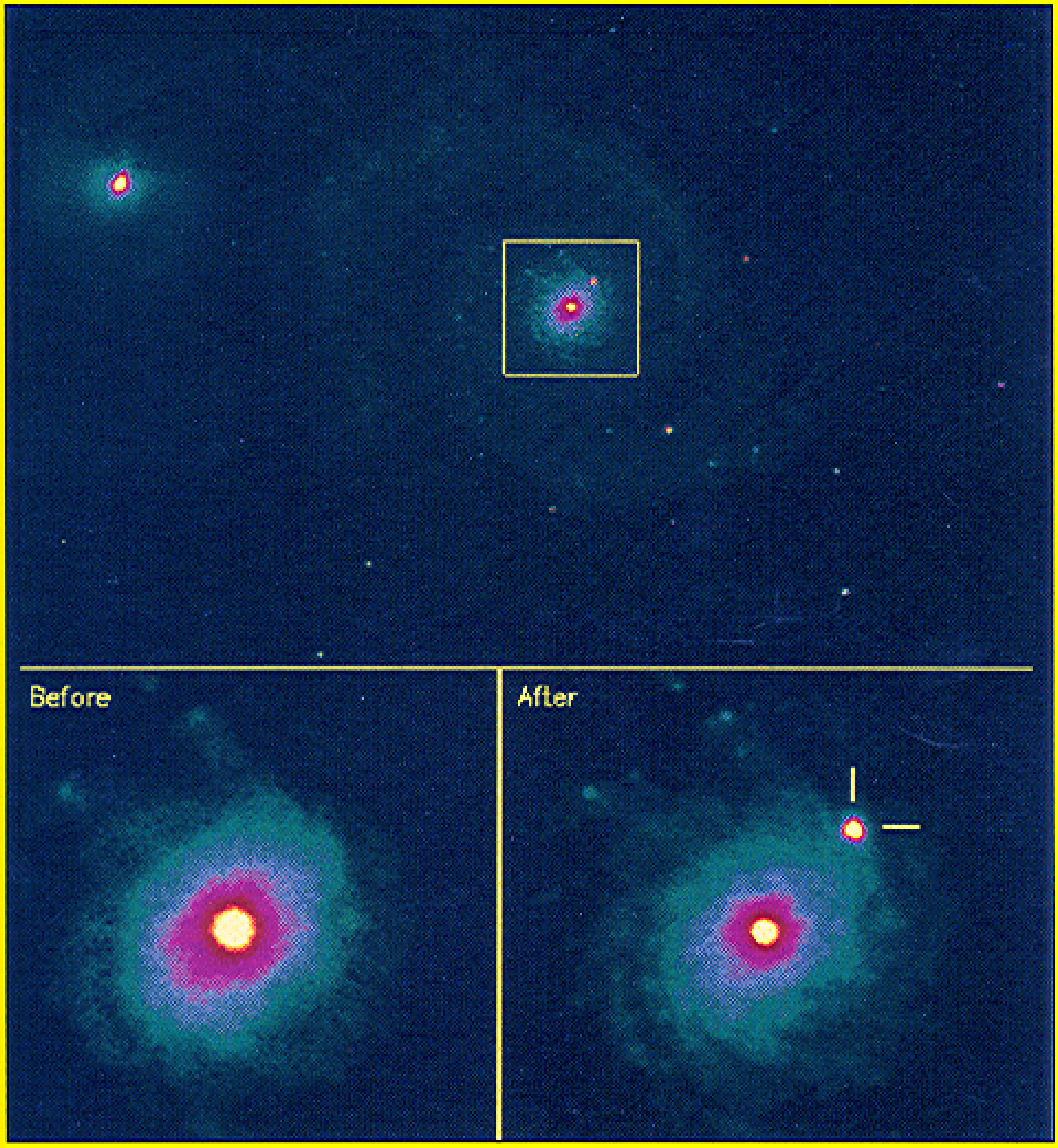
SP-1189
September 1995

IUE — ULDA Access Guide No. 6



International Ultraviolet Explorer — Uniform Low Dispersion Archive

Supernovae

esa

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International Ultraviolet Explorer — Uniform Low Dispersion Archive

Supernovae

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Cover Picture

The cover picture (by courtesy of P. Challis, O. Kuhn & B. Schmidt of the Harvard/ Smithsonian Center for Astrophysics) represents SN 1994I in M51 (Whirlpool Galaxy). It shows the appearance of SN 1994I (discovered independently by the amateur astronomers ***T. Puckett, J. Armstrong, W. Johnson, D. Millar, R. Berry and R. Kushida***) in the nearby galaxy NGC 5194 (M51; also known as the Whirlpool Galaxy).

This supernova was discovered on the night of 1 April 1994 very soon after it exploded. It is thought to be a helium-poor Type Ib (sometimes also referred to as Ic). Type Ic supernovae are caused by the explosive collapse of a massive star (some 40 times the mass of the Sun) that has lost all of its hydrogen and most of its helium as well.

This supernova has been observed in the ultraviolet with both IUE and the Hubble Space Telescope (HST). The images on the cover were taken with the 1.2 m telescope at the Fred Lawrence Whipple Observatory on Mt. Hopkins, Arizona.

Before: 7 January 1994
After: 3 April 1994

ESA SP-1189 IUE—ULDA Access guide No. 6: Supernovae

Prepared by: E. Capellaro, M. Turatto & J. Fernley

Scientific coordinator for the ULDA Access Guides W. Wamsteker

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FOREWORD

The IUE ULDA/USSP Access Guides.

The International Ultraviolet Explorer (IUE) Satellite project is a joint effort between NASA, ESA and the PPARC. The IUE Spacecraft and instruments are operated in a Guest Observer mode and are designed for Ultraviolet Spectrophotometry at two resolutions in the wavelength range from 115nm to 320nm: a low resolution at R=300 (1,000 Km/sec.) and a high resolution mode at R=10,000 (19 Km/sec.). The IUE S/C, its scientific instruments and the data acquisition and reduction procedures, are described in "*Exploring the Universe with the IUE Satellite*", Part I, Part VI and Part VII (Astrophysics and Space Sciences Library volume 129, Y. Kondo, Editor-in-Chief, Kluwer Acad. Publ. Co.) and references therein. A more recent overview of the IUE Project is given in *"15 Years of IUE"* in Frontiers of Ground-based and Space Astronomy (Astrophysics and Space Sciences Library volume 187, pg. 77-86, Eds. W.Wamsteker, M.Longair and Y. Kondo, Kluwer Acad. Publ. Co.). Extensive information on the IUE Project can also be found on the World-Wide-Web under: ***http://www.vilspa.esa.es/iue/iue.html***. From the very beginning of the project (launched on 26 January 1978), it was expected that the archival value of the data obtained with IUE would be very high. This expectation has been borne out fully, especially after 16 years of orbital operations. The average IUE Archive data retrieval rate is some 61,000 spectra per year. This compares with a new data collection rate of 5,500 spectra per year. Considering that the demand for observing time still exceeds the available time by a factor of 3, it is clear that the IUE Archive is an important source of data. The IUE ULDA/USSP (**U**niform **L**ow **D**ispersion **A**rchive/**U**LDA **S**upport **S**oftware **P**ackage) was developed by ESA to make IUE low resolution spectra available in a way which would not involve project staff and simplify consulting IUE data. It continues to support some 47% of all data retrieval from the IUE Project. At the ESA IUE Observatory the ULDA/USSP is an integral part of the archival data distribution system in which **National Hosts** play an important role. Pioneering remote de-archiving, the ULDA/USSP has fulfilled an existing need in the access to IUE Data. The low resolution data set was chosen since it represented a data set excellently suitable for remote de-archiving, and at the same time not overloading the facilities available in 1987 at the National Host Institutes. Currently 24 National Hosts participate in the ULDA/USSP system and serve the need for IUE data of scientists in 27 countries. New hosts continue to be integrated easily and regularly.

The subset of the IUE Archive contained in the ULDA and accessible through the USSP, consists of the low resolution IUE spectra in a form directly applicable to all modern Scientific Analysis techniques. Version 4.0 of the ULDA/USSP has been released in February 1993 and contains all -98.7% complete- low resolution spectra obtained with IUE before January 1st, 1992 (54,200 spectra). The details of the construction of the ULDA and the design of the USSP can be found in Wamsteker et al. (Astronomy and Astrophysics Supplement Series, Vol. 79, pg. 1-10, 1989) and in ESA IUE Newsletter#30, which also contains a Users Guide. The design and software coding of the USSP has been a coordinated effort between the ST-ECF, R.A.L., Trieste Observatory and the ESA IUE Observatory. The production of the ULDA and the overall coordination of the ULDA/USSP has been done at the ESA IUE Observatory at

VILSPA. New developments include a UNIX version of the USSP (USSP Version 4.0), developed in collaboration with the Canadian National Host (CADC), Trieste Observatory and the Spanish National Host (LAEFF).

The quantity of data in the IUE Archive is sufficiently large that it is not necessarily simple to address the data efficiently in the context of an astrophysical problem, even though access to the data is extremely easy. The purpose of the series of ULDA Access Guides is: To facilitate the use of the IUE Archive for scientists with a specific astrophysical problem in mind. The series of ULDA/USSP Access Guides consists of a number of subject-oriented books, for which a specialist in the field has been invited to take the scientific responsibility. *ULDA Access Guide No.6* treats the data of SUPERNOVAE and has been compiled by Dr. Enrico Cappellaro and Dr. Massimo Turatto of the Osservatorio Astronomico di Padova in Padova, Italy together with Dr. John Fernley (PPARC) of the ESA IUE Observatory in Madrid, Spain. In this issue they present an overview of all IUE spectra of the 24 Supernovae observed with IUE until 1994. Since no Ultraviolet spectra in the range from 115 nm-320 nm of Supernovae had been obtained before the launch of IUE, the material collected here summarizes essentially all UV observations of the final life cycle of stars. Of course the observational material on SN1987A takes up a significant portion of the contents since the observations of SN1987A have played an important role in the IUE Observing program in the years following. Just after the completion of the ULDA Guide an important detailed analysis of all low resolution UV spectroscopy of SN1987A has appeared in preprint form (Chun, S.J. et al., 1995; Harvard-Smithsonian preprint No. 4044; to be published in Ap.J. Supl. Ser. later this year). In the present ULDA Guide many references to earlier use of the data and phase information corresponding to the epochs of optical maximum of the IUE observations are supplied, as well as detailed information on the Supernovae and their parent galaxies.

Due to the large amount of work involved in such compilation and the dynamic nature of the ULDA, it is not possible to make both the existing version of the ULDA, and the auxiliary information cover exactly the same period. It was judged to be preferable to collect all information available at the time of preparation, rather than artificially make the time periods covered in the ULDA Guides and the current Version of the ULDA coincide. In this volume 6 the auxiliary information is included for all data until December 1992, while ULDA Version 4.0 extends until to January 1st,1992.

Further volumes of the ULDA Access Guides (see also page vii) will be published whenever the necessary data compilation has been completed by the authors. For details of the access to the ULDA through the National Hosts we refer to the details supplied regularly in the ESA IUE Newsletters (especially Driessen, Pasian and Talavera, 1988, IUE Newsletter #30, containing the ULDA/USSP Users Guide). After this (page ix), we also give the information allowing you to identify the National Host for each country, necessary to access to the IUE-ULDA. Any inquiries on the access to the ULDA and the use of the USSP should be directed to the National Host Managers (see page ix). Inquiries about the specific data content of the ULDA should be directed to ULDA Manager at the ESA IUE Observatory at VILSPA, Madrid, Spain (INTERNET: IUEOBS@VILSPA.ESA.ES).

Issues of the IUE-ULDA Access Guides

No. 1 ESA SP-**1114** C. la Dous
Dwarf Novae and Nova-like Stars

No. 2 ESA SP-**1134** M. Festou
Comets

No. 3 ESA SP-**1146** G. Longo, M. Capaccioli
Normal Galaxies

No. 4 ESA SP-**1153 (Vols. A & B)** T.J.-L. Courvoisier, S. Paltini
Active Galactic Nuclei

No. 5 ESA SP-**1181 (Vols. I & II)** C. la Dous, A Gimenez
Chromospherically Active Binary Stars

No. 6 ESA SP—**1189** E. Cappellaro, M. Turatto, J. Fernley
Supernovae

ULDA National Host Information

June, 1995

The following is basic contact and address information for the ULDA national hosts, ordered alphabetically by the country they serve with the following exceptions: Sweden, Norway, Denmark and Finland are grouped together under 'Nordic Countries' since they share a single host; ST-ECF/ESO and VBO serve themselves and visitors only, though they have national host status.

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INTRODUCTION

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1 IUE Observations of Supernovae

The International Ultraviolet Explorer (IUE) has been the first space born telescope to obtain UV observations of supernovae (SNe). For the observations of unpredictable, fast-evolving events like SNe the main requirement is rapidity in response. IUE is still unmatched from this point of view and has provided unique observations of the early phases for many bright SNe. The Hubble Space Telescope (HST) taking advantage of its larger collecting area is able to obtain spectra with better S/N than IUE (e.g. Kirshner et al. 1993) but, owing to the complexity of its operation, it does not have the flexibility of IUE.

The efficiency of IUE for the observations of bright SNe is illustrated in Fig 1 which highlights the SNe observed by IUE within the histogram of the magnitudes for all the SNe discovered since the launch of the satellite (1978). All the 7 SNe brighter than B=12 and about half of those in the range 12-13 mag have been detected by IUE.

The list of the SNe observed by IUE is reported in Table 1. For each SN are reported the SN type (col. 3), the extimated magnitude at maximum (col. 4), the number of short and long wavelenght IUE spectra (cols. 5 and 6 respectively) and the indicative phase range of the observations (col. 8).

It is not the purpose of this guide to discuss the contribution given by UV observations to the understanding of the SN phenomenon. Overviews

Table 1: List of the SNe observed by IUE as at December 1994.

SN	galaxy	SN type	m_B max	no. spectra SW	LW	phase [day]		
1978G	IC 5201	II	13.2		2	+6	to	+18
1979C	NGC 4321	IIL	11.6	12	19	+6	to	+112
1980K	NGC 6946	IIL	11.6	11	22	+1	to	+68
1980N	NGC 1316	Ia	12.5	1	7	0	to	+36
1981B	NGC 4536	Ia	12.0	2	5	−1	to	+26
1982B	NGC 2268	Ia	13.7	1	2	+2		
1983G	NGC 4753	Ia	13.1	1	7	+1	to	+18
1983N	NGC 5236	Ib	11.7	12	16	-12	to	+380
1984J	NGC 1599	II	13.2	1		+16		
1985F	NGC 4618	Ib	12.1		1	+339		
1985L	NGC 5033	IIL	13.0	1	2	+14	to	+24
1986G	NGC 5128	Ia	12.5		6	−4	to	+18
1987A	LMC	II p	4.8	262	590	+1	to	+2384
1989B	NGC 3627	Ia	12.5	1	4	-5	to	-4
1989M	NGC 4579	Ia	12.7		7	0	to	+14
1990B	NGC 4568	Ic	16.0		2	+7	to	+15
1990M	NGC 5493	Ia	12.6	1	1	−2		
1990N	NGC 4639	Ia	12.7		8	−14	to	+3
1990W	NGC 6221	Ic	15.4		1	+5		
1991T	NGC 4527	Ia p	11.6		5	−2	to	+52
1991bg	NGC 4374	Ia p	14.0		1	+1		
1992A*	NGC 1380	Ia	12.6		10	−5	to	+23
1992ad*	NGC 4411B	II	13.5	1	1	+2		
1993J*	NGC 3031	IIB	10.8	16	18	+3	to	+52

* Not included in ULDA at the time of writing.

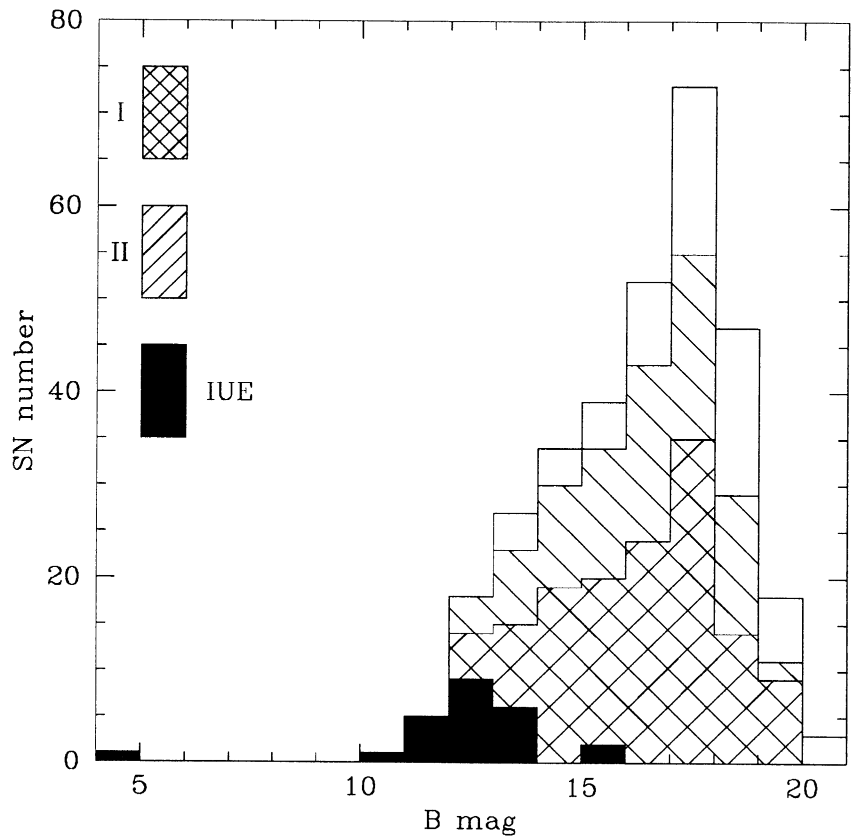

Figure 1: Histogram of the number of SN per interval of magnitude discovered since 1978. Different SN types are indicated. The black area refers to SNe observed with IUE.

on this subject can be found in Kirshner & Gilmozzi (1989), Panagia & Gilmozzi (1991), Gilmozzi (1991) and references therein and IUE observations of recent SNe can be found in Kirshner et al. (1993), de Boer et al. (1993), Sonneborn et al. (1994) (references for individual SNe are given in the attached atlas). However, some remarks may be useful for the planning of future UV observation of SNe.

In Fig 2 are plotted, for each of the SNe observed by IUE and with different symbols for different SN types, the m_{275}–B vs. B–V colors near maximum light (m_{275} is the magnitude derived from LW IUE spectra as described in Sec. 2). It appears that whereas the UV-optical spectral energy distributions of SNII and SNIb are close to those of black bodies, at temperatures of about 10000 °K for type II and 6000 °K for Ib, SNIa have a strong flux deficency in

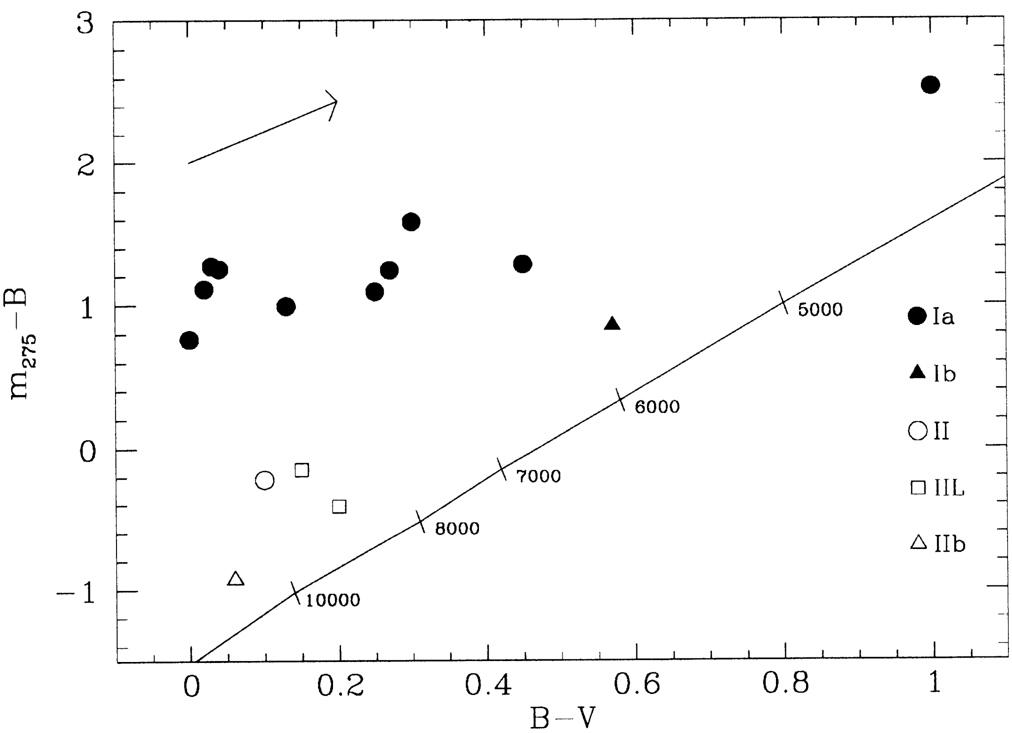

Figure 2: Two colors, m_{275}–B vs. B–V, diagram for SNe near maximum. The line gives the colors of the black body at different temperatures whereas the arrow on the top-left of the figure indicates the reddening line.

the UV compared with the energy distribution of a black body. SNIa exhibit a large spread in colors that is likely related to a) slightly different phases of the SNe at the time of observations and b) reddening (for instance the object on the upper-right corner of the figure (SN 1986G) it is known to be strongly affected by extinction).

The difference in m_{275}-B colors between type I and II SNe is 1.5–2 mag. This means that, for a given UV limiting magnitude of the telescope, the selection criterium for SNII targets, based of the optical magnitude, can be relaxed, by ~1.5 mag, with respect to SNI. E.g. the limiting magnitude for observations of SNe with IUE is B=12 for type I and B=13.5 for type II.

2 The atlas

The purpose of the atlas is to give the basic information for the SNe observed with IUE and allow a quick look through the SN spectra available in ULDA. The present atlas includes and updates the information reported in Benvenuti et al. (1982) where the observations of the first 6 SNe observed by IUE are presented.

It should be noted that the spectra in ULDA have been extracted using IUESIPS, the current software used to process IUE data (Wamsteker et al. 1989, Murray et al. 1990). A new extraction software, NEWSIPS, has been developed and this will be used to reprocess all IUE data to go into the IUE Final Archive. NEWSIPS has several advantages over IUESIPS, most particularly in improving the S/N ratio of faint spectra.

For each of the SNe observed by IUE, the following items are included in the atlas:

a) Data on the parent galaxy and the SN:

- Parent galaxy data are from RC3 (de Vaucouleurs et al. 1991) with the exception of unreddened distance moduli and group affiliations that are from Tully (1988).
- Main sources for the data of SNe are the updated version of the Asiago Supernova Catalogue (Barbon et al. 1989) as well as Leibundgut et al. (1991) and Patat et al. (1993, 1994).

  For several SNe the absolute positions were not measured. In these cases (marked with "*") the reported SN coordinates are computed from the galaxy coordinates combined with the SN offset from the galaxy nucleus.

  When available, photometric data are reported: the epoch and B (or V) magnitude at maximum, the B-V color and the average decline rates in the early phase. The latter have been calculated in the linear branches of the light curves during the first month after maximum for SNI (β) and in the early 100 days after maximum (β_{100}) for SNII. For all SN type the late decline rates (γ) are calculated as close as possible to the phase range 200–400 days.

b) List of IUE spectra: the following columns are reported in the table

1. IUE spectrum identifier
2. civil date of observations

3. U.T. of observations
4. phase relative to the maximum of luminosity
5. Fine Error Sensor magnitudes, m_{FES}, have been calculated in the following manner:

   $m_{FES} = -2.5 * \log 10(\text{FESCTS}) + K$

   where K = 11.16 for UNDERLAP or 16.52 for OVERLAP for observations until 1989 and K = 11.00 for UNDERLAP and 16.33 for OVERLAP for observations made since 1990 (Imhoff & Wasatonic 1986, Peres 1991). To correct for the sensitivity degradation of the FES we use the following relation (Fireman & Imhoff 1989):

   $\text{FESCTS} = \text{RAWCTS}/(1.0-0.0413\times(T-1981.65))$ OVERLAP

   $\text{FESCTS} = \text{RAWCTS}/(1.0-0.0291\times(\text{T}-1980.60))$ UNDERLAP

   where T is the time of the observation and RAWCTS are the observed FES counts. These expressions are valid until the end of 1989. For observations since 1990 no degradation relations are available. Also it should be noted that the RAWCTS are from FAST OVERLAP mode. FES counts in SLOW OVERLAP may be converted to FAST OVERLAP using:

   $\text{RAWCTS(FO)} = \text{ROWCTS(SO)}/4.0$

   These m_{FES} can be converted more closely to Johnson V by including a color term V = m_{FES} + COLOR. The color term has the form (Imhoff and Wasatonic 1986):

   $\text{COLOR} = -0.27 * (\text{B}-\text{V}) - 0.06 * (\text{B}-\text{V})^2 + 0.14 * (\text{B}-\text{V})^3$

   Note that the m_{FES} quoted in the Guide do not include this color term.
6. m_{140} short wavelenght UV magnitudes calculated convolving the SW spectra with the HST FOC F140W filter passband using the program CALCPHOT of the SYNPHOT package in STSDAS (cfr. Kirshner et al. 1993). The filter passband has been truncated below 1225 Å to avoid the contamination from geocoronal Lyα and above 1950 Å, the wavelenght upper limit of IUE SW spectra, to eliminate problems due to extrapolation of the CALCPHOT program. In analogy with the optical bands, it has been assumed that for the star Vega is $m_{140} = 0$.
7. m_{275}, long wavelenght UV magnitudes, calculated convolving the LW spectra with the HST FOC F275W filter passband. The latter

has been truncated below 1900 and above 3300 Å, the range covered by LW IUE spectra, to avoid problems with extrapolation. Again, it has been assumed that for the star Vega is $m_{275} = 0$.

m_{275} and m_{140} magnitudes have been computed in order to allow a quick comparison of the IUE spectrophotometry with the HST photometry of SNe.

None of the listed apparent magnitudes (V, m_{FES}, m_{140} and m_{275}) has been corrected for reddening.

8. Notes on individual spectra.
   - *high res.* indicates that the spectrum has been obtained in the high resolution mode. Excluding SN 1987A (the high resolution observations of this SN are reported in a separate table), only a handful of SN observations have been obtained in this configuration. They are not included in ULDA.
   - *Saturated* is reported when a number of pixels of the original spectrum were saturated.
   - *No ULDA* marks IUE observations that, for different reasons, are not in ULDA.

c) **References:** list of selected references relative to the SN. The list is by no means complete (one can use any of the available electronic bibliographical databases for this purpose) but is a *subjective* selection where priority is given to papers reporting observations and specific theorical interpretation, whereas review papers and more general theoretical work are not included.

d) **Figures:** in general, the following figures are included:

1. **Map** of the field around the SN extracted from the reference indicated in the caption.
2. **V, m_{FES}, m_{140}, m_{275} light curves** of the SN. On the bottom are marked the epochs when IUE spectra have been obtained and optical spectra are available (from the literature).
3. **UV-optical spectra** at selected epochs obtained by merging flux calibrated spectra obtained at similar epochs. The given optical spectra are extracted from the literature.
4. Selected **IUE spectra** from ULDA. SW and LW spectra of the same epochs are displayed.

If data are not available or if the SN has been poorly observed by IUE some figures may be missing.

Finally, we note that, at the time of writing, the spectra of SNe 1992A, 1993J and 1992ad are not yet included in ULDA.

2.1 SN 1987A

IUE had the exceptional opportunity to observe the brightest SN in the last 400 years, SN 1987A in LMC, and did not let it go. The results are in the over 750 UV spectra available in ULDA. A large number of papers have been published dealing with the UV observations of SN 1987A (a selection of the most relevants are reported in the list of references).

To illustrate this material we include in the presentation of this object some additional figures. In particular Figs. 5 and 6 show the m_{140} and m_{275} light curves corrected for the contribution of the nearby stars 2 and 3 (see Fig. 4). These stars strongly contaminate the IUE spectra of SN 1987A and, indeed, at late epochs completely dominate the flux entering the aperture.

References

Barbon, R., Cappellaro, E., Turatto, M., 1989, A&A Suppl. 81, 421

Benvenuti, P., Sanz Fernandez de Cordoba, L., Wamsteker, W., Macchetto, F., Palumbo, G.C., Panagia, N., 1982, *An Atlas of UV spectra of Supernovae* ESA SP-1046

Fireman, G., Imhoff, C., 1989, NASA IUE Newsletter 40, 10

Gilmozzi, R., 1990, in *Evolution in Astrophysics: IUE astronomy in the era of new space missions* ed. E.J. Rolfe, ESA SP–310, p.125

Imhoff, C., Wasatonic, R., 1986, NASA IUE Newsletter 20, 45

Kirshner, R.P., et al., 1993, ApJ 415, 589

Leibundgut, B. et al., 1991, A&A Suppl 89, 537

Murray, J., Driessen, C., Talavera, A., 1990, in *Evolution in Astrophysics: IUE astronomy in the era of new space missions* ed. E.J. Rolfe, ESA SP–310, p.609

Nichols-Bohlin, J., 1990, in *Evolution in Astrophysics: IUE astronomy in the era of new space missions* ed. E.J. Rolfe, ESA SP–310, p.207

Panagia, N., Gilmozzi, R., 1991, in *Supernova 1987A and other supernovae* I.J. Danziger & K, Kiär eds., ESO Workshop and Conference Proceedings No. 37, p. 575

Patat, F., Barbon, R., Cappellaro, E., Turatto, M., 1993, A&A Suppl. 98, 443

Patat, F., Barbon, R., Cappellaro, E., Turatto, M., 1994, A&A 282, 731

Peres, M., 1991, ESA IUE Newsletter 38, 22

Sonneborn, G., Rodriguez, P.M., Wamsteker, W., Fransson, C., 1994, in *Circumstellar media in the late stages of stellar evolution* eds. R.E.S. Clegg, I.R. Stevens, W.P.S. Meikle, Cambridge University Press, Cambridge, p.198

Tully, R. B., 1988, *Nearby Galaxy Catalog*, Cambridge University Press, Cambridge

de Vaucouleurs, G., de Vaucouleurs, A., Corwin, H.G., Buta, R.J., Paturel, G., Foque, P., 1991, *Third Reference Catalogue of Bright Galaxies*, Springer-Verlag (New York)

Wamsteker, W., et al. 1989, A&AS 79,1

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