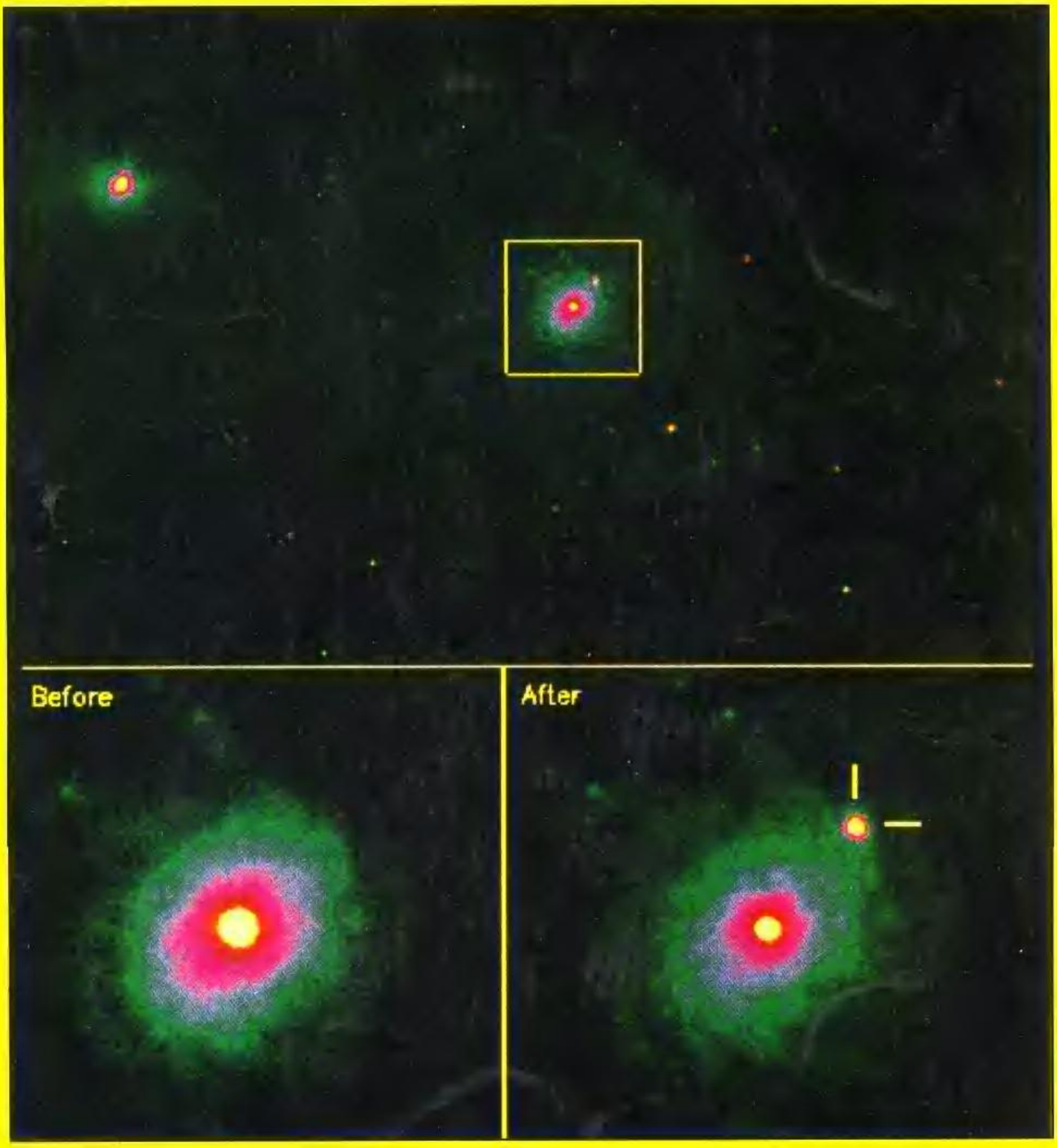
SP-1189
September 1995

IUE — ULDA Access Guide No. 6



International Ultraviolet Explorer — Uniform Low Dispersion Archive

Supernovae

esa

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prepared by
Enrico Cappellaro
&
Massimo Turatto
Osservatorio Astronomico di Padova
vicolo dell'Osservatorio, 5
I-35122 Padova
Italy

John Fernley
The ESA IUE Observatory
Apartado 50727
E-28080 Madrid
Spain

Scientific coordinator for the ULDA Access Guides
Dr Willem Wamsteker

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
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Comets

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

Belgium

Host manager:	**Marijke Burger**
E-mail:	marijke@astro.oma.be
Host:	Royal Belgian Observatory, Ringlaan 3, B-1180 Brussels.
Tel.:	+32 2 373-0240 (. . 11 = operator)
Tlx.:	21565 OBSBEL B
Fax:	+32 2 373-9822.

Brazil

Host manager:	**Luis Arakaki**
E-mail:	luis@vax.iagusp.usp.br
Host:	Instituto Astronomico e Geofisico Depto. de Astronomia, Caixa Postal 30627, CEP 01051, Sao Paulo - SP.
Tel.:	+55 11 577 8599
Tlx.:	1156735 IAGM BR
Fax:	+55 11 815 4272

Canada

Host manager: **Dennis Crabtree**

E-mail: crabtree@dao.nrc.ca

Host: CADC, Dominion Astrophysical Observatory,
5071 W. Saanich Rd.,Victoria B.C.,
Canada V8X 4M6

Tel.: +1 604 363-0025 or - 0001 (switch board)

Fax: +1 604 363 0045

Chile

Host manager: **Steve Heathcote**

E-mail: steve@ctiow1.ctio.noao.edu

Host: Cerro-Tololo Inter-Amer. Observatory,
Casilla 603, La Serena, Chile 1353.
(US uers: CTIO Support Office, P.O. Box 26732,
Tuscon, Arizona 85726-6732).

Tel: +56 51 225415 ext 342

Fax: +56 51 205342

China, (People's Rep. of)

Host manager: **Cheng Fuzhen, Cheng Fuhua, Wang Ting-gui**

E-mail:

Host: Centre for Astrophysics
University of Science and Technology of China
Hefei, Anhui 230026, P.R. China

Tel: +86 [0]551 - 301852 -- 527

Tlx: 90028 USTC CN

Fax: +86 [0]551 - 3631760

Costa Rica

Host manager: **Jorge Paez**

E-mail: jpaezp@cariari.ucr.ac.cr

Host: School of Physics, University of Costa Rica,
San Jose, Costa Rica.

Tel.: +506 535323, ext. 5147

Fax: +506 249367

France

Host manager:	**Gérard Jasniewicz**
E-mail:	gerard@simbad.u-strasbg.fr
Host:	CDS, Observatoire de Strasbourg, 11, rue de l'Université, 67000 Strasbourg.
Tel.:	+33-88 358216 (358418)
Tlx.:	890506 STAROBS F
Fax:	+33 88 250160

Germany

Host manager:	**Berhard Pflueger**
E-mail:	pflueger@aitmvx.ait.physik.uni-tuebingen.de
Host:	Astronomisches Institut der Universitat Waldhauserstrasse 64, 74 Tubingen.
Tel.:	+49 7071 29 5471
Fax:	+49 7071 29 3458

India

Host Manager:	**C. P. Revankar, S. C. Chakravarty**
E-mail:	cpr@isro.ernet.in
Host:	Space Science Data Centre, ISRO HQ, Antariksh Bhavan, Bangalore 560 094, India.
Tel.:	+91-80-333 4474
Fax:	+91-80-333 4229
Tlx:	+81-845-2499

Israel

Host Manager:	**Noah Brosch**
E-mail:	noah@wise1.tau.ac.il
Host:	Wise Observatory, Tel Aviv University, Tel Aviv 69978, Israel.
Tel.:	+972 - 3 - 640-8792 or -9279
Fax	+972 - 3 - 640-8179

Italy

Host manager: **Mariagrazia Franchini**

E-mail: franchini@oat.ts.astro.it

Host: Osservatorio Astronomico di Trieste
Via G.B. Tiepolo 11, I - 34131, Trieste.

Tel.: +39 40 3199 111

Fax: +39 40 309418

Japan

Host manager: **Shin-ichi Ichikawa**

E-mail: richika@c1.mtk.nao.ac.jp

Host: Computer and Analysis Center for Astr.Data,
National Astronomical Observatory,
Osawa, Mitaka, Tokyo, Japan.

Tel.: +81 422 34 3609, 3611

Fax: +81 422 34 3608

Mexico

Host manager: **Luis J. Corral**

E-mail: lcorral@tonali.inaoep.mx

Host: Instituto Nacional de Astrofisica, Optica y Electronica
Apartado Postal Nos. 51 y 216
Puebla, Pue. C.P. 72000, Mexico

Tel.: +52 22 472011

Fax: +53 22 472231

Netherlands

Host manager: **Ed Van der Zalm**

E-mail: vdzalm@fys.ruu.nl

Host: Sterrenkundig Instituut ,UniversiteitUtrecht,
P.O. Box 80000, NL-3508 TA Utrecht

Tel.: +31-30 535200 / 535227 (Ed Van der Zalm)

Fax: +31-30 535201

Nordic countries

Host manager:	**Kjell Eriksson**
E-mail:	Kjell.Eriksson@astro.uu.se
Host:	Uppsala Astronomical Observatory, P.O. Box 515, S-75120 Uppsala, Sweden.
Tel.:	+46 18 530265 (512488)
Fax.:	+46 18 527583

South Africa

Host manager:	**Luis A. Balona**
E-mail:	lab@saao.ac.za
Host:	South African Astronomical Observatory PO Box 9, Observatory, 7935 South Africa
Tel.:	+27 21-47-0025
Fax.:	+27 21-47-3639

Spain

Host manager:	**Eduardo Fernandes Vieira**
E-mail:	efv@laeff.esa.es
Host:	LAEFF , Villafranca del Castillo Apartado 50727, E-28080 Madrid, SPAIN
Tel.:	+34 1 813 1161
Tlx.:	42555 VILS E
Fax:	+34 1 813 1160

ST-ECF / ESO

Host manager:	**Benoit Pirenne**
E-mail:	bpirenne@eso.org
Host:	ST-ECF/ESO, Karl Schwarzschild Strasse 2, D-85748 Garching, Germany.
Tel.:	+49 89 32006291 (32006433)
Fax:	+49 89 32006480

Switzerland

Host manager: **Stephane Paltani**

E-mail: paltani@scsun.unige.ch

Host: Institut d'Astronomie de Universite de Lausanne
CH - 1290 Chavannes-des-bois.

Tel.: +41 22 7552611

Fax: +41 22 7553983

Taiwan

Host manager: **Wei-Hsin Sun**

E-mail: sun@angel.phy.ncu.edu.tw

Host: Institute of Physics and Astronomy,
National Central University, Chung-Li, Taiwan 32054.

Tel. +886 3 4227151 ext. 5950 or 4262302

Fax: +886 3 4262304

Turkey

Host manager: **Umit Kiziloglu**

E-mail: umk@newton.physics.metu.edu.tr

Host: Physics dept., METU,
Ankara 06351, Turkey.

Tel.: +90 312 210 1000 / 3275

Fax : +90 312 210 1281

Telex : 42761 UDTKTR (not dep. but presidental office)

United Kingdom

Host manager: **Dave Stickland**

E-mail: ds@ast.star.rl.ac.uk

Host: Rutherford Appleton Laboratory (RAL)
Chilton, Didcot, Oxon OX11 OQX, England

Tel.: +44 1235 821900 (ext. 6523)

Fax : +44 1235 445848

USA

Host managers: **Charleen Perry, Michael Van Steenberg**

E-mail: NCF::PERRY (DECnet)

Host: Code 633,NASA/GSFC Goddard Space Flight Center
Greenbelt, MD 20771, USA

Tel.: +1 (301) 286 2899

Tlx.: 89675 NASCOM GBLT

TWX: 7108289716

VBO

Host Manager: **K. K. Ghosh**

E-mail: kkg@iiap.ernet.in

Host: Indian Institute of Astrophysics,
Vainu Bappu Observatory,
Kavalur, Alangayam, NAA 635 701, India

Tel.: +91 04174-87 222 , 87 255, 87 268

Fax: +91 80 5534043

Tlx: 0845-2763 IIAB IN

INTRODUCTION

Enrico Cappellaro
and
Massimo Turatto
Osservatorio Astronomico di Padova
vicolo dell'Osservatorio, 5
35122 Padova - Italy

John Fernley
The ESA IUE Observatory
Apartado 50727
28080 Madrid - Spain

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.

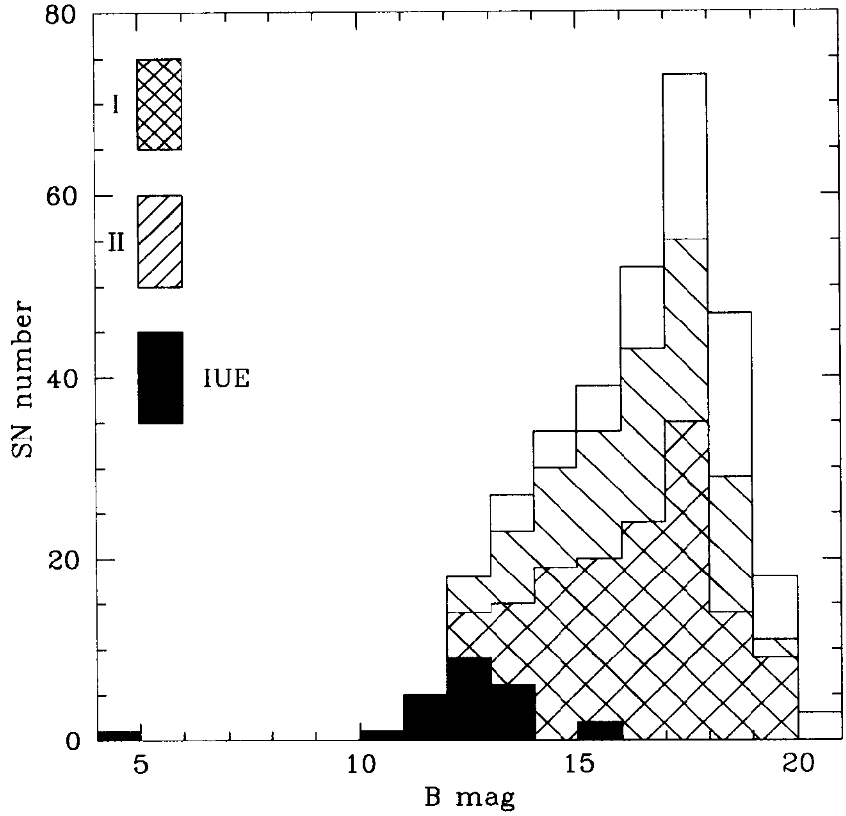

Figure 1: Histogram of the number of SN per interval of magnitude discovered since 1978. Different SN types are indicated. The black area refers to SNe observed with IUE.

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

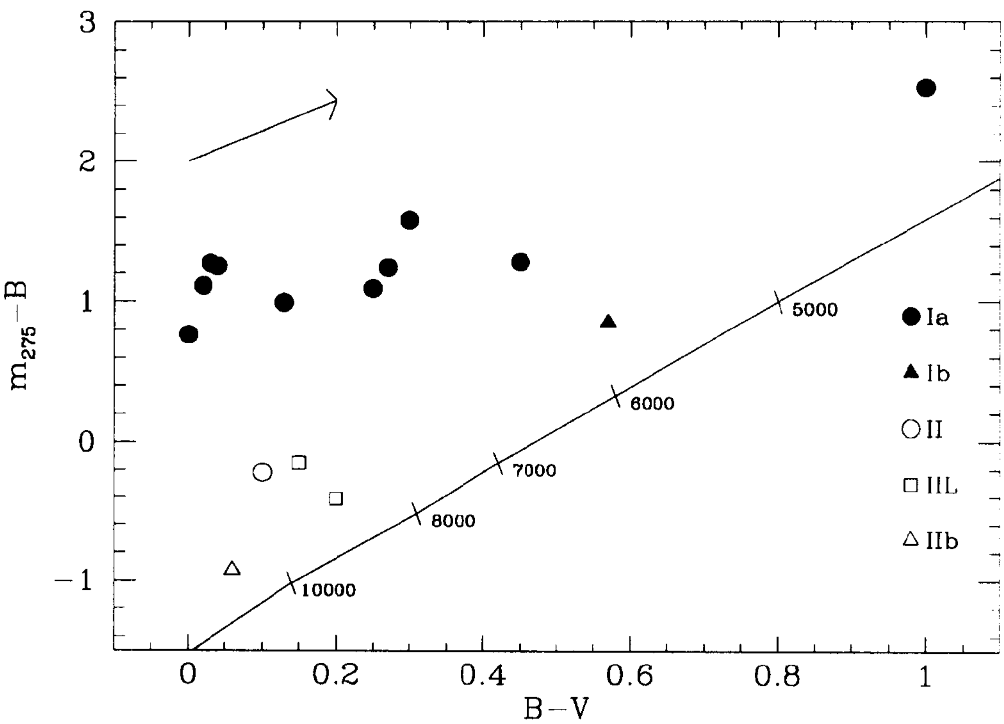

Figure 2: Two colors, m_{275}-B vs. B–V, diagram for SNe near maximum. The line gives the colors of the black body at different temperatures whereas the arrow on the top-left of the figure indicates the reddening line.

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.