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J/A+A/580/A131 Circumstellar-interacting supernovae (Taddia+, 2015)

Metallicity at the explosion sites of interacting transients.
Taddia F., Sollerman J., Fremling C., Pastorello A., Leloudas G.,
Fransson C., Nyholm A., Stritzinger M.D., Ergon M., Roy R., Migotto K.
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circumstellar matter - stars: winds, outflows

Abstract:
Some circumstellar-interacting (CSI) supernovae (SNe) are produced by the explosions of massive stars that have lost mass shortly before the SN explosion. There is evidence that the precursors of some SNe IIn were luminous blue variable (LBV) stars. For a small number of CSI SNe, outbursts have been observed before the SN explosion. Eruptive events of massive stars are named SN impostors (SN IMs) and whether they herald a forthcoming SN or not is still unclear. The large variety of observational properties of CSI SNe suggests the existence of other progenitors, such as red supergiant (RSG) stars with superwinds. Furthermore, the role of metallicity in the mass loss of CSI SN progenitors is still largely unexplored. Our goal is to gain insight into the nature of the progenitor stars of CSI SNe by studying their environments, in particular the metallicity at their locations. We obtain metallicity measurements at the location of 60 transients (including SNe IIn, SNe Ibn, and SN IMs) via emission-line diagnostic on optical spectra obtained at the Nordic Optical Telescope and through public archives. Metallicity values from the literature complement our sample. We compare the metallicity distributions among the different CSI SN subtypes, and to those of other core-collapse SN types. We also search for possible correlations between metallicity and CSI SN observational properties. We find that SN IMs tend to occur in environments with lower metallicity than those of SNe IIn. Among SNe IIn, SN IIn-L(1998S-like) SNe show higher metallicities, similar to those of SNe IIL/P, whereas long-lasting SNe IIn (1988Z-like) show lower metallicities, similar to those of SN IMs. The metallicity distribution of SNe IIn can be reproduced by combining the metallicity distributions of SN IMs (which may be produced by major outbursts of massive stars like LBVs) and SNe IIP (produced by RSGs). The same applies to the distributions of the normalized cumulative rank (NCR) values, which quantifies the SN association to HII regions. For SNe IIn, we find larger mass-loss rates and higher CSM velocities at higher metallicities. The luminosity increment in the optical bands during SN IM outbursts tend to be larger at higher metallicity, whereas the SN IM quiescent optical luminosities tend to be lower. The difference in metallicity between SNe IIn and SN IMs indicates that LBVs are only one of the progenitor channels for SNe IIn, with 1988Z-like and 1998S-like SNe possibly arising from LBVs and RSGs, respectively. Finally, even though line-driven winds likely do not primarily drive the late mass-loss of CSI SN progenitors, metallicity has some impact on the observational properties of these transients.

Description:
In Table 1 we report the list of 60 transients included in our sample. Thirty-five of them are SNe IIn, six are SNe Ibn, one is a SN Ia-CSM, 18 are SN IMs (if we also count SN 2009ip in the SN IMs, then we have 19 of these transients).

With the NOT, long-slit spectra were obtained for the host galaxies of 13 SNe IIn, five SNe Ibn, one SN Ia-CSM, and 16 SN IMs (the derived metallicity for SN 2007sv was published in Tartaglia et al. [2015MNRAS.447..117T](#)). The host galaxies observed at the NOT are marked with the letter "o" in the third column of Table 1. With the NOT, we also obtained broad-band R and narrow-band H α images for the SNe IIn (except for SN 1995G) and Ibn. We complemented our observed sample with host galaxies whose metallicities (at the center of the galaxy or at the SN position) were already available in the literature (marked with the letter "l" in the third column of Table 1) or whose spectra were available in public archives (marked with the letter "a" in the third column of Table 1).

File Summary:

FileName	Lrec1	Records	Explanations
ReadMe	80	.	This file
table1.dat	160	60	Sample and basic data of 63 (38 SNe IIn, 6 SNe Ibn, 1 SN Ia-CSM, 18 SN IMs)
table2.dat	77	35	Log of the photometric and spectroscopic observations at the Nordic Optical Telescope with ALFOSC
table3.dat	33	141	Deprojected and normalized distance from the host center and line ratios for the HII regions

			with observed spectrum
table5.dat	156	42	Apparent (u/U,B,V,R/r/unf.,I/i) peak magnitudes, galactic and host extinction for the SNe IIn, Ibn, and Ia-CSM of our sample
table6.dat	61	42	Absolute (U/u,B,V,R/r/unf.,I/i) peak magnitudes for the SNe IIn, Ibn, and Ia-CSM of our sample
table7.dat	86	29	Wind velocity and mass-loss rate for a subsample of CSI SNe (IIn, Ibn, Ia-CSM).
refs.dat	70	56	References

See also:

[B/sn](#) : Asiago Supernova Catalogue (Barbon et al., 1999-)

Byte-by-byte Description of file: [table1.dat](#)

Bytes	Format	Units	Label	Explanations
1- 8	A8	---	SN	SN name
10- 19	A10	---	Type	SN type
26- 28	A3	---	Source	[ola/] Data source (1)
30- 56	A27	---	Host	Host galaxy
58- 65	F8.6	---	z	Redshift
67- 68	I2	h	RAh	SN right ascension (J2000)
70- 71	I2	min	RAm	SN right ascension (J2000)
73- 77	F5.2	s	RA s	SN right ascension (J2000)
79	A1	---	DE-	SN declination sign (J2000)
80- 81	I2	deg	DEd	SN declination (J2000)
83- 84	I2	arcmin	DEm	SN declination (J2000)
86- 89	F4.1	arcsec	DEs	SN declination (J2000)
91- 92	I2	h	RAHh	Host galaxy right ascension (J2000)
94- 95	I2	min	RAHm	Host galaxy right ascension (J2000)
97-101	F5.2	s	RAHs	Host galaxy right ascension (J2000)
103	A1	---	DEH-	Host galaxy declination sign (J2000)
104-105	I2	deg	DEHd	Host galaxy declination (J2000)
107-108	I2	arcmin	DEHm	Host galaxy declination (J2000)
110-113	F4.1	arcsec	DEHs	Host galaxy declination (J2000)
115-121	F7.4	arcmin	2a	?-- Major axis
123-129	F7.4	arcmin	2b	?-- Minor axis
131-134	F4.1	---	ttype	?-- t-type (2)
135	A1	---	l_ttype	[h] h: from Hyperleada
137-139	I3	deg	PA	?-- Position angle
141-147	A7	---	r2a	Reference for a and b axis (3)
149-155	A7	---	rPA	Reference for PA (3)
157-160	F4.2	---	rSN/R25	?-- Radius ratio

Note (1): Data sources as follows:

o = observed
l = literature
a = archive

Note (2): The t-type is obtained from the ASC.

Note (3): References as follows:

NED = B band (de Vaucouleurs et al., 1991, Cat. [VII/155/](#))
NED(B) = B band (Palomar survey)
NED(R) = r band (SDSS)
NED(IR) = K band (2MASS)
NED(Be) = B band (ESO survey)
HYP = Hyperleada
H97 = Hagen et al., [1997A&A...324L..29H](#)
ASI = Asiago Supernova Catalogue,
<https://heasarc.gsfc.nasa.gov/W3Browse/all/asiagosn.html>
NED = From NED
SIM(IR) = From Simbad

Byte-by-byte Description of file: [table2.dat](#)

Bytes	Format	Units	Label	Explanations
1- 7	A7	---	SN	SN name
9- 18	A10	---	Type	SN type
25- 38	A14	---	Galaxy	Galaxy name
41	A1	---	Phot1	Photometry filter
43- 48	A6	---	Int1	Integration time for Phot1 filter (s)
50- 56	A7	---	Phot2	Photometry filter
58- 62	A5	---	Int2	Integration time for Phot2 filter (s)
64- 77	A14	---	IntSp	Spectroscopy integration time (s) (1)

Note (1): Spectroscopic observations were performed with Slit 1.0 +Grism #4. We could not image the host galaxies of the SN IMs because during the observational campaign of April 2014 several nights were lost due to bad weather, and we decided to spend the remaining nights doing spectroscopy.

Byte-by-byte Description of file: [table3.dat](#)

Bytes	Format	Units	Label	Explanations
1- 8	A8	---	SN	SN name
11- 15	F5.3	---	r/R25	? Deprojected and normalized distance from the host center
16- 17	A2	---	n_r/R25	[** SN] Note on r/R25 (1)
19	A1	---	l_log(FNII/FHa)	Upper limit flag on log(FNII/FHa)
20- 25	F6.3	[-]	log(FNII/FHa)	Line ratio F([NII]6584)/F(Ha)
27	A1	---	l_log(FOIII/FHb)	Upper limit flag on log(FOIII/FHb)
28- 33	F6.3	[-]	log(FOIII/FHb)	Line ratio F([OIII]5007)/F(H β)

Note (1): Notes as follows:

** = Excluded from the metallicity analysis after spectral classification with the BPT diagram.

SN = No Deprojected and normalized distance

Byte-by-byte Description of file: [table5.dat](#)

Bytes	Format	Units	Label	Explanations
1- 8	A8	---	SN	SN name
10- 19	A10	---	Type	SN type
25	A1	---	l_Umax	Limit flag on Umax
26- 32	F7.4	mag	Umax	?=- Apparent U peak magnitude
34- 37	F4.2	mag	e_Umax	? rms uncertainty on Umax
40	A1	---	n_Umax	[u] u: u magnitude
43	A1	---	l_Bmax	Limit flag on Bmax
44- 50	F7.4	mag	Bmax	?=- Apparent B peak magnitude
52- 55	F4.2	mag	e_Bmax	? rms uncertainty on Bmax
59	A1	---	l_Vmax	Limit flag on Vmax
60- 66	F7.4	mag	Vmax	?=- Apparent V peak magnitude
68- 71	F4.2	mag	e_Vmax	? rms uncertainty on Vmax
74	A1	---	l_Rmax	Limit flag on Rmax
75- 79	F5.2	mag	Rmax	?=- Apparent R peak magnitude
81- 84	F4.2	mag	e_Rmax	? rms uncertainty on Rmax
87	A1	---	n_Rmax	[ur] r: r magnitude; u: unf magnitude
91	A1	---	l_Imax	Limit flag on Imax
92- 97	F6.3	mag	Imax	?=- Apparent I peak magnitude
99-102	F4.2	mag	e_Imax	? rms uncertainty on Imax
105	A1	---	n_Imax	[i] i: imax magnitude
108-112	F5.3	mag	AV(MW)	Galactic extinction
116-120	F5.3	mag	AV(h)	?=- Host extinction
124-156	A33	---	Ref	References (1)

Note (1): Reference number into parenthesis in refs.dat file.

Byte-by-byte Description of file: [table6.dat](#)

Bytes	Format	Units	Label	Explanations
1- 8	A8	---	SN	SN name
10- 19	A10	---	Type	SN type
21	A1	---	l_U/uMax	Limit flag on U/uMax
22- 27	F6.2	mag	U/uMax	?=- Absolute U or u peak magnitude
29	A1	---	l_BMax	Limit flag on BMax
30- 35	F6.2	mag	BMax	?=- Absolute B peak magnitude
37	A1	---	l_VMax	Limit flag on VMax
38- 43	F6.2	mag	VMax	?=- Absolute V peak magnitude
46	A1	---	l_R/r/unfMax	Limit flag on R/r/unfMax
47- 53	F7.3	mag	R/r/unfMax	? Absolute R, r or unf peak magnitude
55	A1	---	l_I/iMax	Limit flag on I/iMax
56- 61	F6.2	mag	I/iMax	?=- Absolute I or i peak magnitude

Byte-by-byte Description of file: [table7.dat](#)

Bytes	Format	Units	Label	Explanations
1- 8	A8	---	SN	SN name
10- 19	A10	---	Type	SN type
25	A1	---	l_Vw	Limit flag on Vw
26- 29	I4	km/s	Vw	Wind velocity
30	A1	---	---	[-]

31-	34	I4	km/s	Vwu	? Upper value of Vw when interval
37-	40	I4	km/s	e_Vw	? rms uncertainty on Vw
	42	A1	---	l_dM/dt	Limit flag on dM/dt
43-	48	F6.4	Msun/yr	dM/dt	?=- Mass-loss rate
	49	A1	---	---	[-]
50-	55	F6.4	Msun/yr	dM/dtu	? Upper value of dM/dt when interval
57-	62	F6.4	Msun/yr	e_dM/dt	? rms uncertainty on dM/dt
65-	86	A22	---	Ref	References and notes (1)

Note (1): * for SN 1998S: Fassia et al. ([2000MNRAS.318.1093F](#)) report a mass-loss rate of $2\times10^{-5}M_{\odot}/\text{yr}$ for the outer CSM and $3\times10^{-3}M_{\odot}/\text{yr}$ for the inner CSM. The value reported by Anupama et al. ([2001A&A...367..506A](#)) is in the middle of this range.
Reference number into parenthesis in refs.dat file.

Byte-by-byte Description of file: [refs.dat](#)

Bytes	Format	Units	Label	Explanations
1- 2	I2	---	Ref	Reference number
4- 22	A19	---	BibCode	BibCode
24- 41	A18	---	Aut	Author's name
43- 70	A28	---	Com	Comments

History:
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(End) Patricia Vannier [CDS] 03-Nov-2015

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