SN 2008S

an electron capture SN from a super AGB progenitor?

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in collaboration with:

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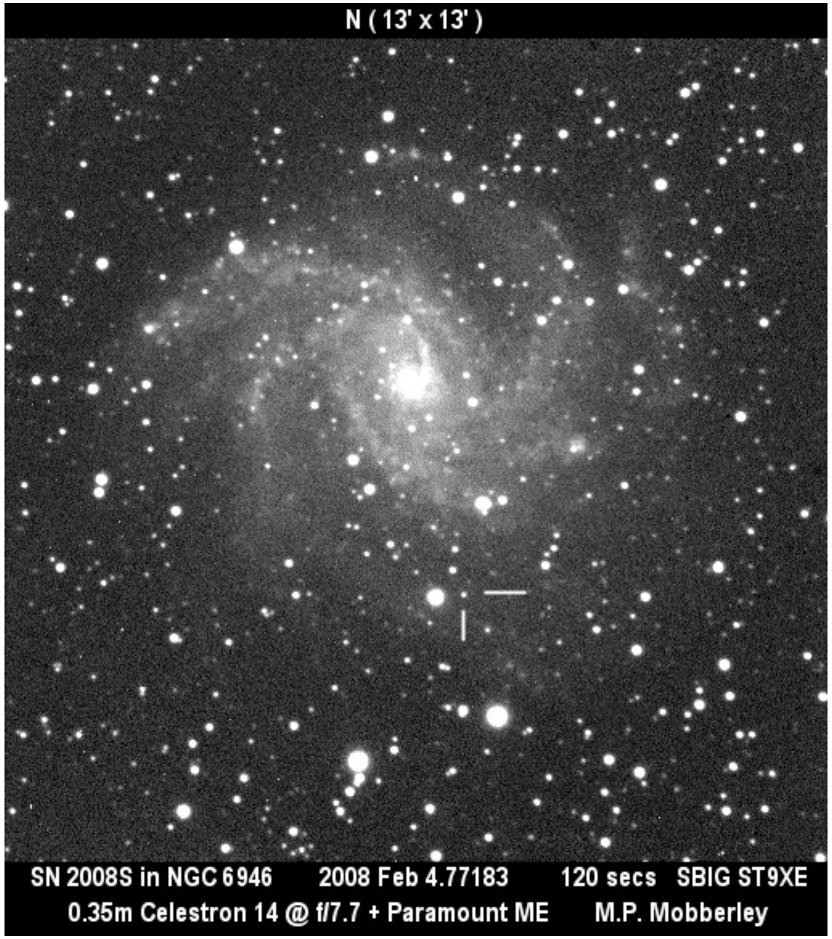
Outlines

- ✓ Progenitor star
- ✓ Photometric evolution
- ✓ MIR and NIR excess
- ✓ Spectroscopic evolution
- ✓ Comparison with similar transients
- ✓ A possible scenario



R. A.=20:34:45.37 Dec=60:05:58

NGC 6946   d ~ 5.6 Mpc

Feb. 1.79 UT   ~ 17.6 mag (CBET 1234)

Feb. 4 UT NOT spectrum → SN IIn (CBET 1236)

Feb. 29 UT 3m t. spectrum → SN impostor (CBET 1275)

Detected in
optical Swift   Feb. 4.8 UT
MIR   Spitzer   Feb. 7.6 UT (CBET 1381)

No detected in
X ray   Swift   Feb. 10.5 UT
UV   Swift   Feb. 6.0 UT
Radio   VLA   Feb. 10.62 UT (ATEL 1382)

no detection on 16 Jan. (mag > 19)
first detection on 24 Jan.
} explosion date → 20 Jan. ± 4 days

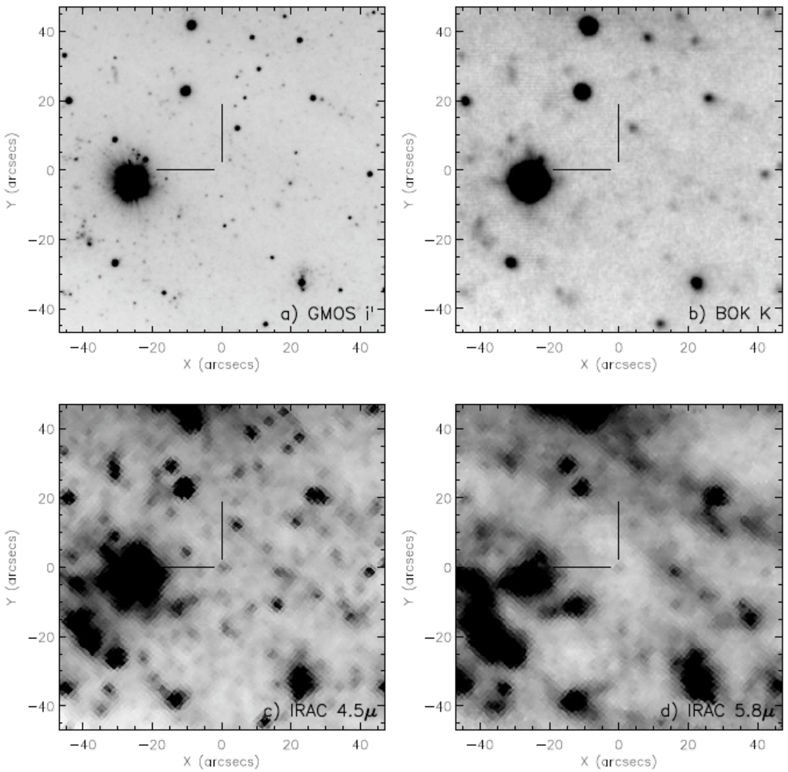
- progenitor star detected only in MIR pre explosion images
- sub luminous transient with peculiar spectral properties
- slow photometric evolution and almost no spectral variability
- complex CSM and evidences for newly formed dust
- similar characteristics with NGC 300 OT2008-1 and M85 OT2006-1

OPEN QUESTIONS:

- progenitor mass and evolutionary stage
- outburst or explosion
- new class of transients

Botticella et al 2009 MNRAS in press (arXiv 0903.1286)

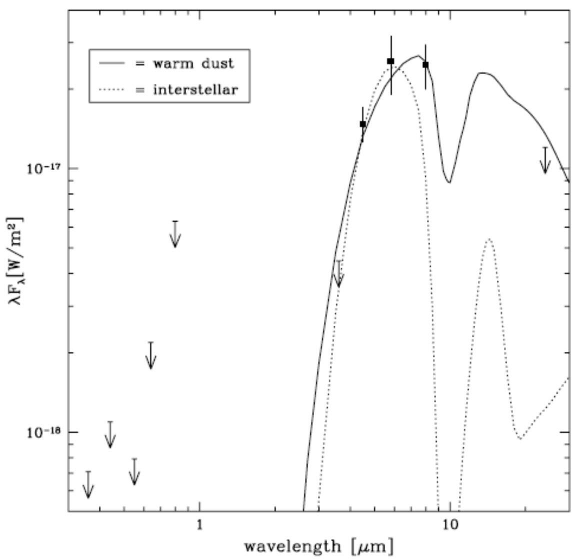
other references:
Prieto et al 2008 Thompson et al 2009 Smith et al 2009 Bond et al 2009 Berger et al 2009
Prieto et al 2009 Wesson et al 2009 Wanajo et al 2009 Patat et al 2009 Gogarten et al 2009



Progenitor detection

U	LBT	> 25.1	Vega Mag
B	LBT	> 24.5	Vega Mag
V	LBT	> 24.5	Vega Mag
i	GMOS-N	> 24.4	Vega mag
K'	PISCES	> 18	Vega Mag
3.6μm	IRAC	< 3.6	μJy
4.5μm	IRAC	21.3 ± 1.5	μJy
5.8μm	IRAC	45.6 ± 2.4	μJy
8.0μm	IRAC	59.5 ± 4.3	μJy

DUSTY model →



optically thick shell

T_{dust} 800 K

τ_V 150

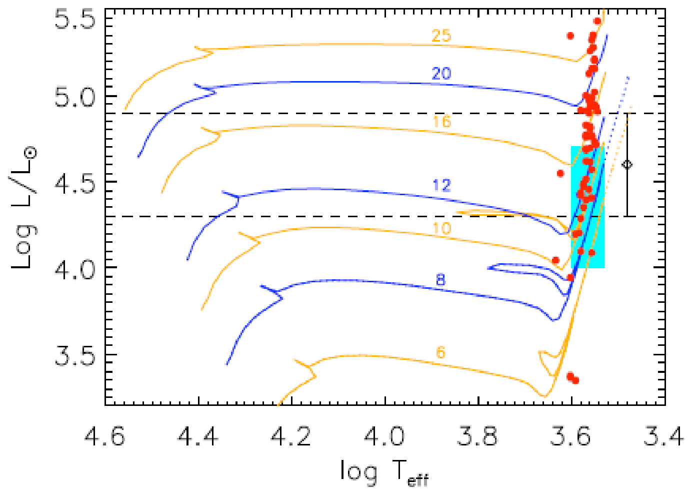
R_{inner} 90 AU

R_{outer} 450 AU

↓

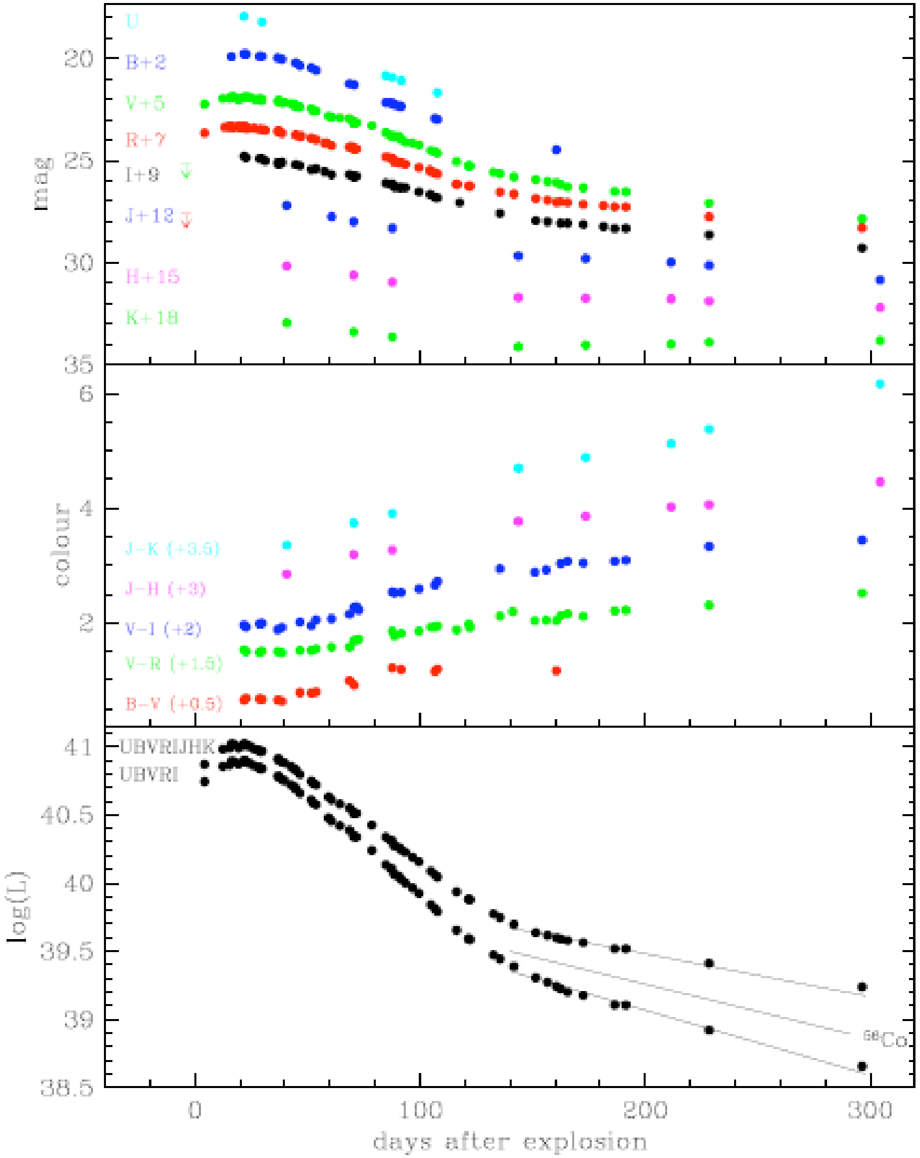
T_{eff} ~3000K

L ~ $10^{4.6}$ $L_\odot$



6-8 $M_\odot$

Photometric evolution

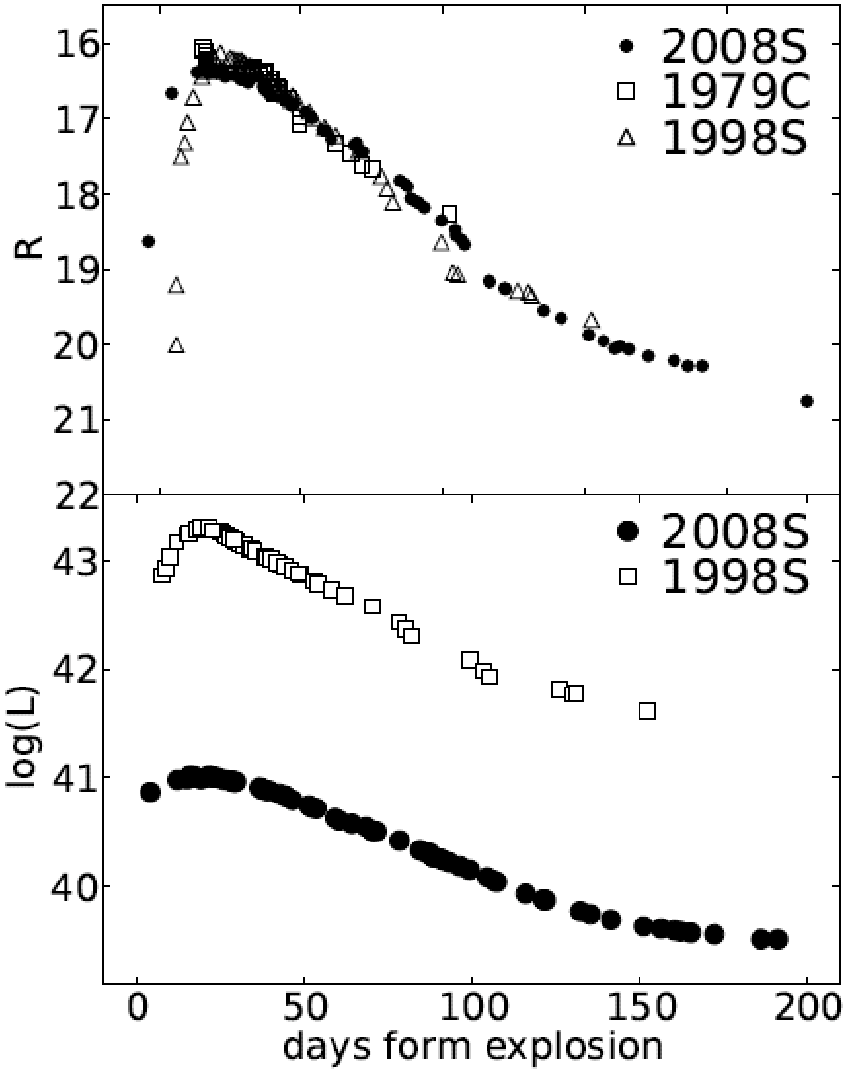


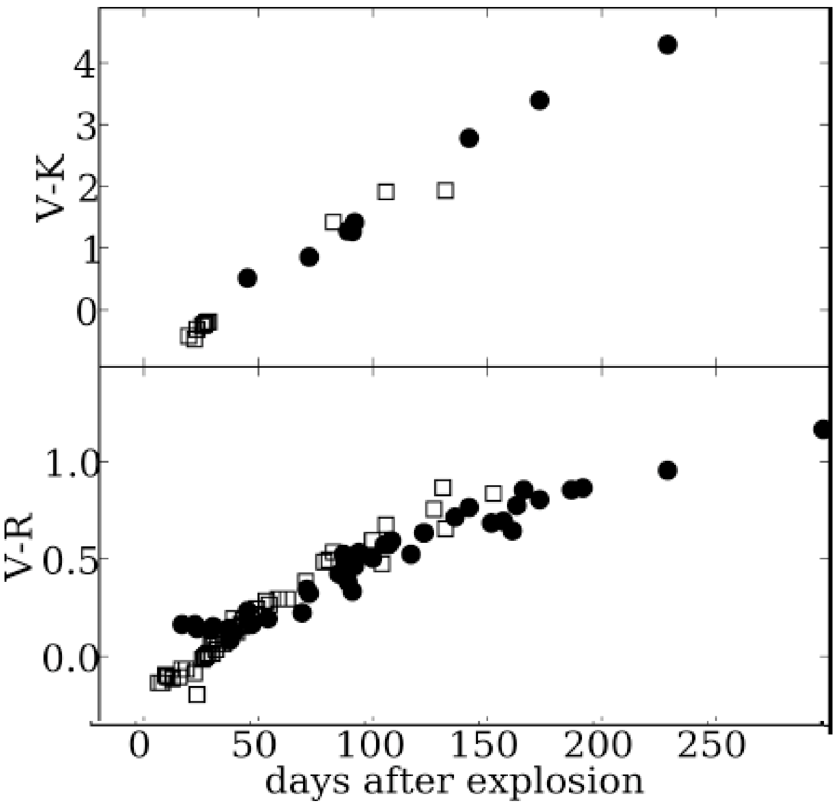
Filter	JD[a]	ph[b]	m_{max}	M_{max}
B	509 ± 2	23	17.83 ± 0.05	-13.76 ± 0.16
V	505 ± 2	19	16.95 ± 0.05	-13.97 ± 0.16
R	503 ± 2	17	16.33 ± 0.05	-14.17 ± 0.16
I	502 ± 3	16	15.85 ± 0.05	-14.20 ± 0.16

Filter	ph_1[a]	γ_1(mag/100d)	ph_2[a]	γ_2 (mag/100d)
B	50-100	4.5 ± 0.10	100-160	2.8 ± 0.10
V	50-120	4.0 ± 0.05	140-300	1.3 ± 0.06
R	60-120	3.4 ± 0.05	140-300	1.0 ± 0.05
I	60-120	2.8 ± 0.05	140-300	0.93 ± 0.06
J	40-120	2.4 ± 0.10	140-310	0.7 ± 0.05
H	40-120	1.5 ± 0.10	140-310	0.4 ± 0.10
K	40-120	1.5 ± 0.09	140-310	-0.2 ± 0.06

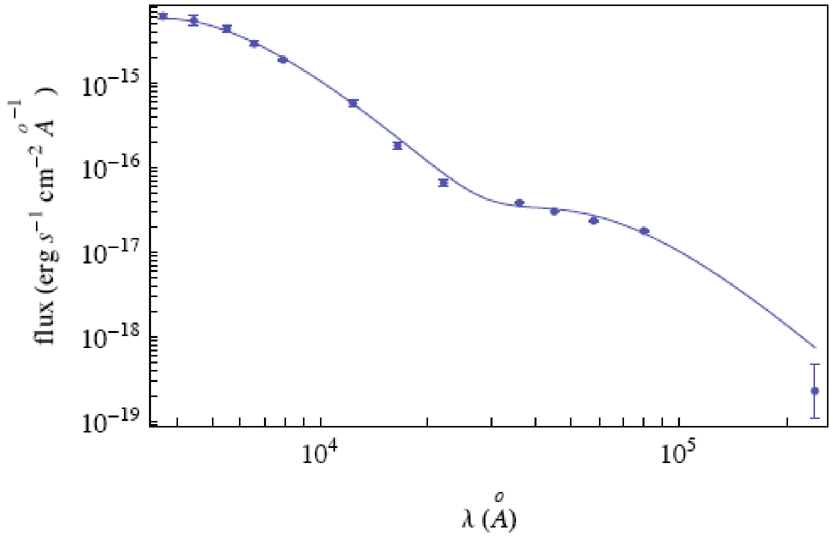
γ=0.9 ± 0.05 mag/100d

^{56}Ni mass = 0.0014 ± 0.0003 $M_\odot$

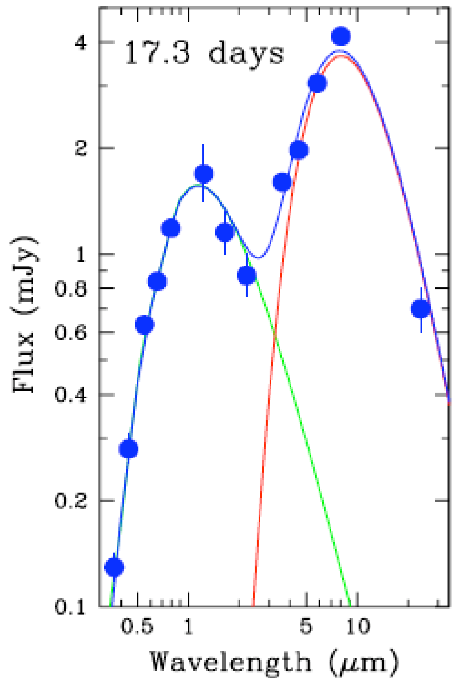

2008S
1979C
1998S
R
16
17
18
19
20
21
22
2008S
1998S
log(L)
43
42
41
40
0
50
100
150
200
days form explosion


V-K
4
3
2
1
0
V-R
1.0
0.5
0.0
0
50
100
150
200
250
days after explosion

MIR light echo



$T_{hot\ bb}$ ~ 8000 K $R_{hot\ bb}$ ~ $2x\ 10^{14}$ cm
$T_{warm\ bb}$ ~ 600 K $R_{warm\ bb}$ ~ 10^{16} cm



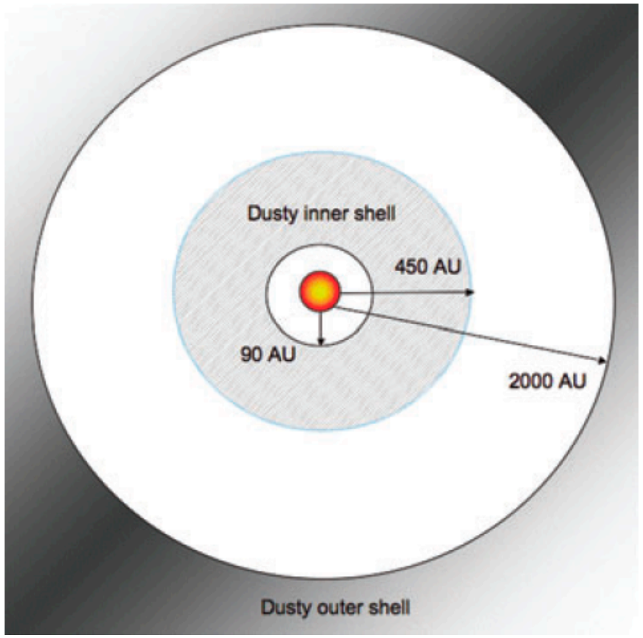
d. f. cavity ~ 2000AU

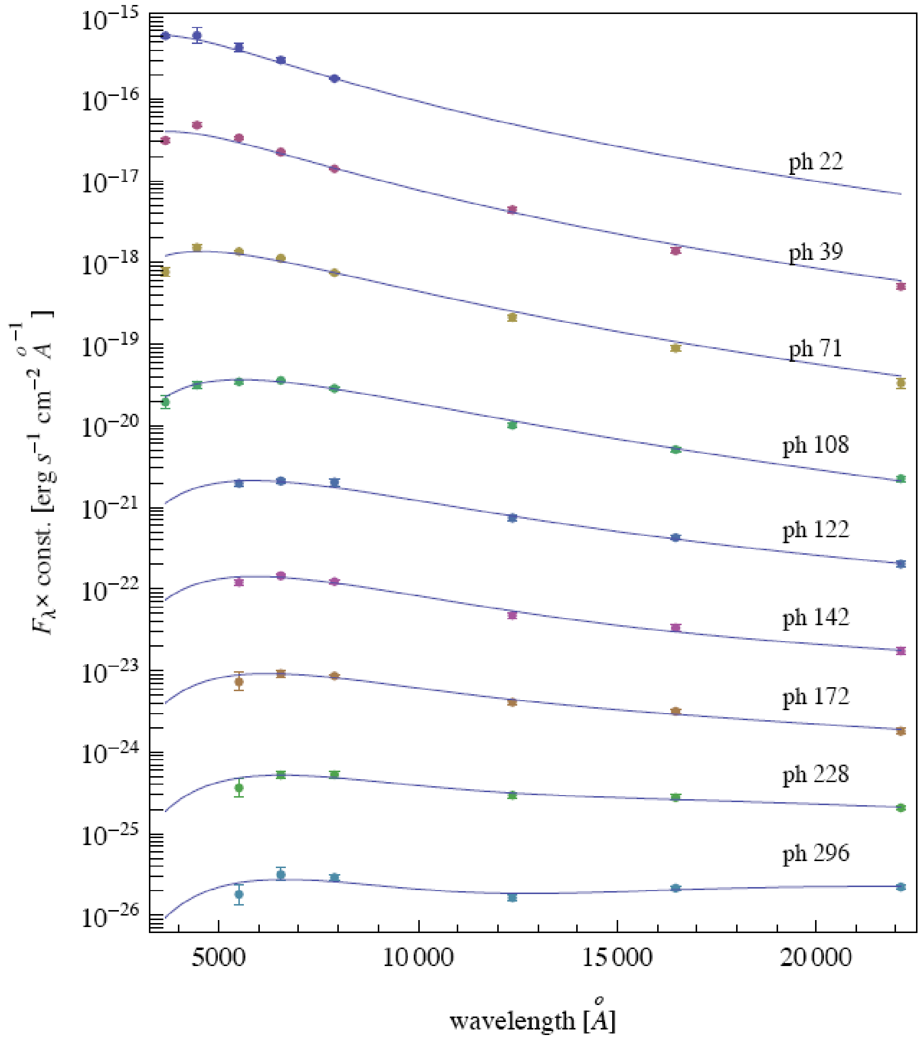
M_{dust} ~ $1.4 \times 10^{-3}\ M_{\odot}$

model details in
Meikle et al 2006

progenitor SED model

MIR echo model



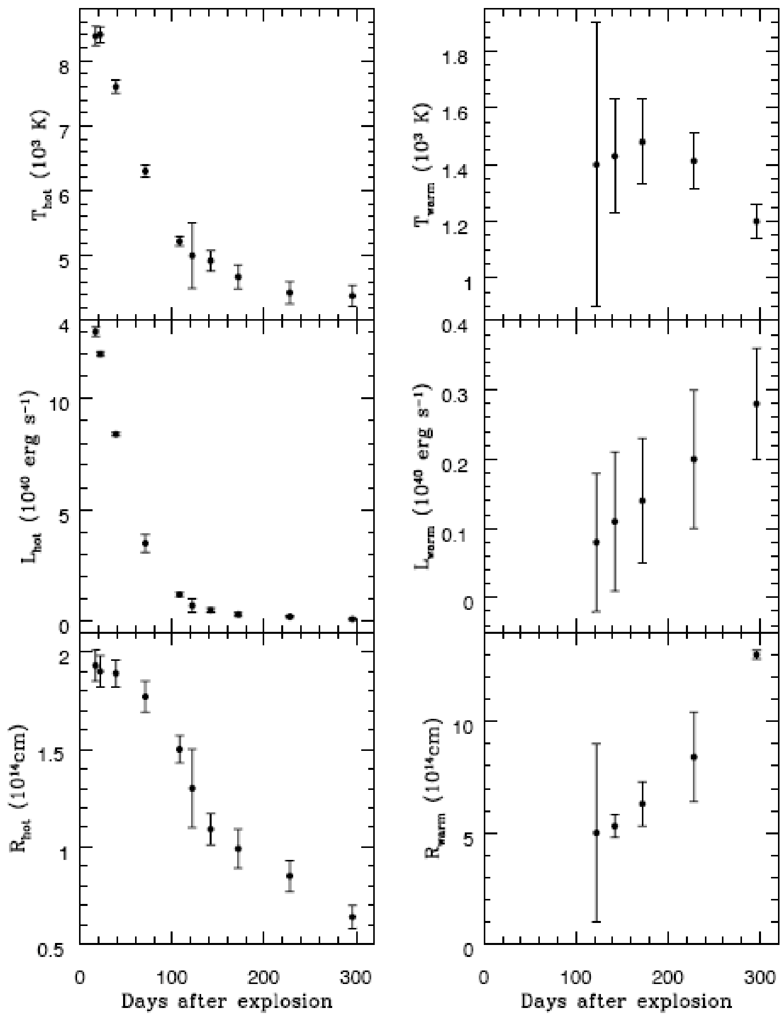


clear NIR excess
after 120 days

↓

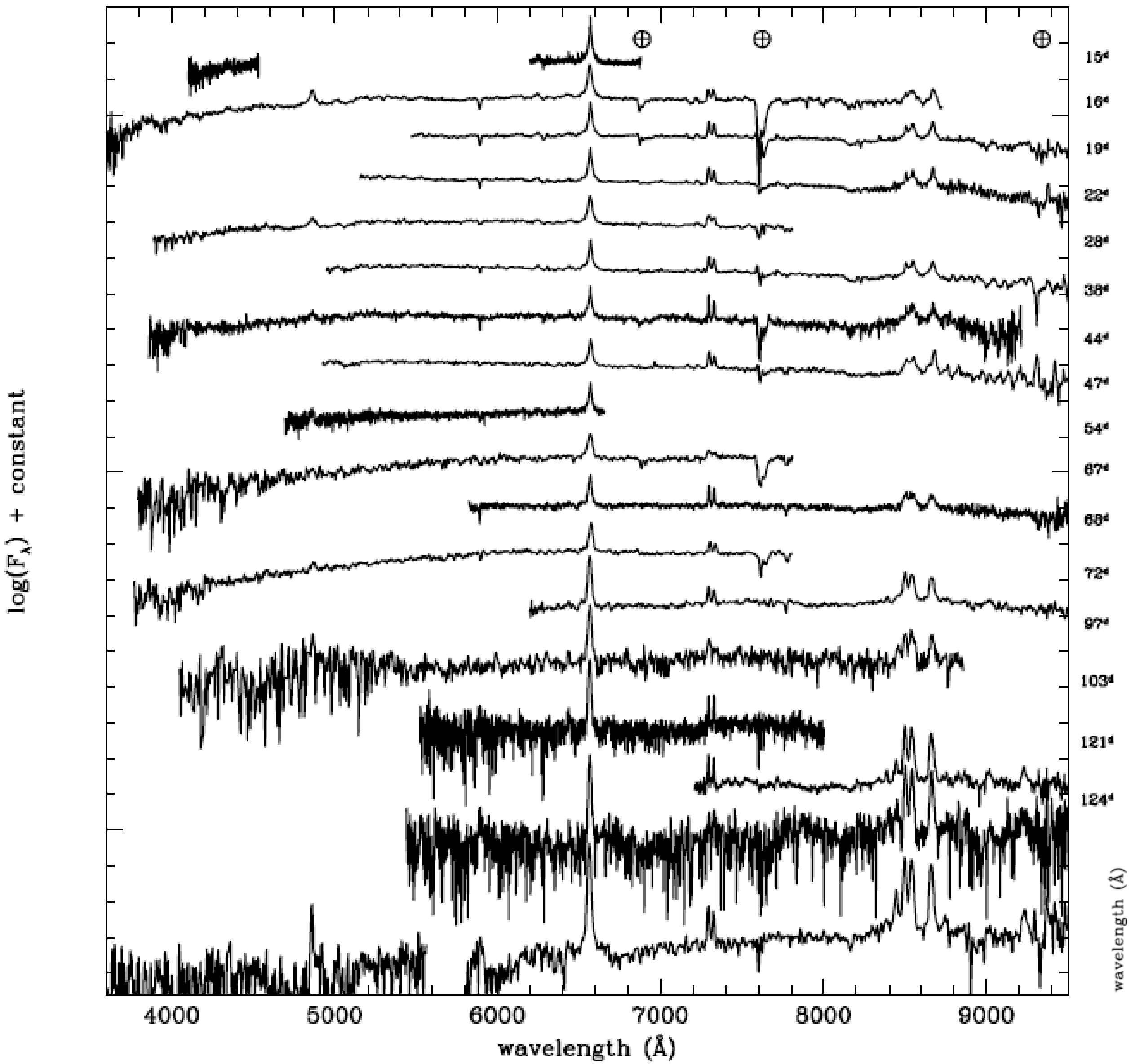
thermal emission from warm dust

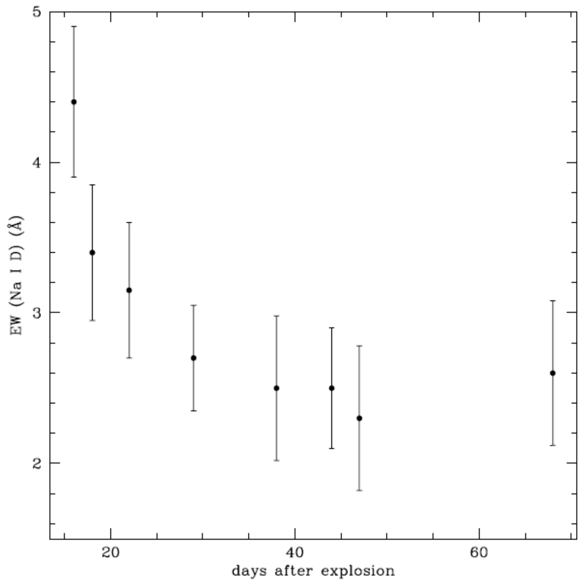
SED evolution

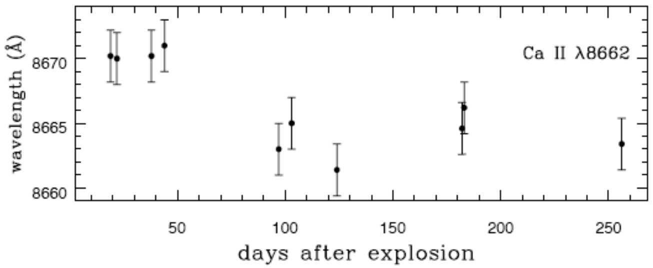


$M_{dust} \sim 10^{-6} M_\odot$
grain location
heating mechanism ?

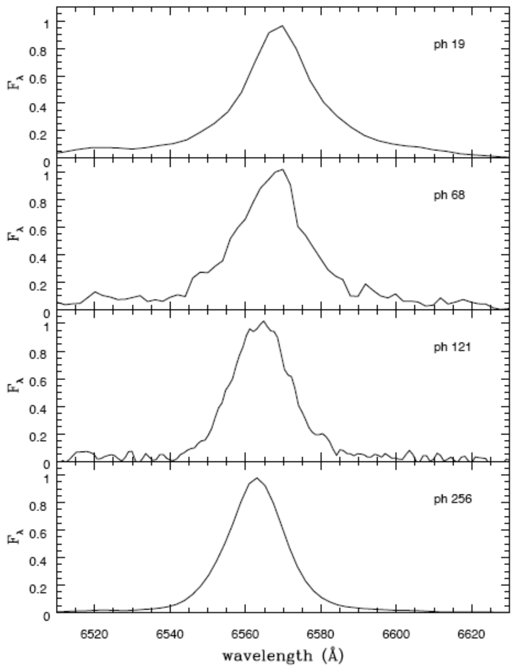
Spectroscopic evolution

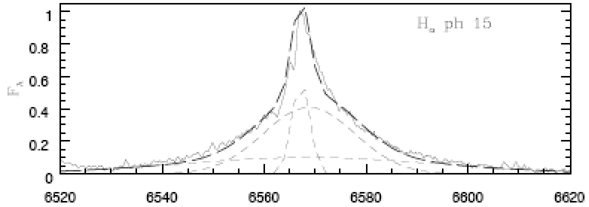


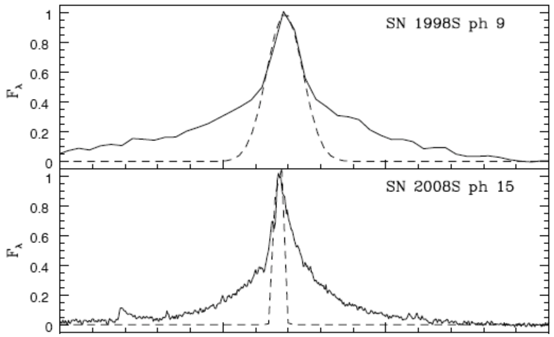




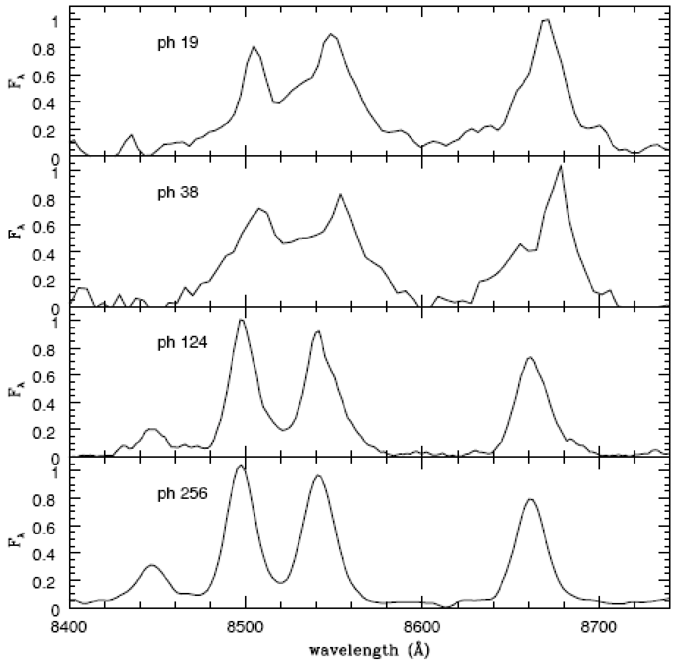
Emission line profiles





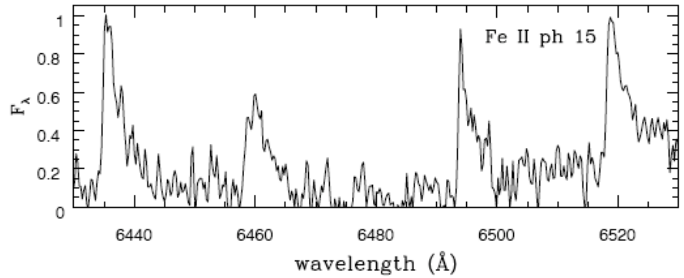


Hα

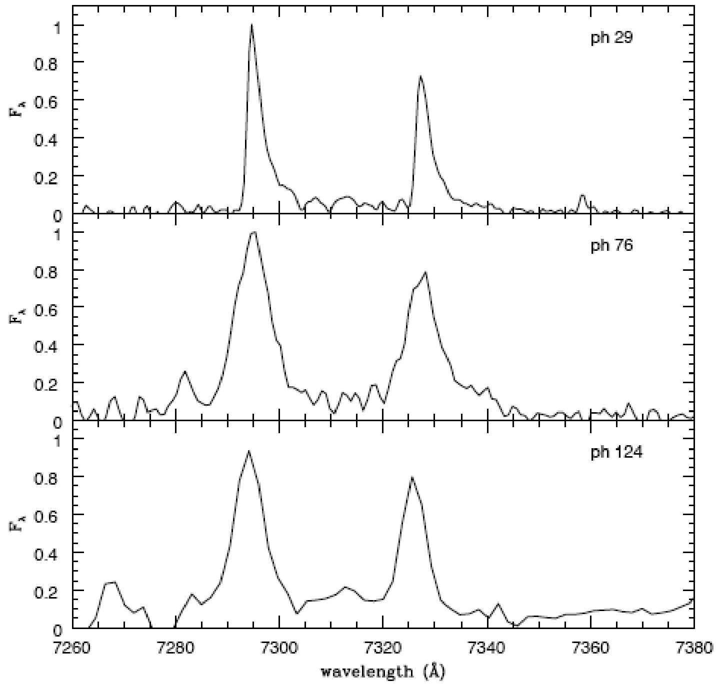


Ca II NIR

Emission line profiles



Fe II

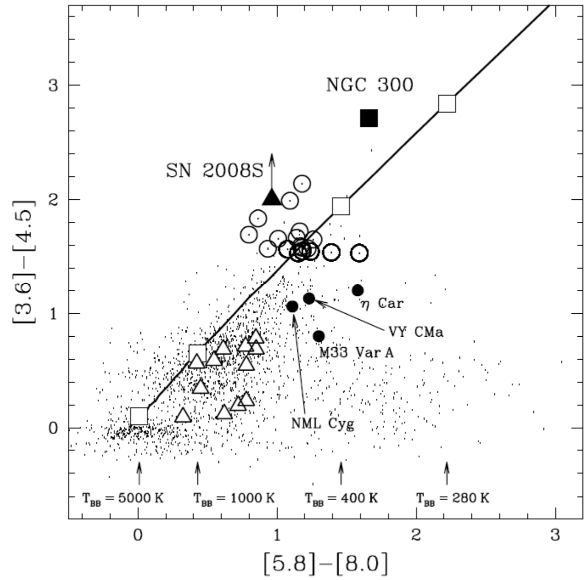


[Ca II]

Comparison with NGC 300 OT2008-1 and M85 OT2006-1

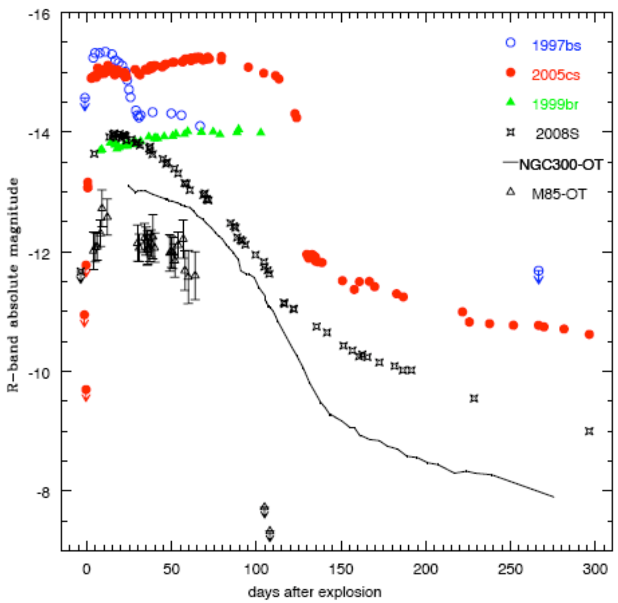
- ✓ similar progenitor characteristics ($10^{4.6}$ $L_\odot$)
- ✓ similar geometry of obscuring CSM

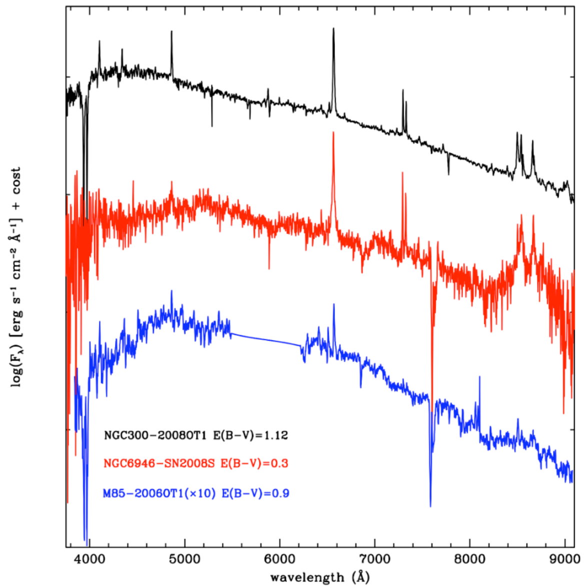
(Thompson et al 2009 ,Prieto et al 2009, Patat et al 2009)



(Thompson et al 2009)

- ✓ similar light curves and spectra





Progenitor

$L \sim 10^{4.6} L_\odot$

$M \sim 6\text{-}8\ M_\odot$

CSM

T_{dust} 800 K

τ_V 150

R_{inner} 90 AU

R_{outer} 450 AU

Transient

$V_{max} \sim -14$ mag

$L_{max} \sim 10^{41}$ erg s^{-1}

$v_{max} \leq 3000$ km s^{-1}

^{56}Ni mass $\sim 0.0014\ M_\odot$

super AGB star

dense and dusty CSM
high mass loss rate

low energy explosion

electron capture SN
from a star of 6-8 $M_\odot$
in the super AGB stage

Mass (8-10 $M_\odot$)

Luminosity ($10^5 L_\odot$)

CSM interaction

Energy ($1\text{-}2 \times 10^{50}$)

^{56}Ni mass (0.002)

(Kitaura et al 2006
Eldridge et al 2007
Wanajo et al 2008)

other suggested scenarios

- 15-20 $M_\odot$ progenitor, failed super Eddington wind (Smith et al 2009)
- 10-15 $M_\odot$ progenitor, OH/IR outburst on blue loop (Bond et al 09)
- 10-20 $M_\odot$ compact progenitor (BSG or pre WR star), outburst (Berger et al 2009)
- 6-10 $M_\odot$ carbon rich or super AGB star explosive event (Prieto et al 2009)

<u>late observations and remnant analysis will give a definitive answer</u>