MCSS
Millennium Center for Supernova Science

The CHASE follow-up programme

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Out line

- CHASE-search
- CHASE-follow up

- 2008bk
- 2009bb
- 2010lp
- 2011ja

CHASE-PROMPT survey

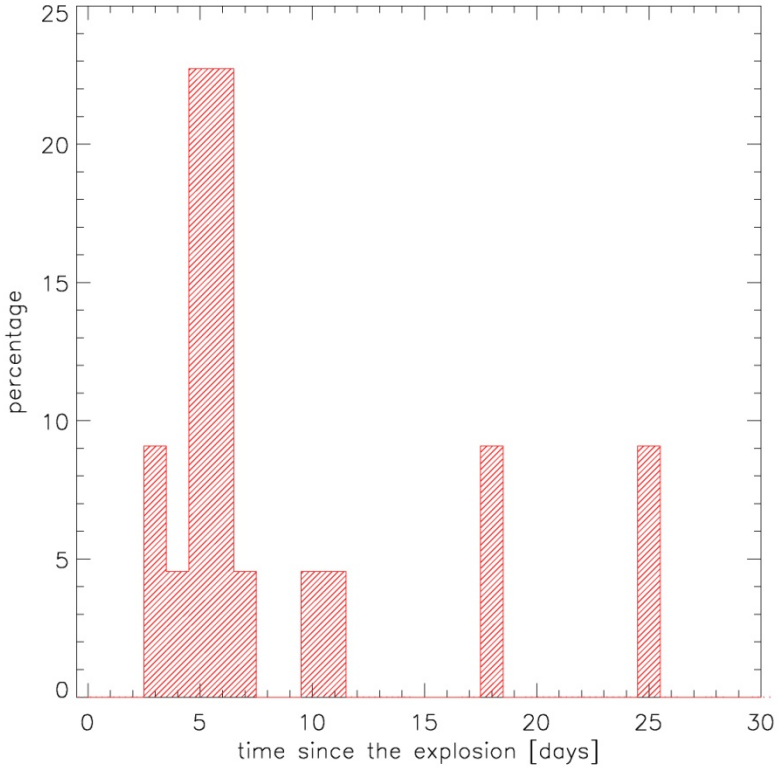
We use the 10% Chilean time on four of the PROMPTs

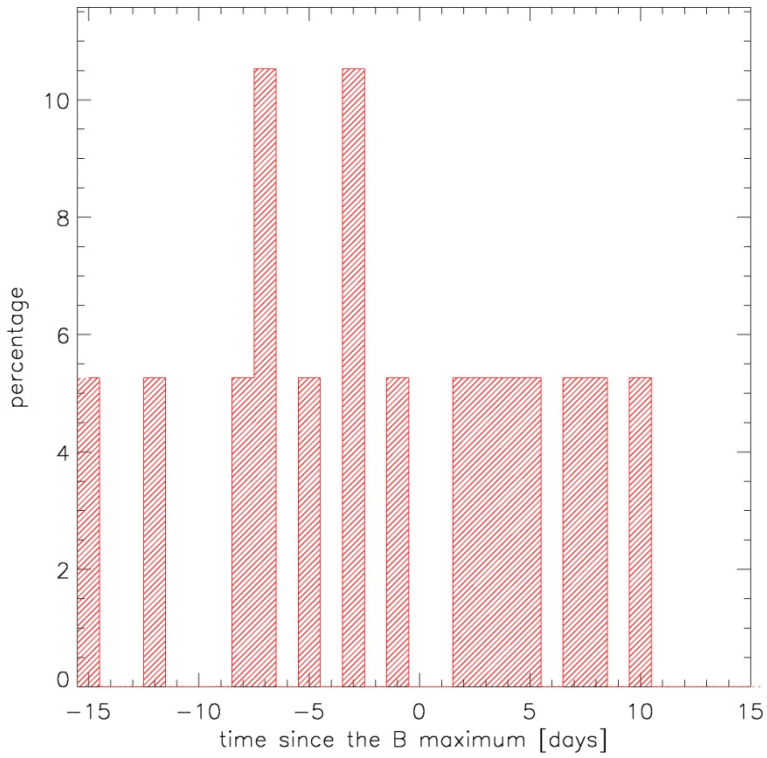
Golden list => Vr < 2000 Km/sec => obs every day !!
Silver list => 2000 < Vr < 6000 => ~ obs every 4 days

Diameter =40 cm
Pixel scale = 0.6 "/pix
FoW = 10´x10´
Read out time = 9 sec
Mag lim ~ 18.0 in 80 sec
Located at CTIO

The CHASE-search numbers

163 SNe discovered so far !





59.1.5% Sne II discovered before a week after the explosion

47.3% SNe I discovered before B max

CHASE follow-up => study the SN physics

Tot =57

17 Ia (most for the nebular spectroscopy program)

2008bc , 2008fp, 2008hv, 2009le, 2010ae , 2009el, 2010ev, 2010gp, 2010hg, 2010iu, 2010jg, 2010ko(sub), 2010lp(pec), 2011Z(sub), 2011bf, 2011iv, 2012Z(pec)

15 IIP (most of them with well defined explosion date)

2008bk(sub,pre,ce) 2008cn(pre), 2009N, 2009ib(pre,ce), 2010F, 2010co, 2010jc , 2011dd, 2011dg(sub), 2011ja(pec,pre), 2012A, 2012aw(pre), 2012dh, 2012ec(pre), 2012hc (pre)

4 IIL 2009aj, 2009kr, 2009el, 2010hv

6 IIb 2009K, 2010jr, 2011cb, 2011hs, 2011ei, 2012dy

5 IIn 2009au, 2010jl, 2011A, 2011ir(Ibn), 2011js

5 Ibc 2009bb(bl), 2009jf, 2010as, 2010cn , 2010il

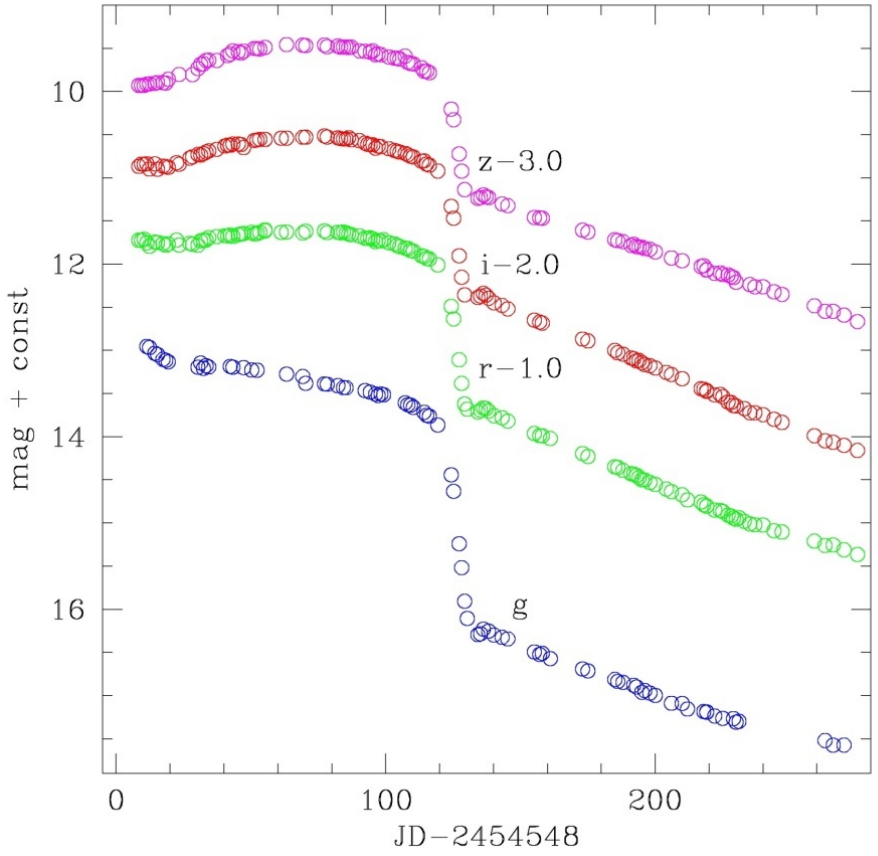
2 LBV 2009ip, 2010jp

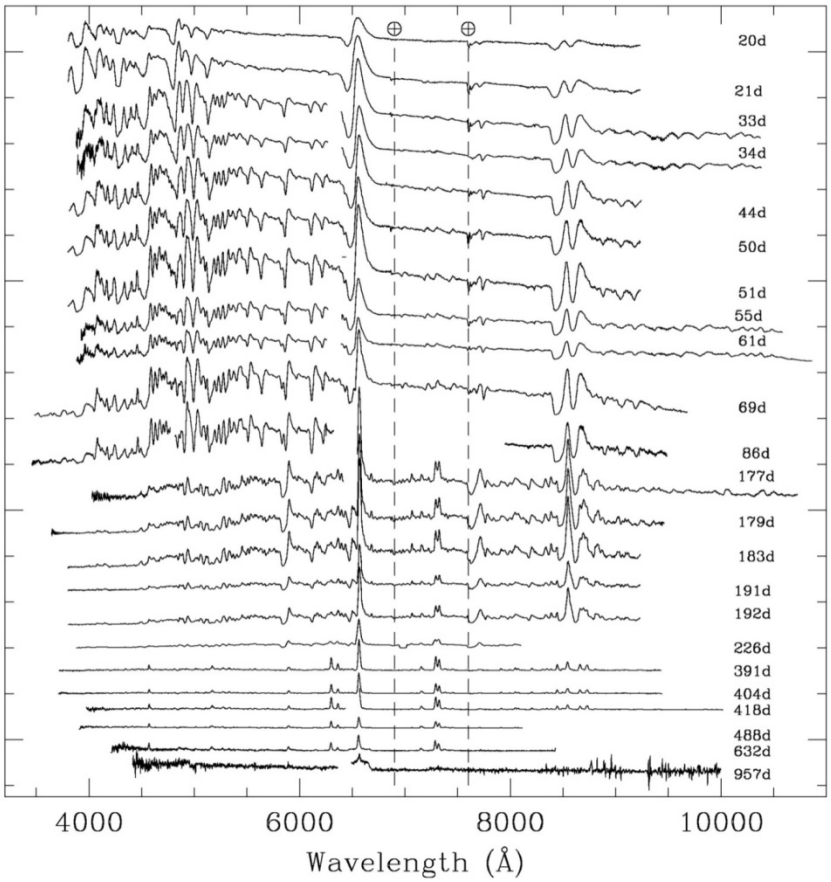
1 1987A like 2009mw

1 optical transient opt NGC300

1 ? 2010iy

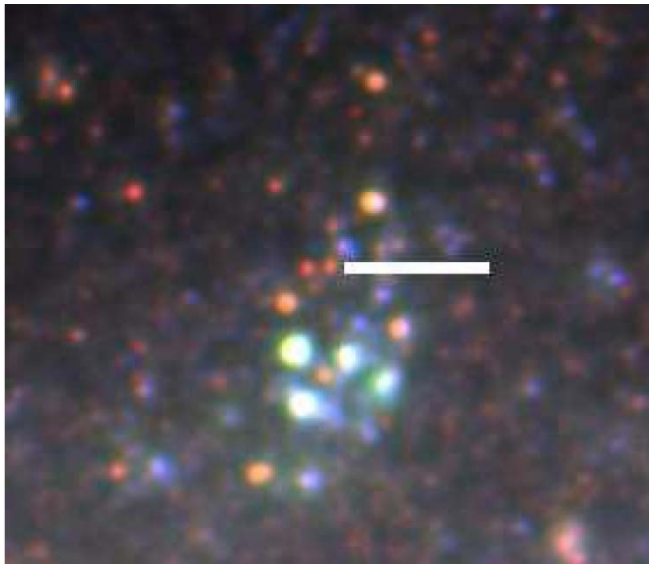
SN 2008bk





SN 2008bk: Pignata et al 2013

SN 2008bk: The best progenitor detection after SN1987A

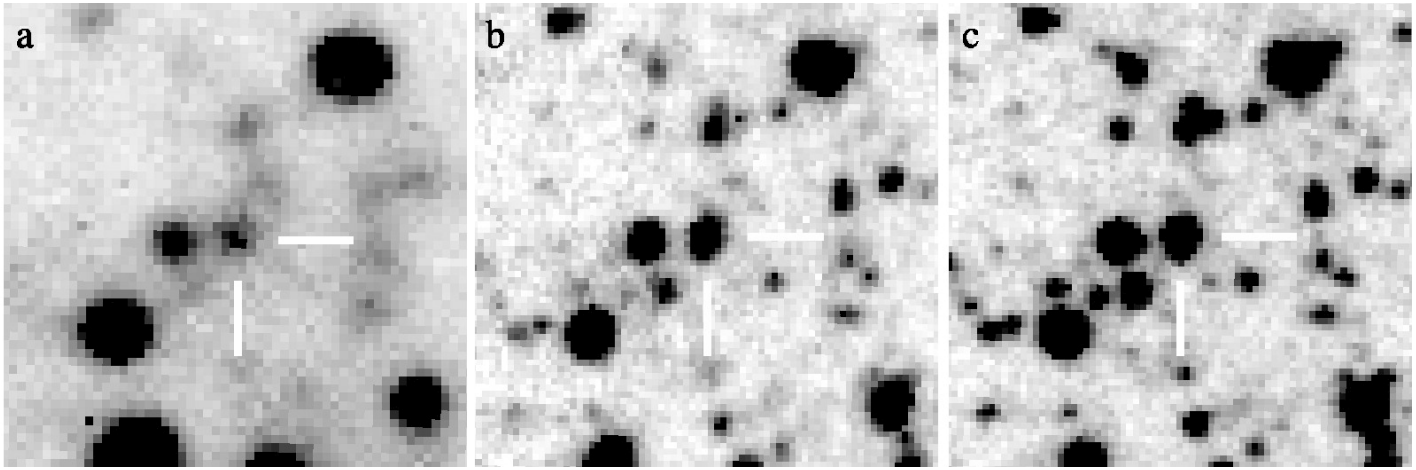


V = 23.42 ± 0.24 R = 22.53 ± 0.10
I = 21.20 ± 0.10, Van Dyk et al. 2012.

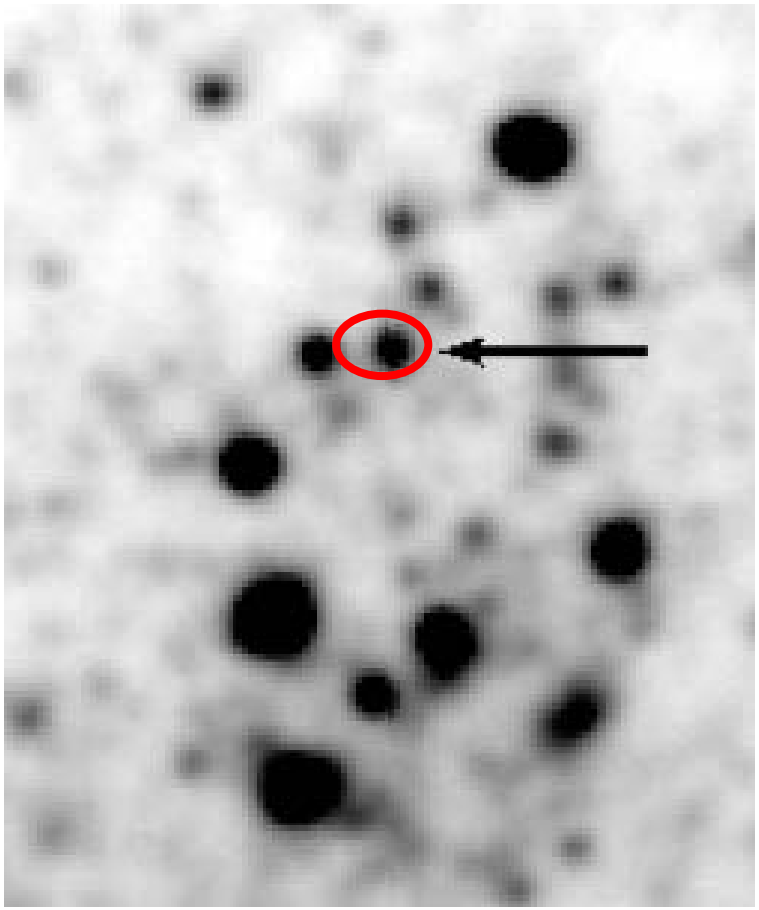
B > 22.9 V > 23.0 I=21.20 ± 0.19
J=19.50±0.06 H=18.78±0.11 K=18.34±0.07
Mattila el al. 2009

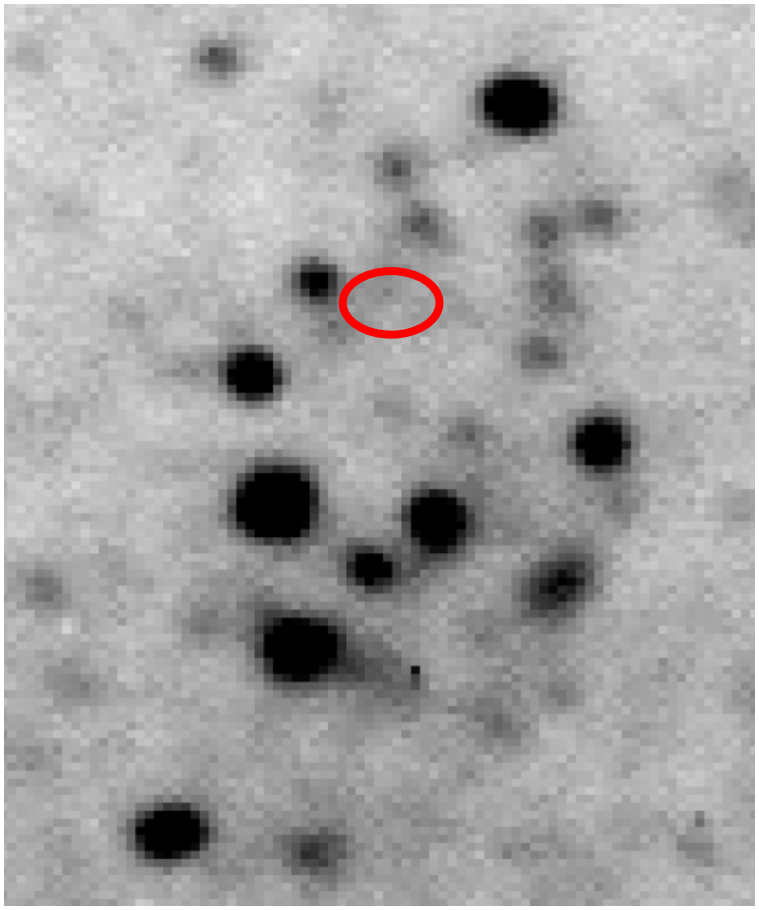
The other progenitors were observed with only one or two bands

I J K



The progenitor is gone !!



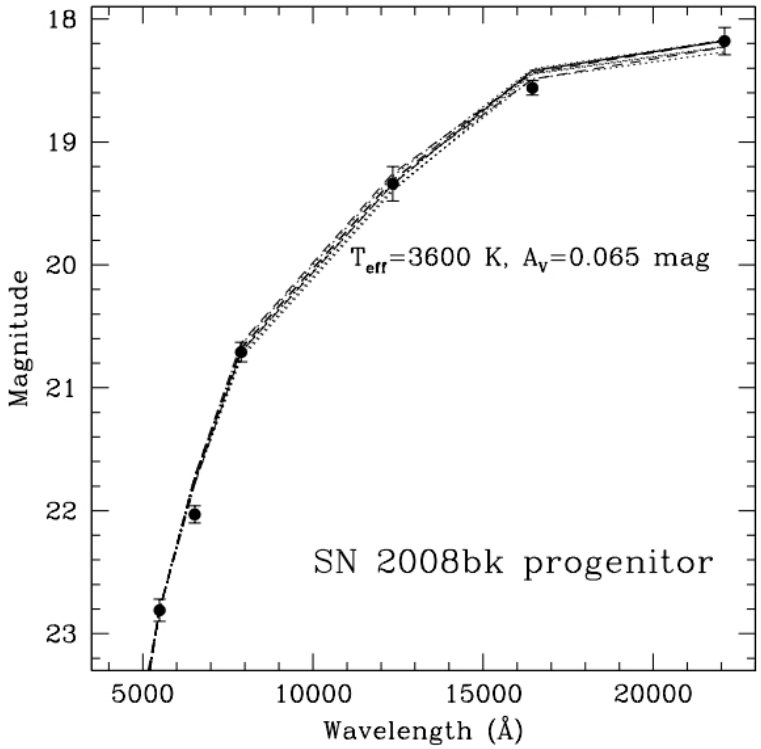


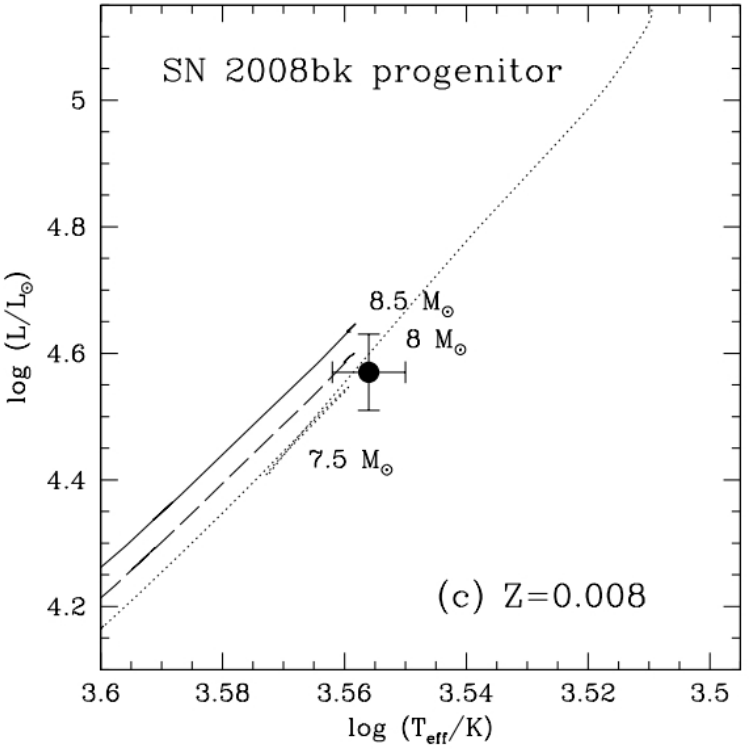
i' band progenitor

i' band now

Pignata et al., 2013

SN 2008bk progenitor mass

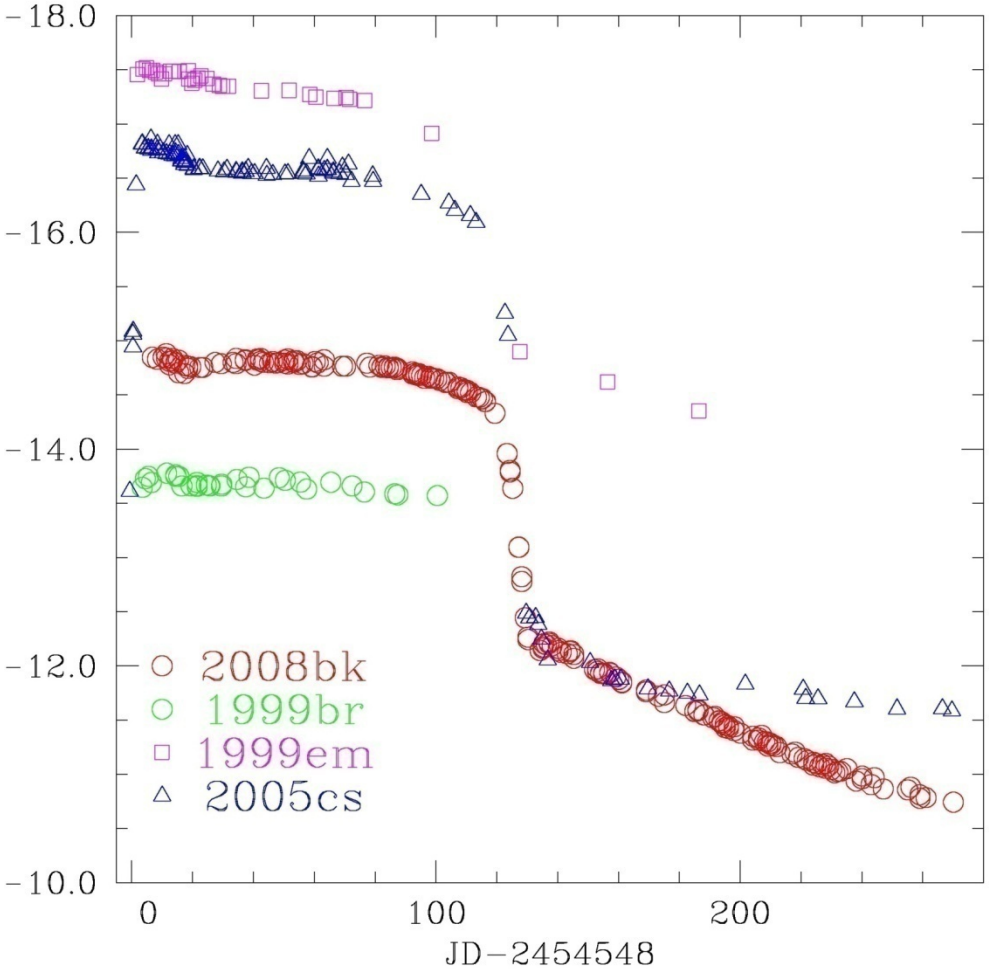




Van Dyk. et al., 2011

Progenitor mass = 8–8.5 M_{sun} R=496 ± 34 R_{sun}

SN 2008bk: *A low luminosity IIP*

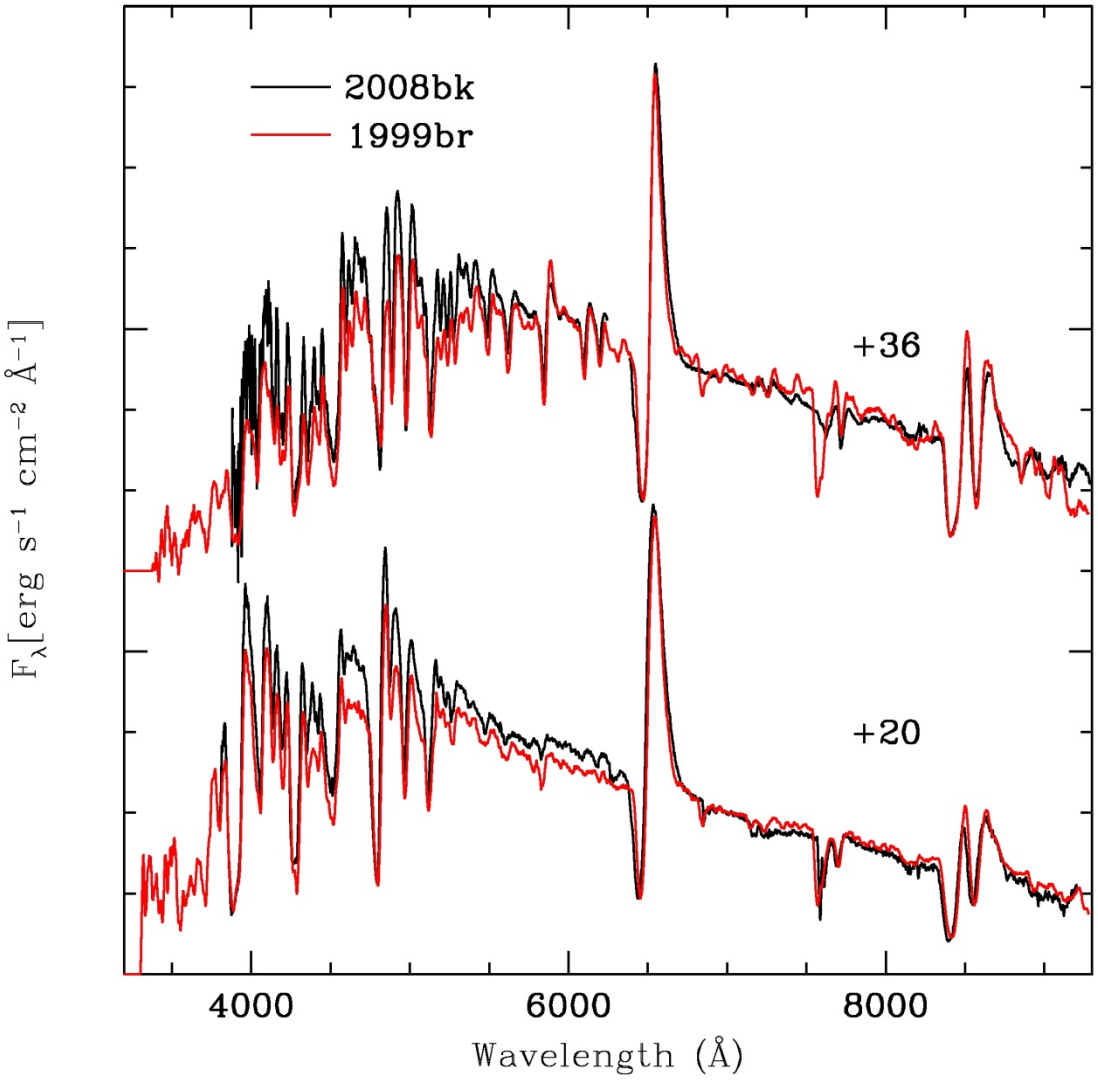


Distance modulus = 27.68
Derived from Cepheids . (Pietrzynski et al. 2010)

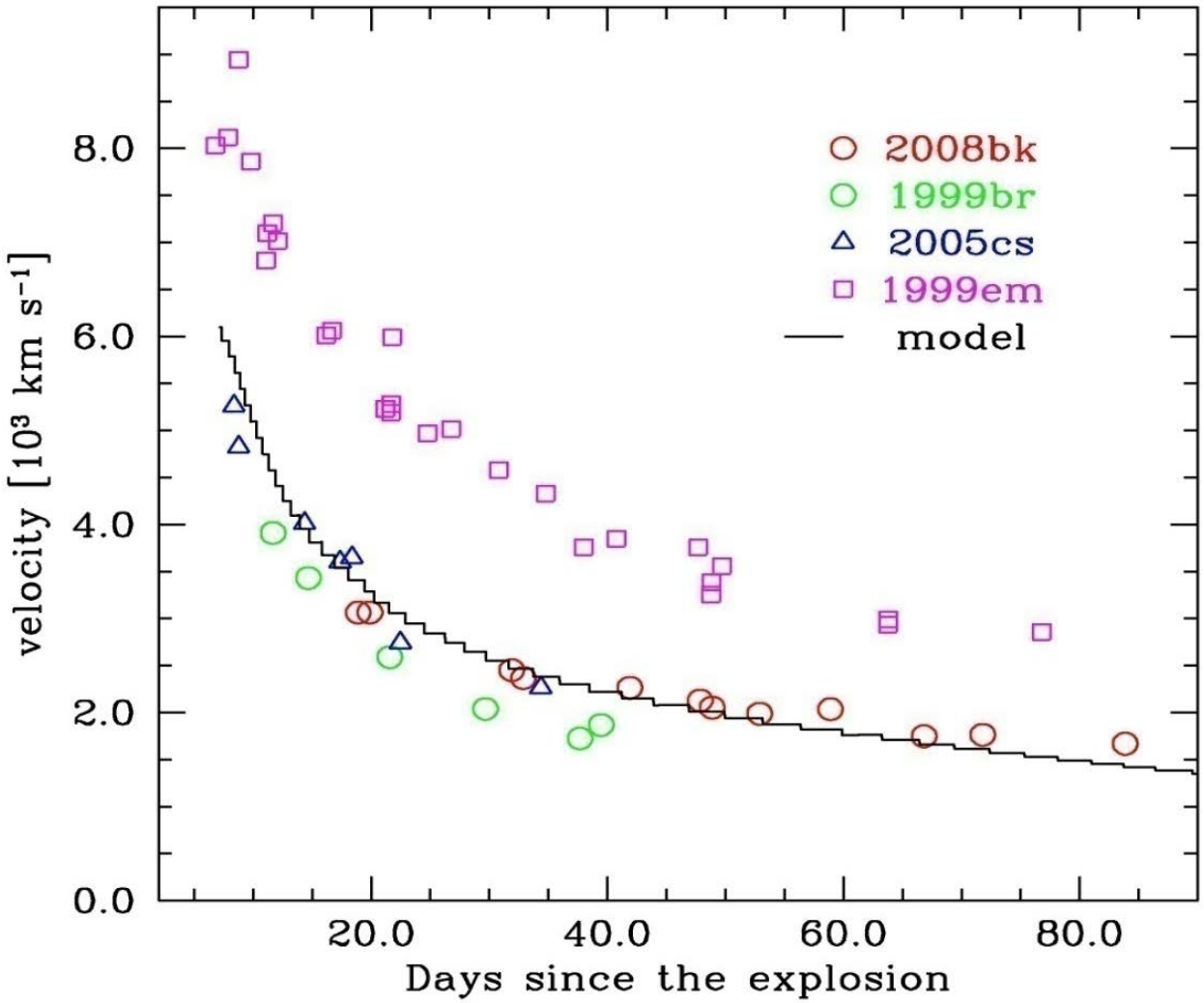
Very well definded absolute luminosity !!

This is not the case of SN1999br and SN2005cs

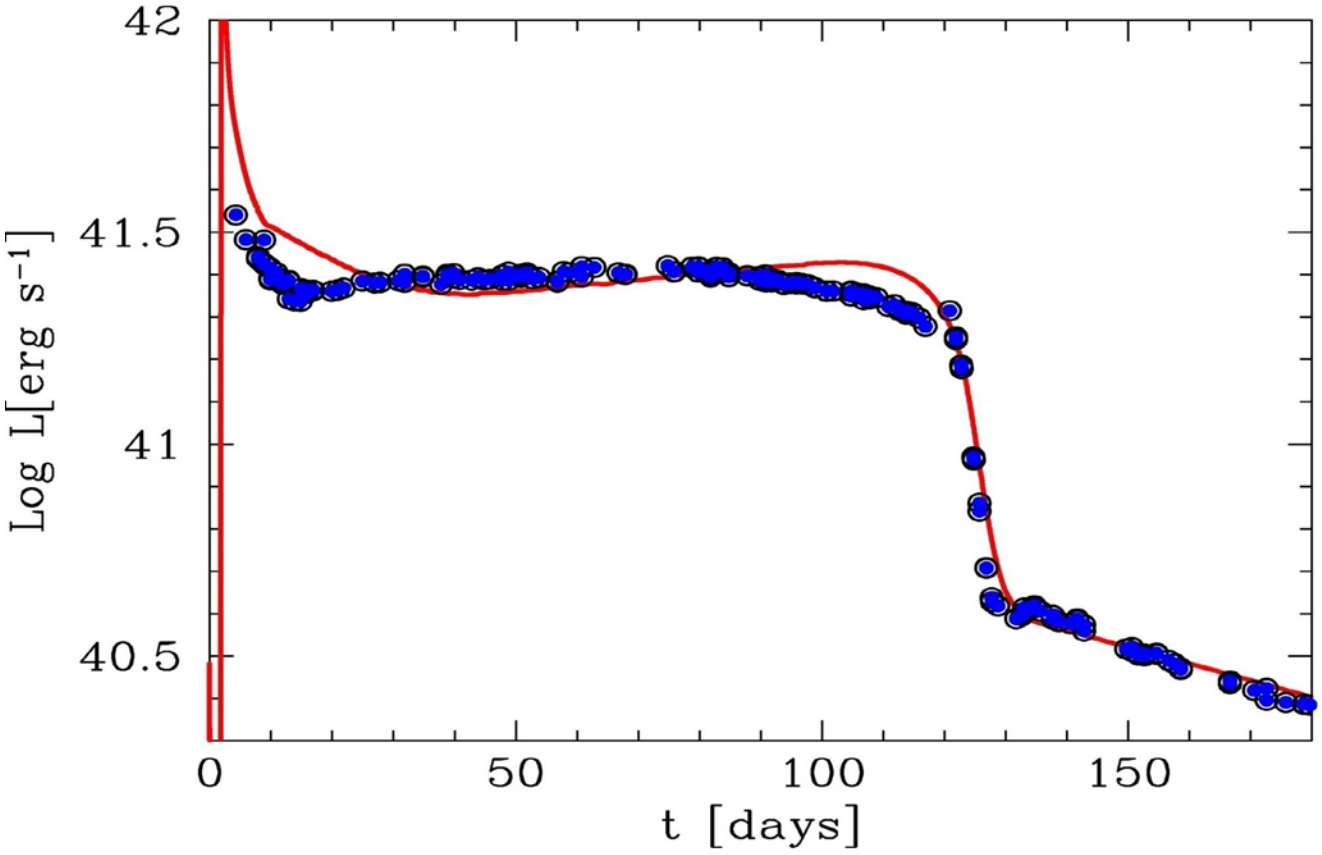
SN 2008bk a twin of SN 1999br



SN 2008bk: *A* low velocity IIP



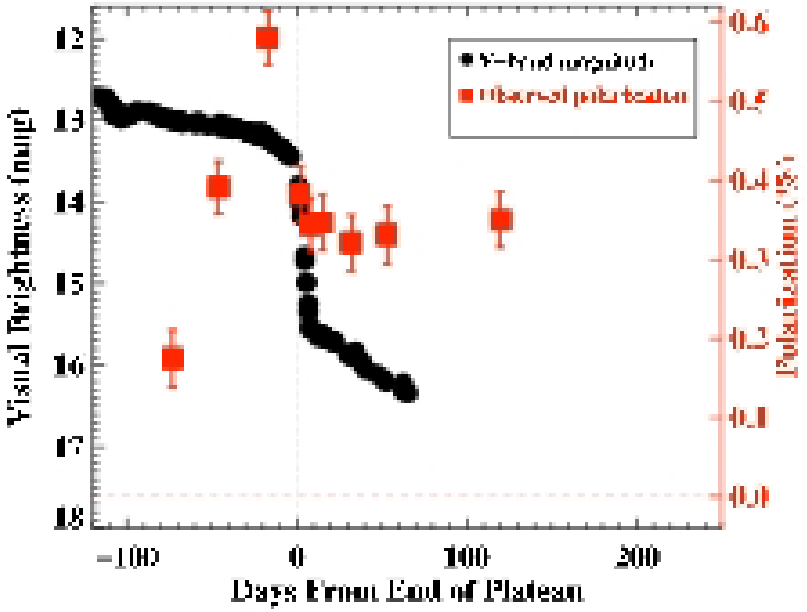
Light curve modelling



Low Ni production 9 x 10^{-3} (normal ~ 6-10 x 10^{-2})

Progenitor mass ~ 12 M_{sun} R=580 R_{sun}

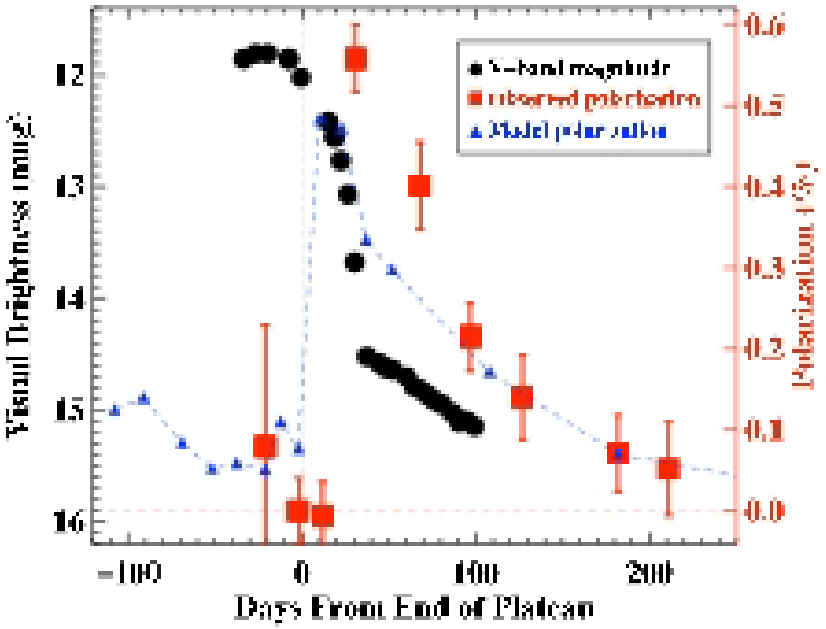
A strong evolution in the continuum polarization



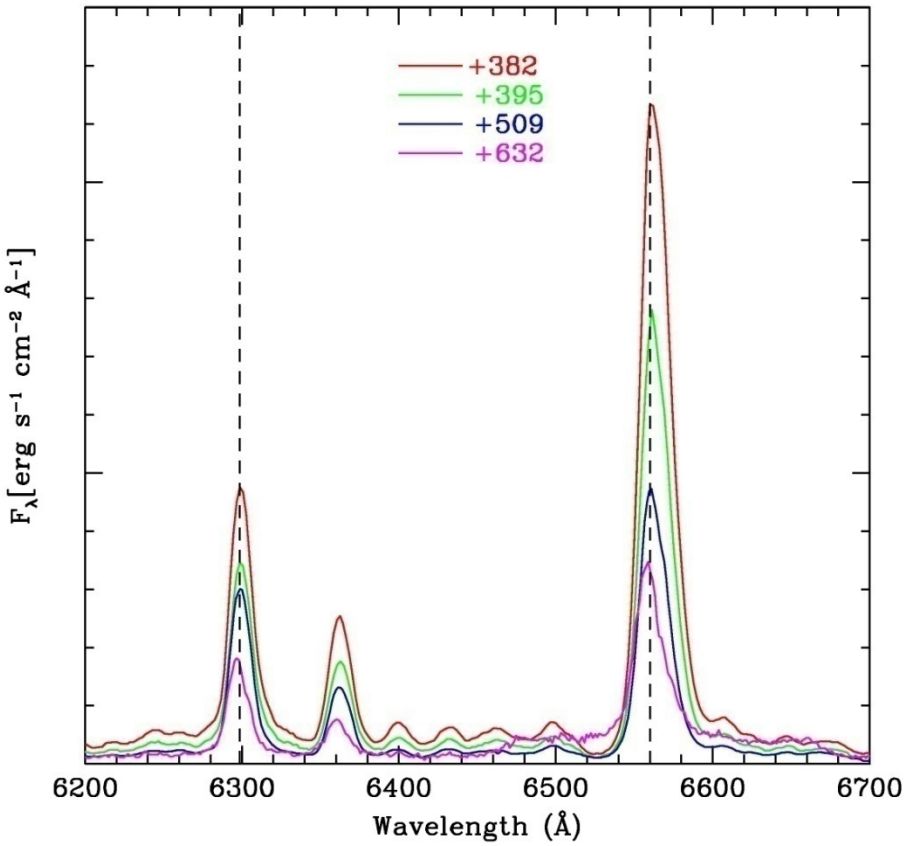
SN2008bk

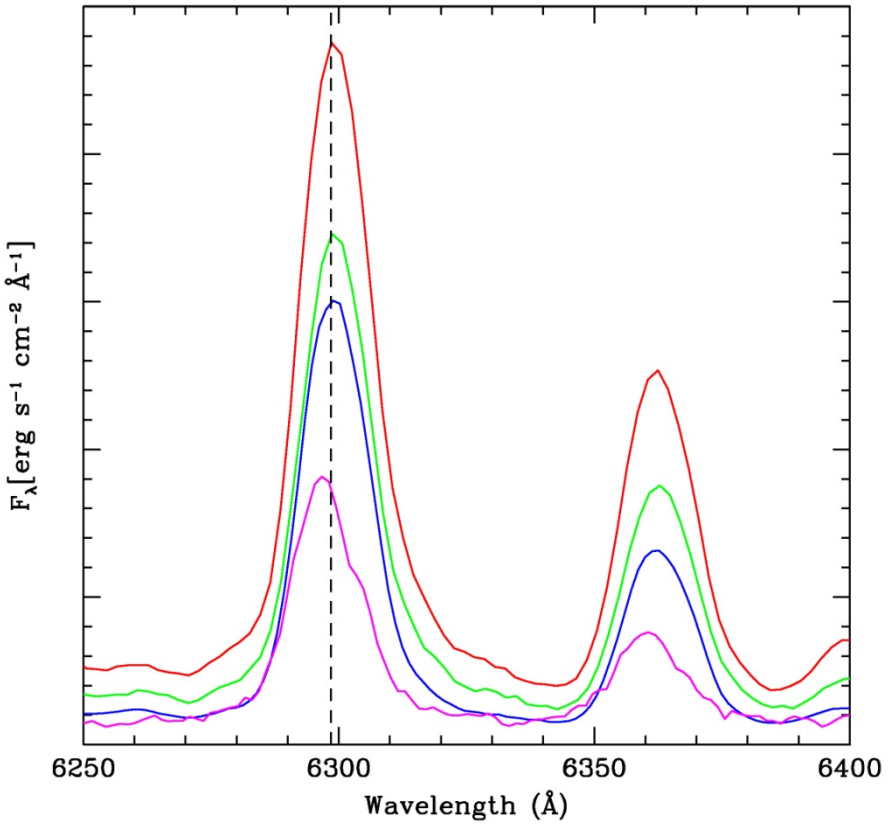
Leonard et al. 2012

SN2004dj



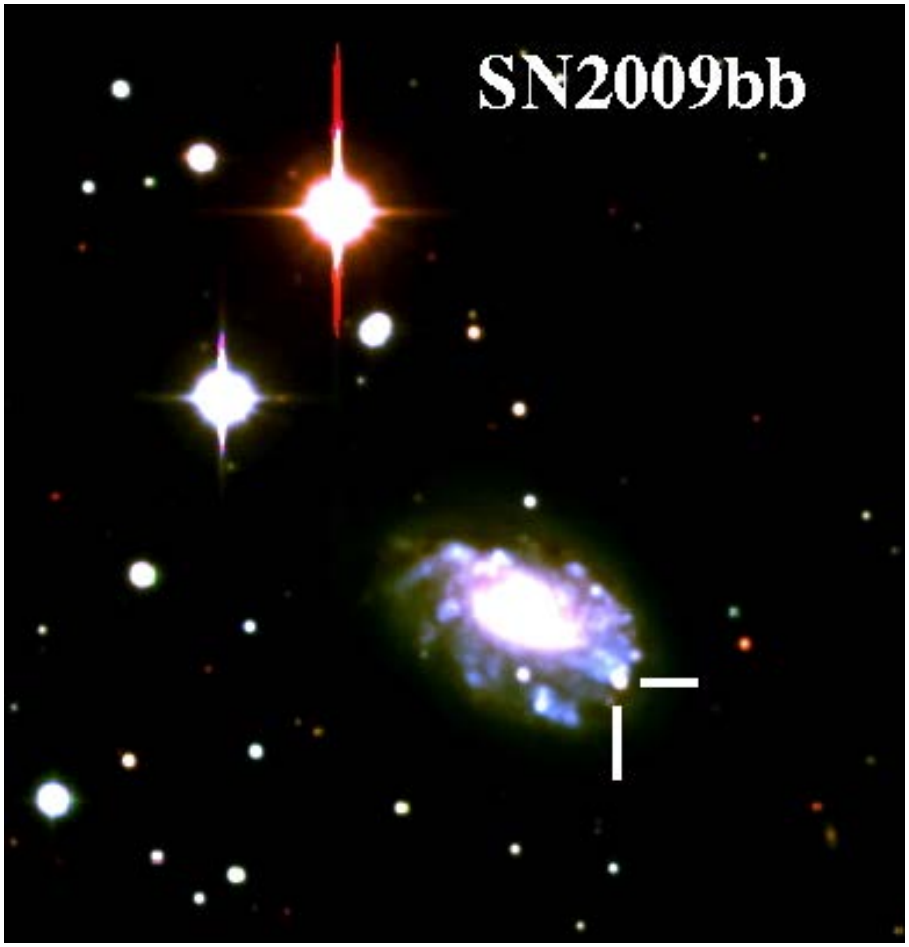
Dust formation





Pignata et al. 2013

SN 2009bb in NGC 3278



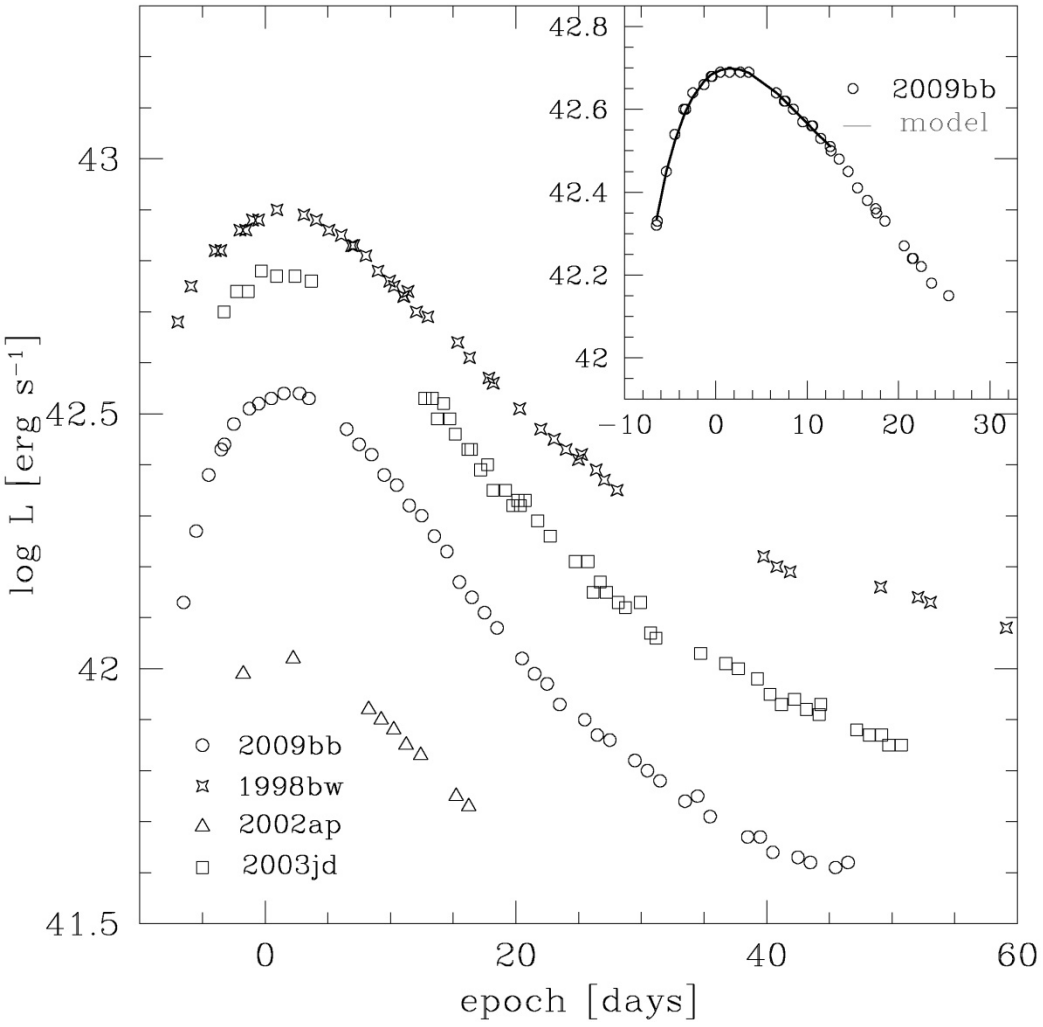
Negative detection two days before the discovery made by CHASE !!! **(Pignata et al. 2009)**

Strong constraint on the explosion date

Relativistic material inferred through radio observations (Soderberg et al. 2010)
But no GRB detection

Pignata et al. 2011

Pseudo-bolometric light curve

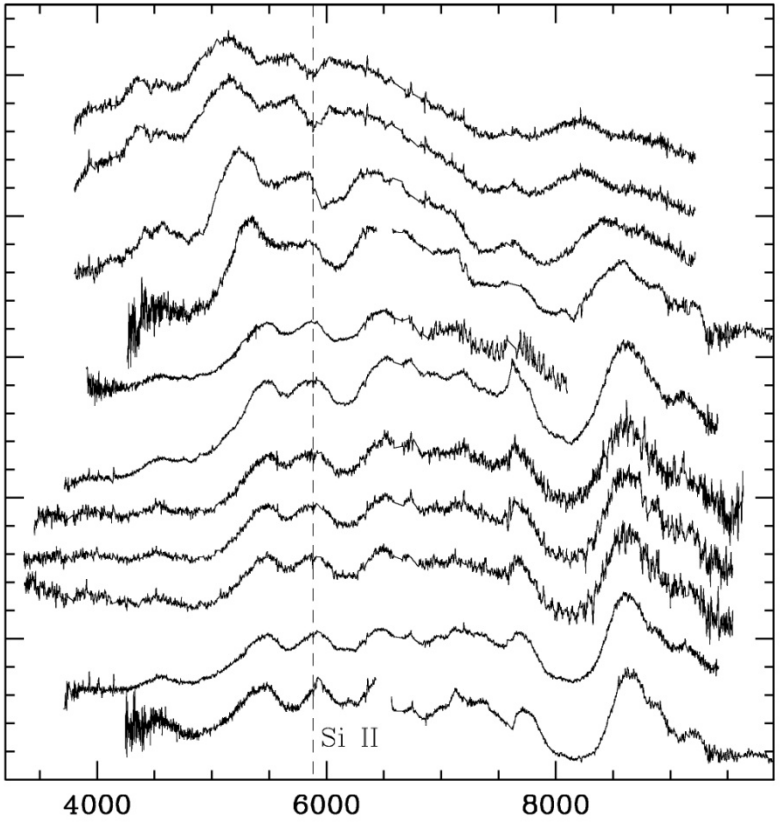


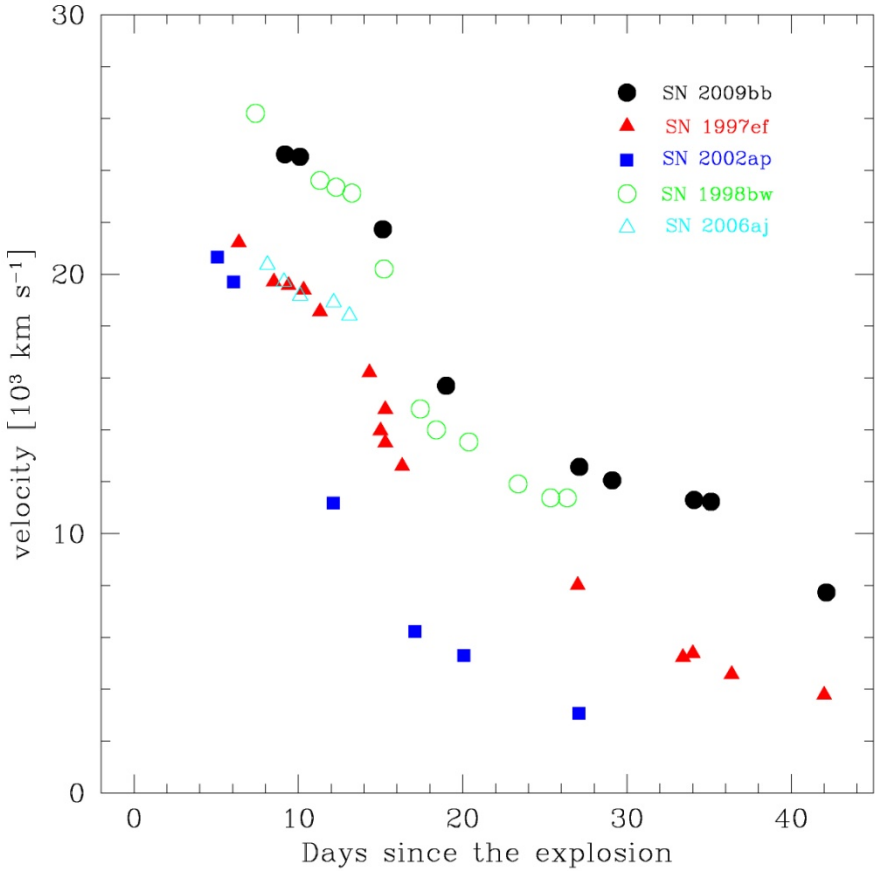
Using the analytic equations
by Arnett 1989

SN 2009bb
M_{ej} ~ 6 Msun
M_{Ni} ~ 0.2 Msun

SN 1998bw
M_{ej} ~ 8 Msun
M_{Ni} ~ 1.0 Msun

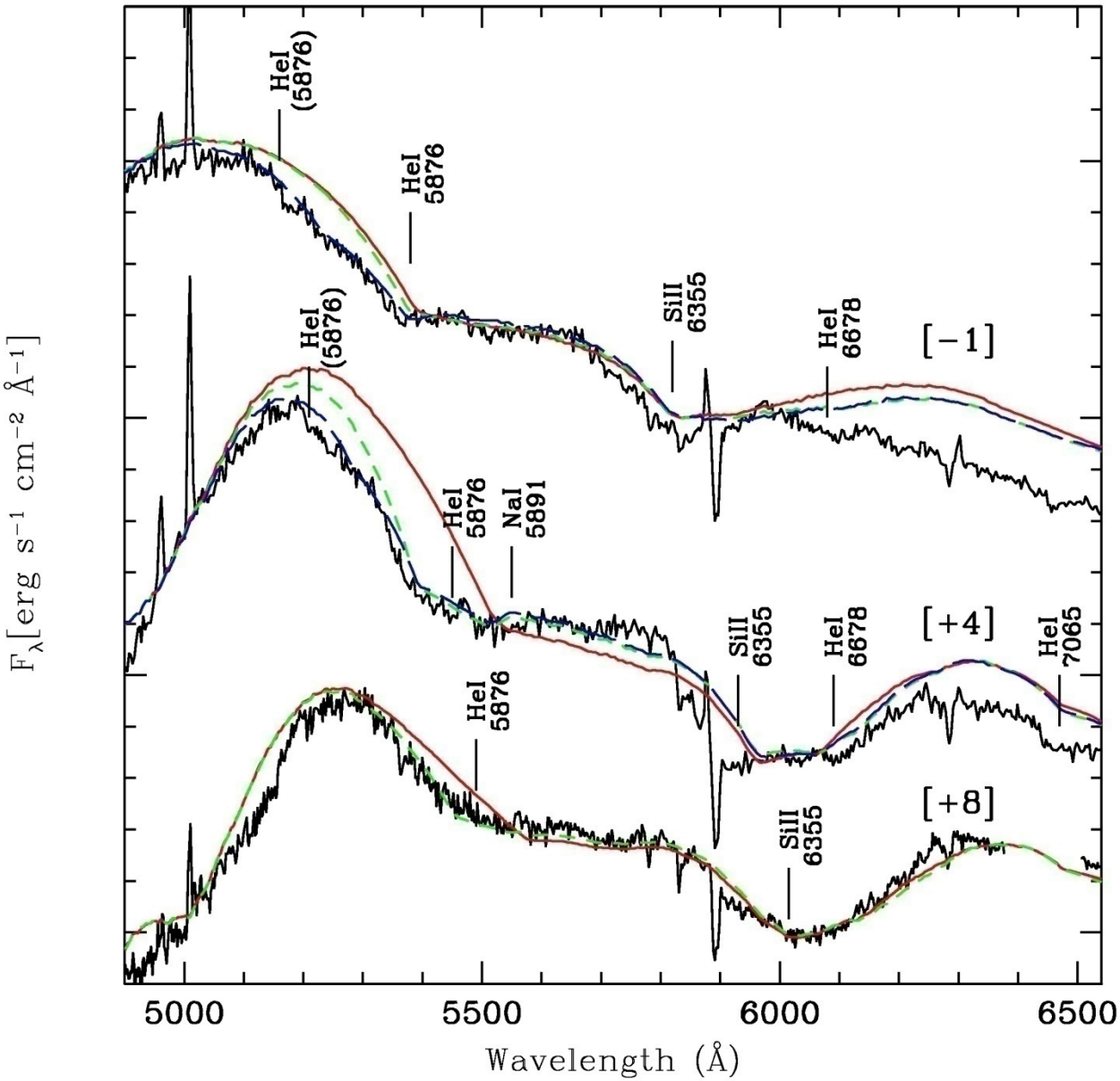
SN 2009bb spectral evolution



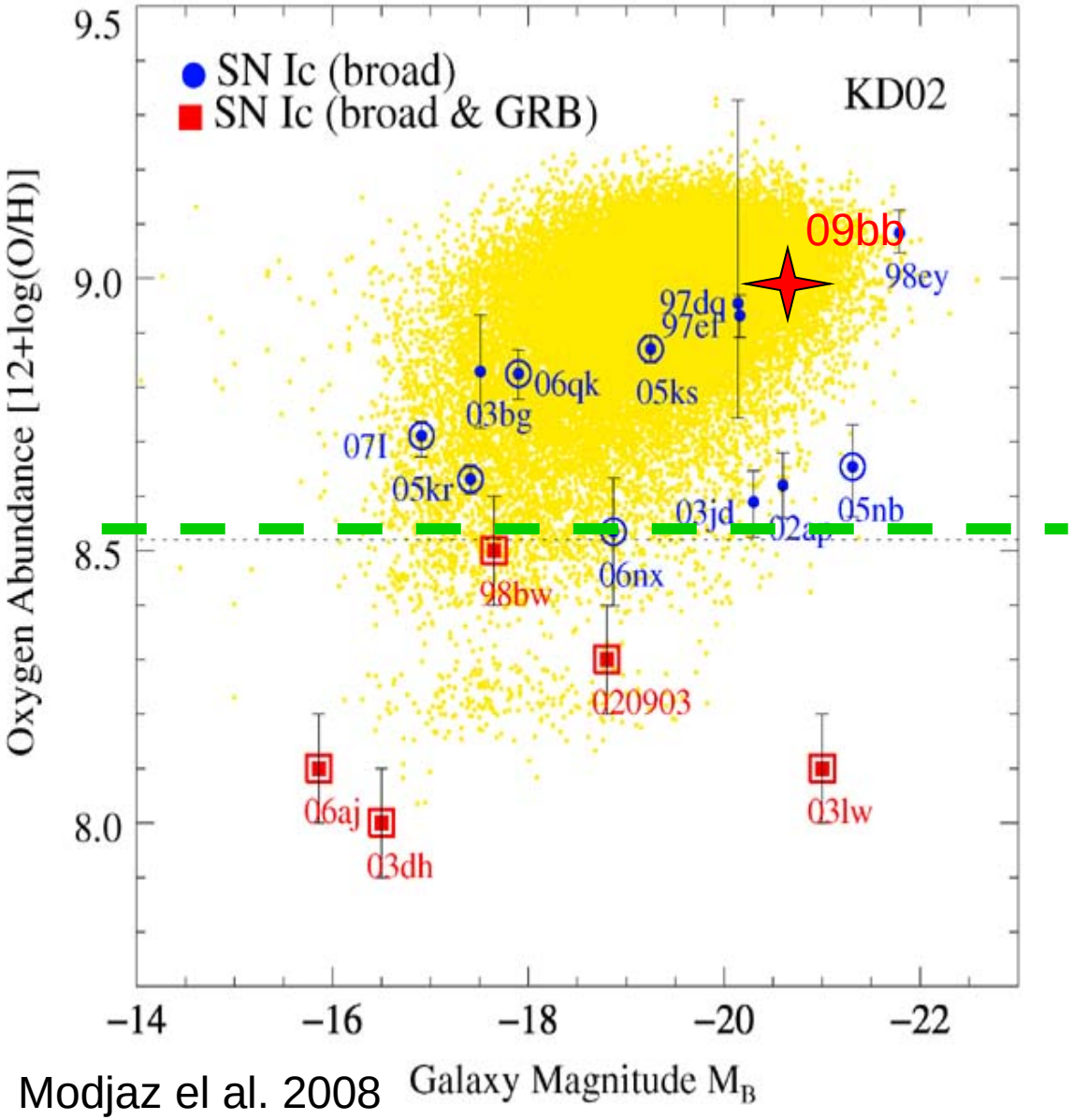


Expanction velocities similar to SN 1998bw

Helium detection ?



SN – GRB environment

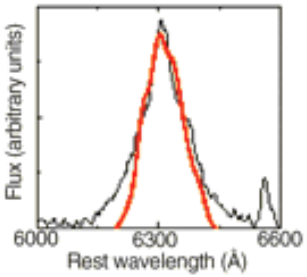


Modjaz el al. 2008

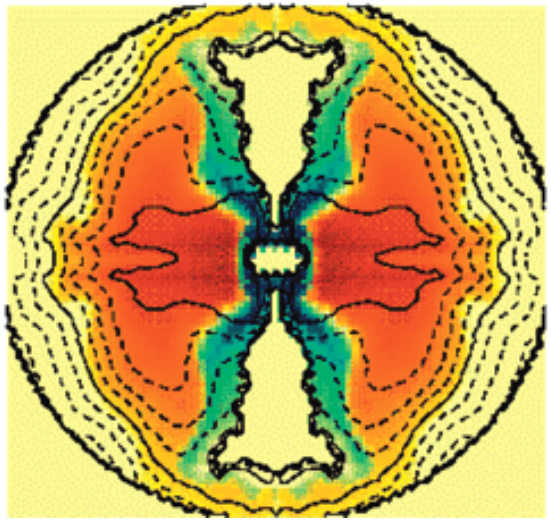
SN connected with GRB explode in a metal poor environment

But SN 2009bb do NOT explode in a metal poor environment (Levesque et al. 2010)

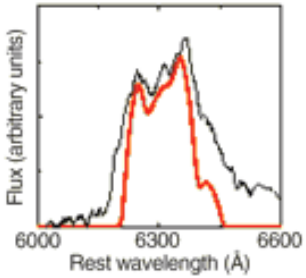
Is it view angle effect ?

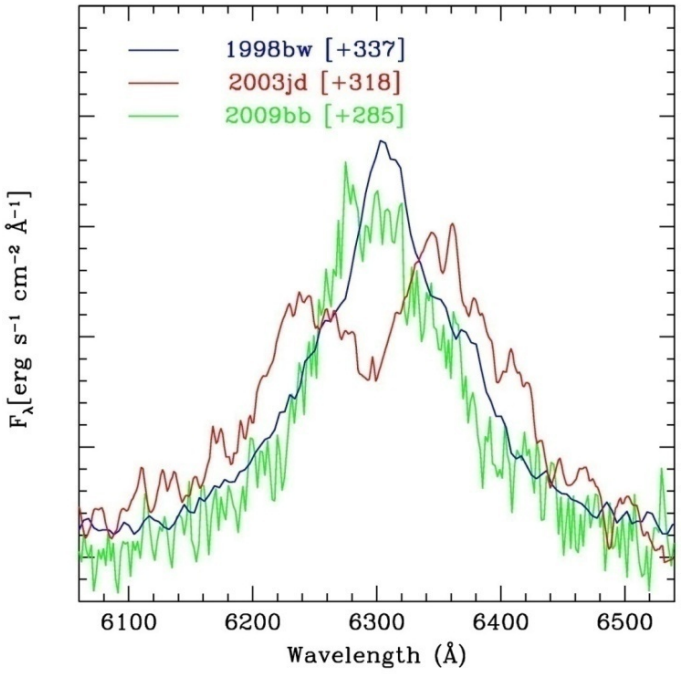


1998bw



2003jd

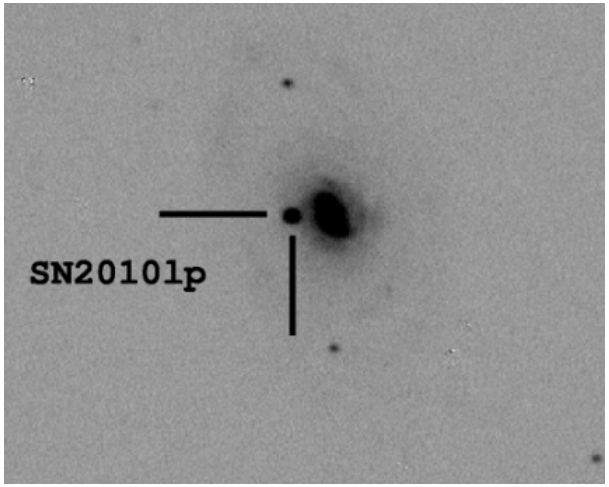


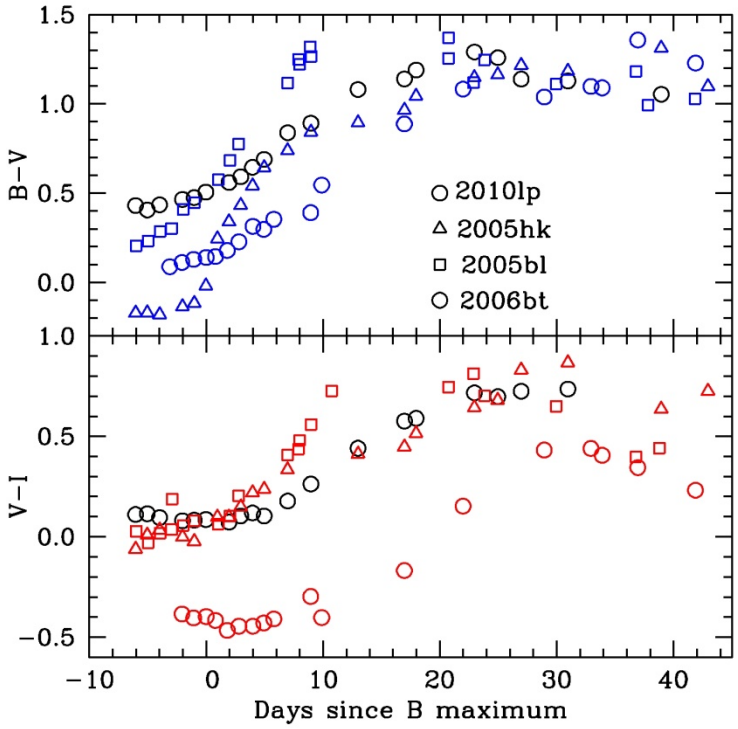


Mazzali 2005 + Maeda 2007

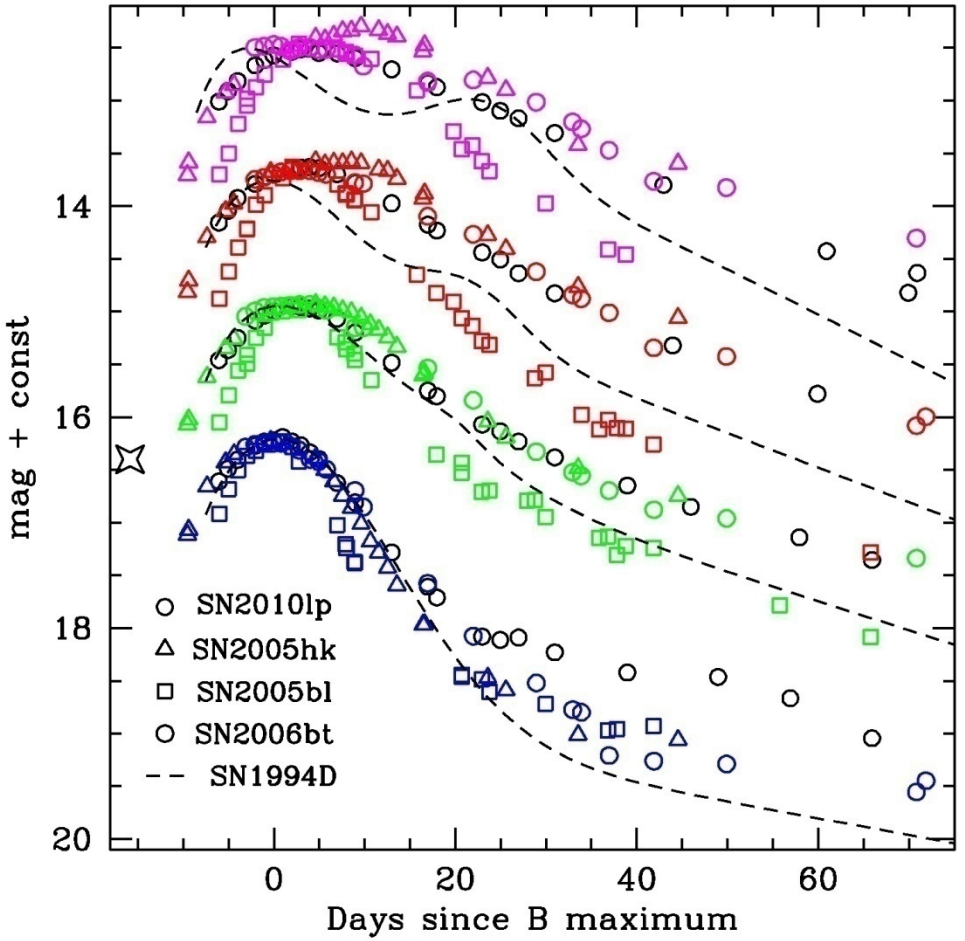
SN 1998bw => on axis
SN 2003jd => off axis

SN 2010lp



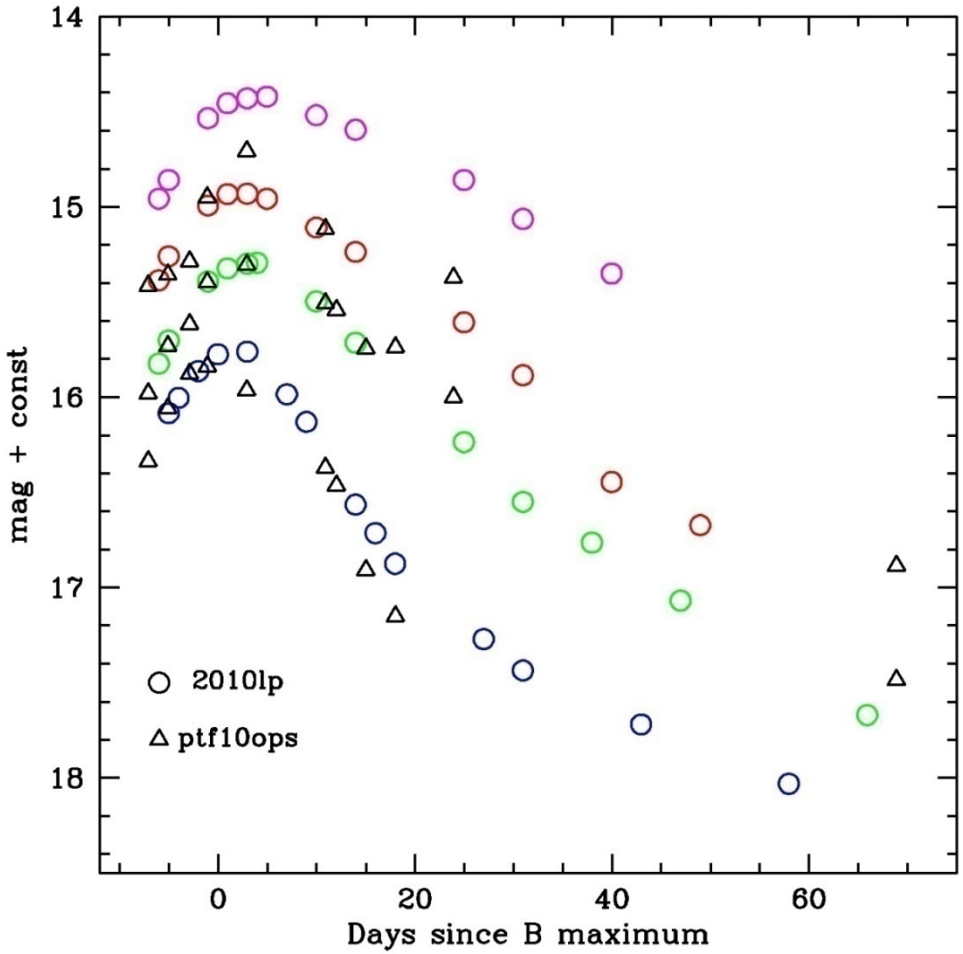


Red colors



But broad light curve => Δm_{15}=1.23
No second maximum in the I band
Underluminous => B=-17.7

SN2010lp

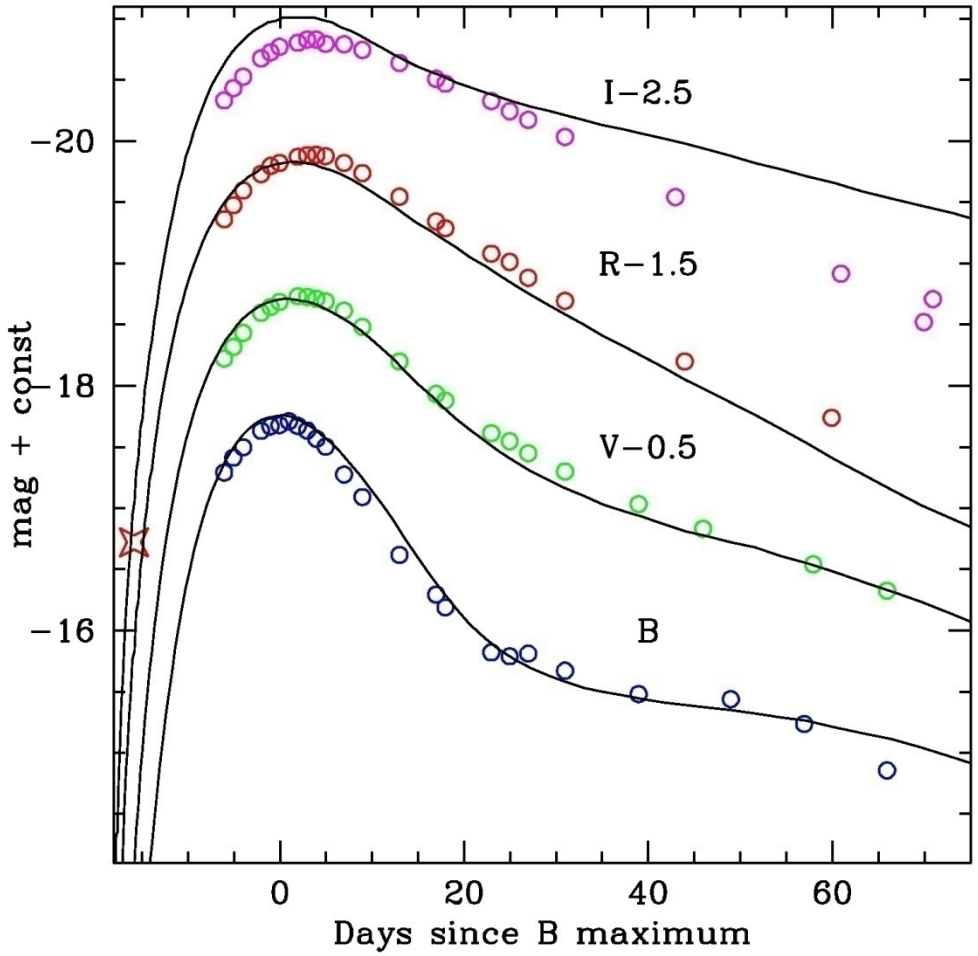


Similar to ptf10ops

Maguire et al. 2011

g' r' i' z' light curve

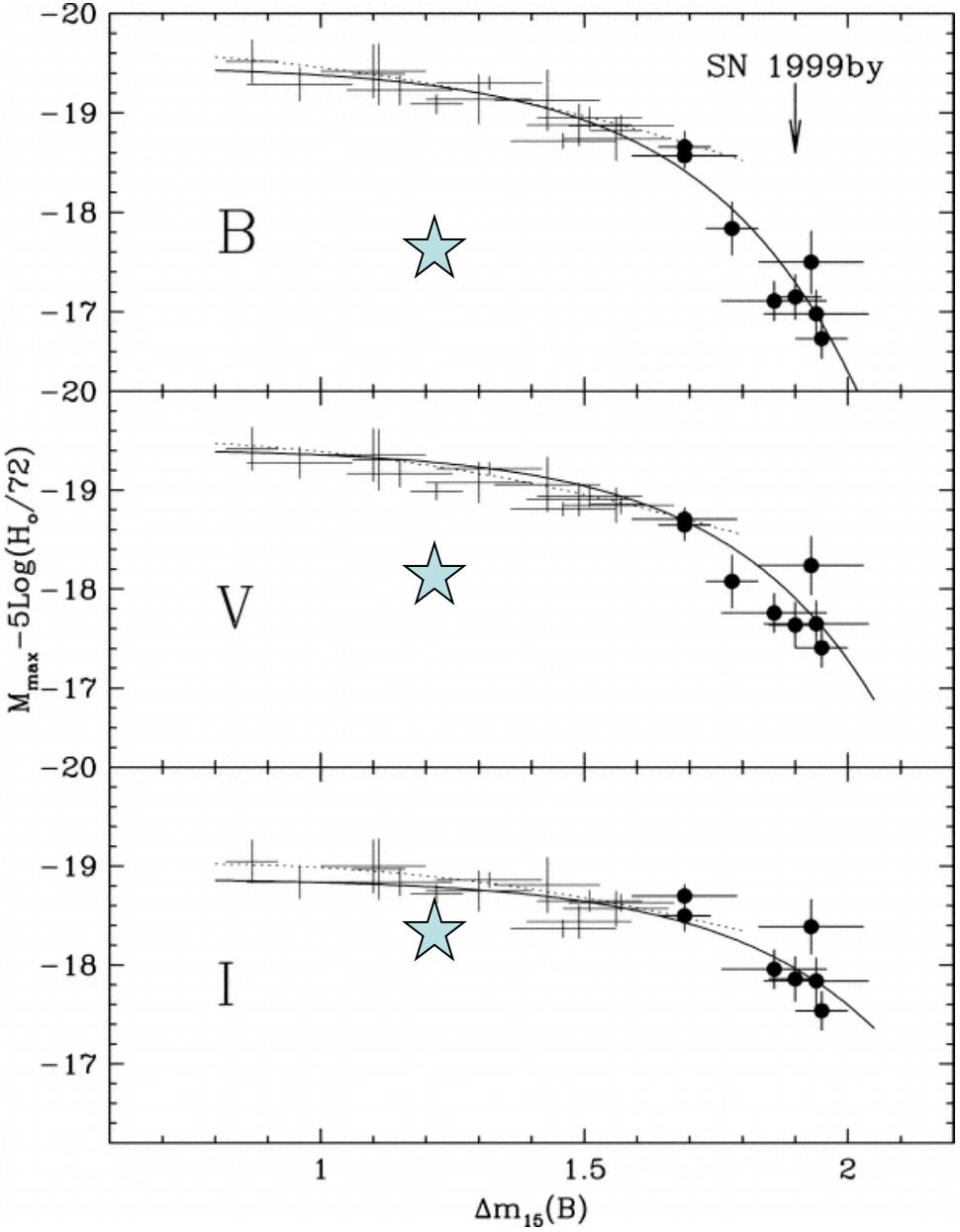
Light curve modelling

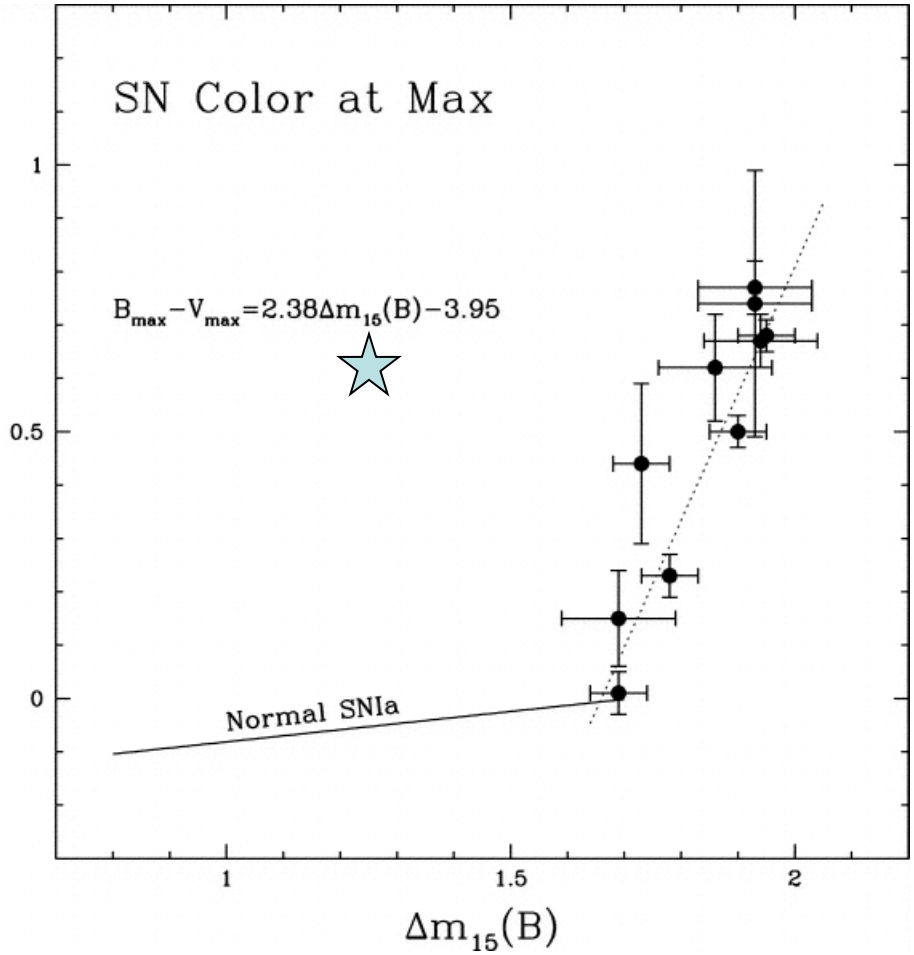


Two WD merger
M1 =0.9 M_{sun} M2 = 0.76 M_{sun}
M_{ni} = 0.18 M_{sun}

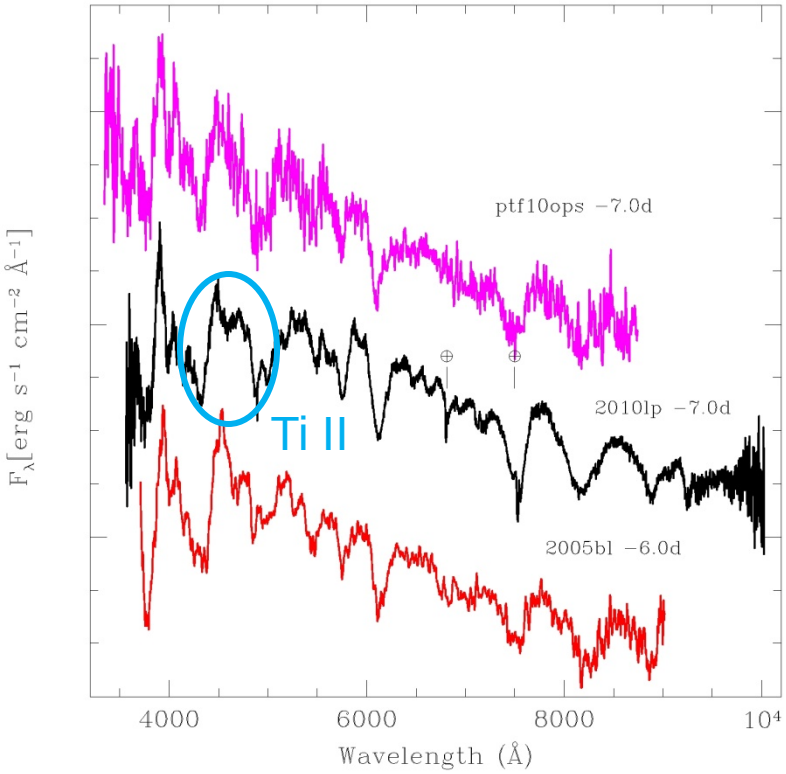
Cortesy of Kromer & Ruediger

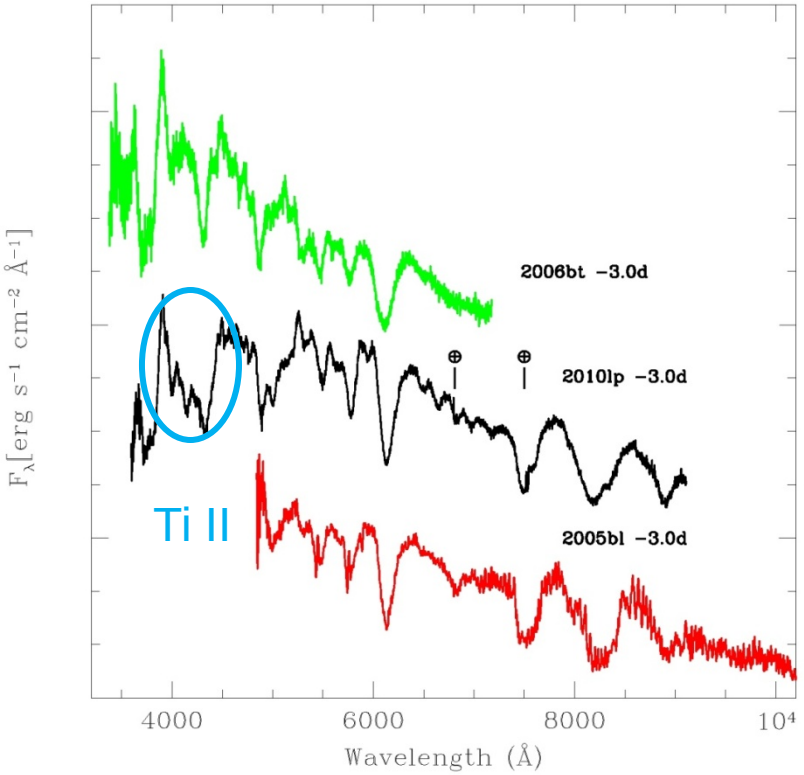
A Different SN Ia



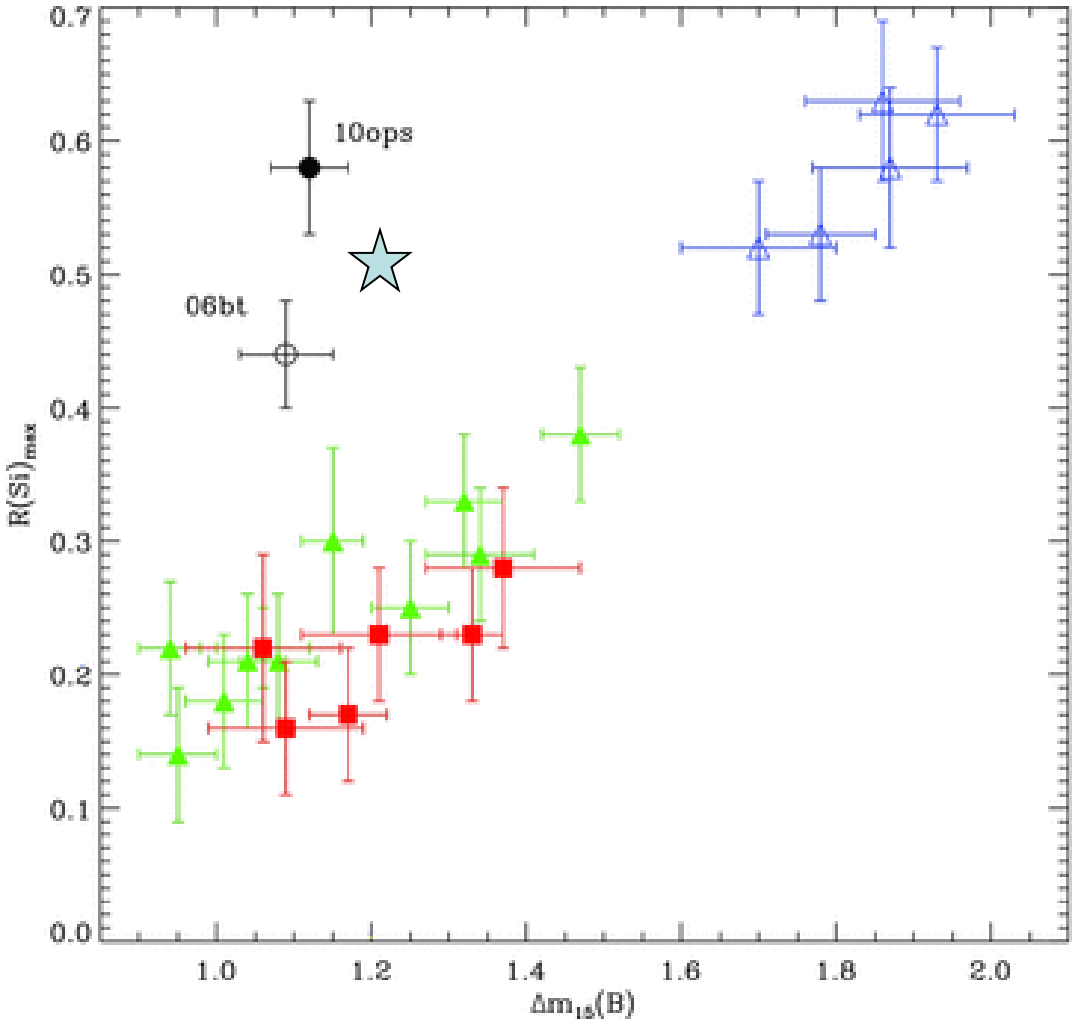


A cool spectrum

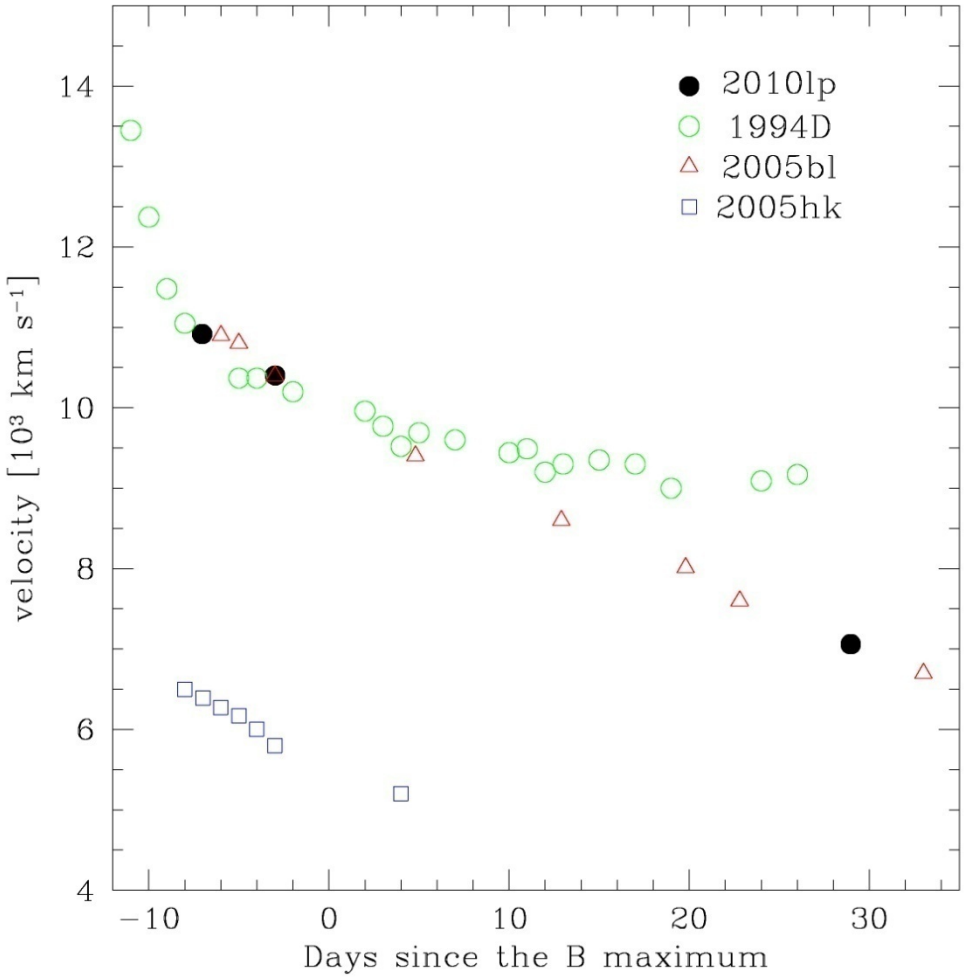




Again out of correlations

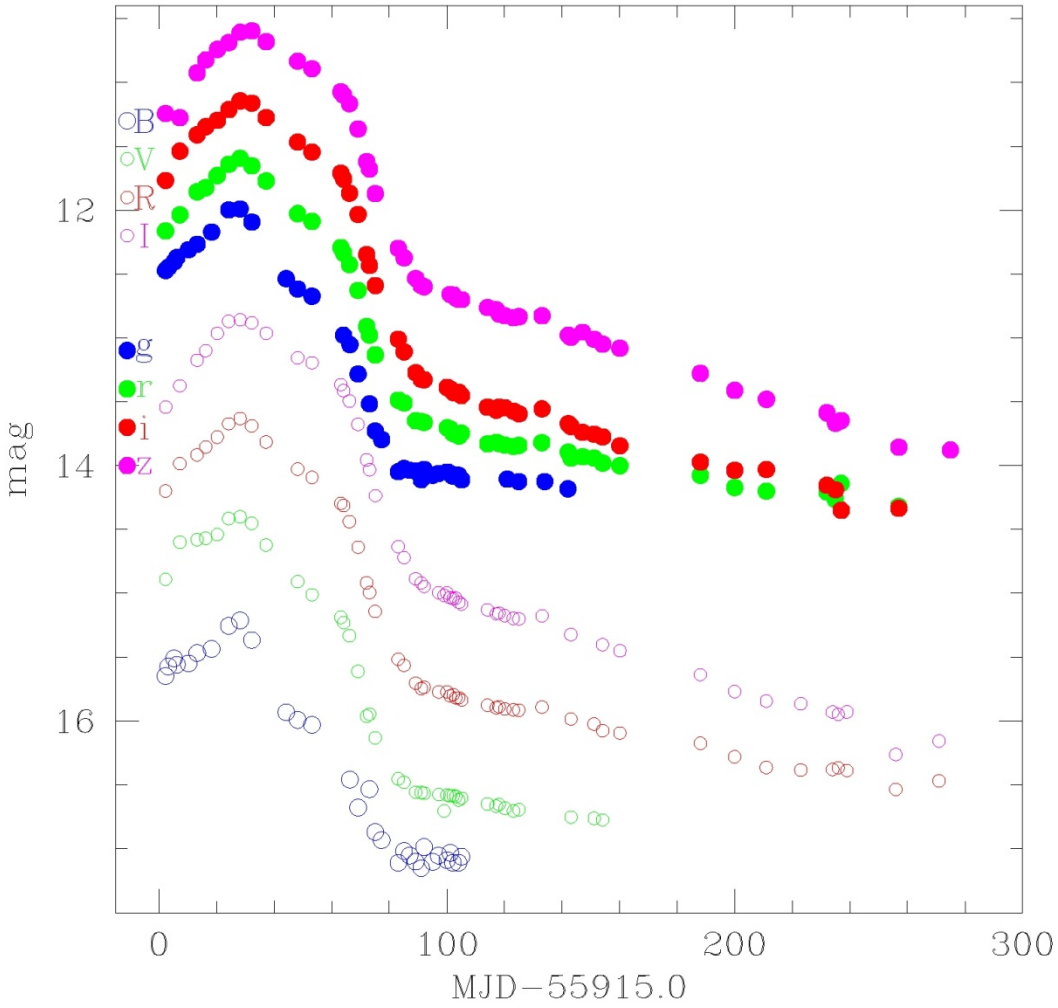


Expansión velocities



The evolution is very silar to 91bg-like SNe

SN 2011ja



Thank you !!