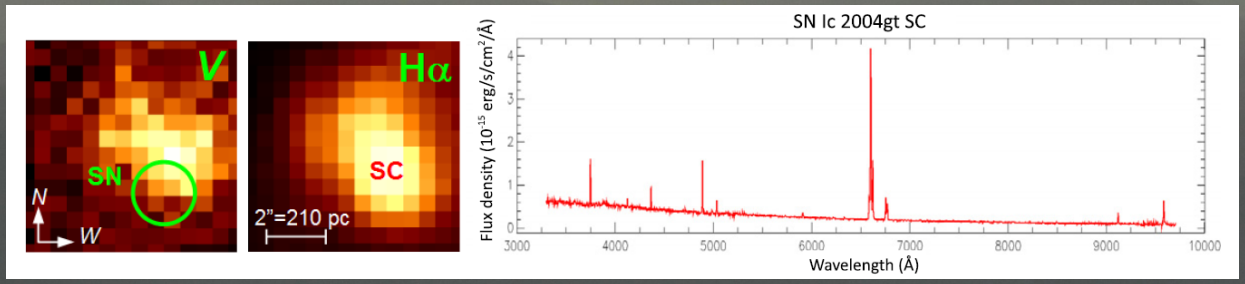




Single-star models (Groh+'13)



IFU spectra of underlying emission
Kuncarayakti+'13ab,'18
Galbany+'16,'18



Light-curve shapes

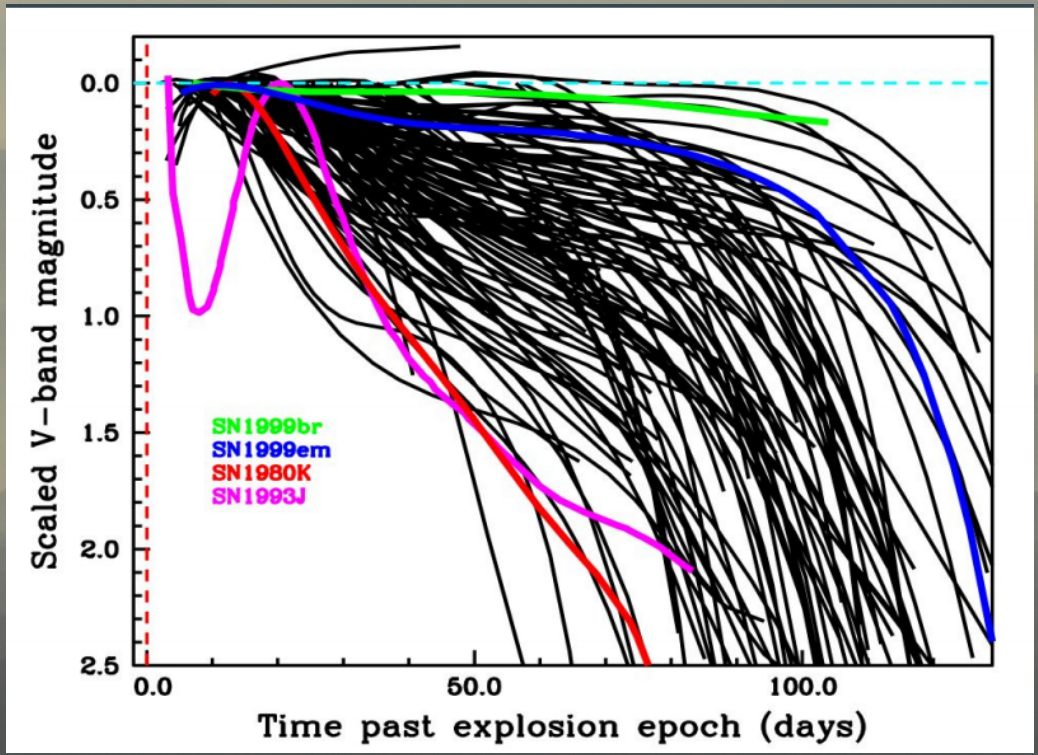
Are SNe II and IIb connected through envelope mass?

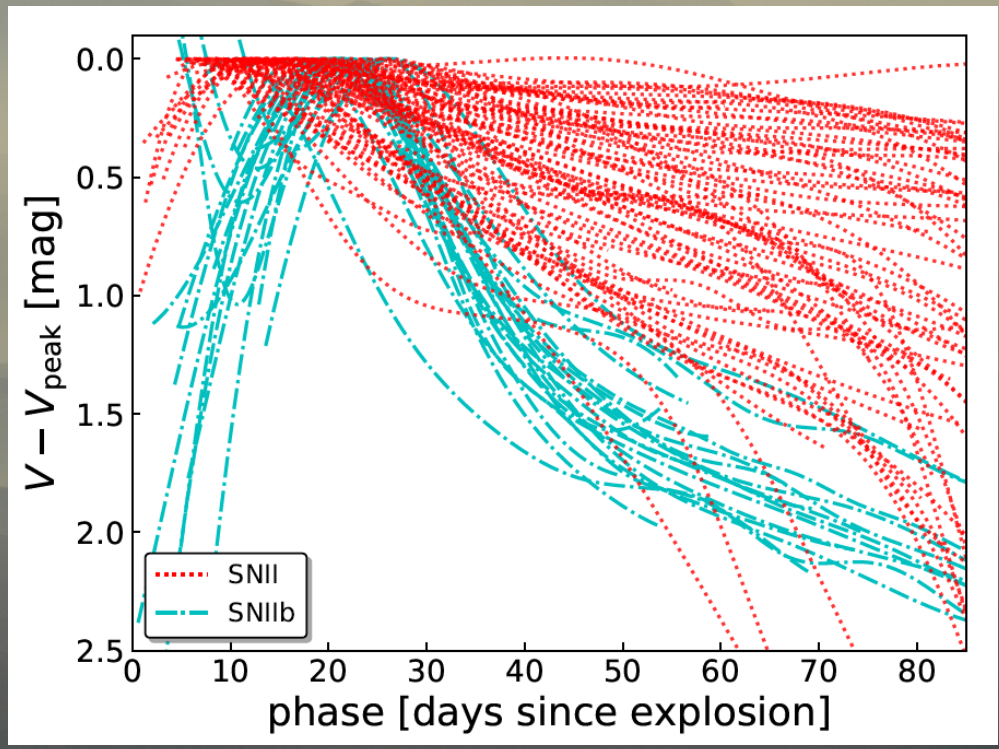
Large sample of SNe II and IIb *BVR* light curves

Search for bridging objects

Priscila J. Pessi

Light-curve morphology of SNe II and IIb





Anderson+'14 (see also Arcavi+'12)

Pessi,GF+ subm.

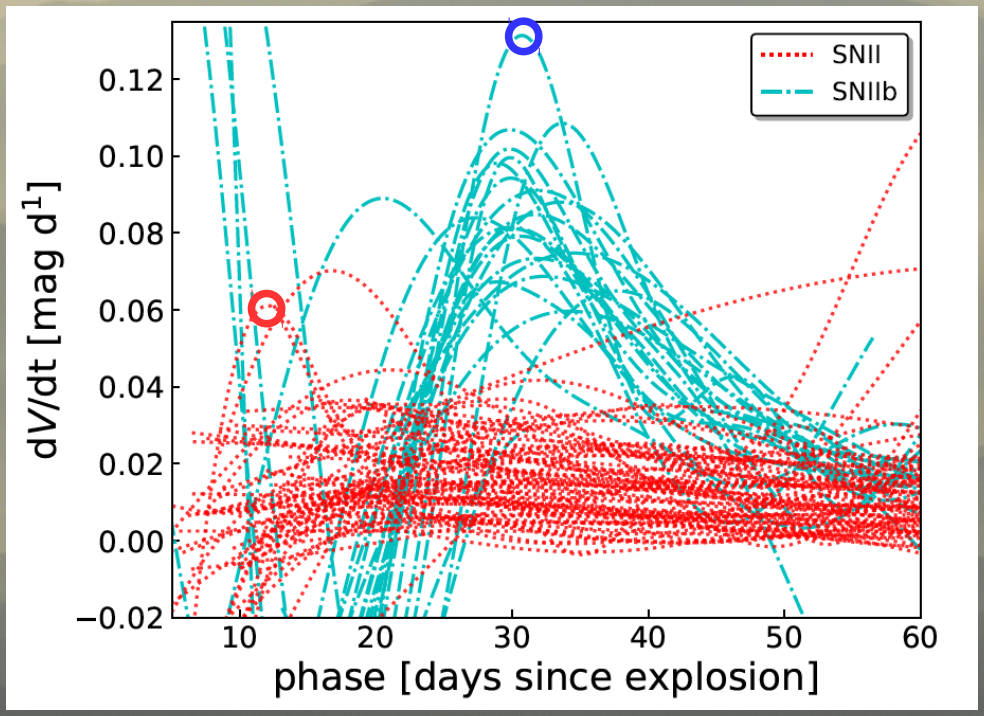
Light-curve shapes

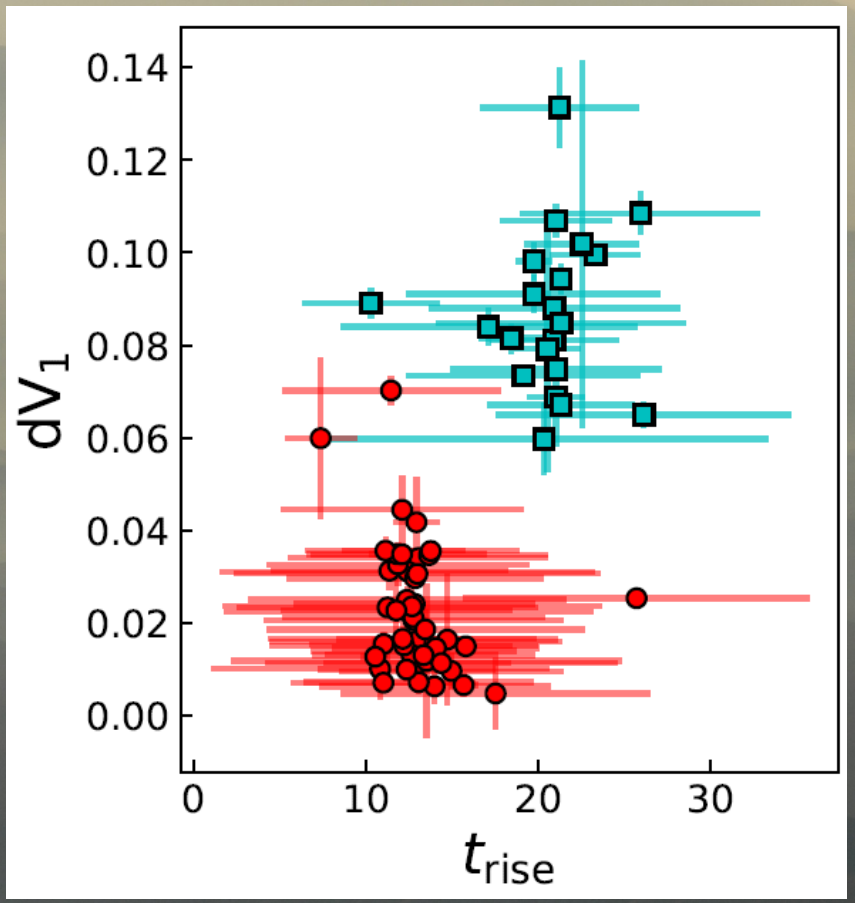
Large sample of SNe II and IIb BVR light curves

Search for bridging objects

Time derivatives of SNe II and IIb light curves

Priscila J. Pessi





Quantified LC shape parameters
Pessi,GF+ subm.

Direct identifications

High-resolution, deep imaging (HST)

Combined with evolutionary tracks

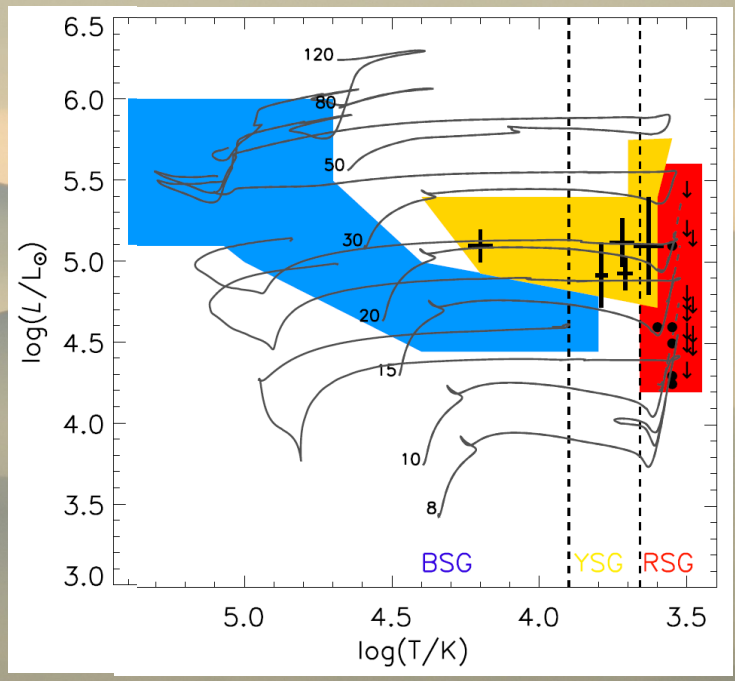
Feasible out to distances of ~ 30 Mpc

Over a dozen SN II progenitor detections

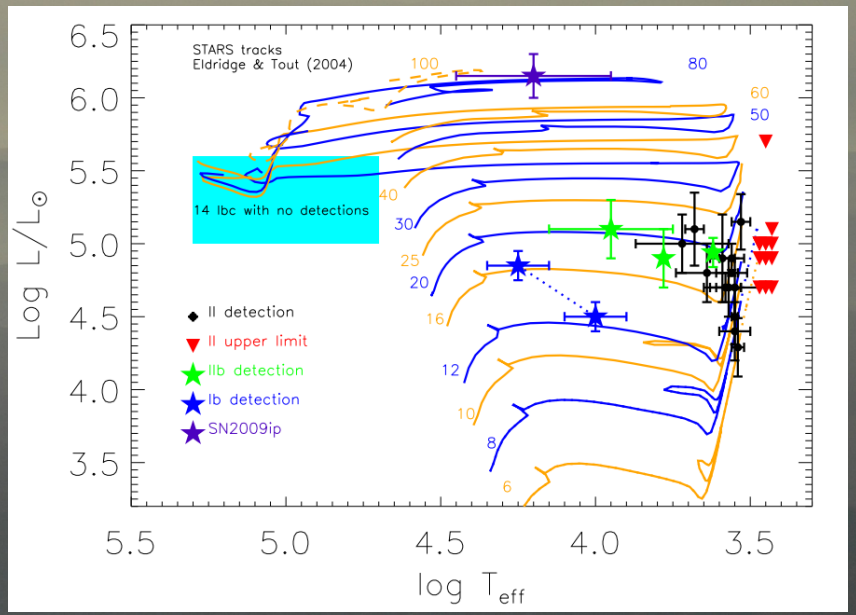
SNe Ib: only iPTF13bvn (confirmed). Blue progenitor likely in a binary system

SNe Ic: SN2017ein (to be confirmed). Luminous object, compatible with very massive star. Search for companion stars

SNe IIb: four confirmed id's. Luminous, *warm* (YSG) stars. Likely from binary systems. Three possible companion detections



Single and binary tracks
Eldridge+'13 (also Yoon+'17)

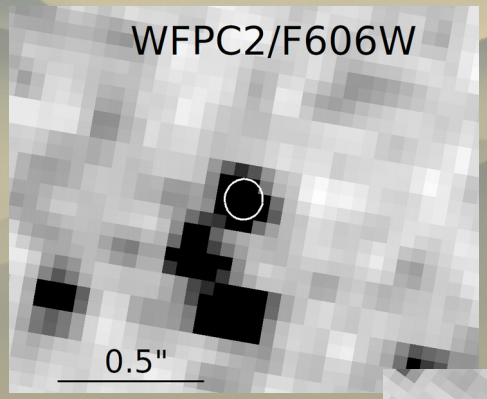


Progenitor detections – Smartt+'15

Direct identifications

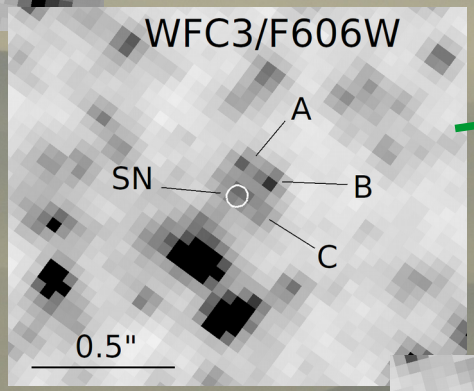
Type IIb SN 2008ax (Crockett+'08)

Progenitor revisited: ~30 R☼ star (Folatelli+'15)

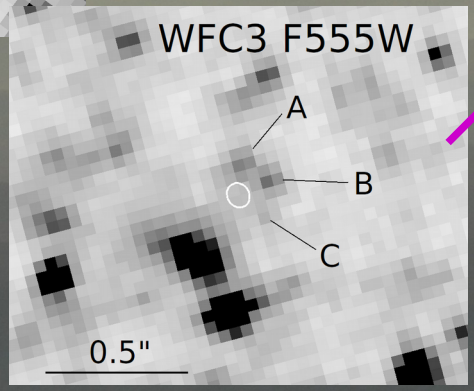


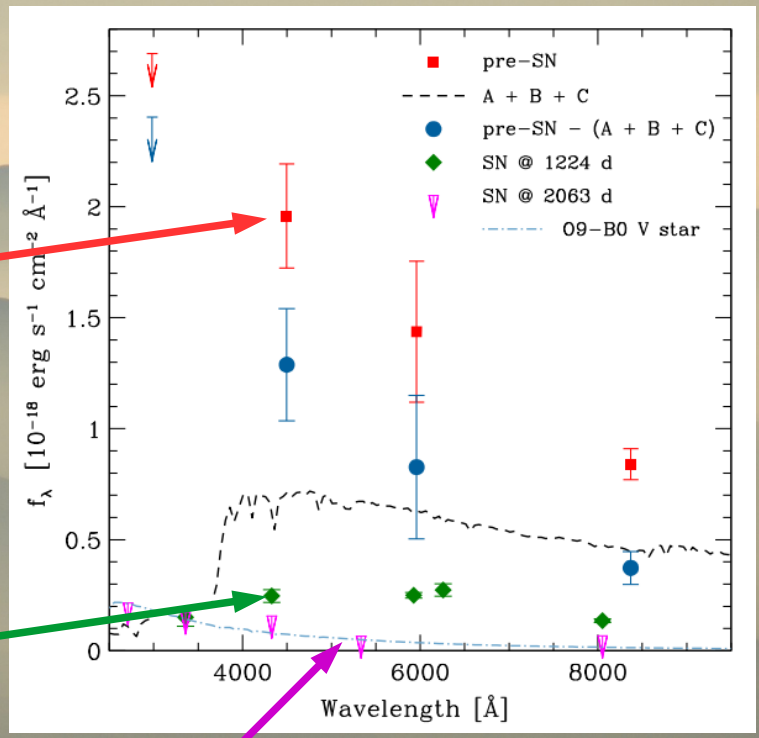
Pre-SN (1994)

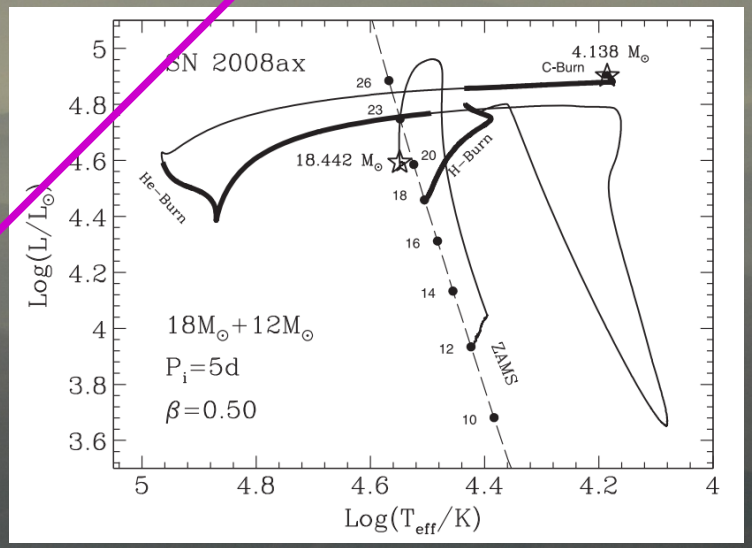
SN @ 3 yr (2011)



Post-SN (2013)







Coarser resolution @ pre-SN

Stars resolved as SN faded

Constraint on possible binary companion

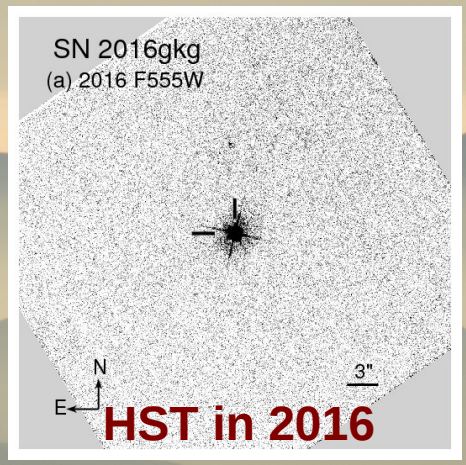
The type-IIb SN 2016gkg

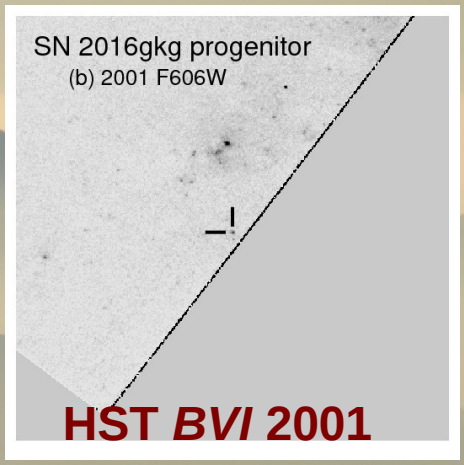
Pre-SN HST imaging

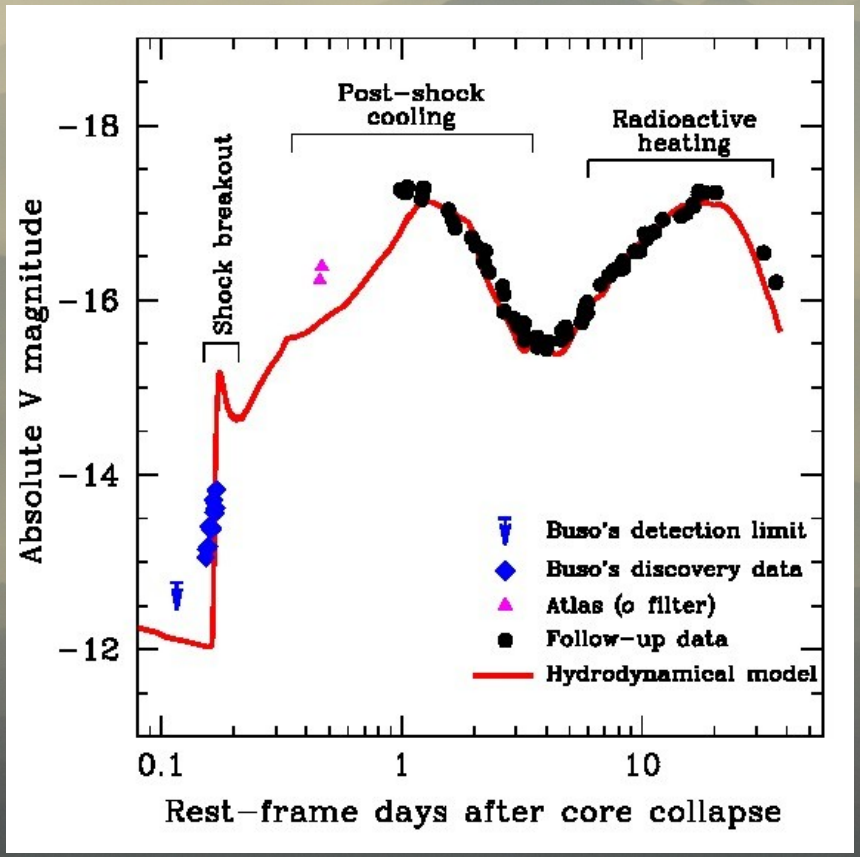
BVI photometry → R ~ 250 R☼

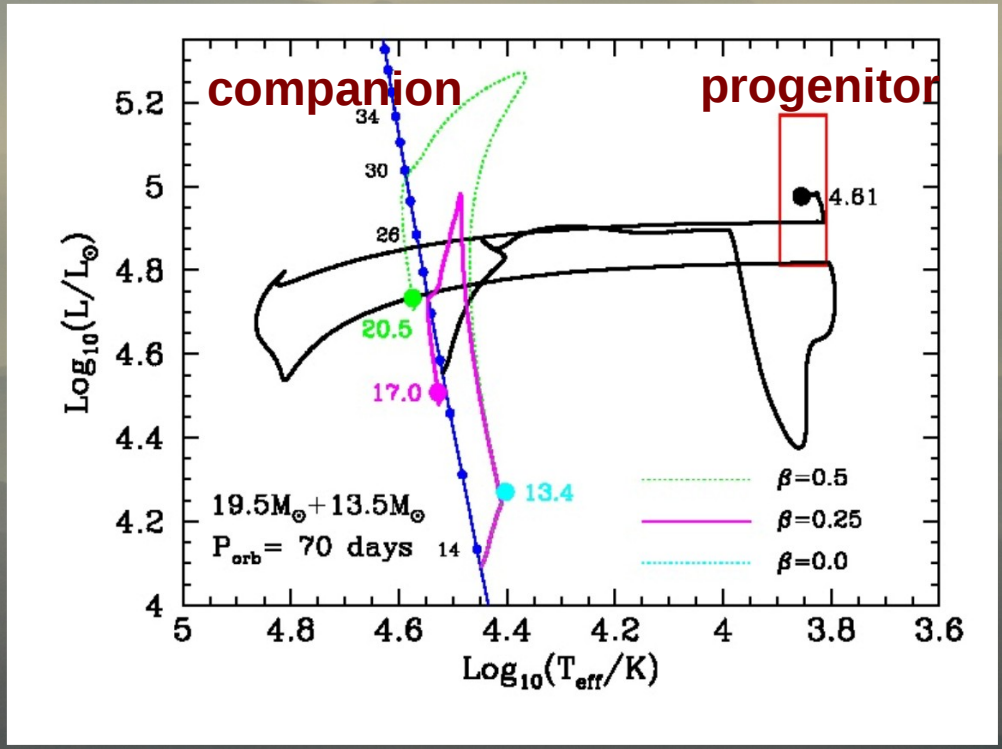
Binary evolution model:

Progenitor with M ~ 4.6 M☼ R ~ 200 R☼









Bersten,GF+'18 (also Tartaglia+'17, Kilpatrick+'17, Arcavi+'17, Sravan+'18)

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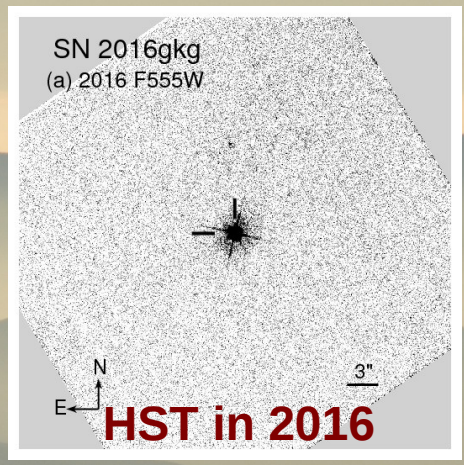

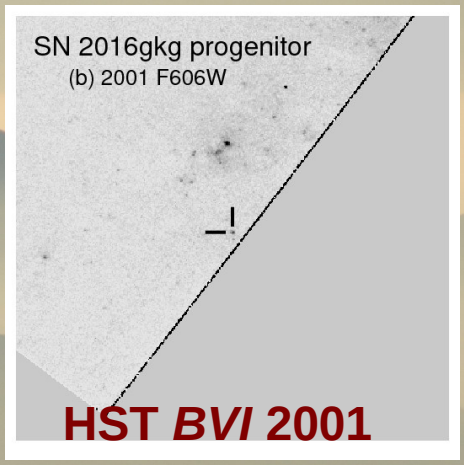

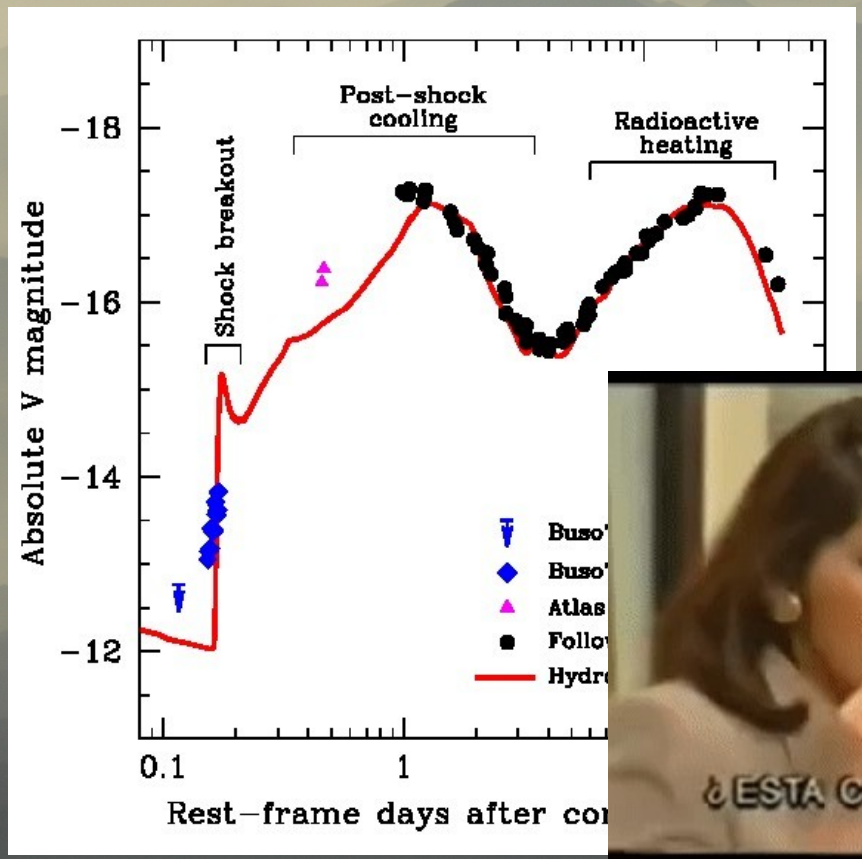

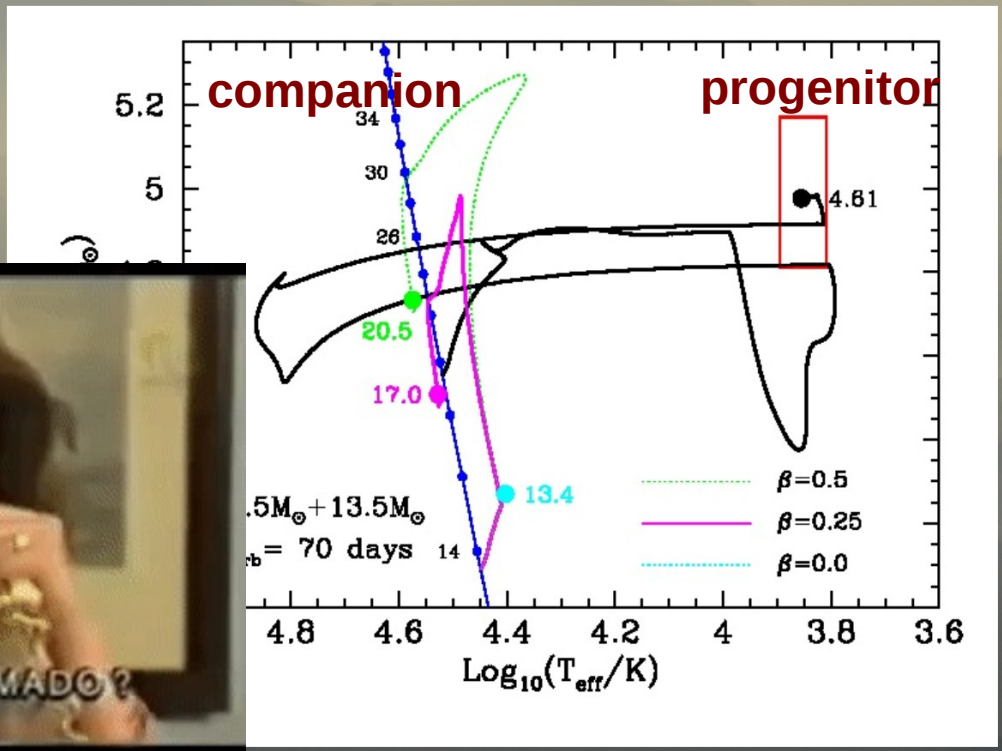

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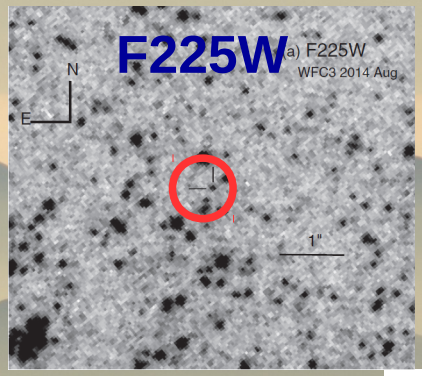
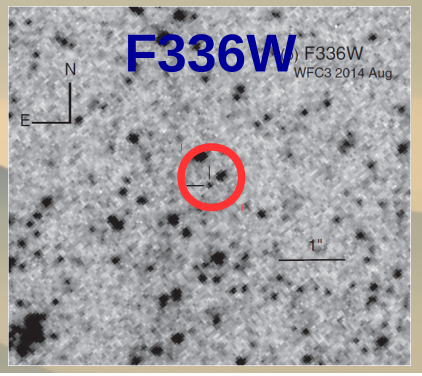
Binary companions of SNe IIb

Confirmed id's for SNe 93J, 08ax, 11dh and 13df: variety of progenitor radii

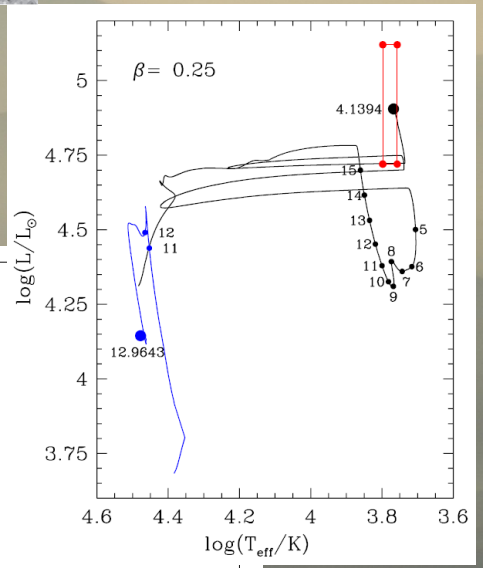
Three possible companion detections for 93J, 11dh and 01ig

B-type stars, compatible with evolutionary models

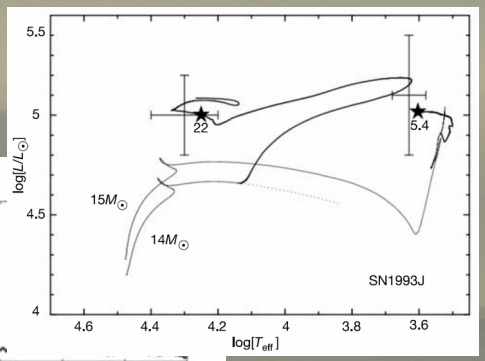


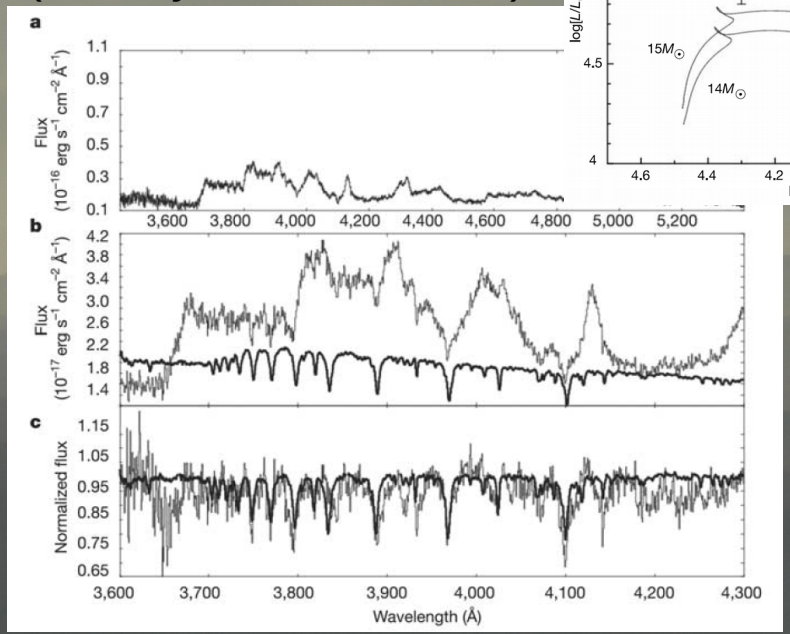


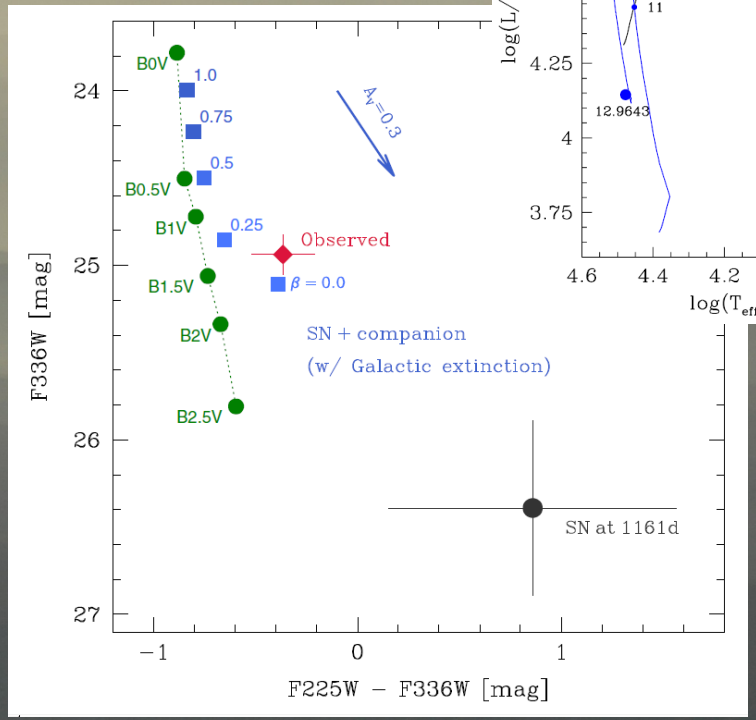
SN 2011dh – Folatelli+'14
See Maund+'15



SN 1993J – Maund+'04 (Van Dyk+'02, Fox+'14)







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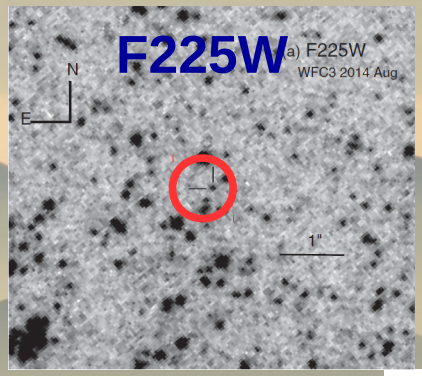

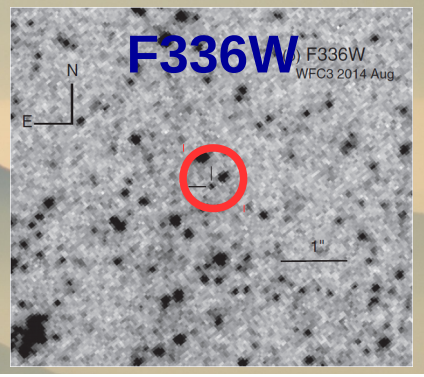

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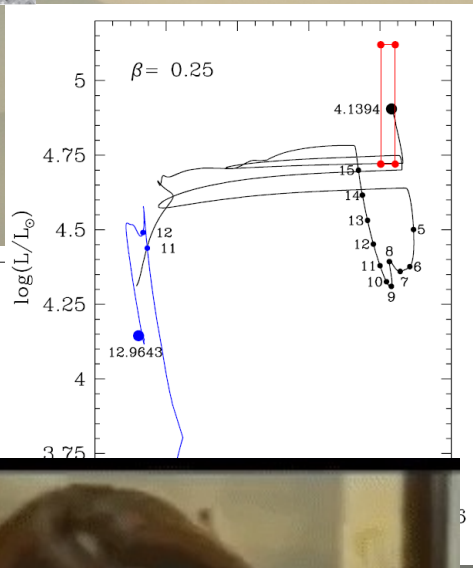

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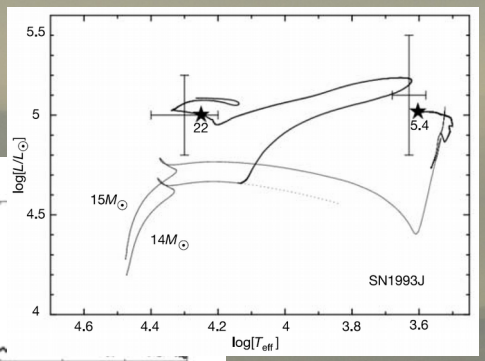

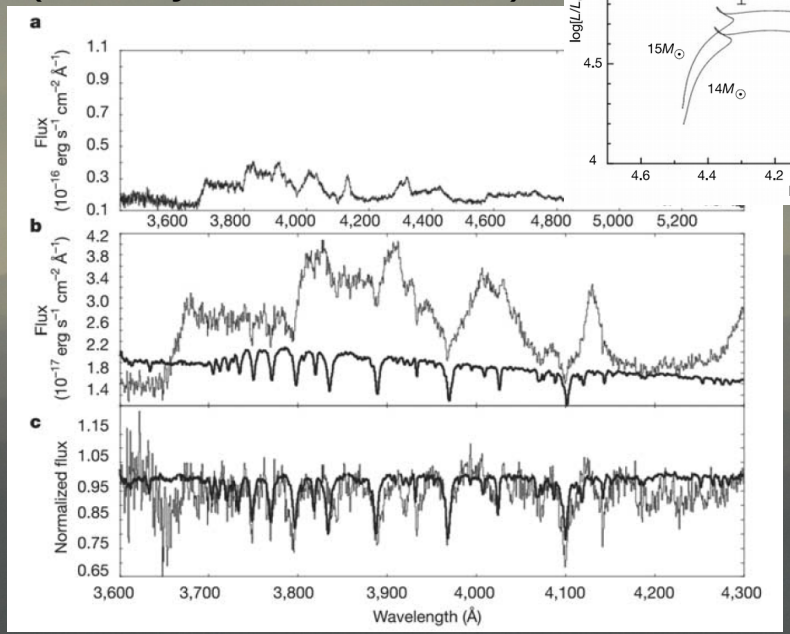

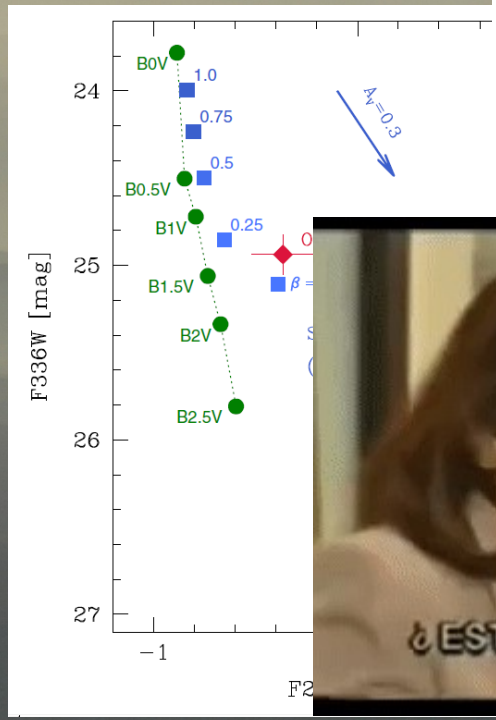

Telescopio Rafael Montemayor

- 46-cm Newtonian
- *UBVRI* filters
- 1 x 1 deg FoV
- Heavy-duty design to operate in a remote site
- Fully automatized
- Web-based, user-friendly control interphase
- To be installed in Argentina by the end of 2019
- Rapid transient follow-up

Conclusions

SNe II and IIb do not show a continuum in light-curve shapes. This suggests a different progenitor origin.

It is esential to confirm progenitor candidates from pre-explosion images.

SNe IIb appear to be strongly associated to interacting binary systems. Maybe most SE SNe are too.

Important efforts are required to search for companion stars.

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¡Thanks!