Results of the SCP Keck Spectroscopy campaigns

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1 Instrument

The spectra showned in this study were obtained with the ESI (Echellette Spectrograph and Imager) instrument mounted on the 10 meters class telescope Keck II. ESI is a multi-mode instruments with a Direct imaging mode, a Low Resolution mode and an Echellette mode. This is the last mode, we used to get the spectra of the supernovae. The Echellette mode is achieved to disperse the light into 10 orders, from the 6^{th} in red to the 15^{th} order in the blue, in the 3900-11000Å range of wavelength with the spectral resolution $\mathcal{R} = \Delta\lambda \setminus \lambda = 13000$. One of the best advantage of using ESI come from the extreme stability of this instrument, due to an active flexure compensation system.

2 Reduction scheme

The reduction was performed using both IRAF and IDL. The common IRAF `echelle` package was used to do most part of the reduction. We followed the usual scheme to perform the reduction. One can remind briefly the different command we used in our reduction :

- `zerocombine` and `flatcombine` to combine the bias exposures and the flat exposures respectivly.
- `ccdproc` was used to apply a pixel mask on each exposure to remove the bad columns existing on the CCD.
- An IDL code has been developped to do all the preprocessing, that means substraction of the overscans, of the bias and the flat-fielding. Morover, this routine is using an algorithm developped by P.G. Van Dokkum[1] called L.A. COSMIC [Van Dokkum, P.G., 2001], based on a laplacian method, to remove the existing cosmics on the spectral images. After substration of the overscan, the bias and after the flat fielding, the ten orders are straightened and the Laplacian method is used for each of them. At the end each orders recover their initial curvature.
- Finding and extracting the signal was done using `apall` command.
- `ecidentify` and `ecreidentify` for the calibration of the relation of dispersion.
- `hedit` or `refspectra+dispcor` can be used to apply the relation of dispersion to each extracted spectra.
- Merging the ten orders was done using `scombine` to get a single spectrum over the whole range of wavelength.

[1] routine avalaible in IRAF CL & IDL at http://www.astro.caltech.edu/ pgd/lacosmic/

- The `Continuum` task was used to determine the ripple function.
- Finally, the usual set of command `standard`, `sensfunc` and `calibrate` allowed us to calibrate each spectra of supernovae in flux with a standard star spectrum.

3 The photometric Data

The photometric data were taken using the 12K camera of the Canada-France-Hawaii-Telescope (CFHT), the BTC camera of the Cerro-Tololo Inter-American Observatory (CTIO) and the Suprime Camera mounted on the Subaru Telescope. The first two telescopes are 4 meters class telescope and Subaru is a 8 meters class telescope.
In the table (Tab : 3), for each object, one can find the telescope used to find the candidates, you also have some informations on the discovery magnitude, the evolution of the magnitude between the two observations.

IAUC/SCP name	Tele Obs	Date Ref	Date New	PI[a]	New Mag[b]	Host Mag	Neigh. Dist[c]
sn2001gk	CFHT	03/30	04/20	28.80	24.08	20.90	2.94
sn2001gm	CFHT	03/30	04/20	38.46	23.40	20.90	2.26
sn2001gn	CHFT	03/30	04/20	95.25	24.96	24.95	3.44
sn2001gp	CFHT	03/29	04/15	100.60	25.50	23.32	2.27
sn2001gq	CFHT	03/28	04/18	326.60	24.76	23.93	0.85
sn2001gt	CTIO	03/28	04/18	1413?	22.67	22.28	6.02
sn2001gv	CTIO	03/28	04/18	28.69	23.67	22.26	6.01
sn2001gw	CTIO	03/29	04/18	110.50	???	???	1.51
sn2001gx	CTIO	03/28	04/18	44.35	23.76	21.35	5.76
sn2001gz	CTIO	03/28	04/19	71.63	24.14	22.62	6.11
sn2001ha	CTIO	03/28	04/17	1386?	23.49	23.15	13.03
sn2001hb	CTIO	03/28	04/18	326.60	24.76	24.76	6.13
sn2001hd	CTIO	03/29	04/18	25.69	22.76	22.76	0.36
sn2001he	CTIO	03/29	04/18	32.33	22.98	22.98	0.15
S01-021	CTIO	03/28	04/18	1406?	24.05	20.76	5.90
S01-058	CFHT			1284	25.06	24.31	6.97
sn2002fl	CFHT	-	RS mode[d]	-	-	18.99	4.06
C02-008	CFHT	-	RS mode	-	-	23.80	0.05
S02-016	Subaru	03/19	04/09	20.25	23.59	21.80	0.28
S02-027	Subaru	03/19	04/09	25.36	23.60	23.74	6.26
S02-032	Subaru	03/19	04/09	363.80	23.03	22.16	6.54
S02-035	Subaru	03/19	04/09	76.78	23.58	23.32	0.06
S02-049	Subaru	03/19	04/09	91.00	24.00	23.82	0.47
SuF02-000	Subaru	09/30	11/02	21.68	24.68	22.75	0.66
SuF02-012	Subaru	09/30	11/02	117.70	25.17	24.10	3.83
SuF02-017	Subaru	09/30	11/02	1782?	24.61	22.34	4.03
SuF02-019	Subaru	09/30	11/02	34.99	24.59	23.32	0.28
SuF02-021	Subaru	09/30	11/02	50.09	24.28	20.48	2.64
SuF02-026	Subaru	09/30	11/02	28.23	24.83	23.30	0.35
SuF02-027	Subaru	09/30	11/02	101.80	23.29	23.13	0.41
SuF02-037	Subaru	09/30	11/02	27.03	24.39	22.86	0.27
SuF02-055	Subaru	09/30	11/02	660.30	23.41	23.50	4.92
SuF02-059	Subaru	09/30	11/02	83.42	25.39	24.07	6.92
SuF02-061	Subaru	09/30	11/02	105.30	24.55	24.53	0.41
SuF02-071	Subaru	09/30	11/02	581.70	23.92	24.05	1.65
SuF02-077	Subaru	09/30	11/02	10.13	24.72	22.06	0.48
SuF02-082	Subaru	09/30	11/02	15.06	25.03	22.35	1.00

a PI : Percentage of increase of the flux between the reference image and the subtracted image.

b Magnitude of the object found after subtration of the new image to the reference image.

c Distance in arcsecond between the center of the object on the subtracted image and the center of gravity of the host galaxy.

d 'RS mode' for rolling search mode : it was a new kind of observations of supernovae with some new images every three days.

Table 1: ***Photometric informations on the candidates of the spring 2001, spring 2002 and fall 2002 campaigns.***

4 Results of the spectrometric observations with ESI

4.1 Summary of the observations

IAUC/SCP name	TE Time[a]	PA[b]	Type	Redshift	Phase[c]	HTyped
sn2001gk	3600	-45	?	0.661	-	-
sn2001gm	1200	-45	Ia	0.49	+3	Sa
sn2001gn	7900	-45	Ia	1.10	-7	-
sn2001gp	10800	+45	?	1.067?	-	-
sn2001gq	5400	+50	Ia	0671	-14	-
sn2001gt	3600	-30	Ia	0.55	-3	-
sn2001gv	3000	0	Ia	0.601	-	-
sn2001gw	480	+70	Ia	0.363	-1	-
sn2001gx	3600	-45	?	0.579	-	-
sn2001gz	27200	-10	?	-	-	-
sn2001ha	2700	-10	Ia	0.58	max	-
sn2001hb	7200	-60	Ia	1.054	-	-
sn2001hd	3000	+64	Ia	0.51	+2	S0
sn2001he	7200	+70	Ia	0.59	-3	E
S01-021	3600	-30	-	-	-	-
S01-058	10800	+30	-	-	-	-
sn2002fl	1800	+40	Ia	0.26	-8	-
C02-008	600	+45	?	0.31	-3	-
S02-016	3600	0	?	-	-	-
S02-027	3600	-68	?	-	-	-
S02-032	4680	-30	?	-	-	-
S02-035	3600	-30	?	-	-	-
S02-049	3979	-8	?	-	-	-
SuF02-000	3900	85	?	0.92?	-	-
SuF02-012	9100	-24	-	1.3?	-	-
SuF02-017	6100	-61,53	-	1.0?	-	-
SuF02-019	3000	-61	-	0.505?	-	-
SuF02-021	7200	?	-	-	-	-
SuF02-026	5400	-53	-	-	-	-
SuF02-027	1800	-20	-	-	-	-
SuF02-037	2400	45	-	-	-	-
SuF02-055	3600	-18	Ia	0.66	-	-
SuF02-059	3600	90	-	0.269	-	-
SuF02-061	7200	0	-	-	-	-
SuF02-071	6000	85	-	-	-	-
SuF02-077	1800	-45	-	-	-	-
SuF02-082	3050	-8	-	0.623	-	-

[a] TE Time : Total Spectrometric Exposure Time invested on the object.
[b] PA : Position angle; relative to the parallactic angle.
[c] Phase : Date of the spectrum found by the cross correlation program, relative to the maximum of luminosity.

Table 2: *Summary of the Spectrometric informations for the whole set of candidates.*

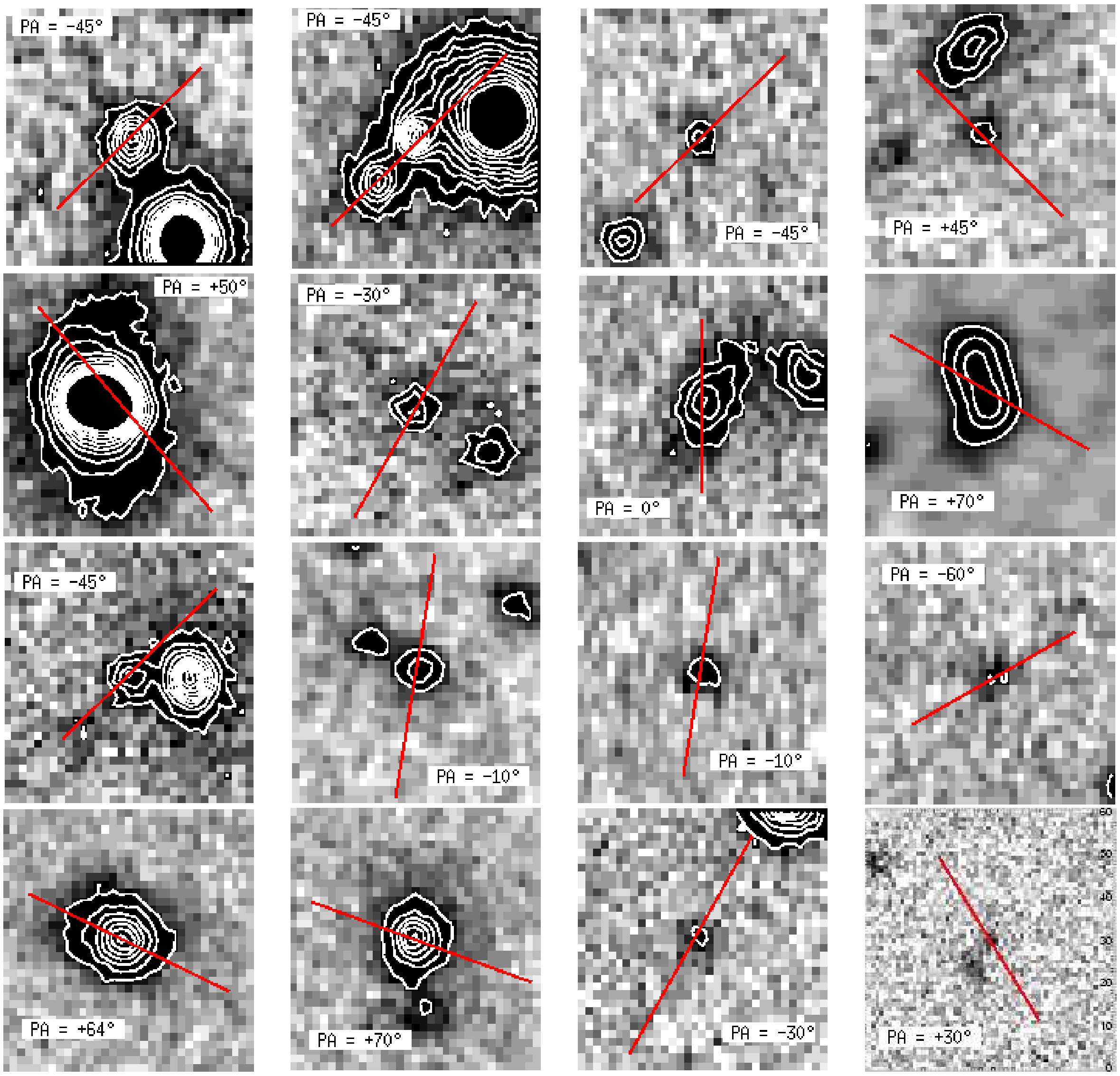

Figure 1: *Vignets showing the spring 2001 candidates with (in most case) its host galaxy. The red full line represents the approximative position of the slit set for the spectroscopy. The images of the different objects are in the same order than in the table.*

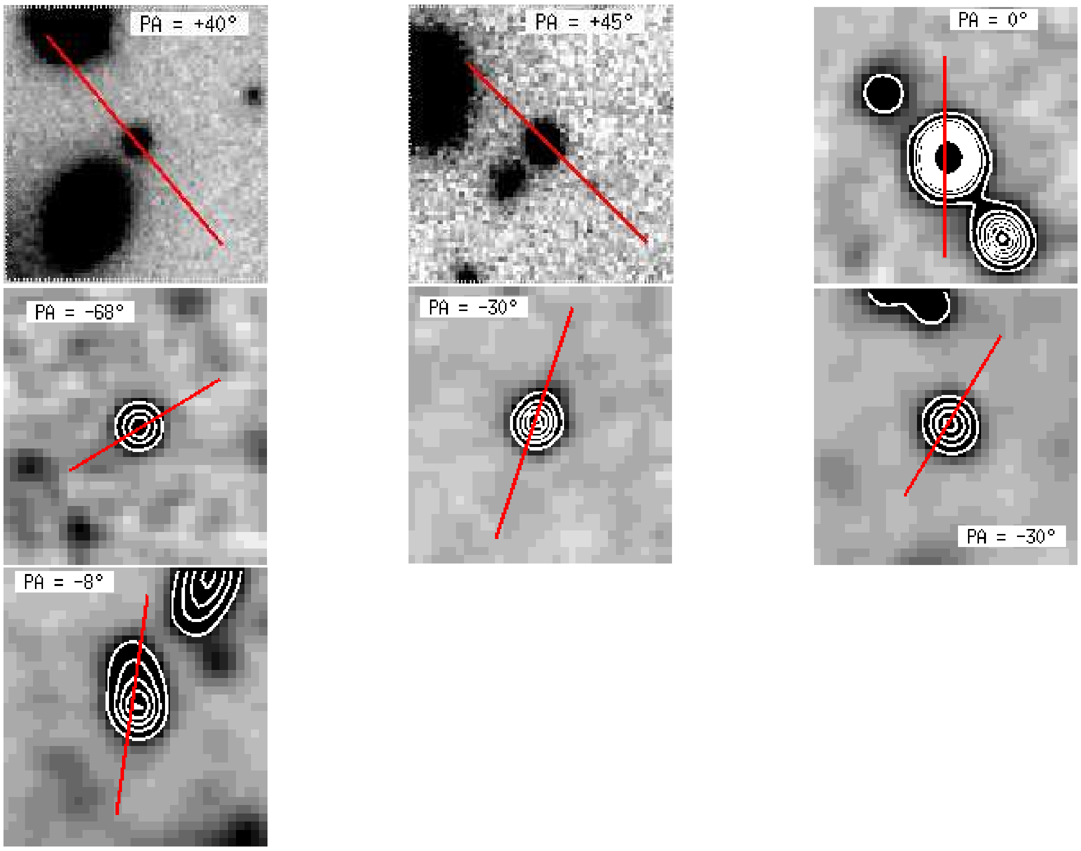

Figure 2: *Vignets showing the spring 2002 candidates with (in most case) its host galaxy. The red full line represents the approximative position of the slit set for the spectroscopy. The images of the different objects are in the same order than in the table.*

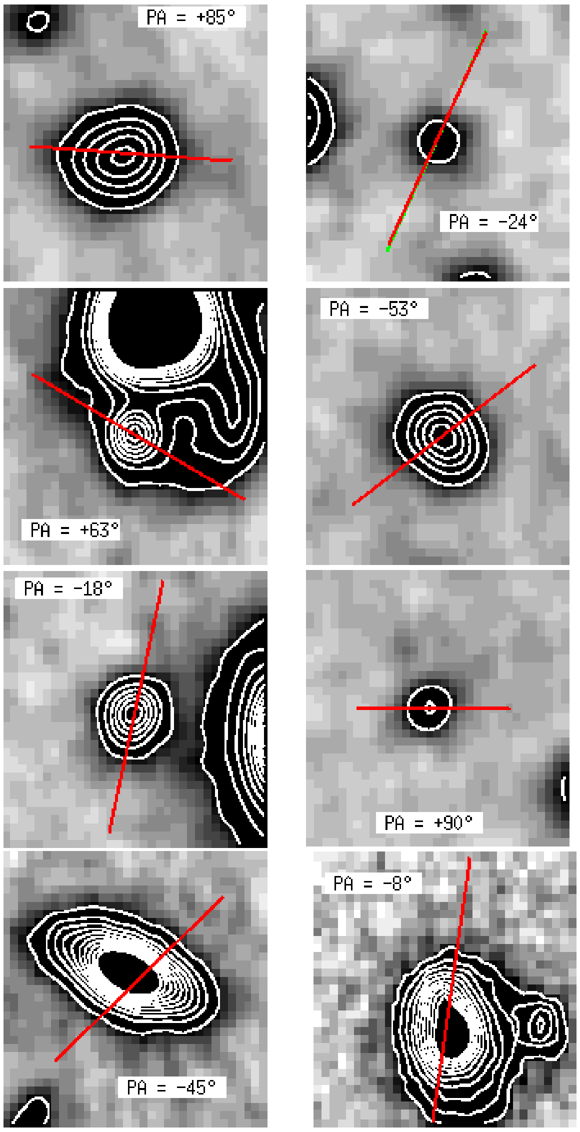

Figure 3: *Vignets showing the fall 2002 candidates with (in most case) its host galaxy. The red full line represents the approximative position of the slit set for the spectroscopy. The images of the different objects are in the same order than in the table.*

4.2 Details on the spectra...

sn2001gm

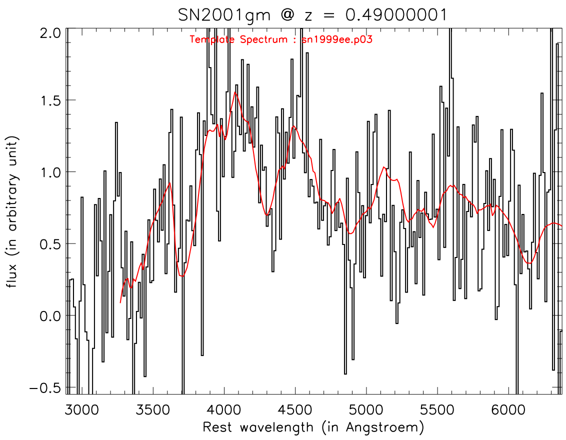

Figure 4: *sn2001gm spectrum. The best match supernova is sn1999ee at 3 days before the maximum of luminosity.*

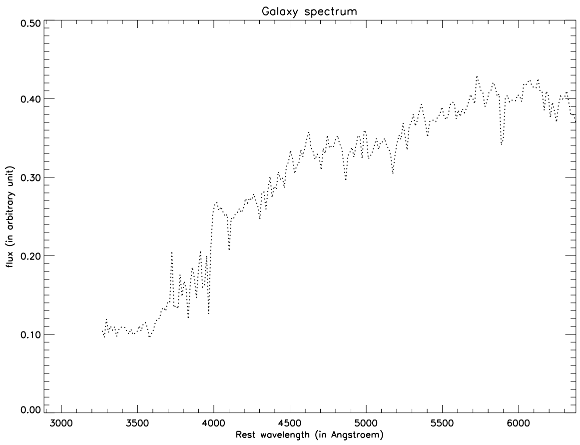

Figure 5: *Host spectrum of sn2001gm. The best match supernova is sn1999ee at 3 days before the maximum of luminosity.*

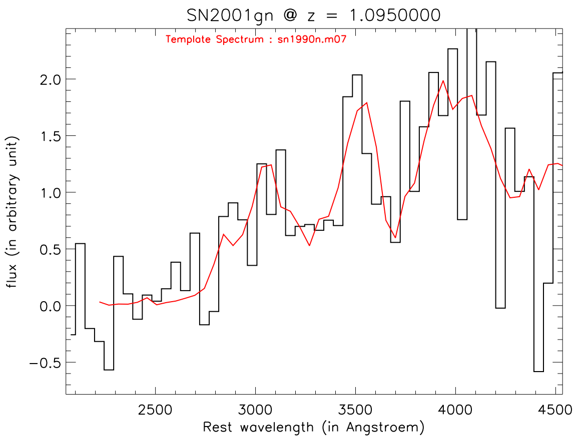

Figure 6: *sn2001gn spectrum. The best match supernova is sn1990n at 7 days before the maximum of luminosity. In good agreement with the light curve.*

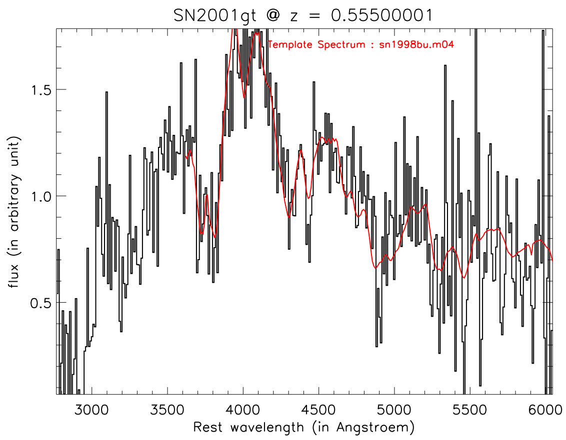

Figure 7: *sn2001gt spectrum. The best match supernova is sn1998bu at 4 days before the maximum of luminosity.*

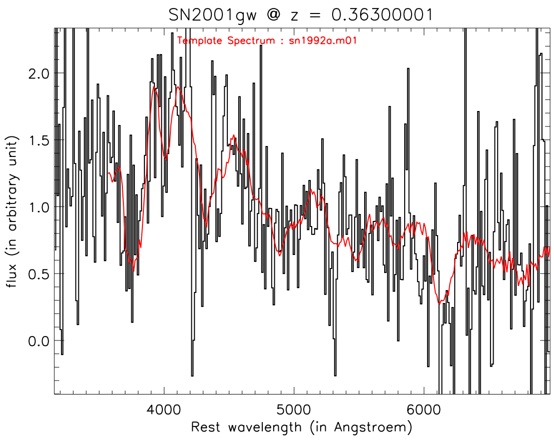

Figure 8: *sn2001gw spectrum. This spectrum looks like the spectrum of sn1992a at 1 day before the maximum of luminosity.*

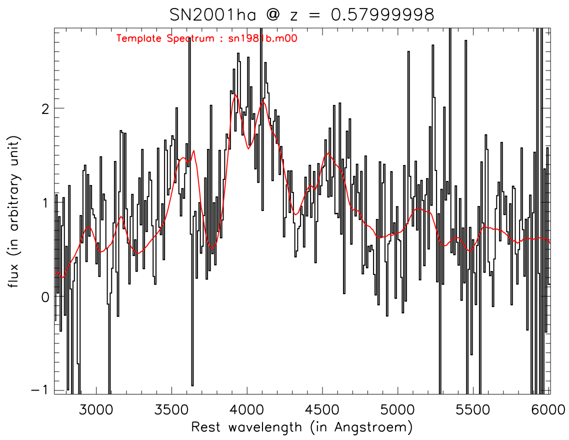

Figure 9: *sn2001ha spectrum. The best match supernova is sn1981b at the maximum of luminosity.*

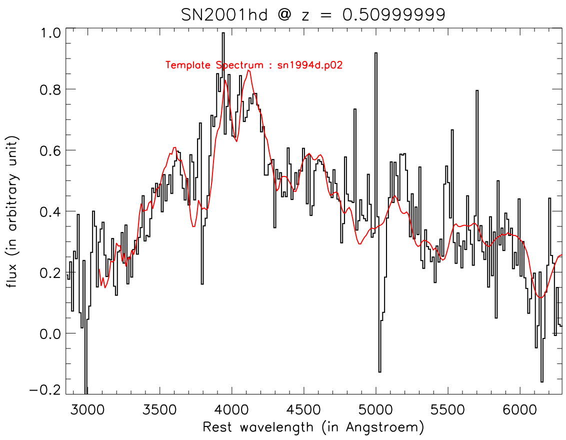

Figure 10: *sn2001hd spectrum. The best match supernova is sn1989b at 5 days before the maximum of luminosity.*

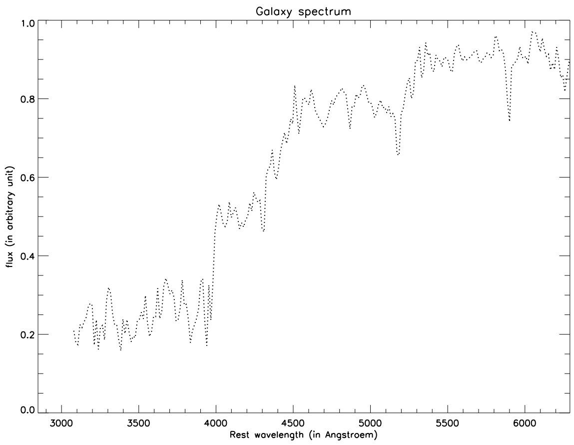

Figure 11: *Host galaxy spectrum of sn2001hd substracted from the original spectrum.*

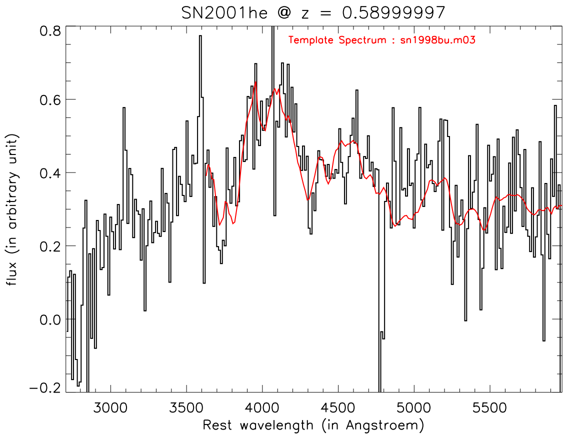

Figure 12: *sn2001he spectrum. The best match supernova is sn1998bu at 3 days before the maximum of luminosity.*

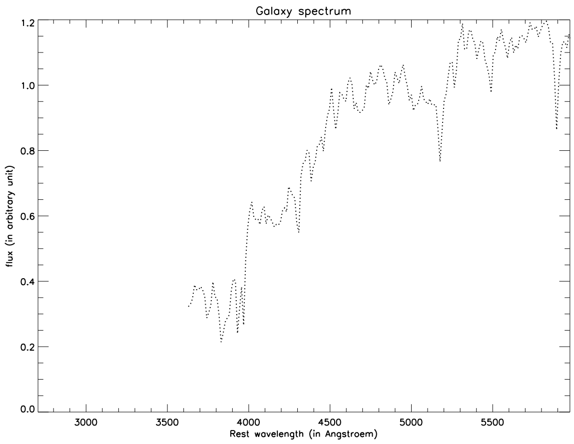

Figure 13: *Host spectrum of sn2001he, substracted from the original spectrum. It's an elliptical galaxy spectrum.*

References

[Schahmaneche K.,2001] Schahmaneche K., 2001, IAU *Circ* 7763.

[SCP, 2001] Supernova Cosmology Project, 2001, IAU *Circ* 7764.

[SCP, 2002] Supernova Cosmology Project, 2002, IAU *Circ* 7971.

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