The first RTNIA
The rising of SN 2002bo

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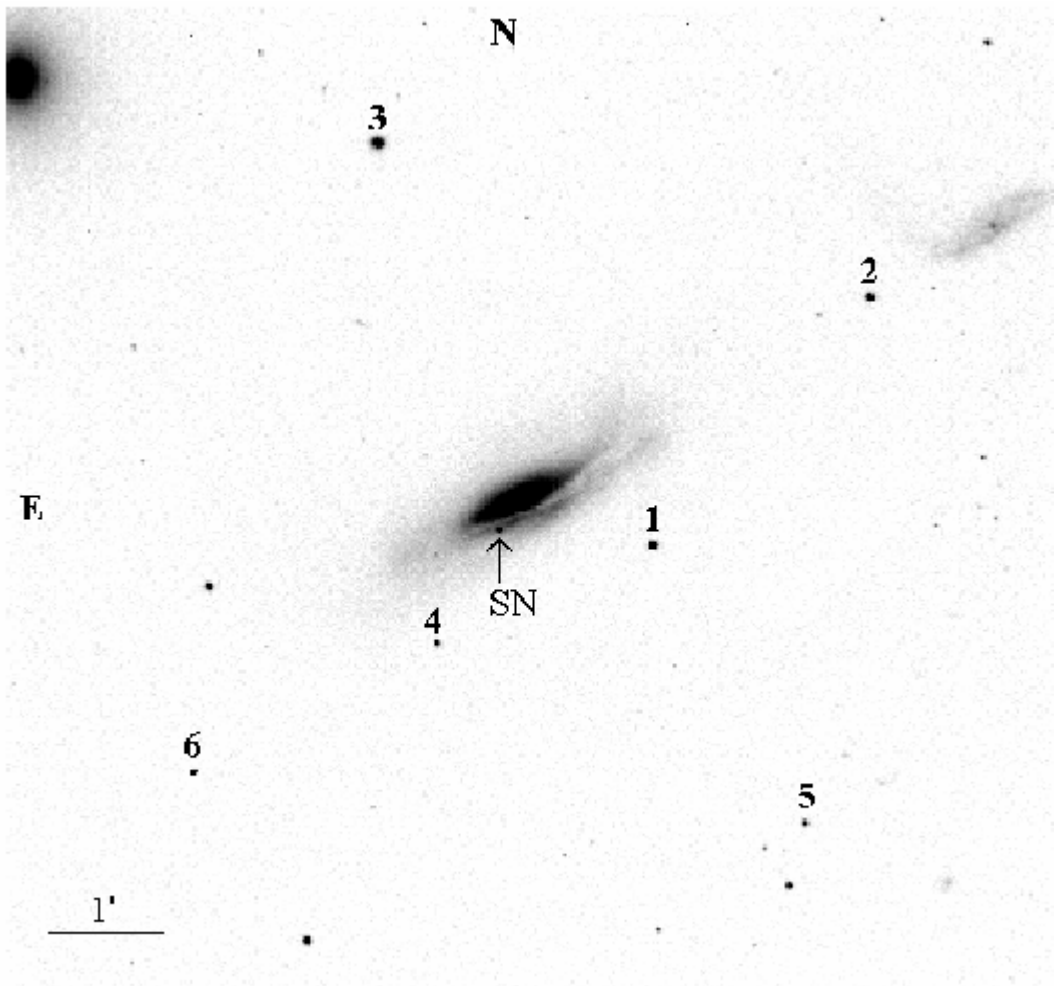


10 different telescopes/instruments

Observing Log

date	J.D. 2400000+	B	V	R	I	instr.
9/3/02	52343.45	16.96 (0.03)	16.22 (0.05)	15.89 (0.05)	15.86 (0.10)	A1.82
11/3/02	52344.51	16.31 (0.10)	15.70 (0.12)	15.37 (0.09)	15.32 (0.05)	A1.82
12/3/02	52345.52	15.72 (0.06)	15.18 (0.03)	14.89 (0.04)	14.87 (0.07)	A1.82
12/3/02	52346.49	15.35 (0.09)	14.93 (0.05)	14.54 (0.08)	14.47 (0.05)	A1.82
13/3/02	52347.42	15.12 (0.03)	14.71 (0.04)	14.29 (0.04)	14.29 (0.03)	A1.82
15/3/02	52348.52	14.83 (0.03)				NOT
16/3/02	52350.42	14.47 (0.03)				NOT
19/3/02	52352.54	14.22 (0.03)				NOT
19/3/02	52352.55	14.24 (0.03)	13.88 (0.04)	13.61 (0.11)	13.53 (0.07)	A1.82
19/3/02	52353.46	14.11 (0.06)	13.75 (0.06)	13.51 (0.07)	13.48 (0.09)	A1.82
20/3/02	52354.39	14.08 (0.03)				NOT
21/3/02	52355.34	14.06 (0.10)	13.67 (0.10)	13.48 (0.10)	13.48 (0.10)	A1.82
21/3/02	52355.45	14.08 (0.07)				NOT
28/3/02	52361.58	14.13 (0.06)	13.64 (0.05)	13.42 (0.11)	13.69 (0.06)	JKT
6/5/02*	52401.39	17.03 (0.05)	15.63 (0.05)	15.13 (0.05)	14.92 (0.05)	TNG
15/5/02	52410.45	17.14 (0.08)	15.83 (0.06)	15.48 (0.05)	15.21 (0.06)	A1.82
10/6/02	52436.37	17.48 (0.06)	16.46 (0.07)	16.42 (0.07)	16.52 (0.07)	A1.82
14/6/02	52440.48	17.52 (0.06)	16.66 (0.04)	16.47 (0.04)	16.58 (0.04)	NTT
27/6/02	52453.42	17.65 (0.04)	16.95 (0.04)	16.81 (0.04)	16.90 (0.06)	INT
29/6/02	52455.44		17.03 (0.05)	17.04 (0.07)	17.06 (0.10)	JKT
30/6/02	52456.42	17.73 (0.04)				JKT
2/7/02	52458.44	17.72 (0.05)	17.20 (0.05)	17.01 (0.10)	16.99 (0.13)	JKT

* for this epoch is available also an estimate of $U = 17.58 \pm 0.05$
A1.82 = Asiago1.82m telescope + AFOSC
NOT = Nordic Optical Telescope + ALFOSC
JKT = 1.0m Jacobus Kapteyn Telescope + CCD camera
TNG = Telescopio Nazionale Galileo + DOLORES
NTT = ESO NTT + EMMI
INT = 2.5m Isaac Newton Telescope + WFC

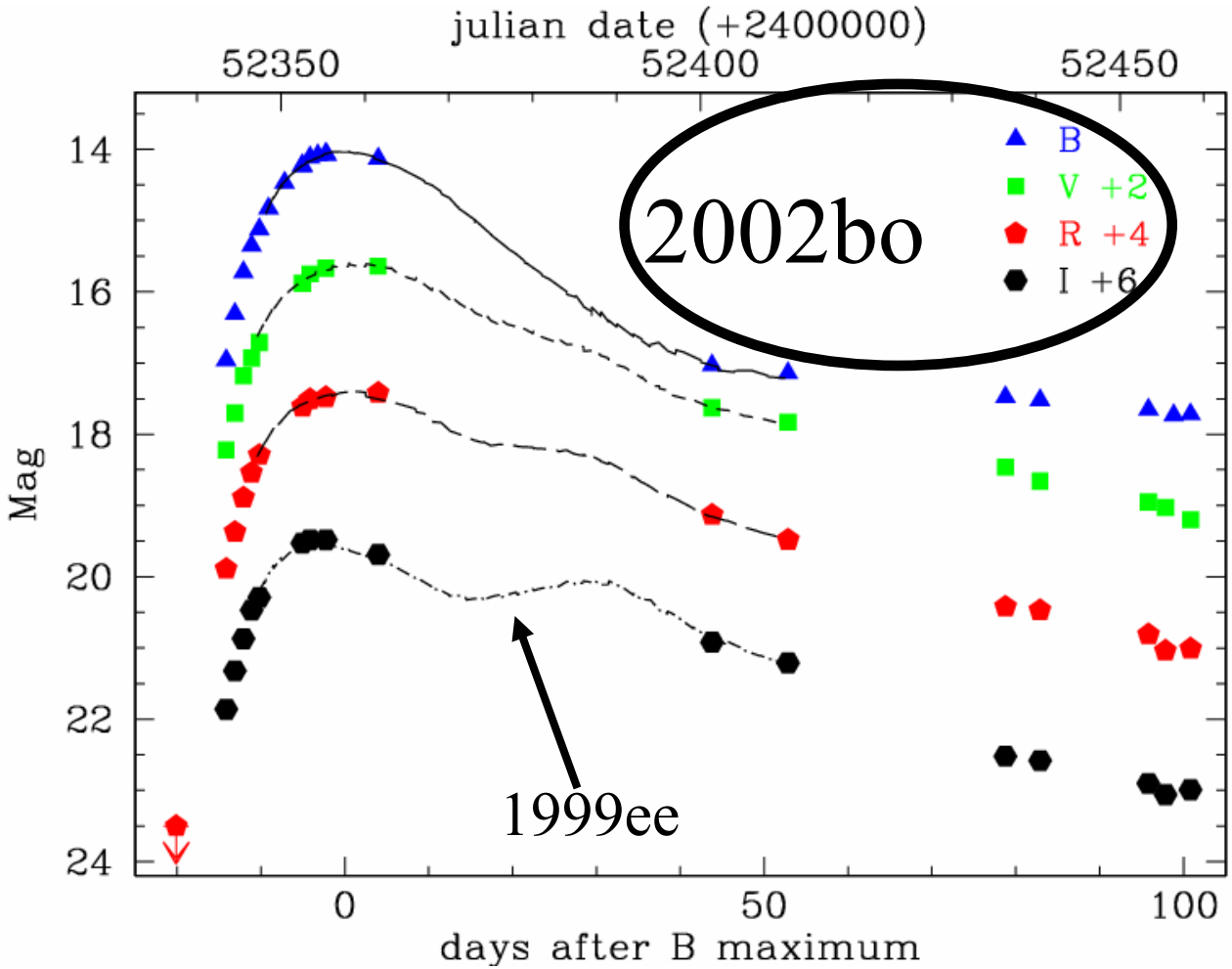
+ nebular phase

Date	phase* (days)	inst.**	exp (min)	range (Å)	res. (Å)
10/03/02	-14	A1.82	40	3600-7700	25
10/03/02	-13.1	A1.82	120	3600-7700	25
11/03/02	-12.1	A1.82	60	3400-7700	25
13/03/02	-10.2	A1.82	60	3400-7700	25
14/03/02	-9.6	UKIRT	??	8135-13060	25
14/03/02	-9.6	UKIRT	??	14666-25400	100
15/03/02	-9.1	NOT	10	3400-9050	14
16/03/02	-7.2	NOT	10	3400-9050	14
18/03/02	-5.2	WHT	??	3200-7550	2
19/03/02	-5.1	A1.82	60	3400-7700	25
16/03/02	-5.0	NOT	5	3400-9050	14
19/03/02	-4.2	A1.82	60	3400-7700	25
20/03/02	-3.2	NOT	14	3400-9050	22
20/03/02	-3.1	A1.82	40	3400-7700	25
21/03/02	-2.2	A1.82	60	3400-7700	25
21/03/02	-2.1	NOT	20	3400-9050	22
22/03/03	-1.9	WHT	??	3200-8900	12
23/03/02	-1.0	A1.82	60	3400-10350	25
28/03/03	+4.8	WHT	??	3100-8800	12
03/04/02	+10.2	UKIRT	??	8180-13390	25
03/04/02	+10.2	UKIRT	??	14725-25250	100
21/04/02	+28.3	UKIRT	??	10680-13880	25
21/04/02	+28.3	UKIRT	??	14780-25260	100
21/04/02	+28.8	INT+I	??	3500-9800	4
23/04/02	+30.3	UKIRT	??	8230-10980	25
01/05/02	+38.8	INT+I	??	3650-9200	4
06/05/02	+43.8	TNG	45	3250-8040	12
17/05/02	+54.8	UKIRT	??	8155-10730	25
18/05/02	+55.9	UKIRT	??	10730-13530	25
22/05/02	+59.9	UKIRT	??	19840-25130	100
14/06/02	+82.9	NTT	15?	3900-9750	10
15/06/02	+83.9	NTT+S	64	9400-16500	21

* - relative to the estimated epoch of B maximum
** - See note to Table 1 for coding plus:
UKIRT = United Kingdom Infrared Telescope + CGS4
WHT = William Herschel Telescope + ISIS
INTI = Isaac Newton Telescope + IDS
NTT+S = ESO NTT + SOFI

optical light curves

1. v.good premax from t_{Bmax}=-14d
2. B_{max}=14.01
3. gap pastmax
4. =1999ee, Δm_{15}=0.94

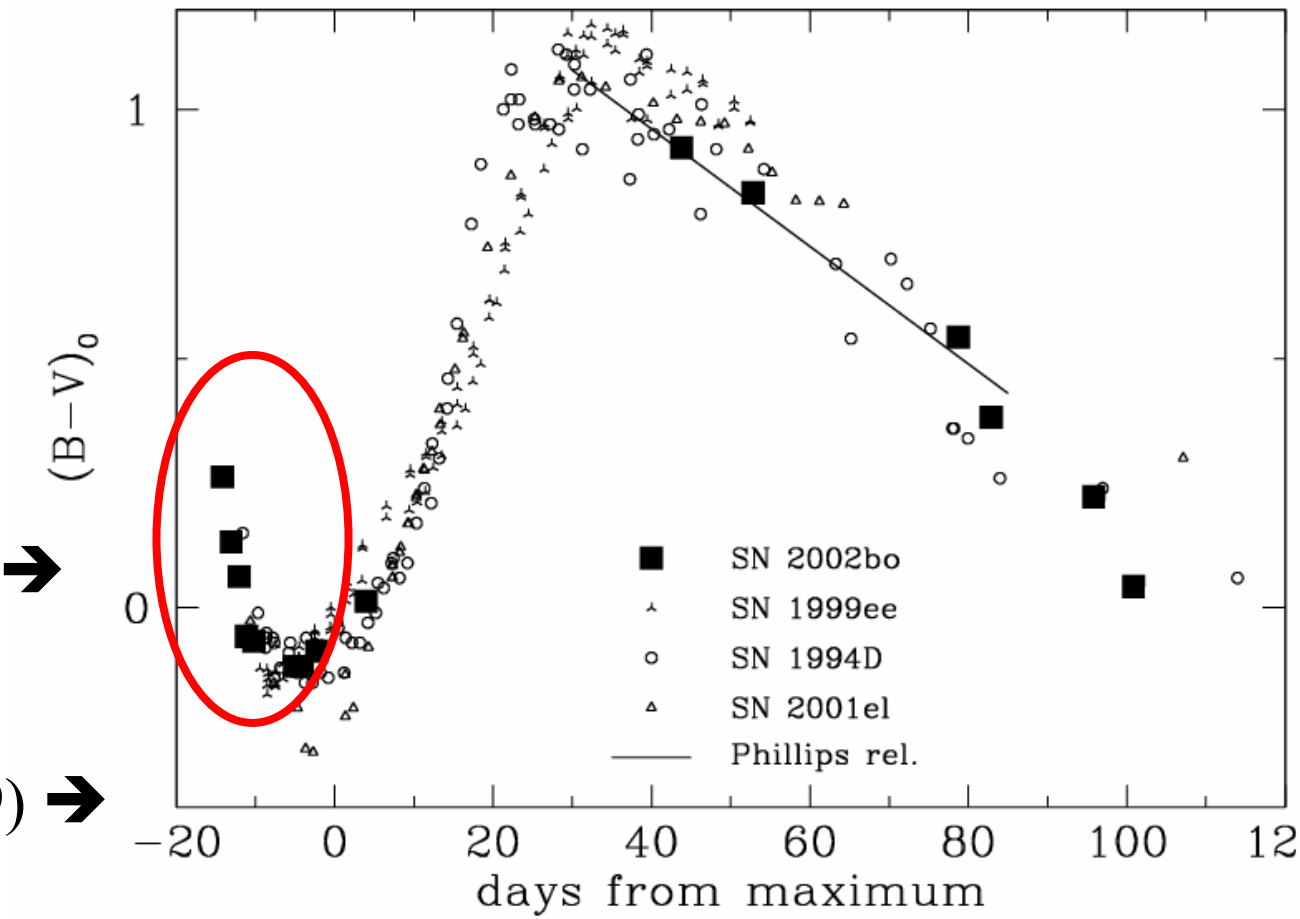


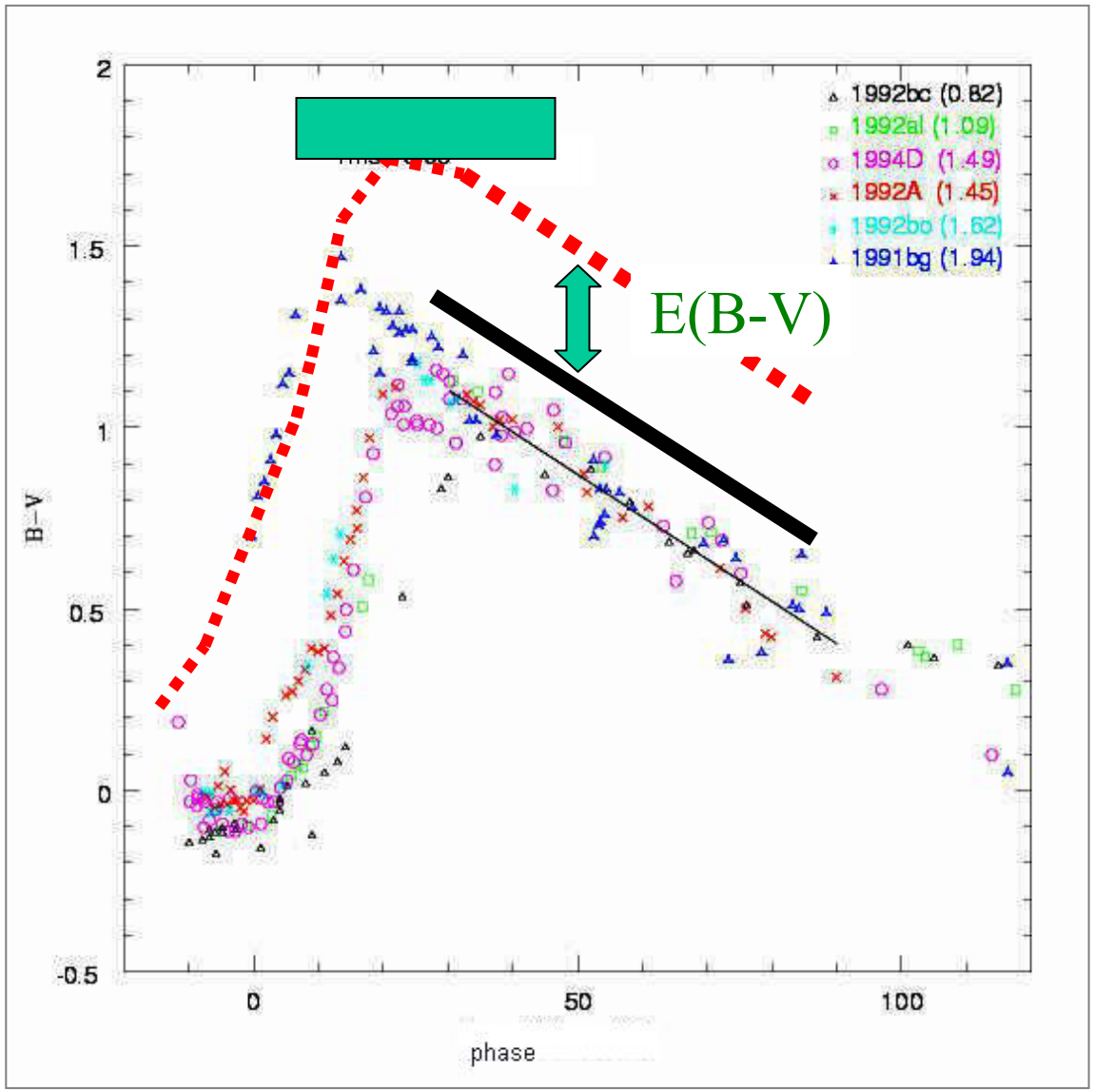
B-V color curve

1. $E(B-V)_{tot}=0.47$
   $(E(B-V)_{Gal}=0.027)$

2. EW(NaID)=2.27A ➔
   E(B-V)>0.36

3. Phillips et al. (1999) ➔
   $M_B=-19.72$
   ➔$\mu=31.82 \sim \mu_{vel}=31.67$




1992bc (0.82)
1992al (1.09)
1994D (1.49)
1992A (1.45)
1992bo (1.62)
1991bg (1.94)
E(B-V)
B−V
phase
2
1.5
1
0.5
0
-0.5
0
50
100

empirical E(B-V) vs.EW(NaID)

-EW(NaID) measured
-E(B-V) from Ia late colors
(Phillips et al. 1999)
- ▲ galactic (Schlegel et al. 1998)

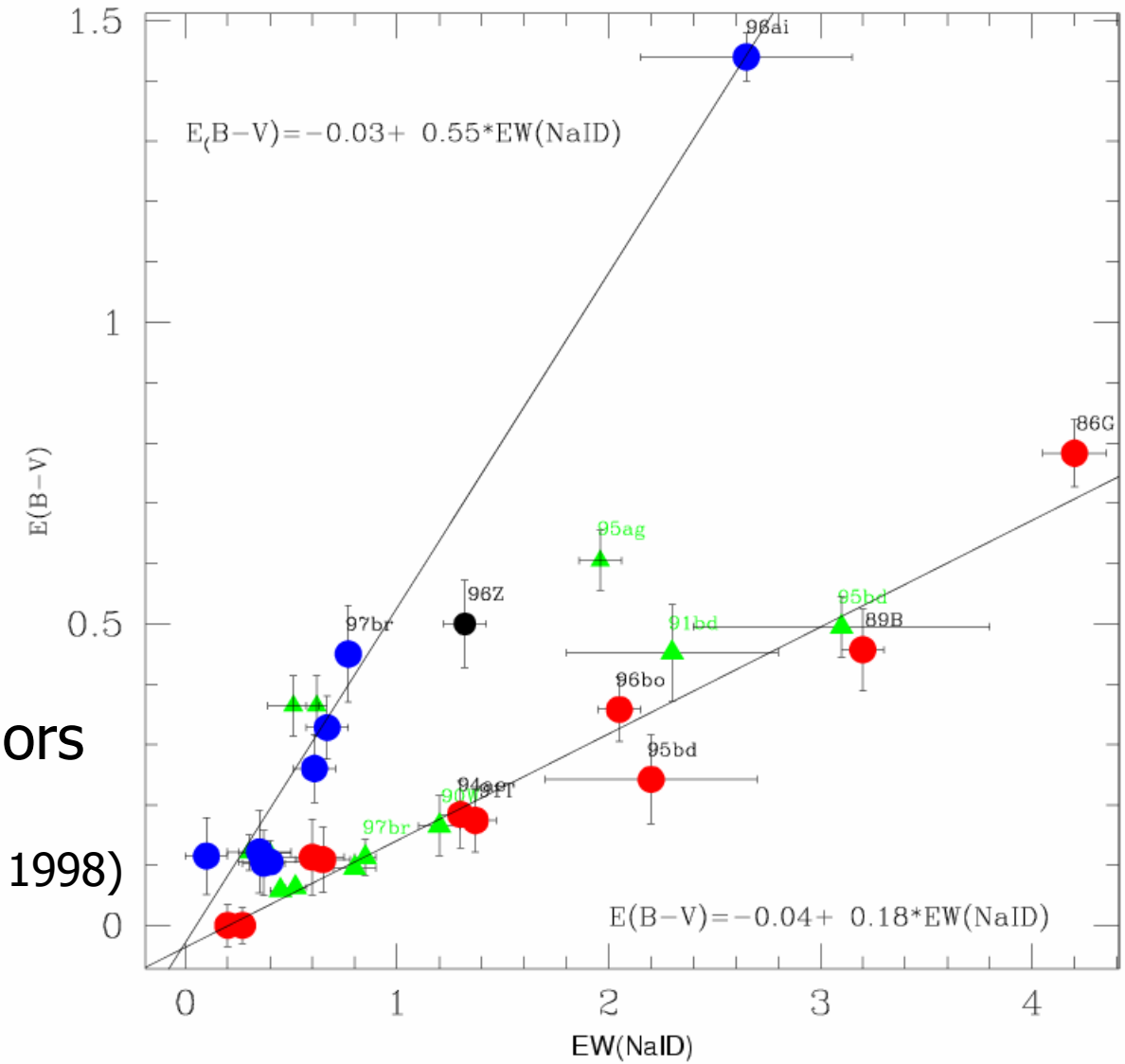


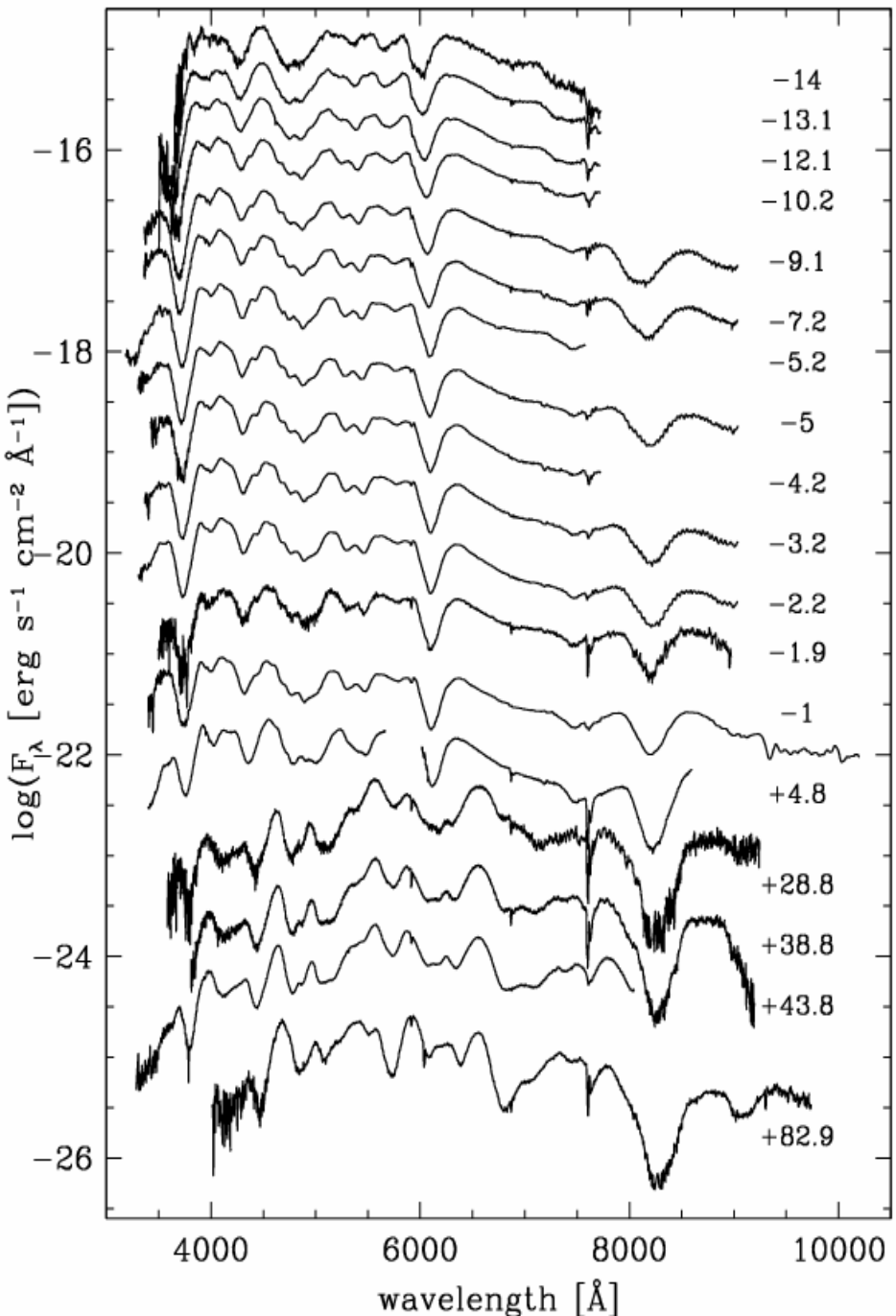
Table 3. Main data of SN 2002bo

Parent galaxy	NGC 3190
Galaxy type	SA(s)a pec sp LINER †
RA (2000)	$10^h18^m06^s.51$
Dec (2000)	$+21°49'41".7$
Recession velocity [km s^{-1}]	1405 ‡
Distance modulus ($H_0 = 65$)	31.67
A_B	1.91
Offset form nucleus	11.6"E 14".2S
Date of B maximum	JD= 2452357.6 ± 0.5 (Mar 24, 2002)
magnitude at max	$B = 14.01 \pm 0.10$, $V = 13.56 \pm 0.10$, $R = 13.40 \pm 0.10$, $I = 13.47 \pm 0.10$
$\Delta\ m_{15}$(B)	0.94

† NED
‡ LEDA, corrected for LG infall (208 km s^{-1})

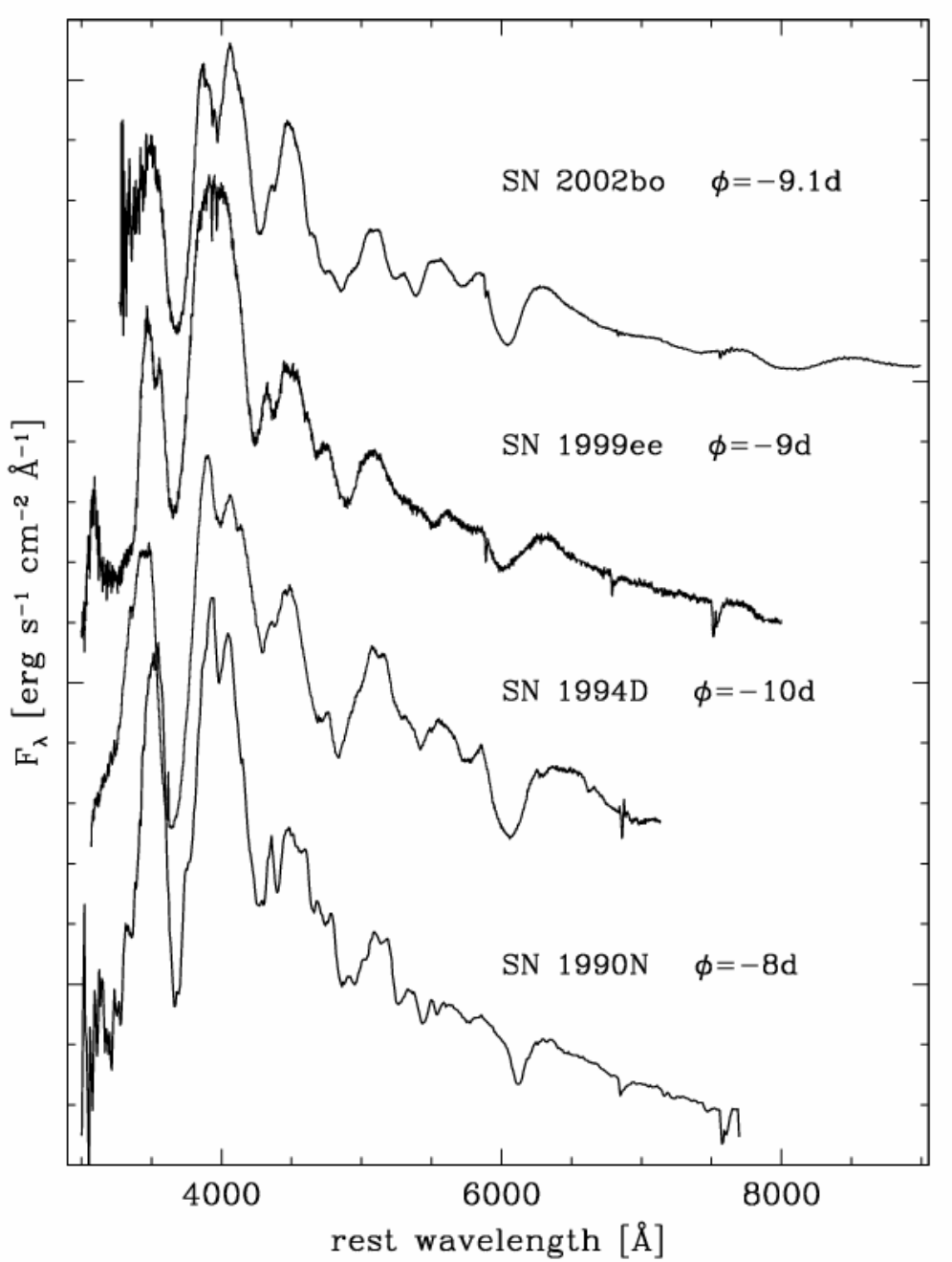
Spectral evolution

Exceptional sampling premax
➔ evolution various features
e.g. line velocities

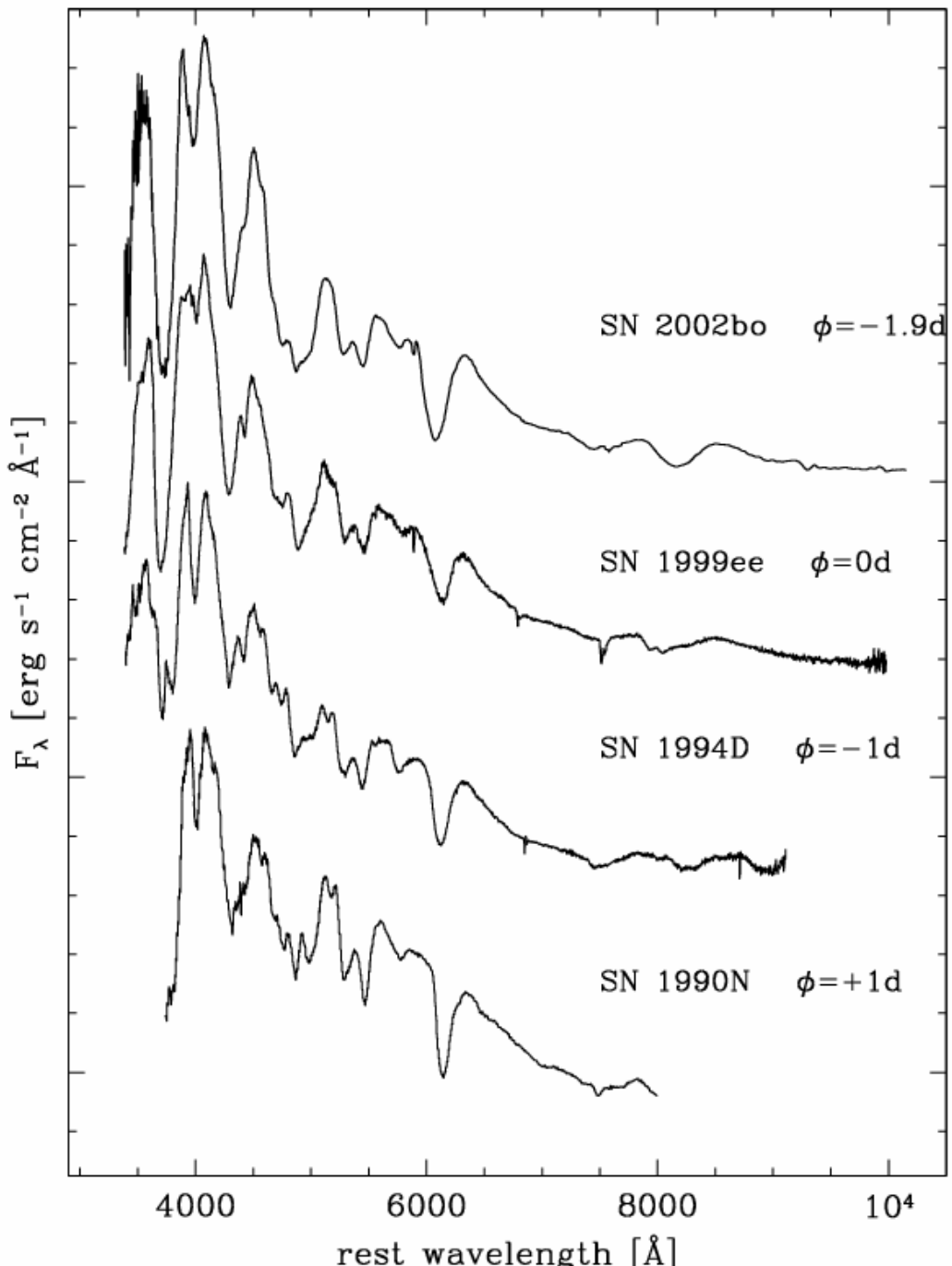


Very early spectra

1. Major differences in blue (only blending??)
2. SiII profile



Spectra @max


SN 2002bo ϕ=−1.9d
SN 1999ee ϕ=0d
SN 1994D ϕ=−1d
SN 1990N ϕ=+1d
F_λ [erg s^{-1} cm^{-2} Å^{-1}]
4000
6000
8000
10^4
rest wavelength [Å]

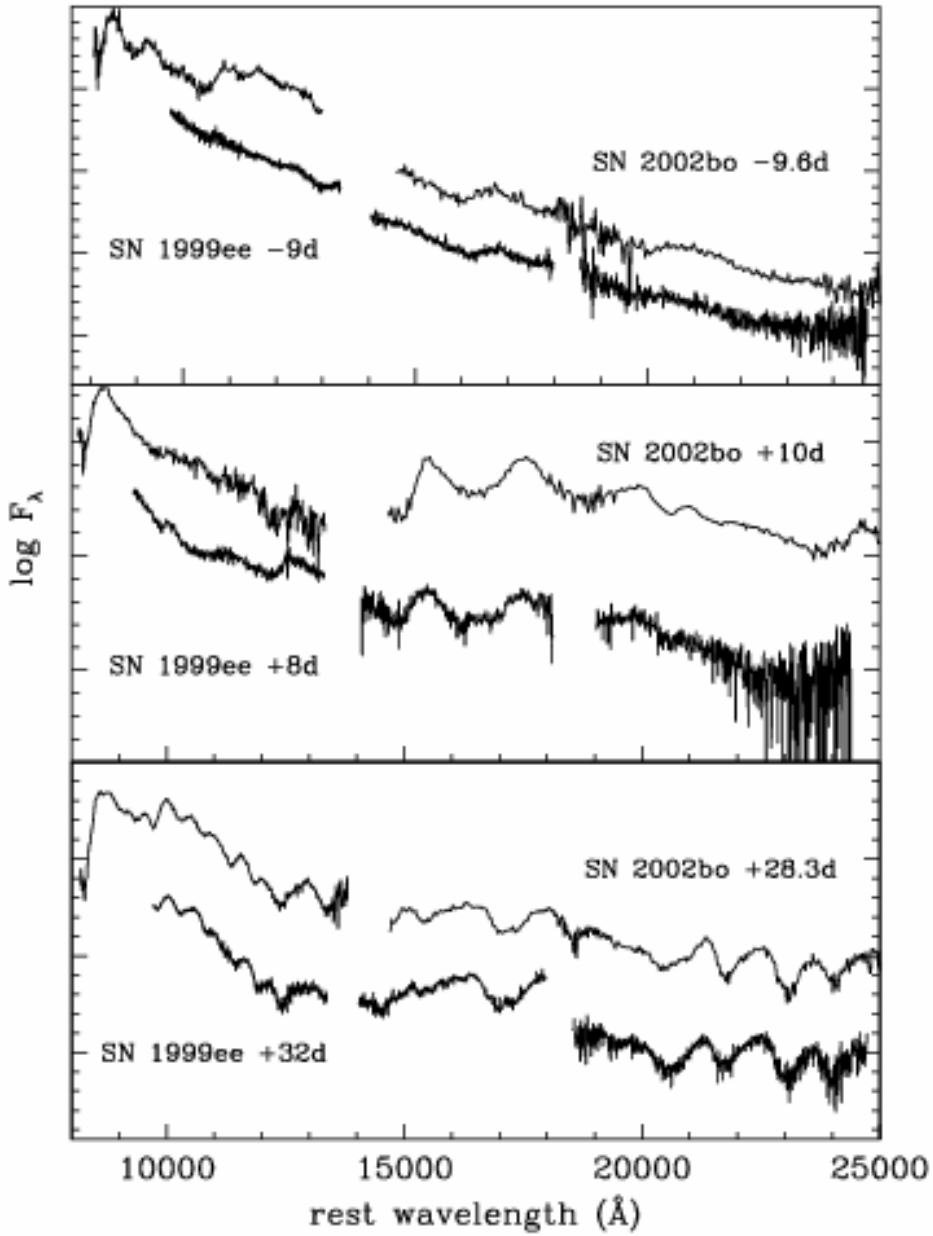
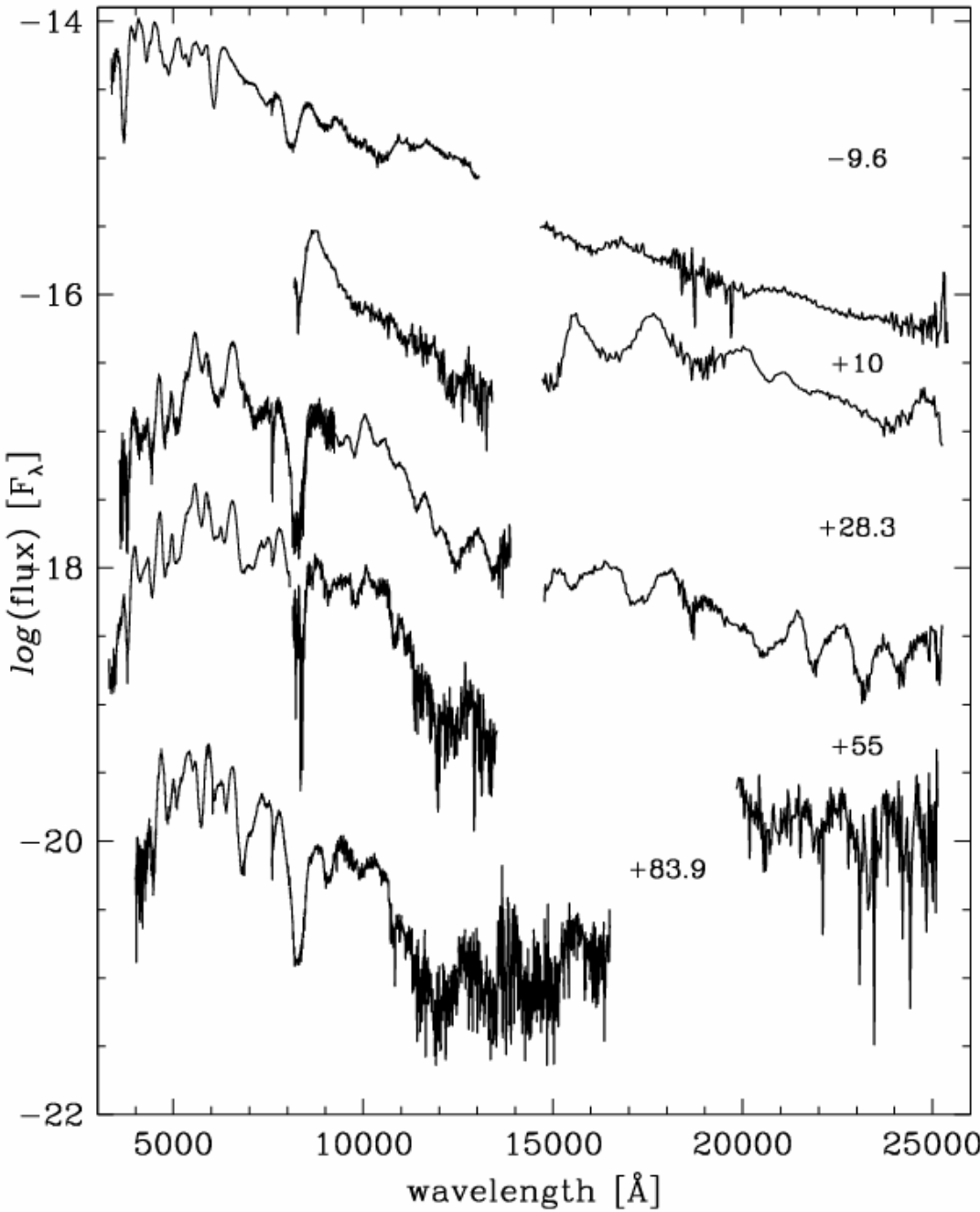


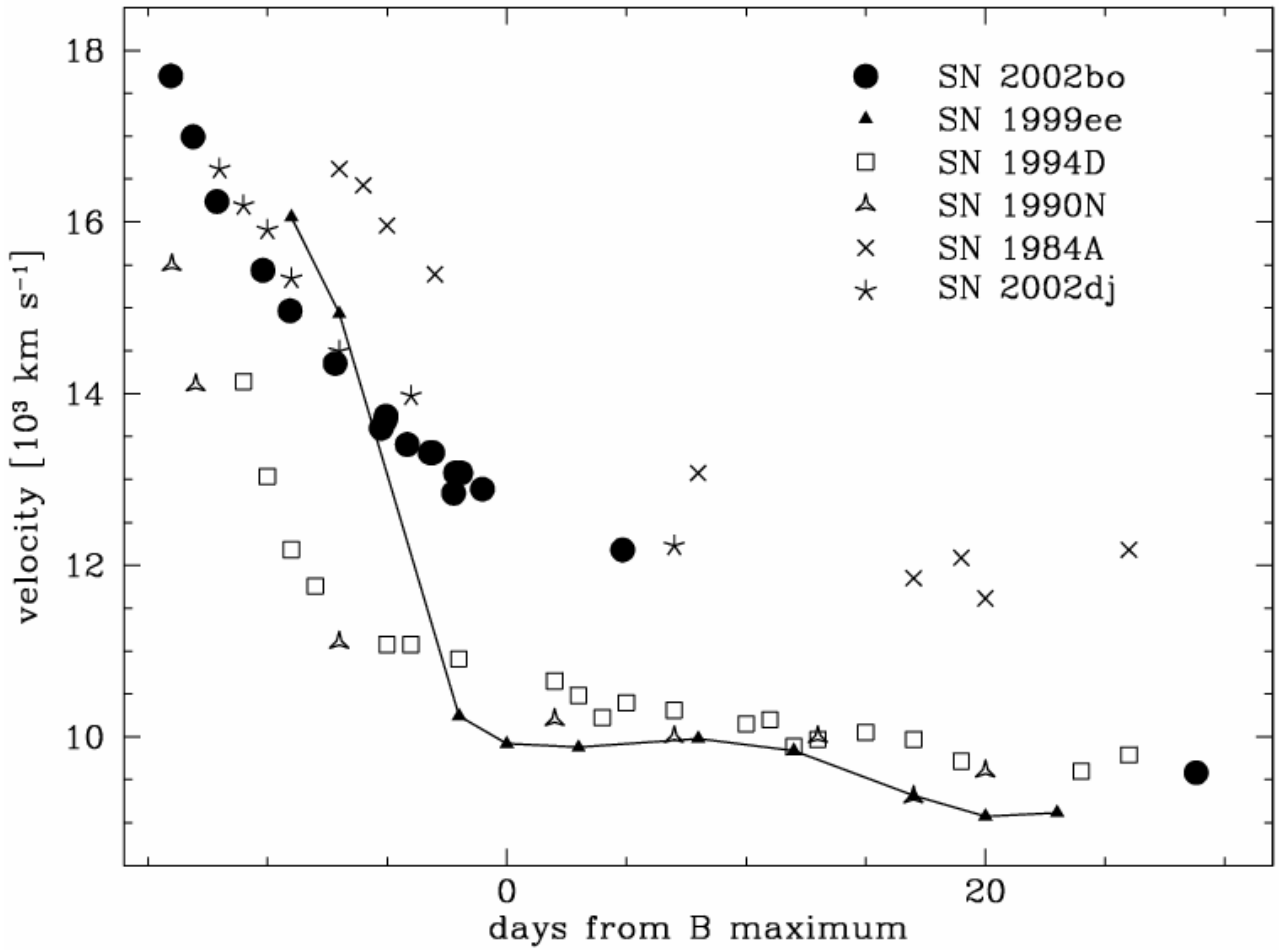
Figure 11. Comparison of SN 2002bo IR spectra with those of SN 1999ee (from Hamuy et al. (2002))

Opt+IR


−14
−16
−18
−20
−22
log(flux) [Fλ]
−9.6
+10
+28.3
+55
+83.9
5000
10000
15000
20000
25000
wavelength [Å]

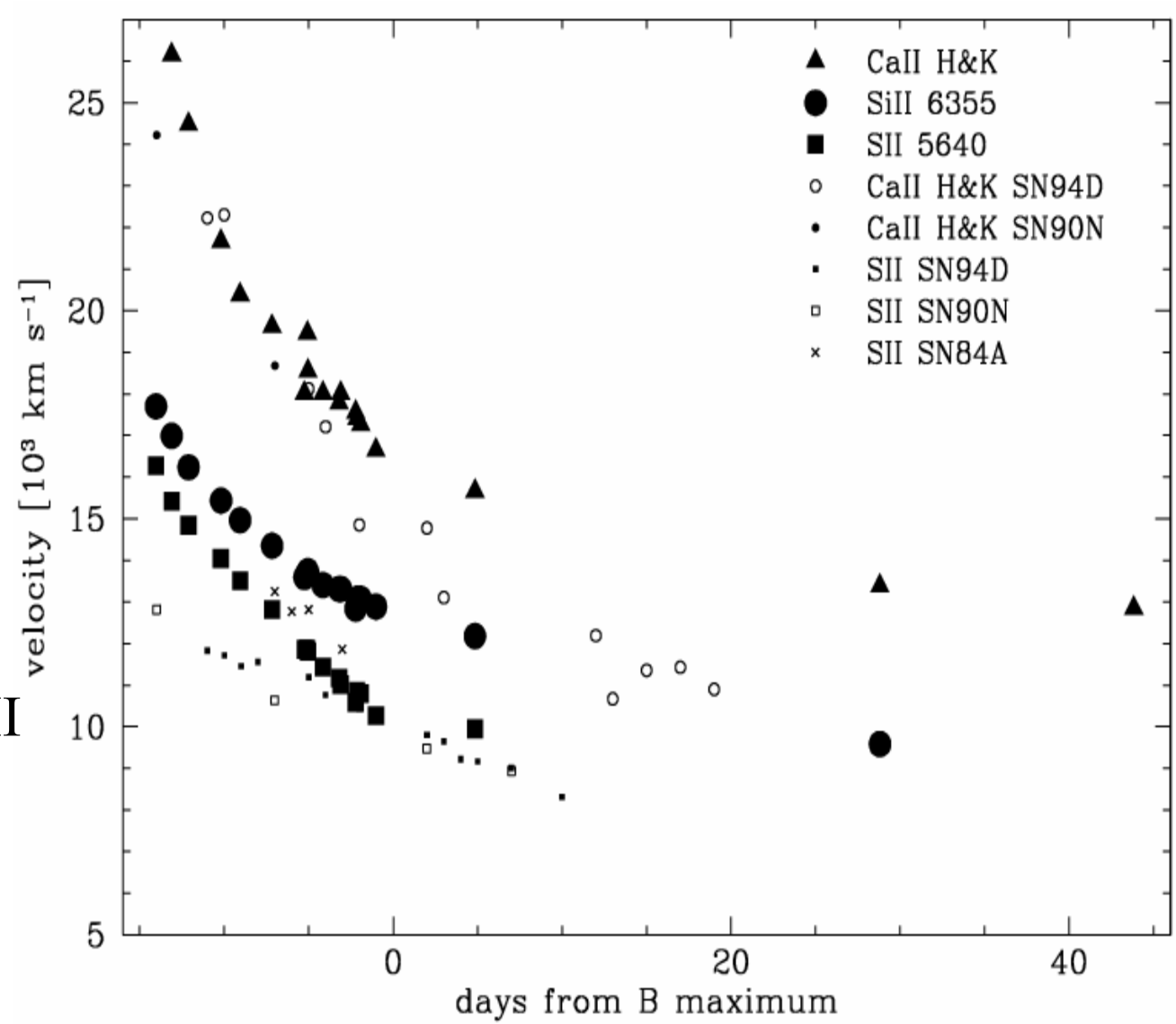
SiII expansion velocity

1. Fast at all epochs
2. No break
3. similar to 2002dj and (other fast SNIa ?!)



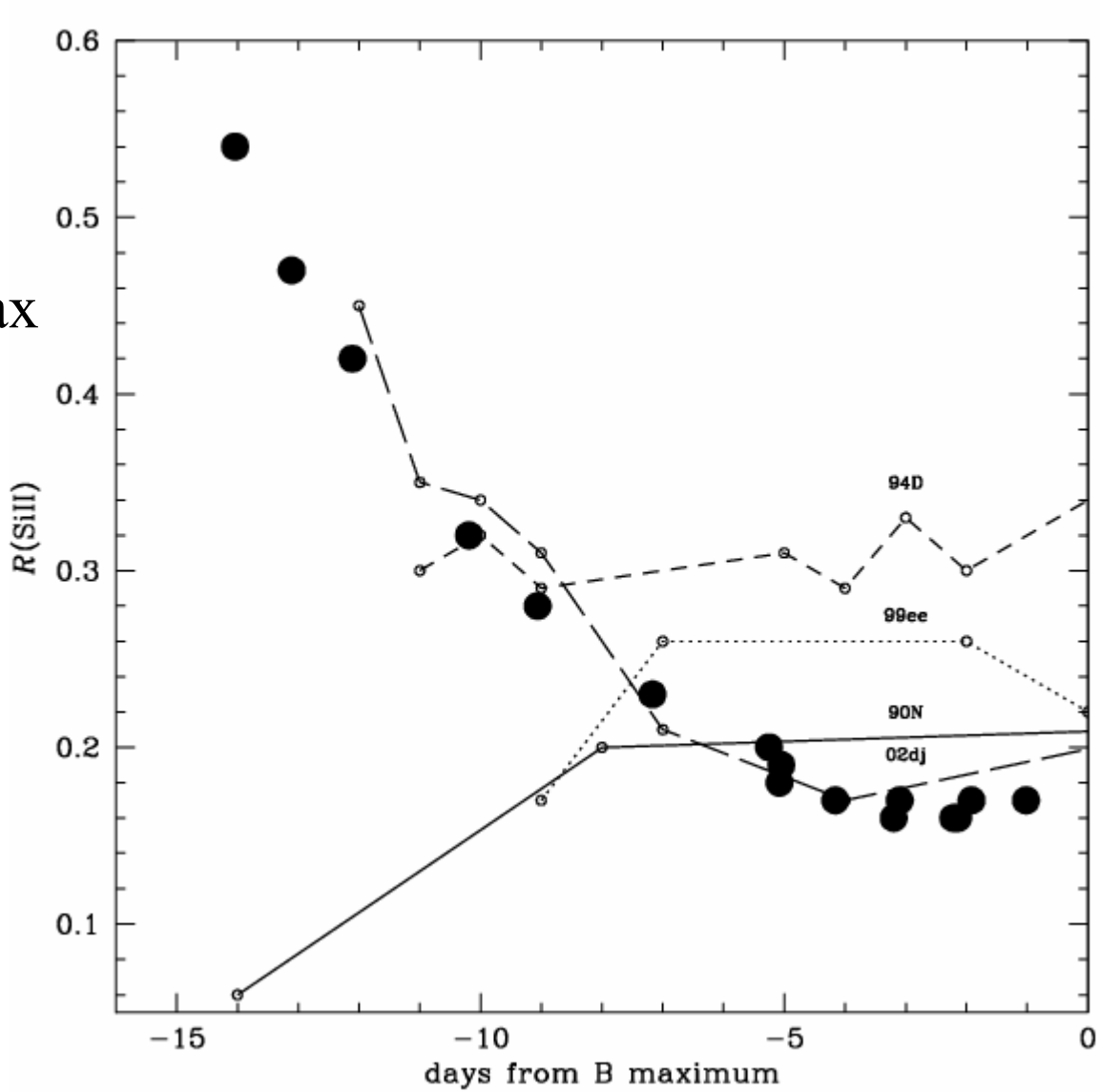
Other line velocities

spread in CaII and SII (after d=-5d) < SiII

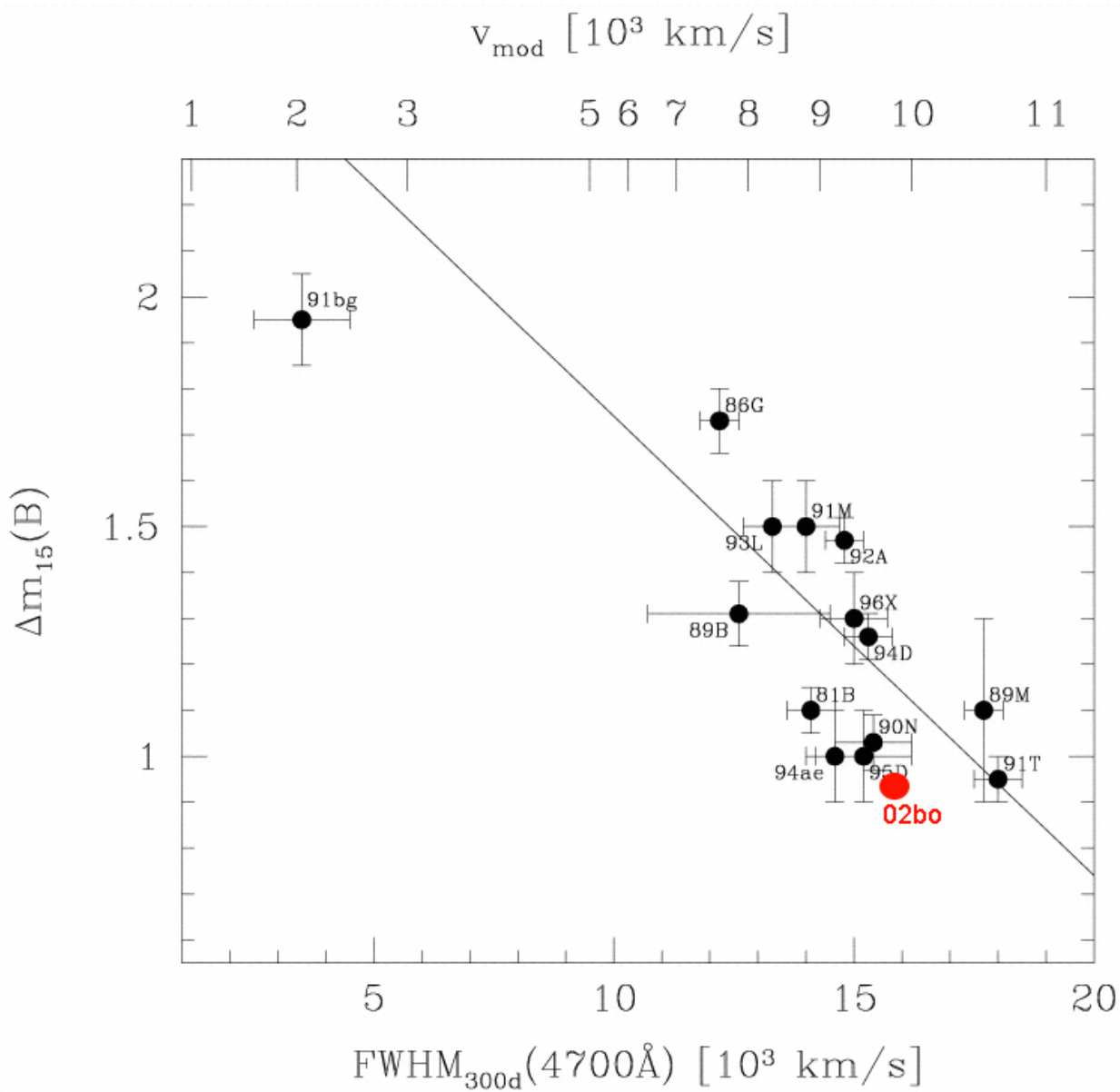


R(SiII) evolution

1. Strong evolution premax
2. 2002bo=2002dj
3. Different behaviours
4. Nugent relation OK (Rmax⇑ M_B⇓)



@1yr


v_mod [10³ km/s]
1
2
3
5
6
7
8
9
10
11
Δm15(B)
2
1.5
1
91bg
86G
91M
93L
92A
96X
89B
94D
81B
89M
90N
94ae
95D
91T
02bo
5
10
15
20
FWHM300d(4700Å) [10³ km/s]