* Are any "unknowns" being put forward as Ia on other basis? e.g. lightcurve?
* Danger of traping ourselves for future work on "unknowns"?

Spectroscopic confirmation of high-redshift supernovae with the ESO VLT *

Greg's Comments

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Received Month DD, YYYY; accepted Month DD, YYYY

This success rate is low. Should we try to understand it before putting out unknowns.

Abstract. We present VLT FORS1 and FORS2 spectra of 40 candidate high-redshift supernovae that were discovered as part of a ~~program to discover~~ cosmological study using Type Ia supernovae (SNe Ia) over a wide range of redshifts. From the spectra alone, 14 candidates are securely identified as SN Ia with redshifts ranging from $z = 0.212$ to $z = 1.181$ and an additional 6 candidates are identified as possible SN Ia with redshifts ranging from $z = 0.44$ to $z = 1.086$. Of the remaining 20 candidates that cannot be identified as SNe Ia, 11 ~~are galaxies~~ possess a galaxy component from which with redshifts ranging from $z = 0.243$ to $z = 1.478$, and 9 have neither redshifts nor secure classifications.

have been measured

Key words. supernovae:general – cosmology:observations

What is value if unknowns can now be shown to be spurious?

1. Introduction

Over the past decade, observations of SNe Ia up to $z = 1$ (why choose this? H2SST 0.97?) have played a leading role in measuring the expansion history of the Universe and in constraining cosmological parameters. It was through these observations that we discovered that the expansion is currently accelerating and that the Universe is presently dominated by an unknown form of dark energy with a negative equation of state (Permutter et al. 1998; Garnavich et al. 1998; Schmidt et al. 1998; Riess et al. 1998; Perlmutter et al. 1999; Tonry et al. 2003; Knop et al. 2003). Riess 04?

When these results are combined with the results that have been derived from the fluctuations in the cosmic microwave background (Jaffe et al. 2001; Bennett et al. 2002; Spergel et al. 2003), the properties of massive clusters (Allen, Schmidt & Fabian 2002; Borgani et al. 2001) and the large scale structure of galaxies (Hawkins et al. 2003), a picture of a flat Universe dominated by dark energy emerges.

More recently, considerable effort has been directed towards extending the redshift range over which SNe Ia are observed. The Hubble diagram of SNe Ia with $z \sim 0.5$ is degenerate to a linear combination of Ω_M and Ω_Λ. Hence, an independent determination of these two parameters from SNe Ia alone is not possible with the current SNe data sets. However, observations of SNe Ia over a wide range of redshifts and, in particular, very distant ($z \gtrsim 1$) SNe Ia can break this degeneracy (Goobar & Perlmutter). With this aim in mind, the Supernova Cosmology Project (SCP) started a program to discover, spectroscopically confirm and photometrically monitor a substantial number of SNe Ia with redshifts ~~up to z ≈ 1.2.~~ $z > 1$ and follow a highly successful pilot search (Aldering '9 IAUC

In this paper, we present VLT FORS1 and FORS2 spectra of 40 candidate high redshift supernovae. We present all spectra, including those spectra for which a secure spectroscopic confirmation was not possible. The results of the photometric follow-up, the derived apparent magnitudes and the implications these measurements have for cosmology will be reported elsewhere.

2. Observations

2.1. Search and Discovery

The candidates discussed in this paper were discovered during 8 separate, but not fully independent, high-redshift supernovae searches. The searches were divided into 4 observing campaigns that occurred during the Northern Springs of 2000, 2001 and 2002 and the Northern Fall of 2002. The observing campaigns, the months during which the reference and search images were taken and the telescopes used in the searches are listed in Table 1.

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* Based on observations obtained at the European Southern Observatory using the ESO Very Large Telescope on Cerro Paranal (ESO programs 265.A-5721(A), 67.A-0361(A), 267.A-5688(A), 169.A-0382(A) and (B)).

* Mark ⊕ features not corrected
* "Pivot" if still in slit after offset or PA = PA(SN, ✱)
* where x-correlations done for galaxy z? χ^2 not as good, esp. if binned.

The prefix is used in the internal SCP name. The individual searches are numbered for easy reference.

Campaign	Months	Instrument/Telescope	Search Number	Search type	Prefix
Spring 2000	April/May	CFHT12k on CFHT	1	Classical	C00
Spring 2001	March/April	CFHT12k on CFHT	2	Classical	S01
	March/April	MOSAICII on CTIO 4m	3	Classical	S01
Spring 2002	March to June	CFHT12k on CFHT	4	Rolling	C02
	April/May	MOSAICII on CTIO 4m	5	Classical	T02
	March/April	SupimeCam on Subaru	6	Back-to-back	S02
	April/May	SupimeCam on Subaru	7	Back-to-back	S02
Fall 2002	October/November	SupimeCam on Subaru	8	Classical	SuF02

Following the search and discovery techniques described in Perlmutter et al. (1995, 1997, 1999), the searches generally consisted of 2 to 3 nights of imaging to take reference images followed 3 to 4 weeks later by an additional 2 to 3 nights of imaging to take search images. Some of the searches were a variation on this theme. The Spring 2002 CFHT search, for example, was a "rolling" search where images were taken once every few nights during a two week period. This was followed one, two and three months later by similar observations on the same fields. In this way, the search images of one month become the reference images of a later month, and, since images of the search fields are taken several times in any one month, one automatically gets a photometric time series without having to schedule follow-up observations, as one must do in a classical search.

The data are processed to find objects that have brightened and the most promising candidates are given an internal SCP name and a priority. The candidates are then distributed to teams working at the Keck, Paranal, Gemini and Subaru Observatories for spectroscopic confirmation. The distribution is handled centrally and is done according to the priority of the candidates, the results of observations of previous nights, the capability and availability of the instruments and the telescopes at each of the observatories and the weather conditions at the individual observatories at any one time.

A preliminary analysis of the data is done within a day of when the data are taken and only those candidates that are securely confirmed as SN Ia are then followed during subsequent months. A more careful reduction of the spectroscopic data is done later and this is when the decision to assign an IAU name is made.

We are presenting the spectra of all candidates that were observed with the ESO VLT, so there are a number of candidates that have only the SCP name. The name consist of a prefix, which indicates from which telescope the SN was discovered, and a running number. A list of prefixes is give in Table 1. The spectra of candidates that were not observed at the ESO VLT will be reported elsewhere.

2.2. Spectroscopic follow-up

We used the long slit spectroscopic modes on FORS1 and FORS2 (Appenzeller et al. 1998) on the ESO VLT to observe candidates. For the purpose of long-slit spectroscopy, FORS1 and FORS2 are very similar instruments. The principle difference is that the detector in FORS1 is a single 2kx2k Tektronix CCD, while the detector in FORS2 is a mosaic of two 2kx4k red-optimized MIT CCDs. The FORS2 detector is more sensitive than the FORS1 detector, especially at red wavelengths. The availability of the red optimized CCDs in FORS2 in March 2002 made it possible to observe and confirm candidates that were thought to be at $z \sim 1.2$.

The dates during which the VLT spectroscopic observations took place and the redshift interval over which SN Ia were targeted are listed in Table 2.

Three grisms (300V, 300I and 600z) and two slit widths (0.7 and 1.0 arc seconds) were used for the observations. In general, the grism was chosen to match the expected redshift of the candidate and the slit was matched to the seeing. The grisms were used in cojunction with order sorting filters. The 300V grism was used with the GG435 filter and the 300I and 600z grisms was used with the OG590 filter.

Nearly all targets were acquired in the same way. The slit was placed through the candidate and a relatively bright offset star. The observational details are listed in Table 3. The candidates (marked with a cross) and the offset stars are shown in Figures 2 to 42. After the offset star was acquired and centered, the telescope was moved to the candidate. Since through slit images were taken before and the offset, we were able to verify that the candidate had been acquired correctly. There were only four exceptions: SuF02-026 and SuF02-012 were observed together and C00-008 and S01-035 were acquired directly.

Generally speaking, three exposures with small offsets along the slit were taken for each candidate. Exceptions occurred when we aborted the observations because we thought that we had sufficient data to identify the candidate or when we integrated longer for the fainter candidates.

Need to warn against statistical analysis if some of these candidates were confirmed at other telescopes. Otherwise the success rate looks pretty bad!

Campaign	Instrument and Telescope	Dates	Observing Mode	Redshift Interval
Spring 2000	FORS1 on Antu (VLT-UT1)	12 May 2000	Service	$z = 0.3 - 0.7$
Spring 2001	FORS1 on Antu (VLT-UT1)	21-22 April 2001	Visitor	$z = 0.3 - 0.7$
		27 April and 28 May 2001	Service	$z = 0.3 - 0.7$
Spring 2002	FORS2 on Yepun (VLT-UT4) and	April-August 2002	Service	$z = 0.3 - 1.2$
	FORS1 on Melipal (VLT-UT3)	11-12 May 2002	Service	$z = 0.3 - 1.0$
Fall 2002	FORS2 on Yepun (VLT-UT4)	7-11 November 2002	Service	$z = 0.8 - 1.2$

In addition to the 40 candidates that were observed soon after they were discovered, we include also the spectrum of the probable host galaxy of T02-047, which was observed many months after it was discovered. The light curve of this T02-047 indicates that it is probably a SN Ia (Knop et al. 2002).

3. Data reduction and classification

The data were processed in the standard way with IRAF. The bias was estimated by fitting the over-scan region with a low order polynomial, flat-fielding was done with lamp flats that were first cleaned of parasitic light, and wavelength calibration was done with arc frames.

For observations with with the 300V grism, fringing is not a significant limitation in the data so the two-dimensional spectra were combined (with suitable clipping to remove cosmic rays) and the sky was removed by estimating the flux on either side of the spectrum.

For observations with the 300I and 600z grisms, fringing is more significant, especially with FORS2. If it is not treated carefully, the systematic error from fringing residuals can be large. Before combining individual spectra, a fringe correction was applied to the data. The fringe correction consists of the following steps:

- Data are sorted with respect to the grism, the slit width, the date of observation and the location of the candidate in the two dimensional spectra.
- Fringe frames are created by clipping object pixels and averaging the remainder. Since the intensity of columns (the spatial direction of the spectra are along columns) can vary with respect to one another, each column is treated individually. Flexures for FORS1 and FORS2 are small, so some fringe frames were created from data that were taken on different nights.
- The fringe frames are subtracted from the data after suitable scaling. Again, each column is treated individually.
- An average sky spectrum (done by averaging along columns) is added back to the data. This helps with the clipping of cosmic rays when the two dimentional spectra are combined.
- The data is combined with suitable clipping for cosmic rays and the sky is removed by estimating the flux on either side of the spectrum.

The resulting two-dimensional sky-subtracted spectra are free of fringes at the expense of a slight reduction in the statistical signal-to-noise ratio.

The spectra of the candidates and, in some cases, the spectra of the hosts were then extracted and calibrated in wavelength and flux. In all cases, we also produce error spectra, which can be used to estimate the significance of spectral features.

The signal-to-noise ratio varies from very low ($\lesssim 1$ per wavelength element) to moderately good ($\gtrsim 10$ per wavelength element). Fortunately, the very broad features in the spectra of SN Ia allow us to rebin the data without significant loss of information.

The spectra with better signal-to-noise ratios are studied in more detail in Garavini et al. 2003.

3.1. Classification

At high redshifts ($z \gtrsim 0.4$), the Si II feature at ~ 6150Å, which is the defining signature of the class, is often outside the wavelength range covered by the spectra. Therefore, we use the spectroscopic criteria described in Hook et al. (2003) to identify SN Ia.

In those cases where the redshift of the host can be measured from emission or absorption lines, the redshift is reported to three decimal places. In those cases where host galaxy lines could not be detected, the redshift is determined from the SNe and is reported to two decimal places.

We also match the spectra of candidates with a library of nearby SN Ia spectra of mixed sub-types and ages to help in the classification process. If the redshift of the host galaxy was known, it is fixed.

Securely classified candidates are assigned the label "Ia" in Table 4. Possible candidates are labeled "Ia?". The question mark indicates some degree of uncertainty. This usually means that we see features that are consistent with the SN Ia classification but that other types, such as a SN Ic, cannot be excluded. A simple question marks indicates that the classification is unknown. For those candidates that have been classified as Ia or Ia?, a comparison spectrum is also plotted.

Some of the unclassified candidates show broad SN-like features. Candidates that fall in this class include 2001gl, 2002lc and SuF02-007. Comparison plots are produced for 2002lc and SuF02-007.

candidates have IAU names.

SCP Name	IAU Name	Campaign	Coordinates of the candidate	Offset Star	Offset	PA	MJD	Grism	Exp. (sec)
C00-008	2000fr	Spring 00	13 42 00.14 +04 43 42.4	-[1]	-[1]	40.00	51676.2	300V	7200
S01-004	2001gl	Spring 01	14 01 16.60 +05 12 48.9	Hex	-6.07, 0.16	92.41	52021.2	300V	3600
S01-005	2001gm	Spring 01	14 01 51.18 +05 05 38.5	Hex	23.92, 24.80	43.97	52021.3	300V	2400
S01-007[4]	2001go	Spring 01	14 02 00.95 +05 00 59.2	Hex	34.22, -4.46	97.42	52021.3	300V	2400
S01-007[4]	2001go	Spring 01	14 02 00.95 +05 00 59.2	Hex	34.22, -4.46	97.43	52027.2	300V	7200
S01-007[4]	2001go	Spring 01	14 02 00.95 +05 00 59.2	Hex	34.22, -4.46	97.43	52058.2	300V	9000
S01-017	2001gr	Spring 01	10 04 23.27 +07 40 48.3	Box	46.41, -3.13	22.19	52021.0	300V	3600
S01-028	2001gs	Spring 01	10 00 52.68 +06 07 09.3	Box	11.89,-25.79	-24.75	52022.1	300V	4800
S01-031	2001gu	Spring 01	10 03 28.61 +07 24 38.9	Hex	37.16, 3.32	84.89	52021.1	300V	4800
S01-033	2001gw	Spring 01	15 43 45.86 +07 57 50.3	Hex	-14.09, 32.22	156.37	52021.4	300V	1200
S01-035	-	Spring 01	14 43 48.29 +08 11 11.0	-[1]	-[1]	136.59	52021.4	300V	1200
S01-036	2001gy	Spring 01	13 57 04.54 +04 30 59.8	Hex	21.49, 0.43	88.85	52021.3	300V	2400
S01-037	-	Spring 01	13 55 51.17 +04 48 06.7	Hex	-56.87, 32.41	119.68	52021.1	300V	3600
S01-054	2001ha	Spring 01	10 06 33.50 +07 38 03.2	Hex	13.51, 22.72	30.74	52022.0	300V	3600
S01-065	2001hc	Spring 01	09 44 31.52 +08 02 02.8	Hex	-14.17, 46.46	-16.96	52022.1	300V	1800
S02-000	2002fd	Spring 02	14 03 54.08 +05 45 41.9	Box	-6.48, 2.62	112.01	52376.1	300V	600
S02-001	-	Spring 02	14 03 56.42 +05 23 16.6	Hex	-27.85, 39.10	144.54	52376.3	300I	2700
S02-002	2002fe	Spring 02	14 04 18.16 +05 19 25.6	B	-8.49, 1.52	100.15	52376.2	300I	2700
S02-025	-	Spring 02	13 57 50.11 +05 17 25.5	Hex	0.09, 14.94	0.34	52376.2	300I	2700
S02-075	2002fg	Spring 02	13 24 25.92 +27 44 33.9	Hex	57.74,-22.44	-68.76	52431.0	300V	7200
C02-016	2002fr	Spring 02	14 00 46.40 +04 33 41.4	Hex	-12.67 10.57	145.65	52400.0	300V	900
C02-028	2002fm	Spring 02	14 00 29.75 +04 46 50.1	B	-27.76, 21.91	128.28	52413.0	300V	1800
C02-030	2002fp	Spring 02	14 02 18.40 +04 47 05.9	Hex	1.69,-21.86	-4.43	52407.1	300I	3600
C02-031	-	Spring 02	14 01 38.07 +04 38 02.2	Box	0.88, 38.36	178.69	52406.1	300I	3600
C02-034	-	Spring 02	14 00 30.75 +05 13 55.6	Hex	-62.66, 35.50	-14.34	52413.0	300V	1800
T02-015	2002gi	Spring 02	13 57 12.25 +04 33 16.8	Hex	1.17,-68.78	-0.97	52407.2	300I	7200
T02-028	2002gj	Spring 02	15 36 25.48 +09 28 18.2	Hex	-40.55, 62.58	147.06	52413.2	300V	3000
T02-029	2002gk	Spring 02	15 37 07.47 +09 36 18.7	C	-20.24, 16.98	129.99	52413.3	300V	900
T02-030	2002gl	Spring 02	15 43 24.40 +07 53 57.5	Hex	2.32, 43.98	-176.98	52413.1	300V	3000
T02-047[3]	-	Spring 02	15 36 29.88 +09 38 42.8	Hex	42.94,-29.25	55.74	52494.0	300V	3000
SuF02-002	2002kq	Fall 02	02 17 12.24 -04 55 08.7	Hex	-21.25, -4.06	79.18	52586.1	300I	3600
SuF02-005	-	Fall 02	02 18 35.67 -04 31 11.2	A	18.26, 0.06	-90.19	52586.1	300I	3600
SuF02-007	-	Fall 02	02 18 52.32 -05 01 14.0	Hex	6.63,-40.66	-9.26	52588.7	300I	13200
SuF02-012	2002lc	Fall 02	02 18 51.60 -04 47 25.7	Hex[2]	-19.04, 14.75	8.81	52588.3	600z	7200
SuF02-017	2002kn	Fall 02	02 16 45.71 -05 09 51.2	Hex	-48.24, -0.53	89.37	52590.2	300I	1800
SuF02-025	2002km	Fall 02	02 16 23.93 -04 49 29.4	Box	-7.30, 5.14	125.15	52588.1	300I	3600
SuF02-026	-	Fall 02	02 18 51.90 -04 46 57.4	Hex[2]	-19.04, 14.75	8.81	52588.3	600z	7200
SuF02-028	-	Fall 02	02 16 56.36 -05 00 58.1	Hex	26.08,-47.36	-28.84	52587.1	300I	3600
SuF02-051	-	Fall 02	02 17 27.47 -04 49 45.3	C	-11.62, -2.10	79.76	52586.3	300I	3600
SuF02-060	2002kr	Fall 02	02 17 34.51 -04 53 46.6	A	19.82,-17.49	-48.75	52587.2	300I	3600
SuF02-065	2002ks	Fall 02	02 17 34.53 -05 00 15.4	A	-28.15,-23.05	50.69	52586.2	300I	3600
SuF02-081	-	Fall 02	02 20 07.49 -05 08 27.4	A	51.24,-20.89	-67.82	52589.2	300I	9600
SuF02-083	-	Fall 02	02 18 06.21 -05 00 38.8	Box	-35.39, 1.64	92.65	52587.1	300I	7200

[1] Centered on the candidate.
[2] The slit passed through SuF02-012 and SuF02-026
[3] The spectra were taken many months after maximum light
[4] SN 2001go was observed at three epochs

4. Results

The results of the four campaigns are summarized in Table 4 and the spectra of all candidates are plotted in Figs. 2 to 42. In some cases, we have compensated for telluric absorption by dividing the spectra with a suitably scaled spectrum of the telluric absorption on Paranal. Spectroscopic features from the host galaxy are marked where appropriate.

In the comparison plots, nearby SNe are shown in blue, while the observations minus the host galaxy template are shown in black. In most cases, the observations have been rebinned to 20Å.

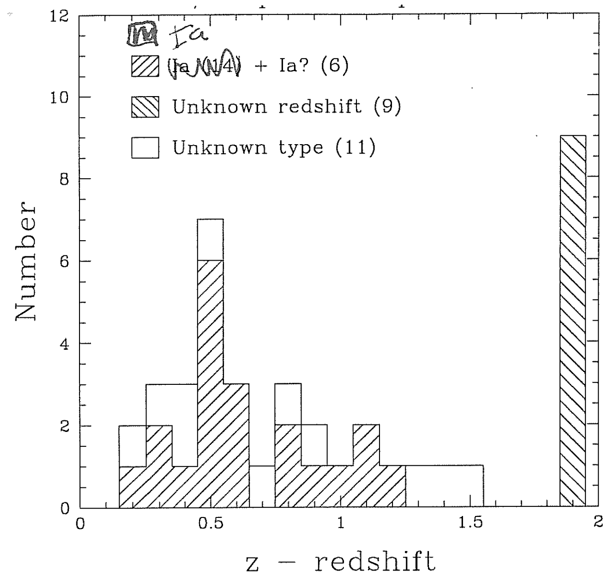

Fig. 1. Histogram of classifed and unclassifed candidates.

The results[1] are summarized as follows:

- 40 candidates were observed
- 20 candidates have been spectroscopically identified as either Ia or Ia?.
- 14 candidates have been securely classified as SN Ia.
- 11 candidates have redshifts from the probable host galaxy but do not show clear SNe features.
- 9 candidates have niether an identification nor a redshift

The histogram of the number of classified and unclassified candidates as a function of redshift is shown in Figure 1.

In terms of securely classifying SNe Ia, there is a clear correlation between the success of a search and the redshift at which SNe Ia were targeted. In searches 1, 2, 3 and 5, (See Table. 1), where SNe Ia at $z \sim 0.5$ were targeted for VLT spectroscopic follow-up, 11 out of 17 candidates (excluding T02-049) are securely classified and another 2 are considered possible. In searches 6, 7 and 8, where SNe Ia at $z \sim 1$ were targeted for VLT spectroscopic follow-up, 3 out of 18 candidates are securely classified and another 4 are considered possible.

There is also a correspondence between the selection criteria that are used to select candidates and the percentage of candidates that are identified as SNe Ia. In the rolling search with the CFHT, none of the 5 candidates could be spectroscopically confirmed as SN Ia. For comparison, in the Spring 2002 search with CTIO, all 4 candidates (excluding T02-049) were confirmed as SN Ia. Although the numbers are small, they are significant. The search area and candidate selection criteria of the rolling search were such that the search was probably detecting relatively fainter supernovae (type II or SN 1991bg like

[1] T02-047 is not considered

of the candidates are dominated by the light of the host galaxy.

4.1. Notes on individual supernova

We remark on some candidates that are noteworthy. Candidates are labeled with either their IAU names or the internal SCP names if no IAU name has been assigned.

SN 2000fr A secure SN Ia at $z = 0.543$. SN 2000fr was first identified as a SN Ia in a very early spectrum that was taken with LRIS on the KeckII telescope on May 4th and was subsequently observed again with FORS1. The FORS1 spectrum has the highest S/N ratio of all securely identified supernovae in this paper. SN 2000fr was followed in the J-band with ISAAC (Noboli et al. 2003) and in the R- and I-bands with HST and ground-based telescopes (Knop et al. 2003). The J-band observations, which corresponds to the rest-frame I-band, show a clear second maximum about 30 days after the first maximum. A spectrum of the host galaxy shows emission in [OII] and [OIII] as well as Balmer absorption lines and can fitted with the spectral energy distribution of a Sd galaxy.

SN 2001gl Unknown. This candidate shows significant broad features; however, a secure match was not possible. A poor match can be obtained with a SN Ia at z=0.84.

SN 2001gm A secure SN Ia at $z = 0.478$. A separate spectrum of the host shows weak [OII] emission.

SN 2001go A secure SN Ia at $z = 0.552$. SN 2001go was observed at three epochs. The intial confirmation spectrum was taken on May 21st, 2001 and additional deeper spectra were taken 6 and 37 days later.

SN 2001gu A possible SN Ia at $z = 0.76$. There is probably significant host galaxy contamination; however, a reliable redshift from the host was not possible.

SN 2001gw A secure SN Ia at $z = 0.363$. Clear SiII at 6150 Å, and 4000Å. A spectrum of the host shows weak [OII] emission.

S01-035 Unknown. A very bright candidate ($R \sim 18$) that was observed during a period of very poor seeing. Normally, such a candidate would not have been targeted, because it is 2 to 3 magnitudes brighter than the expected magnitude of a SN Ia at $z = 0.3$. The spectrum is blue and almost featureless. There is a clear absorption line at 4861.4Å which may be H_β and a less clear absorption line near the cutoff of the order sorting filter which may be H_γ. This suggests that this candidate is in the galaxy.

S01-037 Featureless blue spectra. The flux of this source increased by a factor of 2.

SN 2001ha A secure SN Ia at $z = 0.58$. Clear SiII at 4000Å. No spectral features from the host.

SN 2001hc A secure SN Ia at $z = 0.35$. Clear SiII at 6150 Å, SII "W" feature at 5500 Å, and SiII at 4000Å. No spectral features from the host.

S02-001, SuF02-081 and SuF02-083. Single strong line and a featureless continuum. Given the width and

Redshift based on the SN are quoted to two.

SCP Name	IAU Name	SN Class	Redshift	Template Match	Comments
C00-008	2000fr	Ia	0.543	1990N -7 days	
S01-004[2]	2001gl	? *	?		Broad features
S01-005[2]	2001gm	Ia	0.478	1992A +5 days	
S01-007[2]	2001go	Ia	0.552	1992A +5 days	
S01-017	2001gr	Ia	0.540	1996X +2 days	
S01-028	2001gs	? *	0.658		
S01-031	2001gu	Ia?	0.76?	1989B -5 days	
S01-033	2001gw	Ia	0.363	1989B -1 day	
S01-035	-	?	?		Galactic?
S01-036	2001gy	Ia	0.511	1990N -7 days	
S01-037	-	?	?		Featureless and blue.
S01-054	2001ha	Ia	0.58	1981B Max.	
S01-065	2001hc	Ia	0.35	1981B Max.	
S02-000	2002fd	Ia	0.279	1990N -7days	
S02-001	-	?	1.424		
S02-002	2002fe	Ia?	1.086	1999ee -8 days	
S02-025	-	?	?		
S02-075	2002fg	Ia?	0.80?	1981B Max.	
C02-016	2002fr	? *	0.303?		Blue spectrum
C02-028	2002fm	? *	0.448		
C02-030	2002fp	? *	0.352		
C02-031	-	?	0.541		
C02-034	-	?	0.243		
T02-015	2002gi	Ia	0.912	1996X +2 days	
T02-028	2002gj	Ia?	0.45	1992A +9 days	
T02-029	2002gk	Ia	0.212	1992A +6 days	
T02-030	2002gl	Ia	0.510	1989B -5 days	
T02-047[1]	-	?	0.489		
SuF02-002	2002kq	? *	0.823		
SuF02-005	-	?	0.863		
SuF02-007	-	?	1.16?	1981B Max.	Broad features
SuF02-012	2002lc	? *	1.3?	1999aa -3 days	Broad features
SuF02-017	2002kn	Ia?	1.03	1999bm +3 days	
SuF02-025	2002km	Ia	0.606	1990N -7 days	
SuF02-026	-	?	?		2 unidentified lines
SuF02-028	-	?	0.347		
SuF02-051	-	?	?		
SuF02-060	2002kr	Ia?	1.063	1981B Max.	
SuF02-065	2002ks	Ia	1.181	1981B Max.	
SuF02-081	-	?	1.478		
SuF02-083	-	?	1.272		

[1] The spectrum was taken 1 month after discovery.
[2] These candidates were discovered at the CFHT. The remainder of the candidates with the prefix "S01" were discovered at CTIO.

	CTIO	CFHT	Sub
?	5+1	4	9
Ia?	4	0	2
Ia	9	3	2

* 7 cases w/ IAU name and no spectroscopic basis for SN

shape of the line and the lack of other lines in the wavelength range covered by the spectrum, the line is identified as [OII].

SN 2002gi A secure SN Ia at z=0.912. This SN Ia has the highest redshift of all securely classified SN Ia that were observed with FORS1

SuF02-007 and SuF02-012 Both unknown. The binned spectra show broad SN Ia like features. The spectrum of SuF02-12 is consistent with a SN Ia at $z = 1.3$, however the signal-to-noise ratio is too small for a positive identification.

SuF02-026 Unknown. This candidate has two unidentified emission lines. The line profile and spatial morphology of the lines are very different. The blue line is unresolved while the redder line is resolved (both spatially and kinematically) into three components.

→ have we re-examined Ne? I thought I had proposed a match that worked.

SN 2002ks A secure SN Ia at z=1.181. This SN Ia has the highest redshift of all securely classified SN Ia that were observed with the ESO VLT.

We have presented VLT FORS1 and FORS2 spectra of 40 candidate high-redshift supernovae that were discovered as part of a program to discover Type Ia supernovae (SNe Ia) over a wide range of redshifts. By comparing these spectra with the spectra of nearby SNe Ia, 14 candidates have been identified as SN Ia with redshifts ranging from $z = 0.212$ to $z = 1.181$ and an additional 6 candidates have been identified as possible SN Ia with redshifts ranging from $z = 0.44$ to $z = 1.086$. Of the remaining 20 candidates, 11 have redshifts ranging from $z = 0.243$ to $z = 1.478$, and 9 have neither redshifts nor secure classifications.

Acknowledgements. This work would not have been possible without the dedicated efforts of the daytime and nighttime support staff at the ESO Paranal Observatory. We would also like to thank ECT* (European Centre for Theoretical Studies in Nuclear Physics and Related Areas) for the support they provided during the preparation of this paper.

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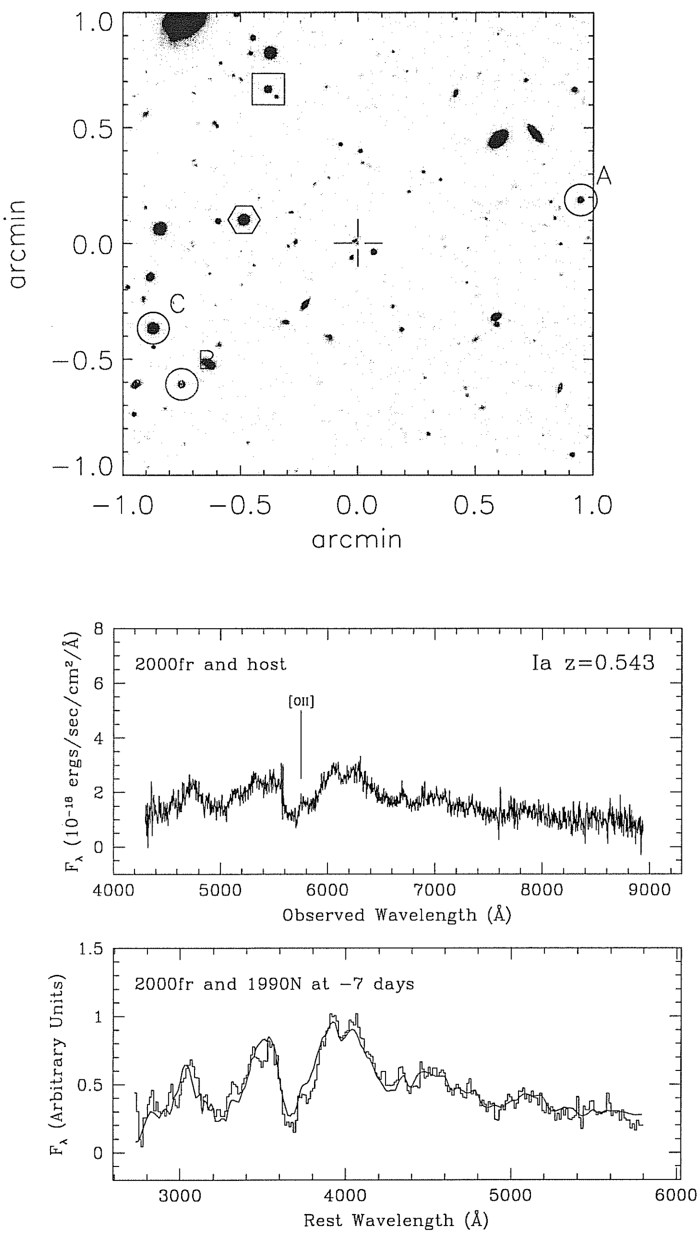
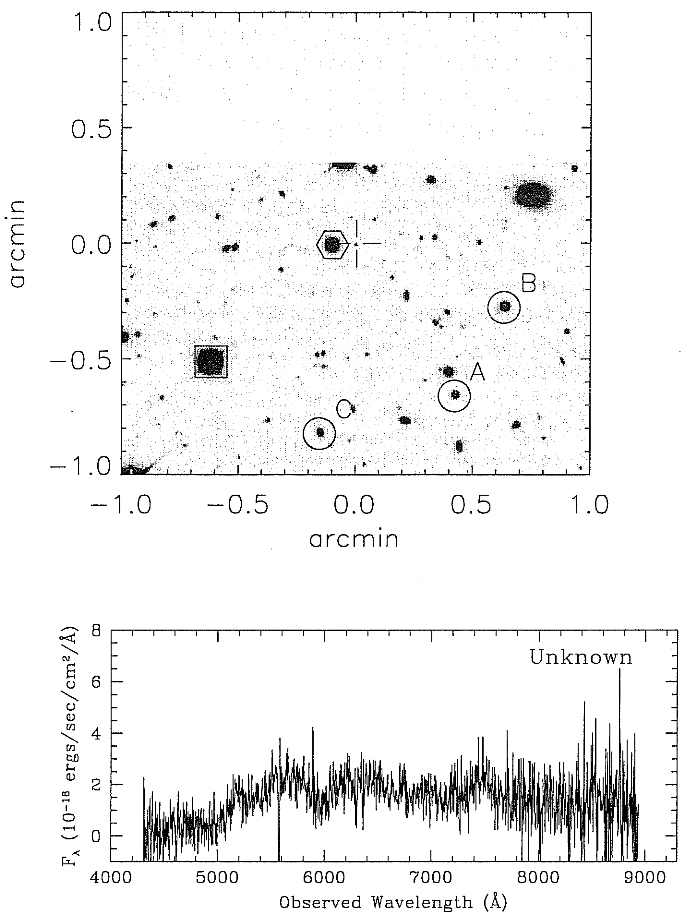


Fig. 2. Finding chart and spectrum of SN 2000fr (C00-008).



Clearly this is something interesting; Ic?

Fig. 3. Finding chart and spectrum of SN 2001gl (S01-004).

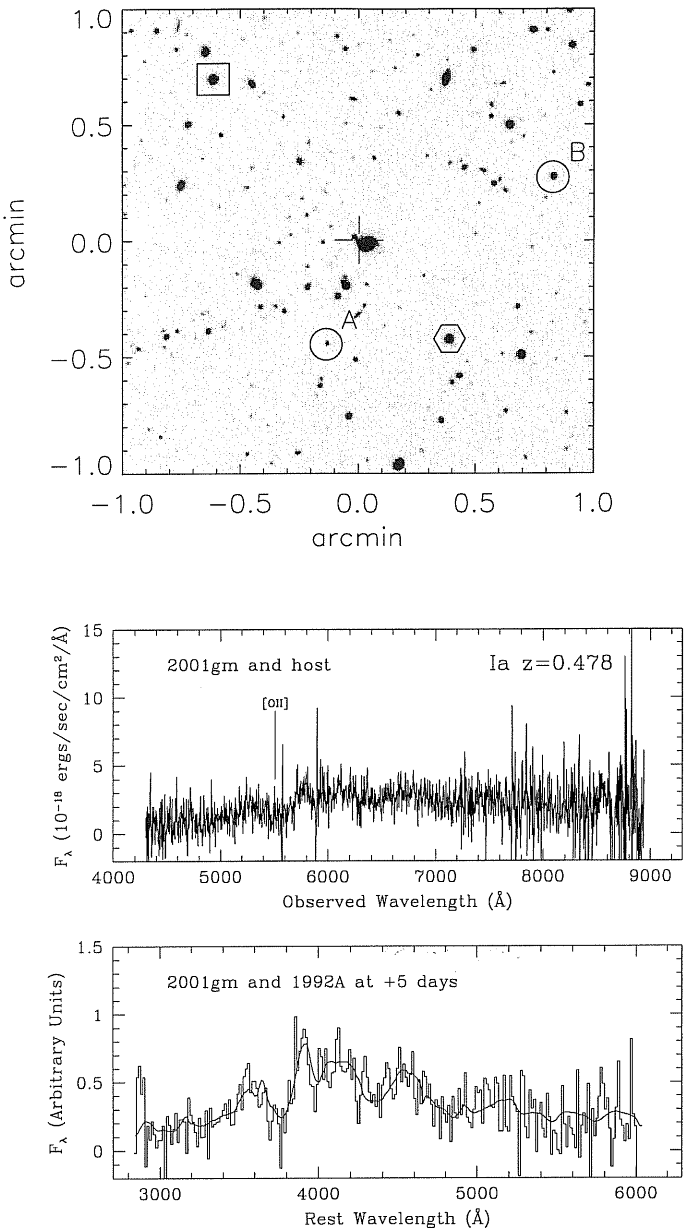


Fig. 4. Finding chart and spectrum of SN 2001gm (S01-005).

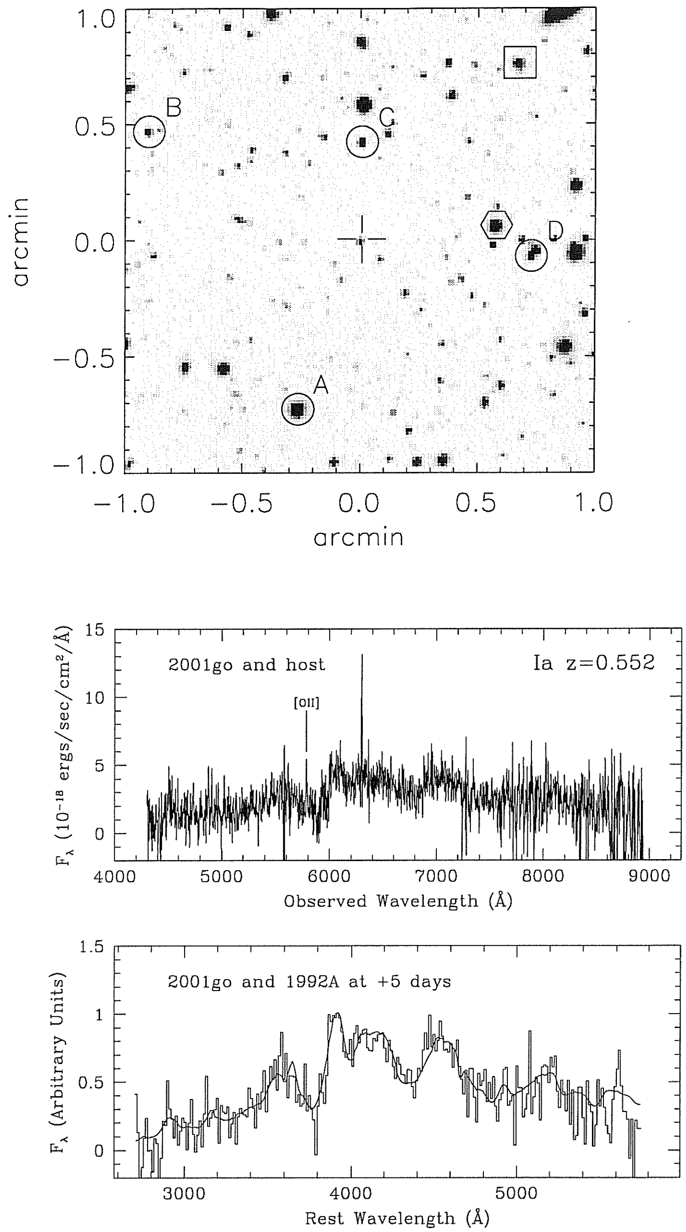


Fig. 5. Finding chart and spectrum of SN 2001go (S01-007).

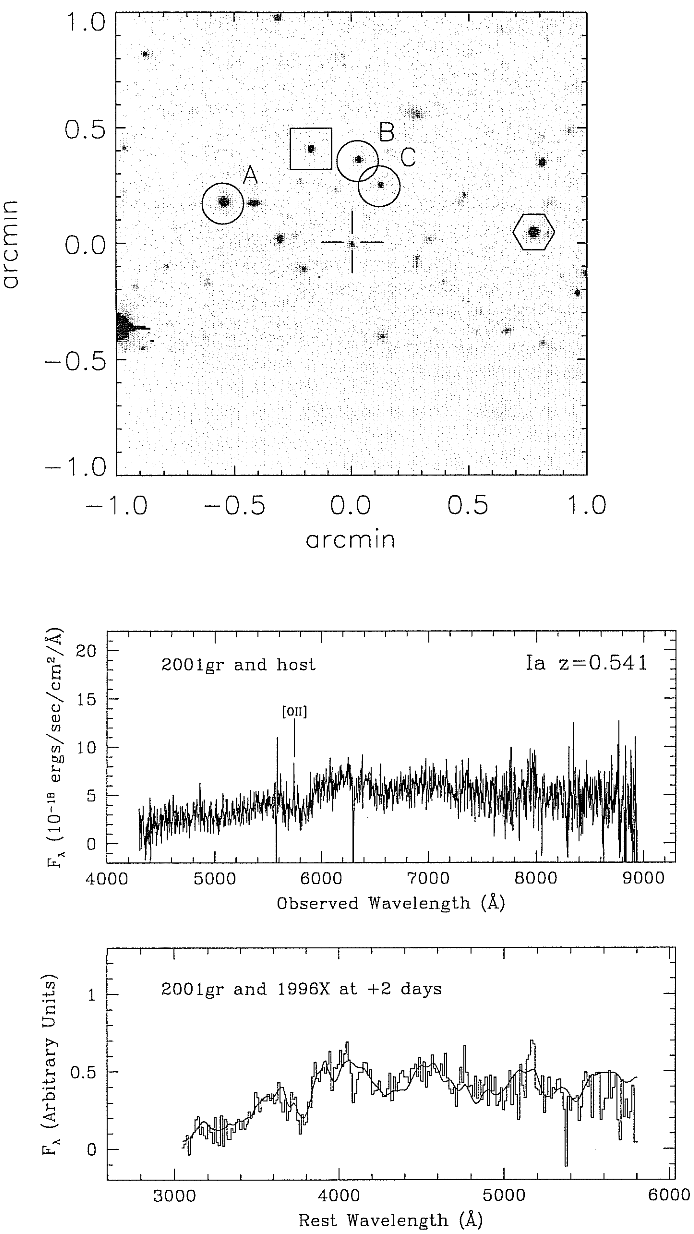
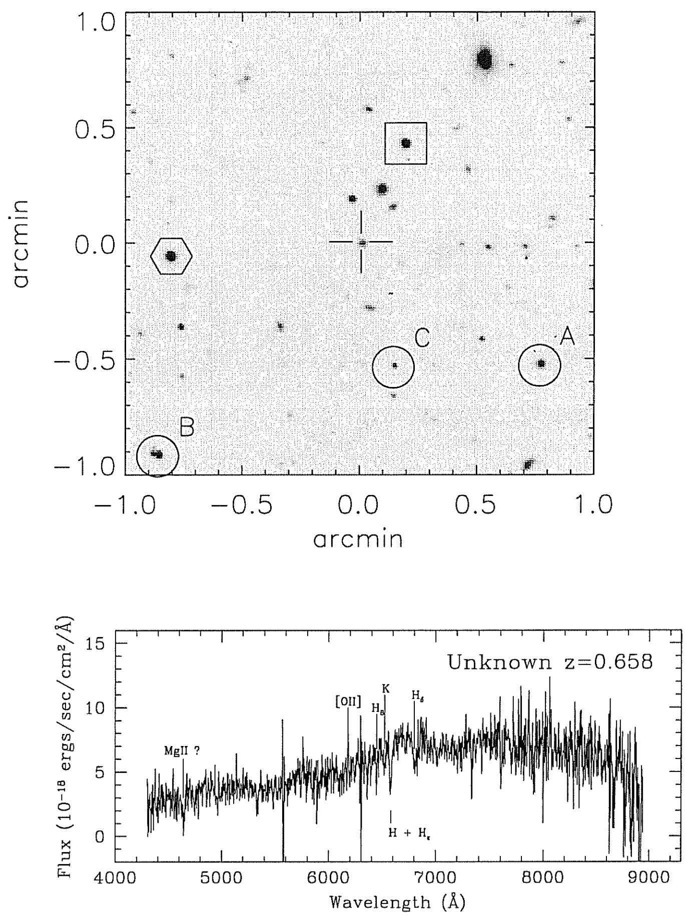


Fig. 6. Finding chart and spectrum of SN 2001gr (S01-017).



E+A galaxy?

Fig. 7. Finding chart and spectrum of SN 2001gs (S01-028).

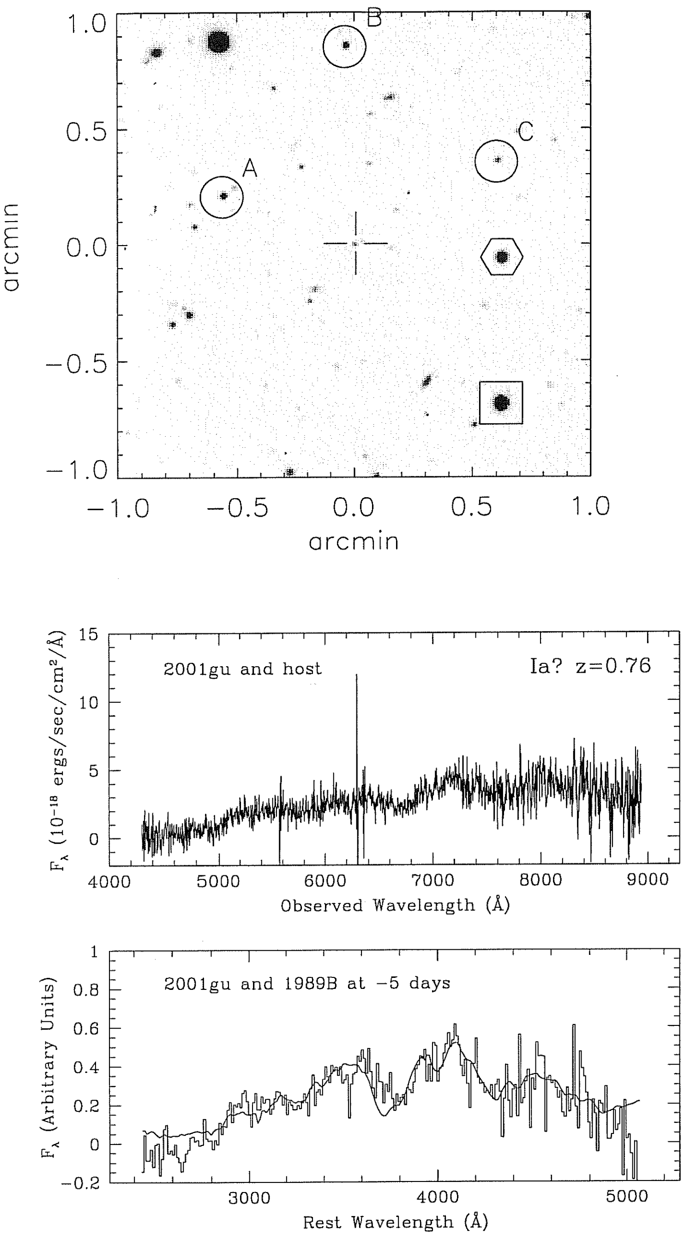


Fig. 8. Finding chart and spectrum of SN 2001gu (S01-031).

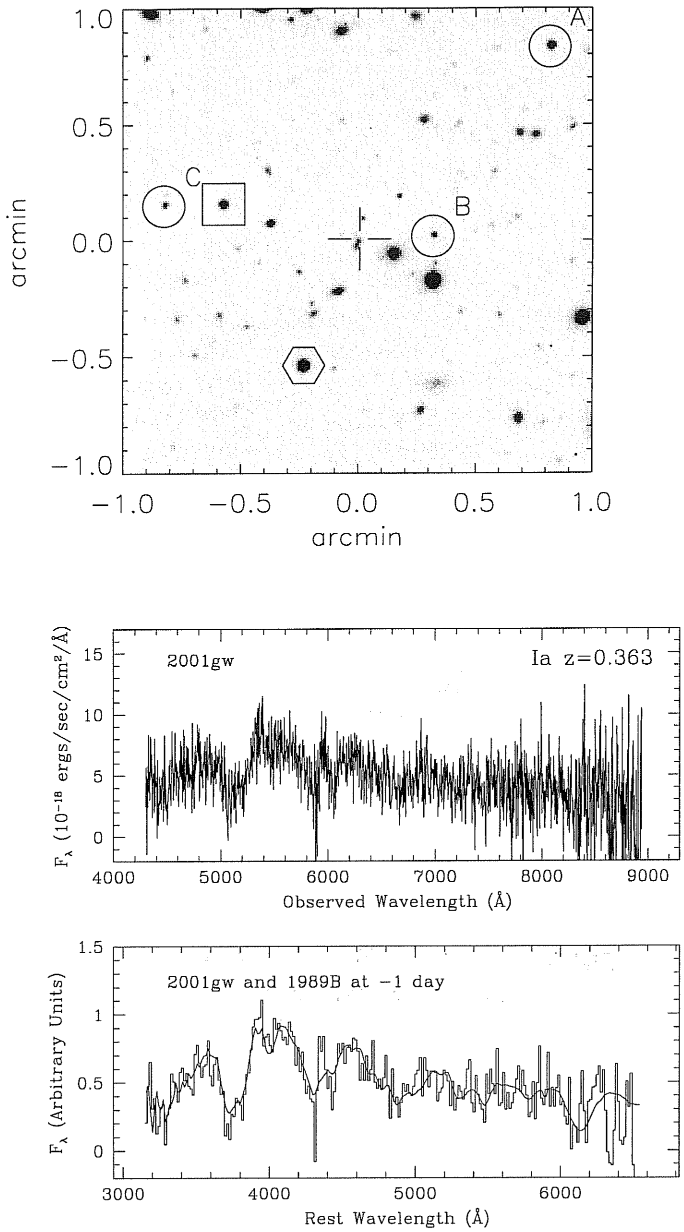
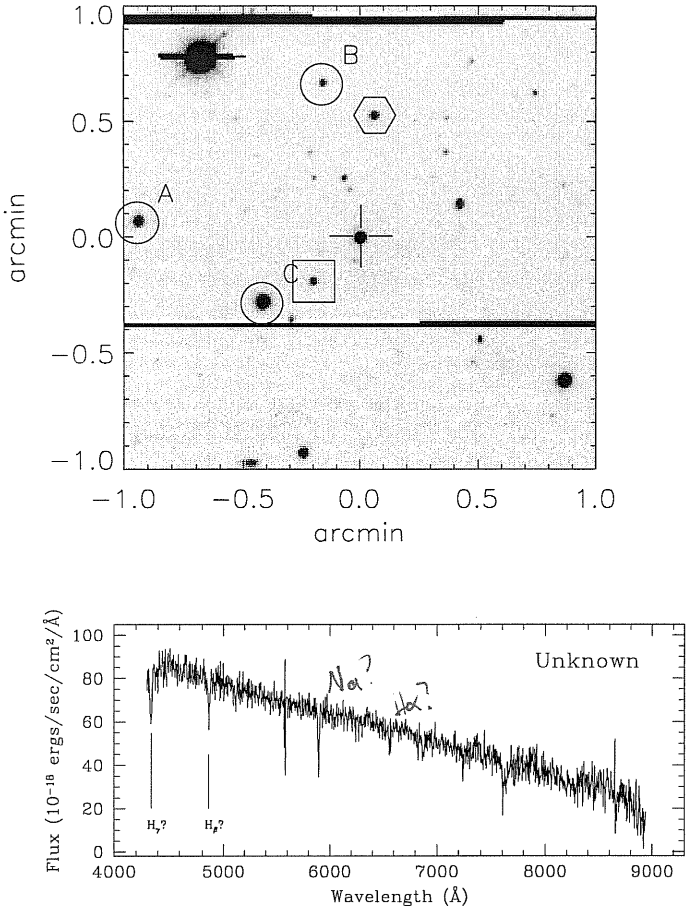


Fig. 9. Finding chart and spectrum of SN 2001gw (S01-033).



should x-correlate w/ star
check If on-core

Fig. 10. Finding chart and spectrum of S01-035.

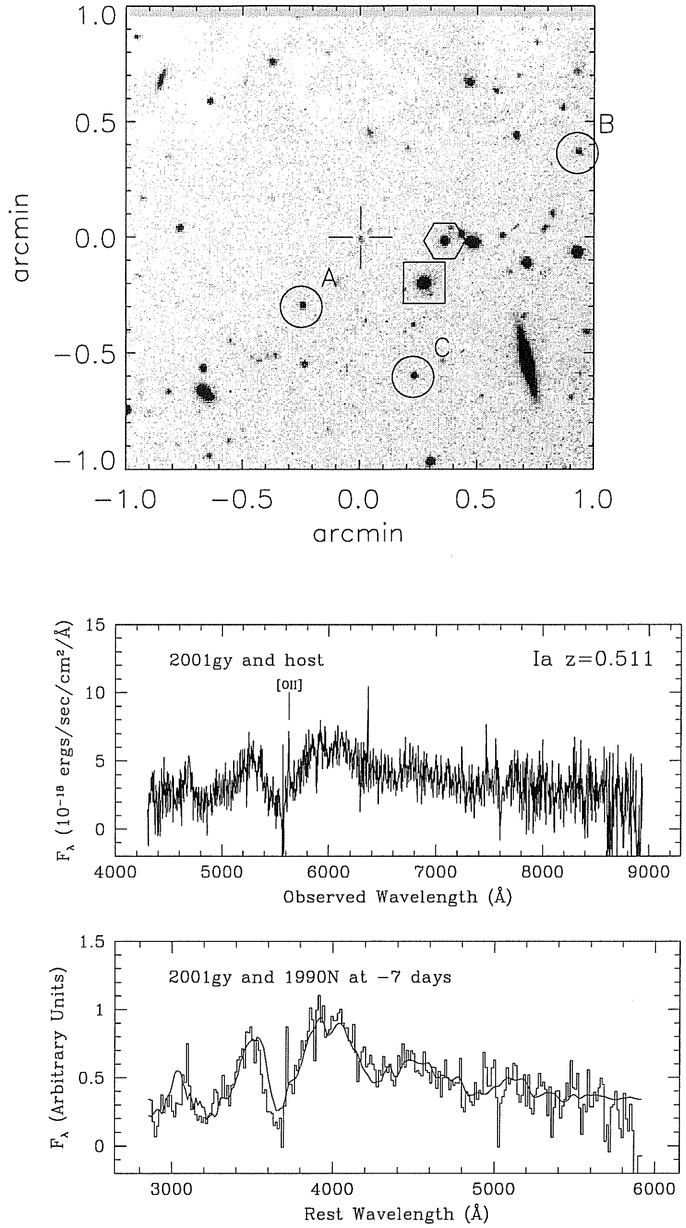


Fig. 11. Finding chart and spectrum of SN 2001gy (S01-036).

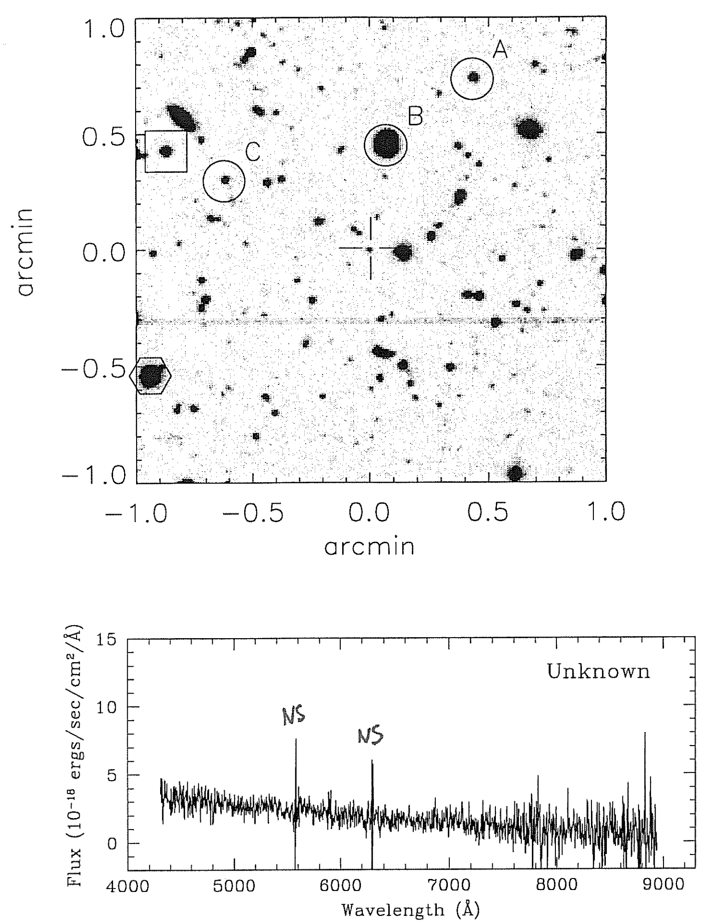


Fig. 12. Finding chart and spectrum of S01-037.

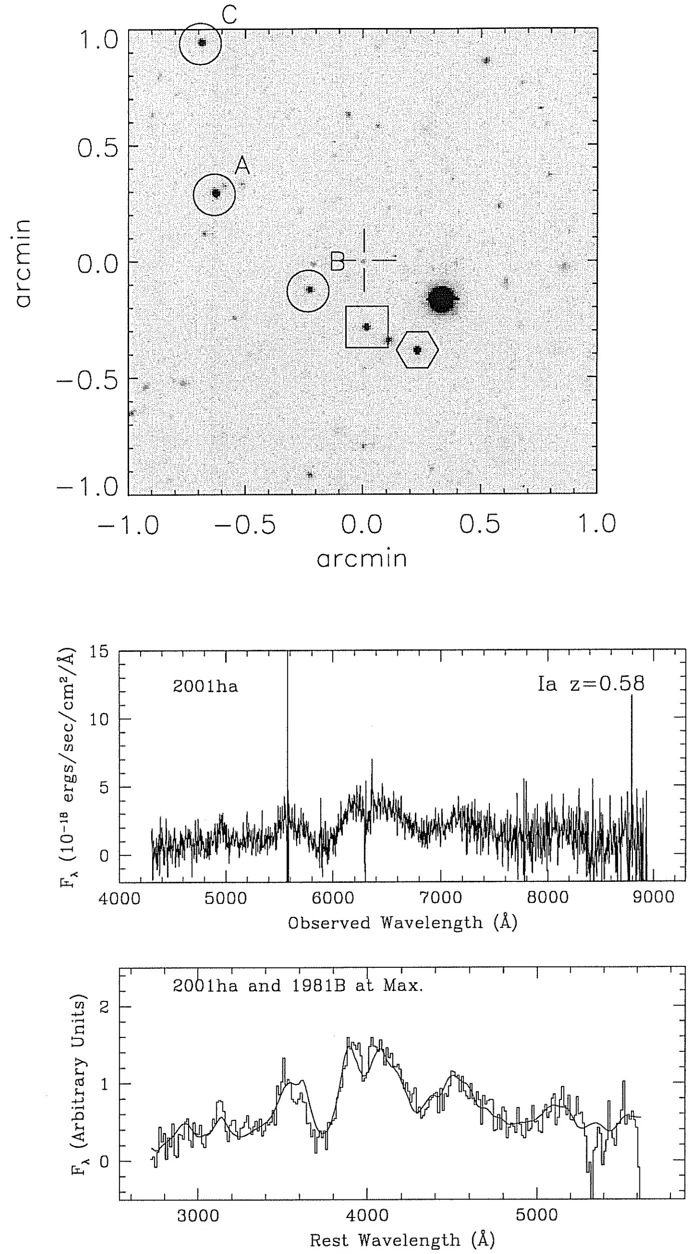


Fig. 13. Finding chart and spectrum of SN 2001ha (S01-054).

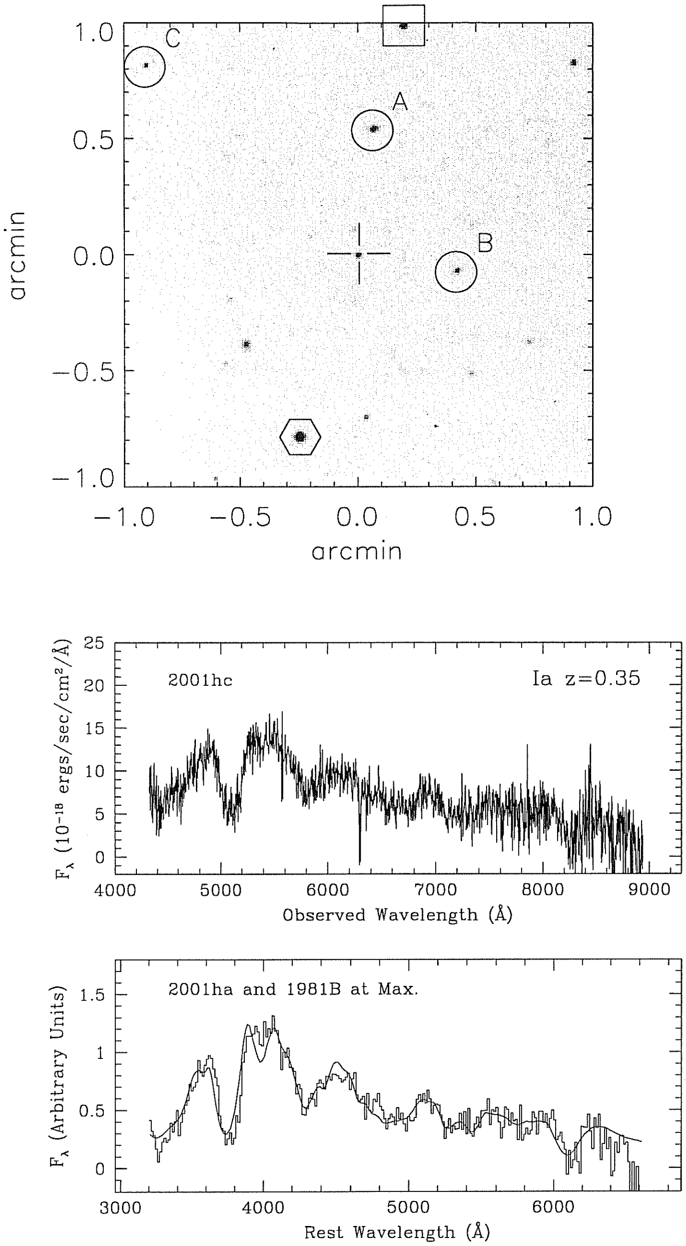


Fig. 14. Finding chart and spectrum of SN 2001hc S01-065.

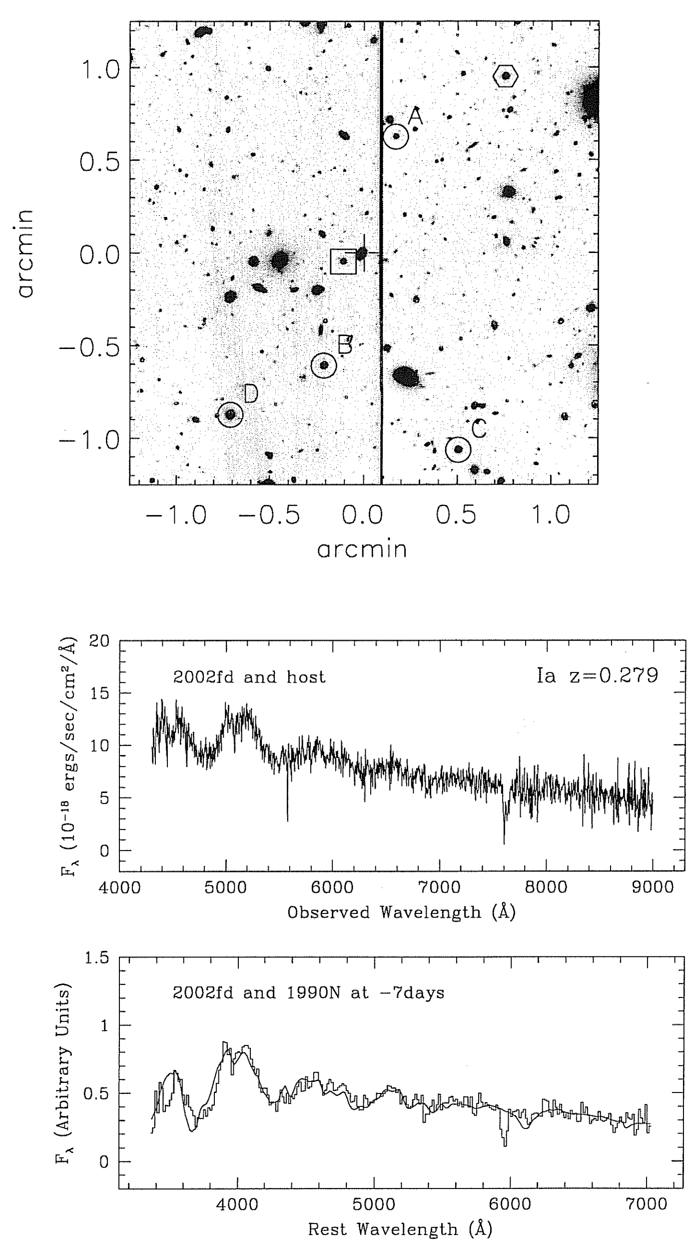


Fig. 15. Finding chart and spectrum of SN 2002fd (S02-000).

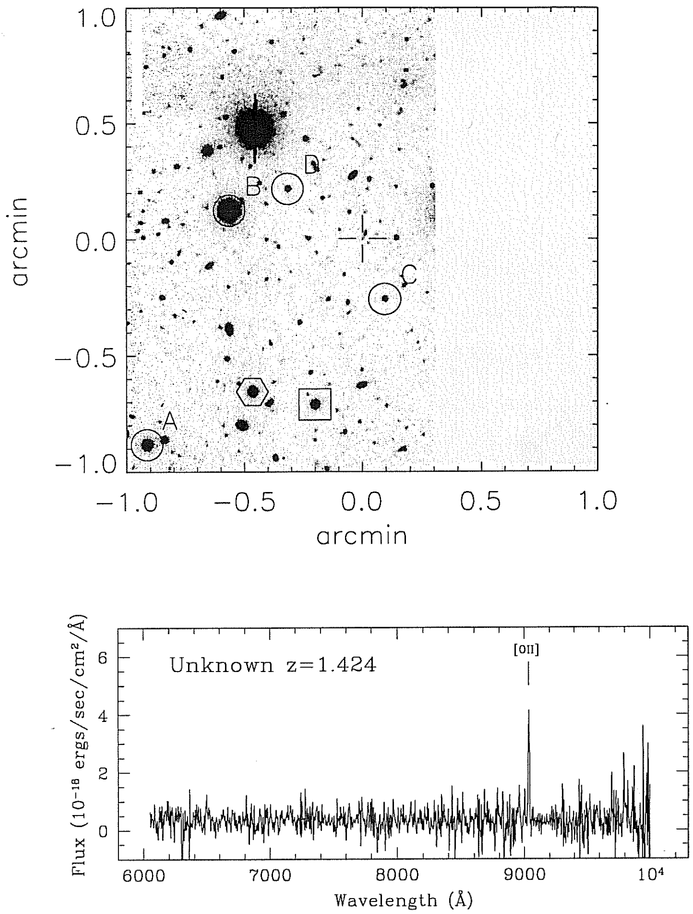


Fig. 16. Finding chart and spectrum of S02-001. This candidate could not be classified.

can Ia be rejected – it appears so

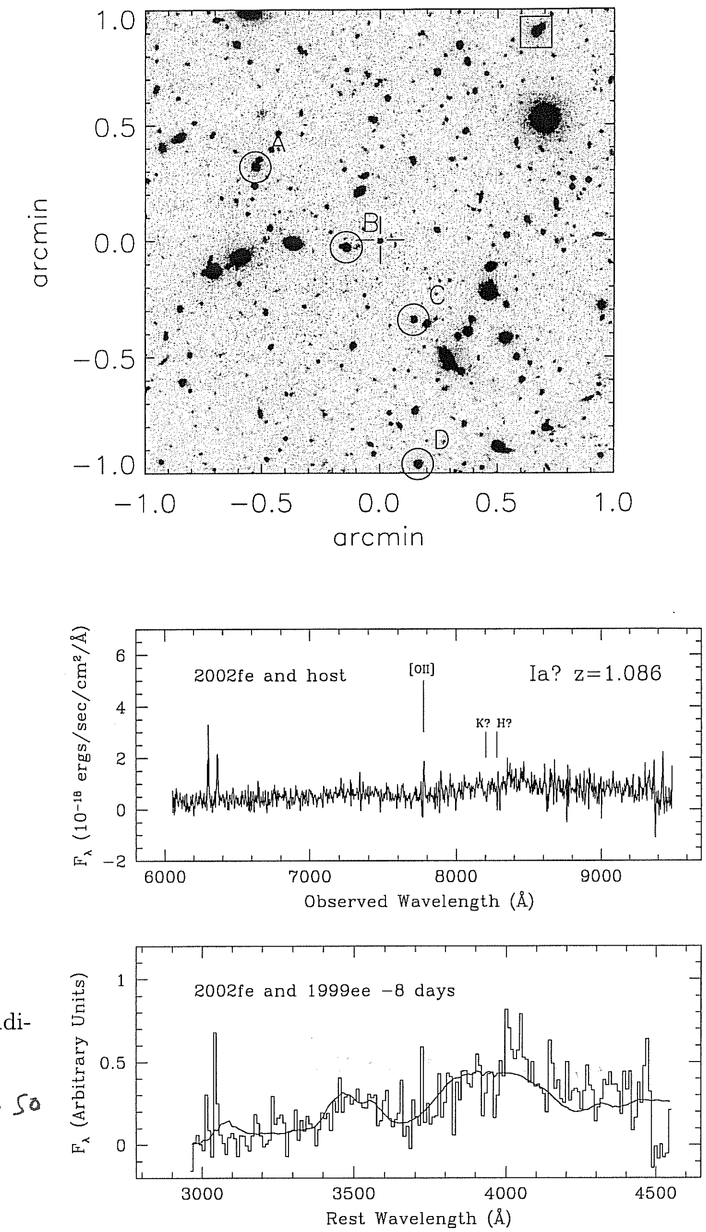


Fig. 17. Finding chart and spectrum of SN 2002fe (S02-002).

revisit line pair

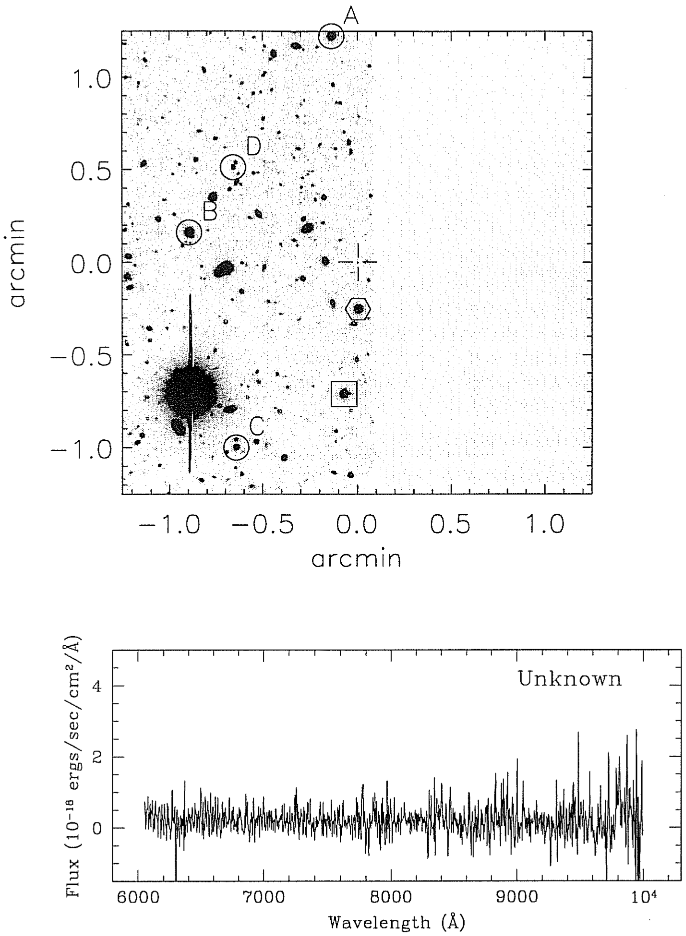


Fig. 18. Finding chart and spectrum of S02-025.

can Ia be ruled out?

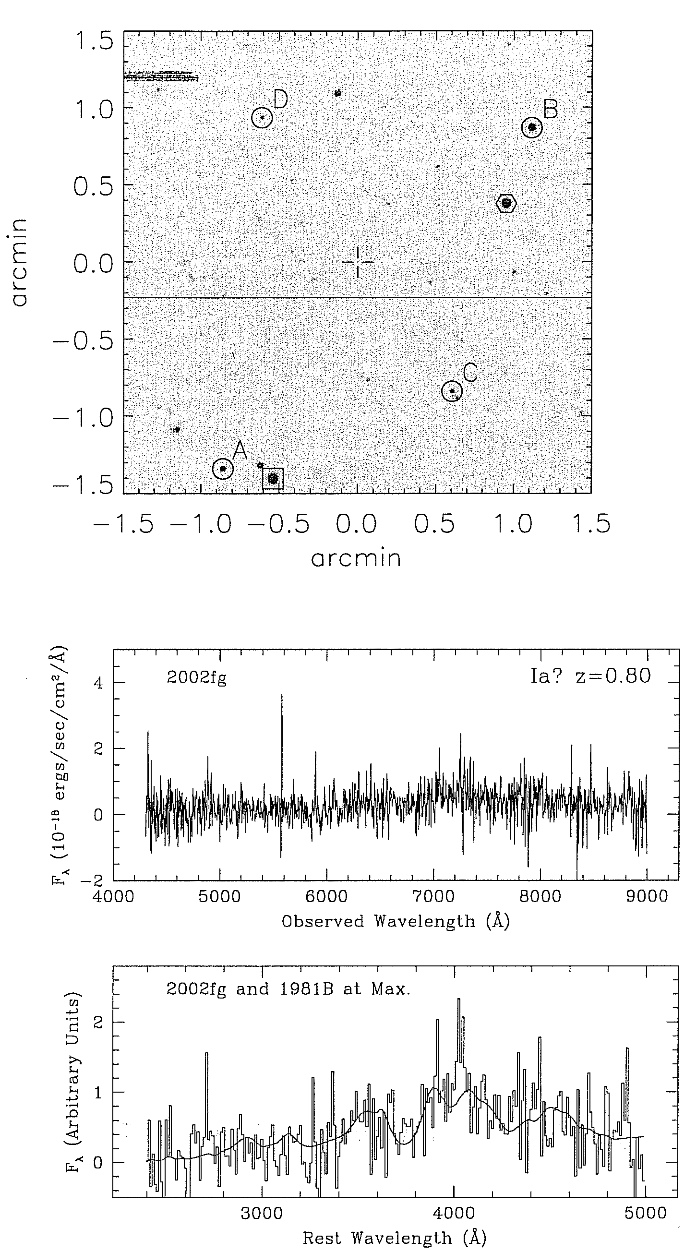


Fig. 19. Finding chart and spectrum of SN 2002fg (S02-075).

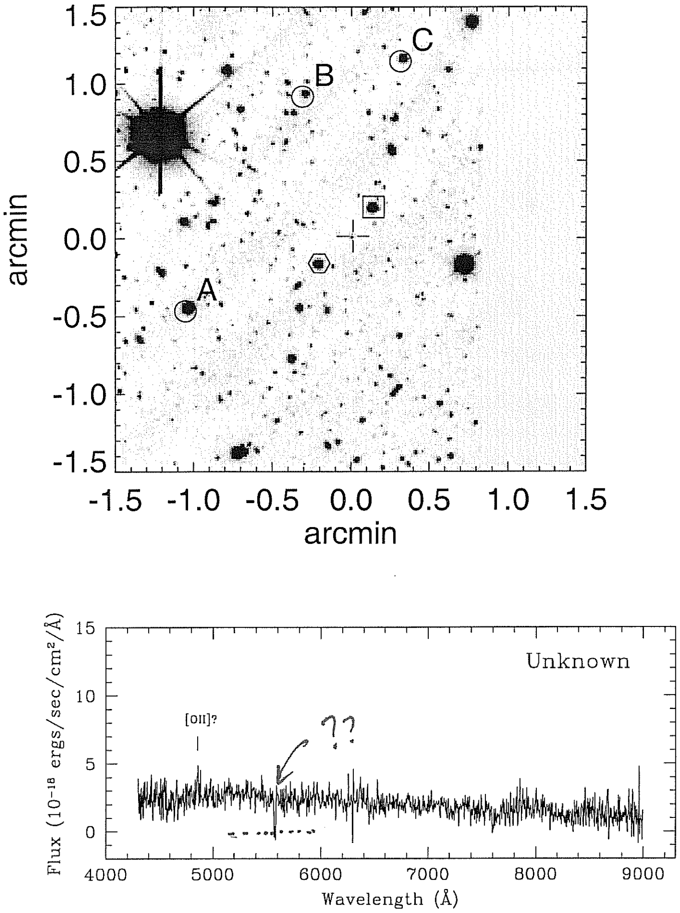


Fig. 20. Finding chart and spectrum of C02-016.

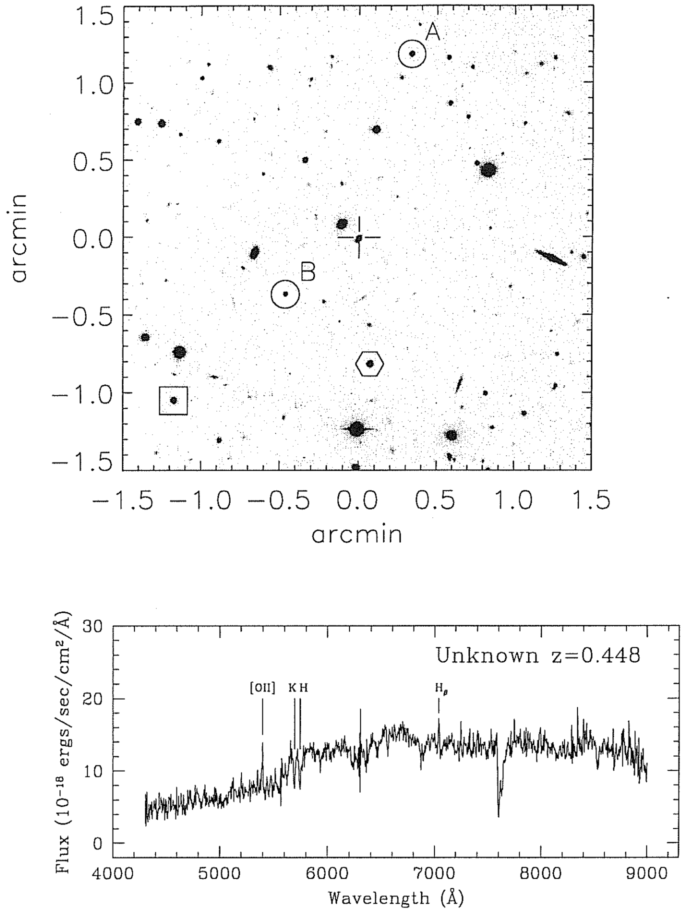


Fig. 21. Finding chart and spectrum of C02-028.

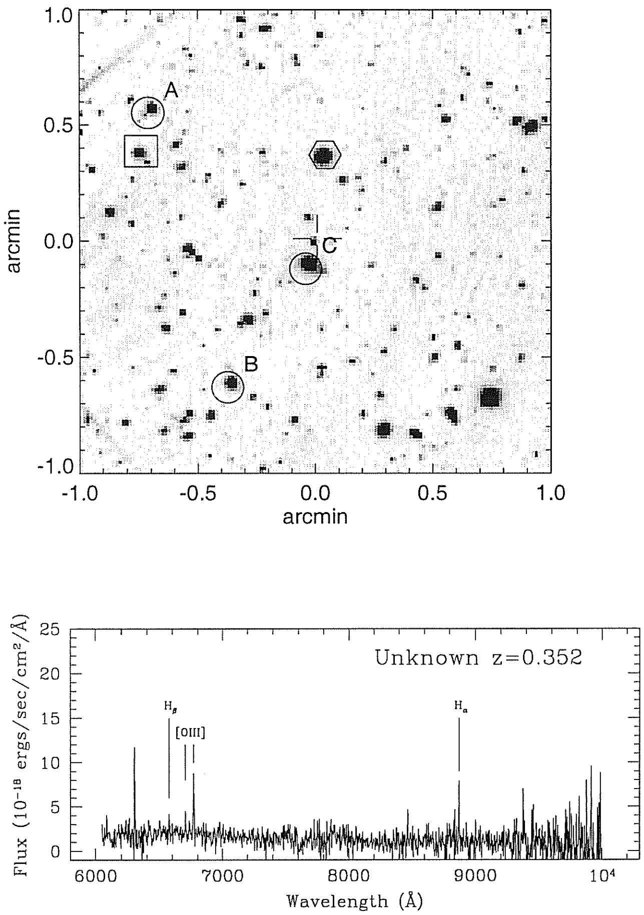


Fig. 22. Finding chart and spectrum of C02-030.

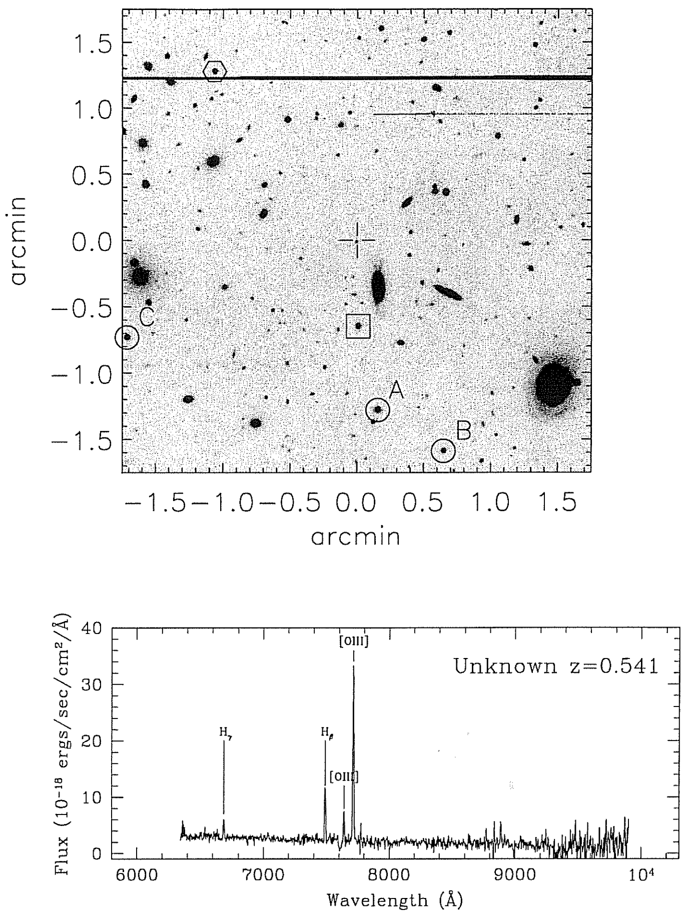


Fig. 23. Finding chart and spectrum of C02-031.

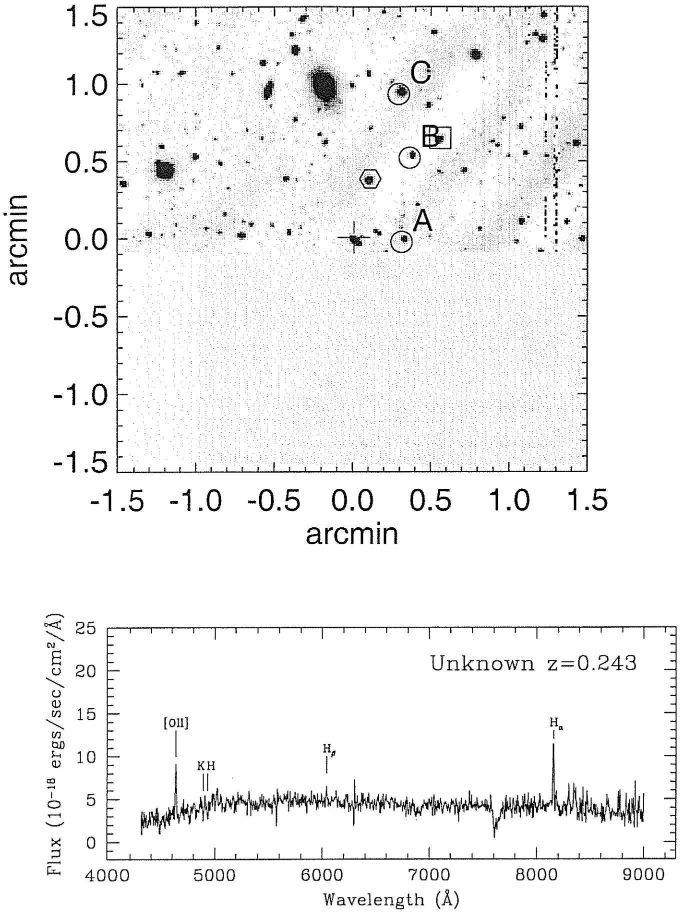


Fig. 24. Finding chart and spectrum of C02-034.

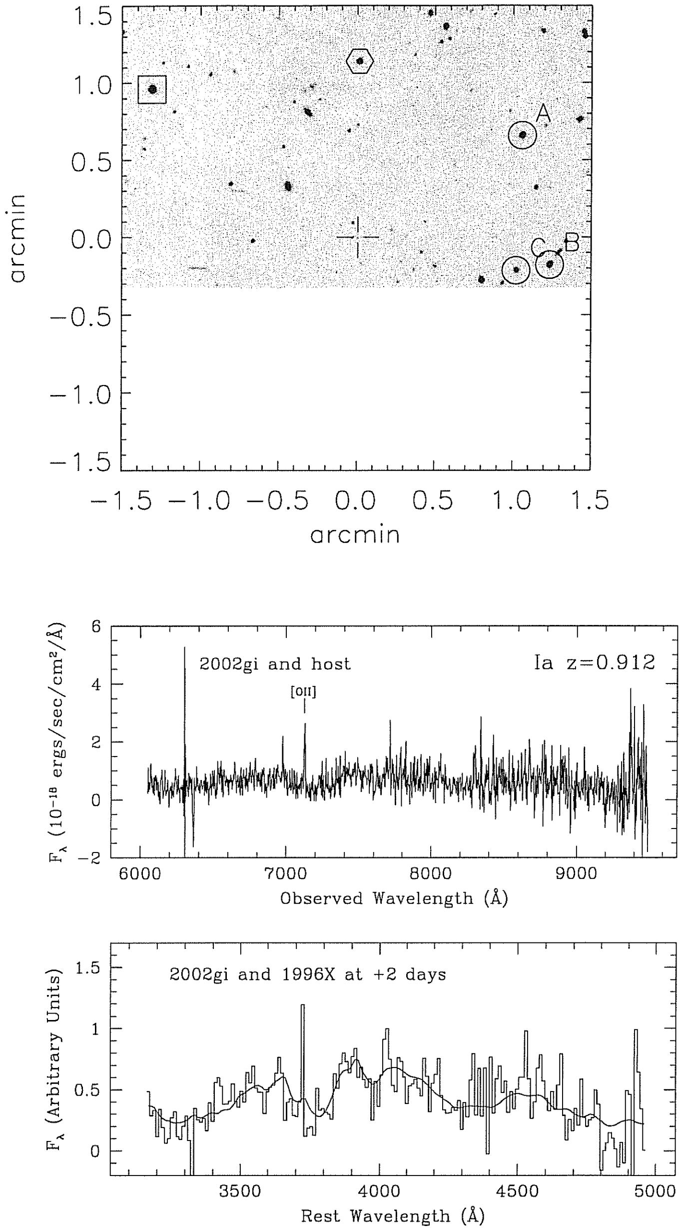


Fig. 25. Finding chart and spectrum of SN 2002gi (T02-015).

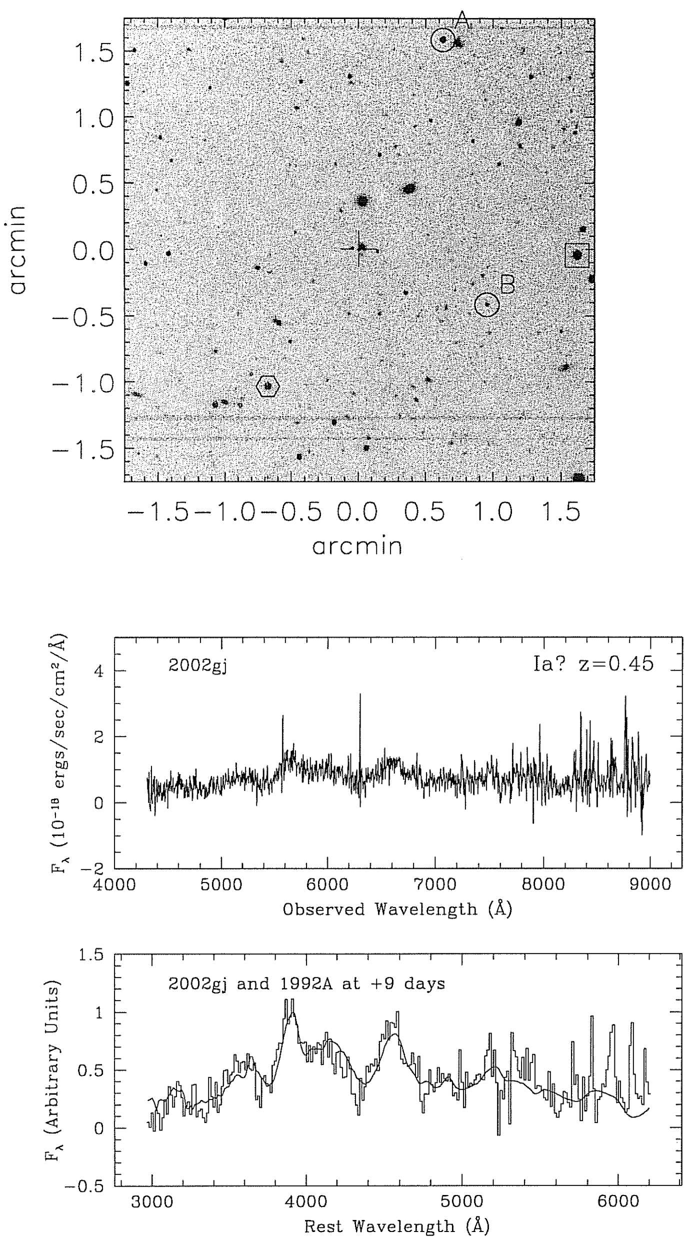


Fig. 26. Finding chart and spectrum of SN 2002gj (T02-028)

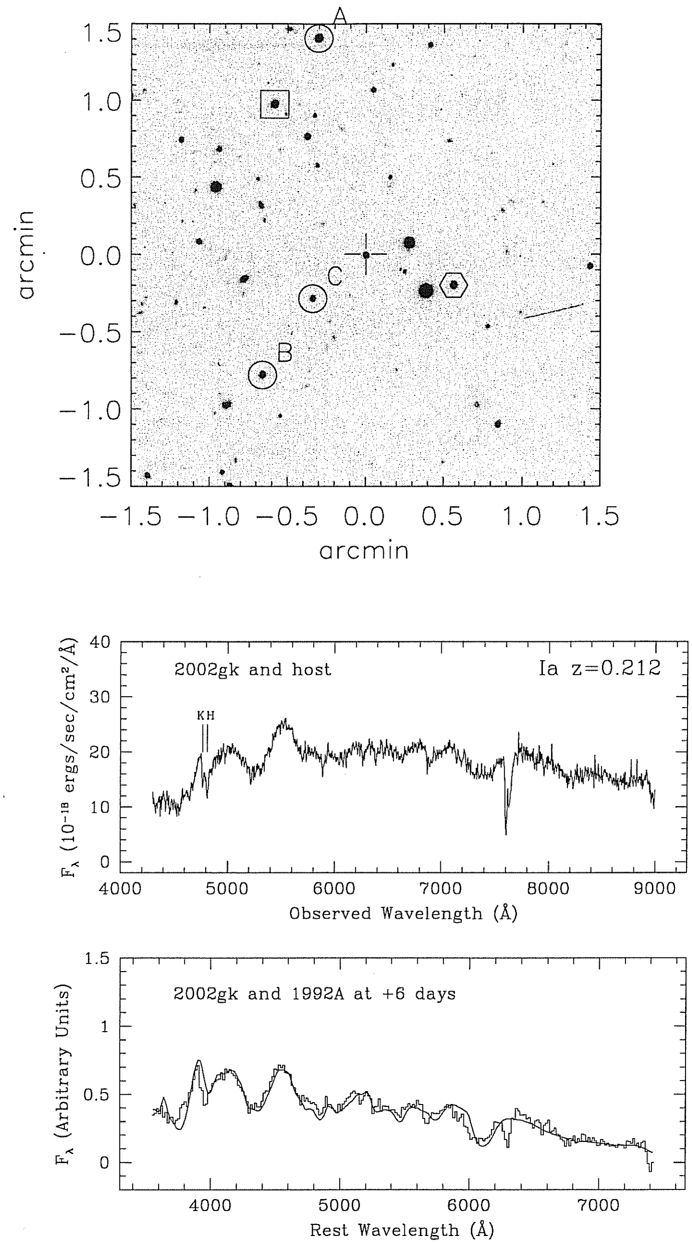


Fig. 27. Finding chart and spectrum of SN 2002gk (T02-029)

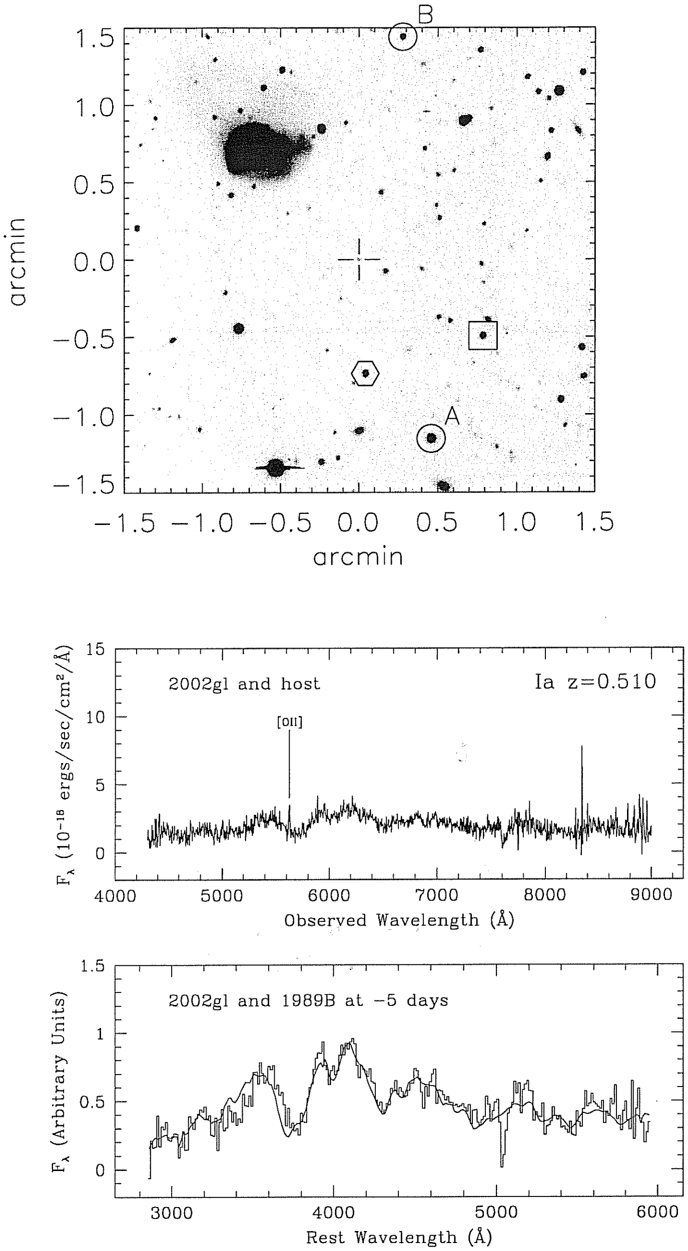


Fig. 28. Finding chart and spectrum of SN 2002gl (T02-030)

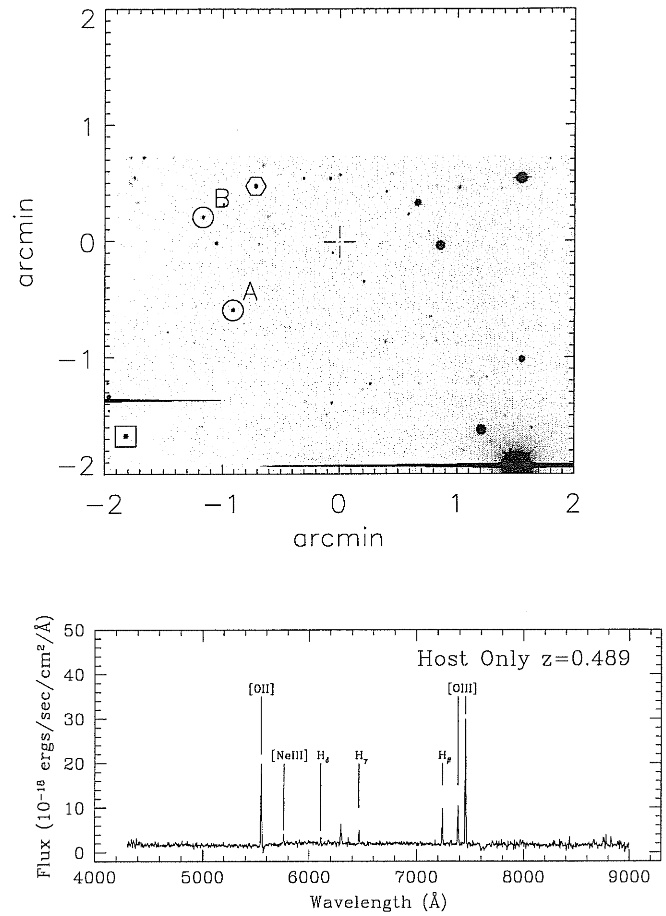


Fig. 29. Finding chart and spectrum of T02-047

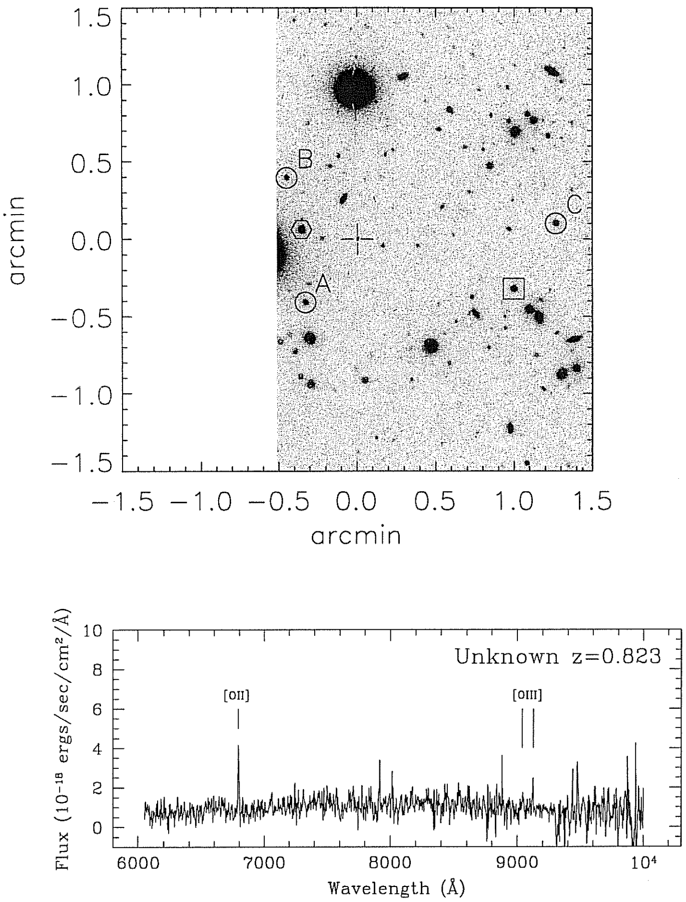


Fig. 30. Finding chart and spectrum of SN 2002kq (SuF02-002)

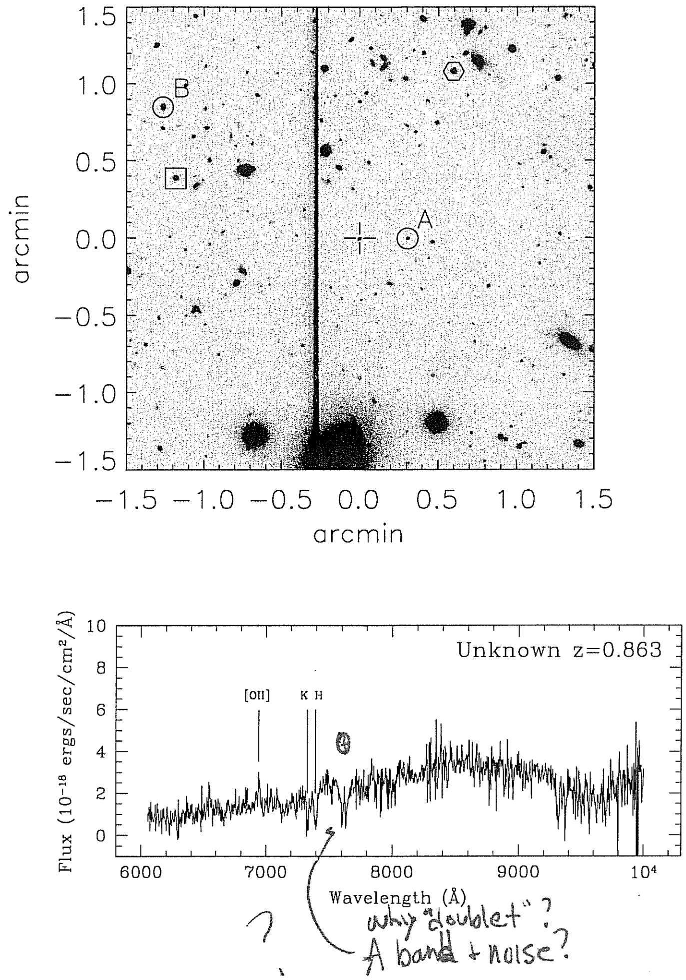


Fig. 31. Finding chart and spectrum of SuF02-005

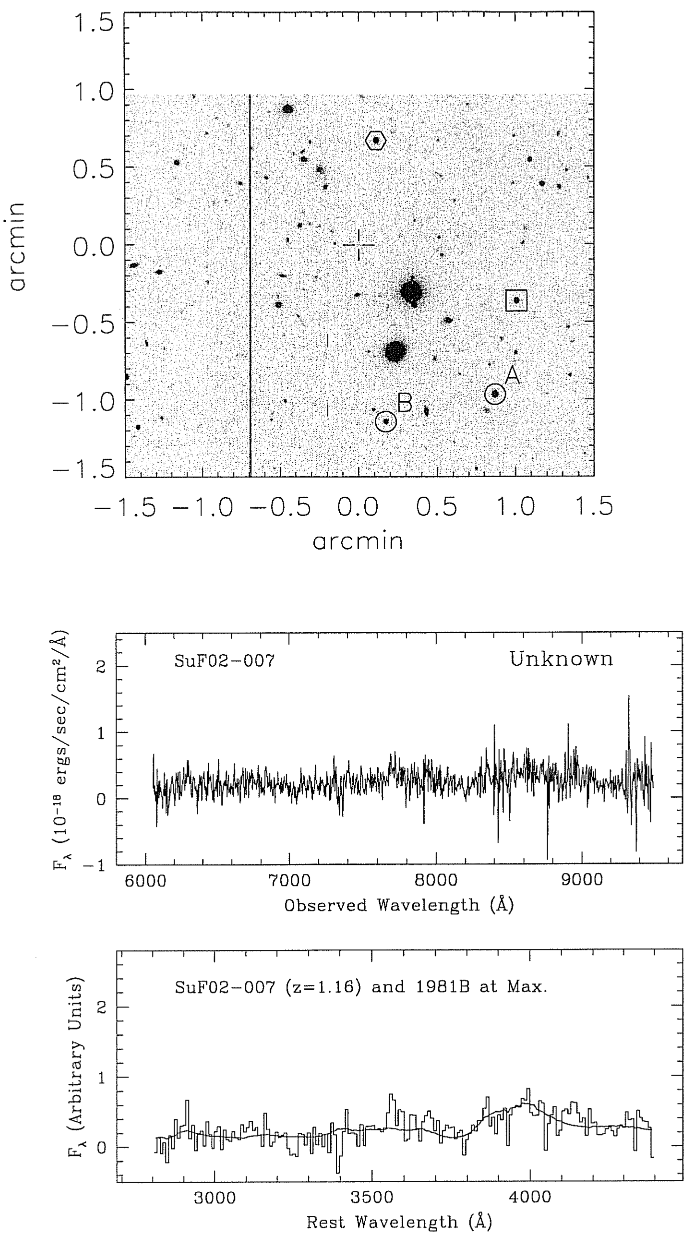


Fig. 32. Finding chart and spectrum of SuF02-007

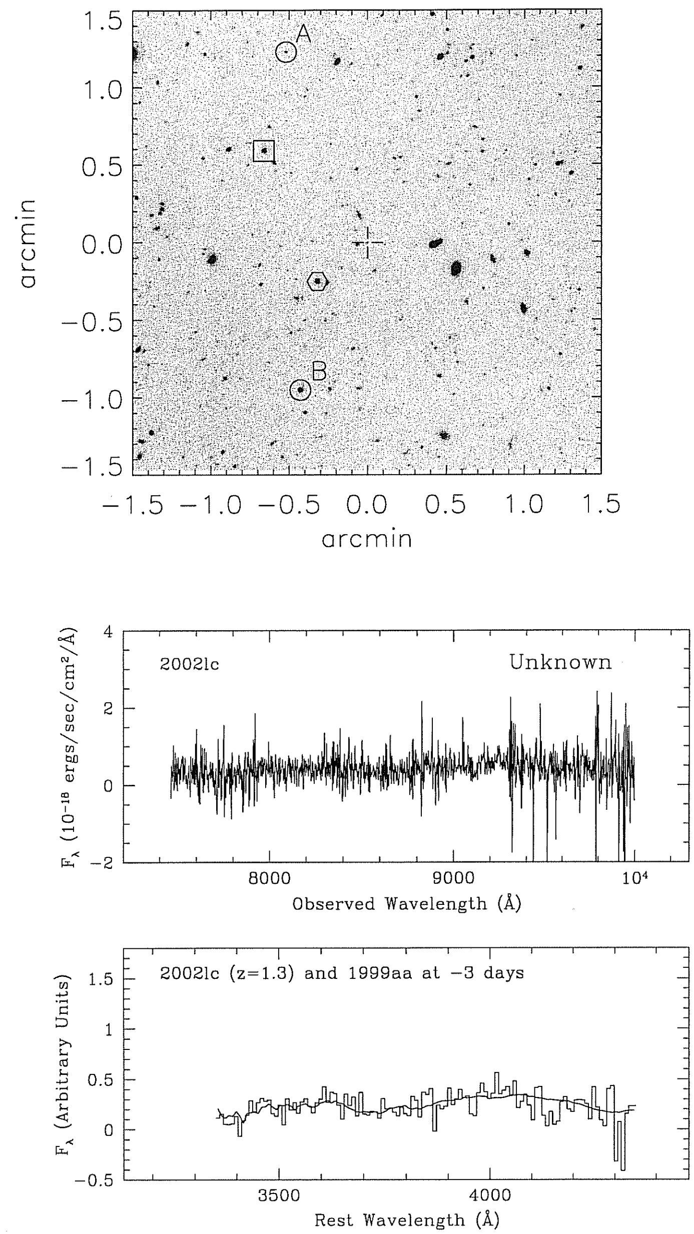


Fig. 33. Finding chart and spectrum of SN 2002lc (SuF02-012)

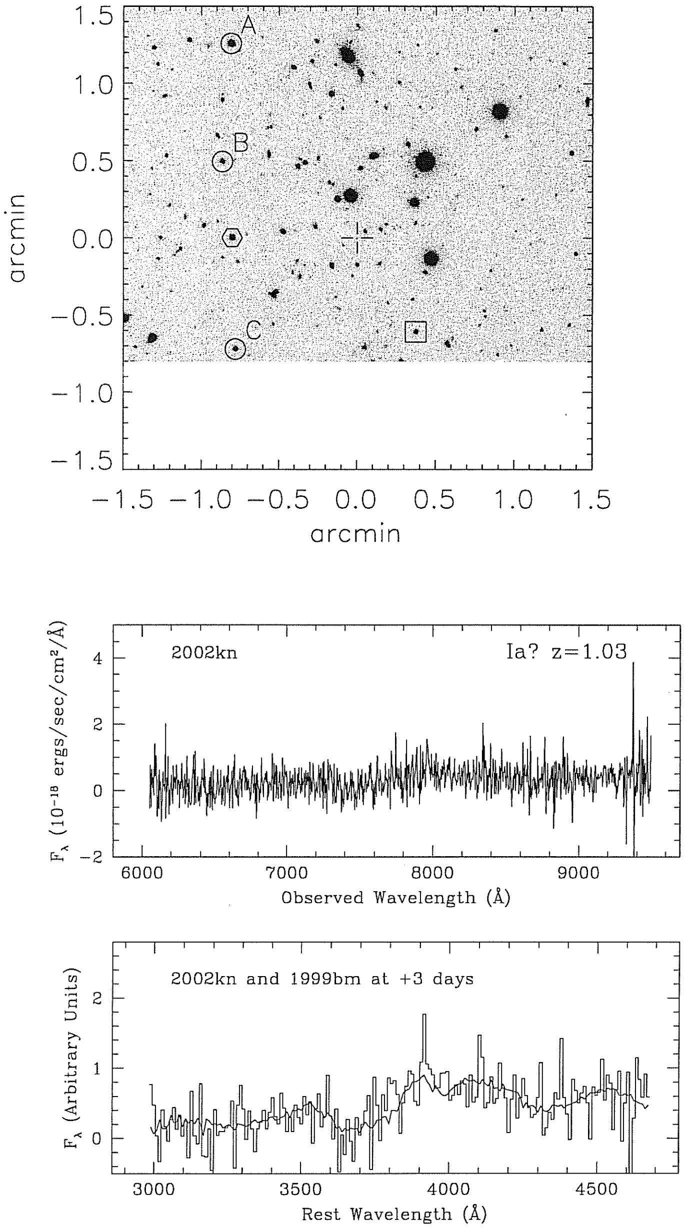


Fig. 34. Finding chart and spectrum of SN 2002kn (SuF02-017)

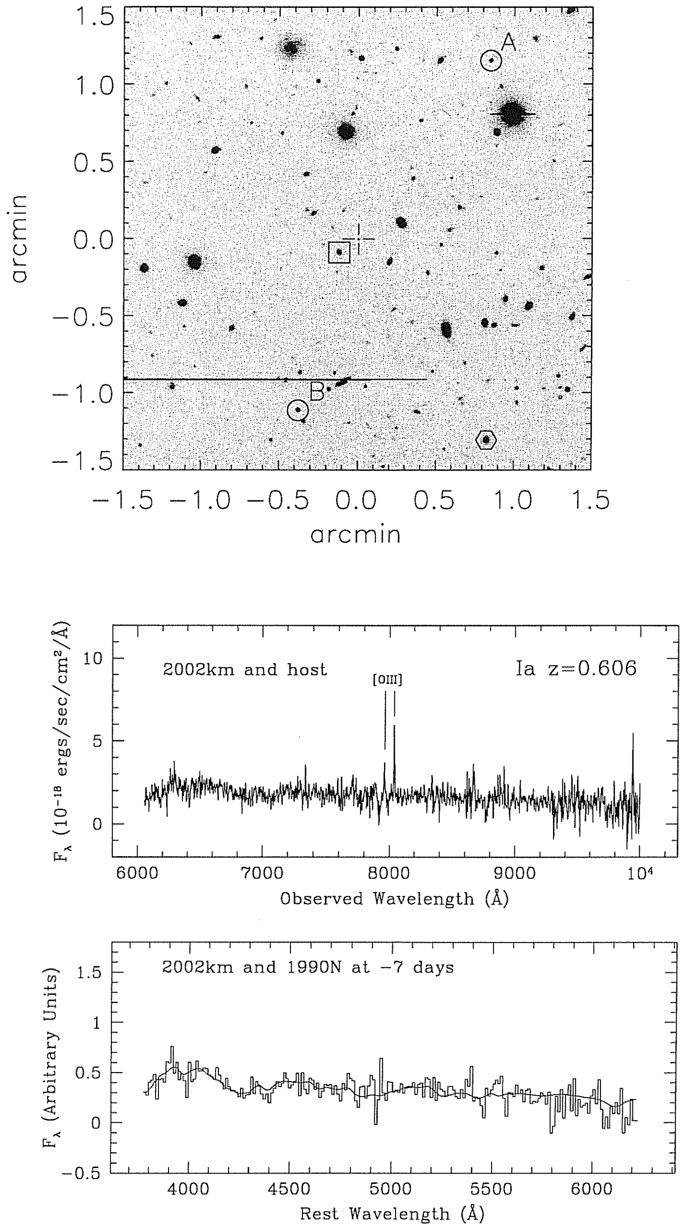
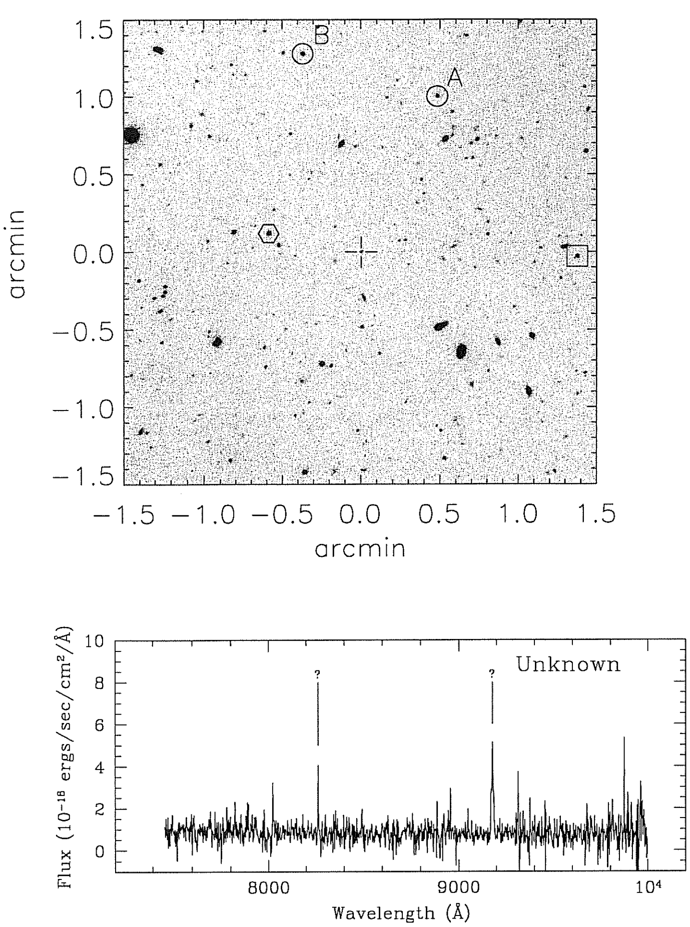


Fig. 35. Finding chart and spectrum of SN 2002km (SuF02-025)



revisit

Fig. 36. Finding chart and spectrum of SuF02-026

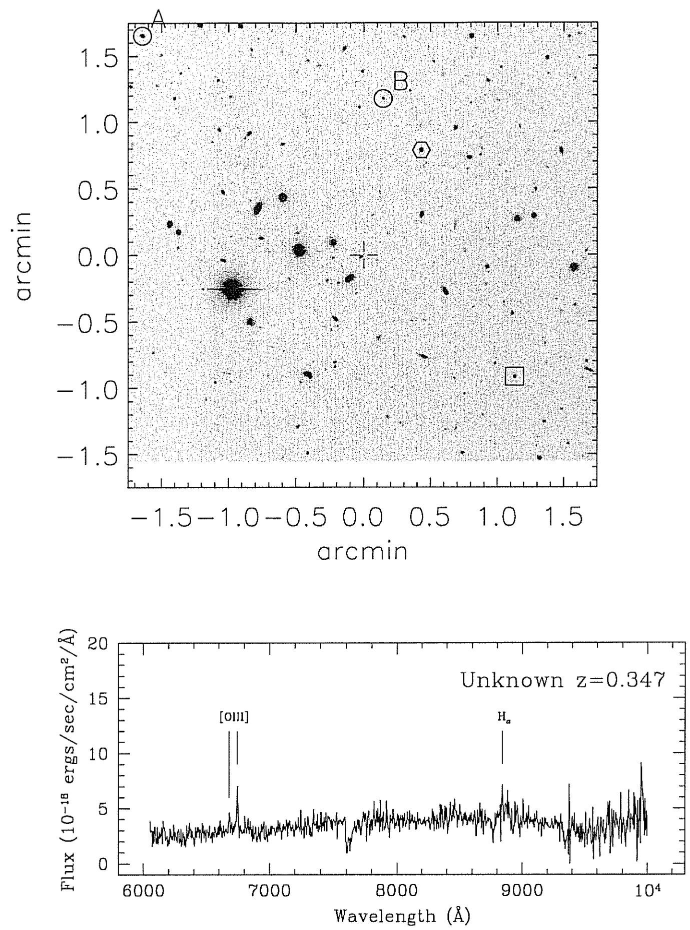


Fig. 37. Finding chart and spectrum of SuF02-028

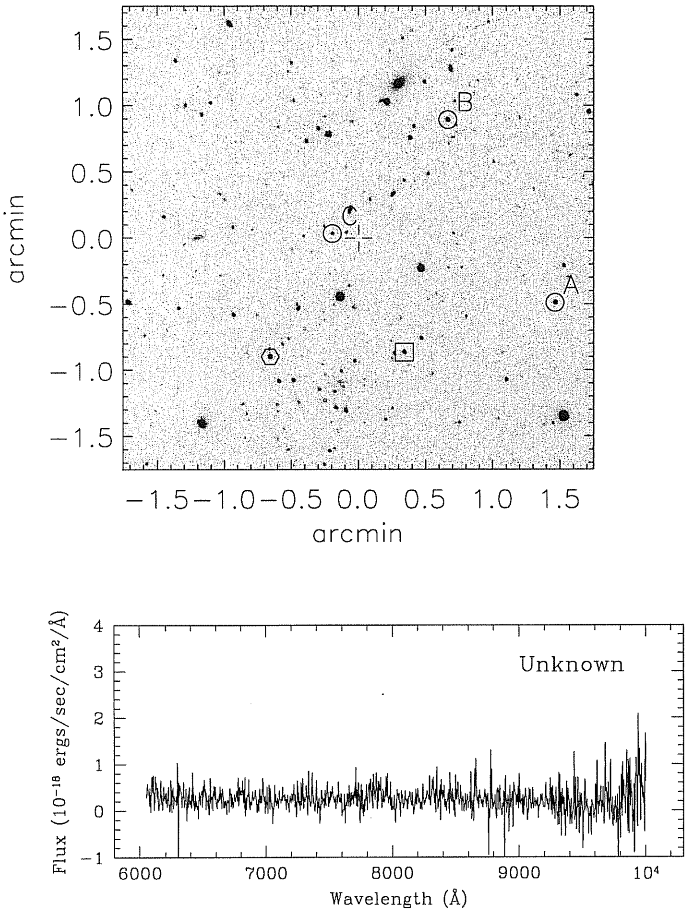


Fig. 38. Finding chart and spectrum of SuF02-051

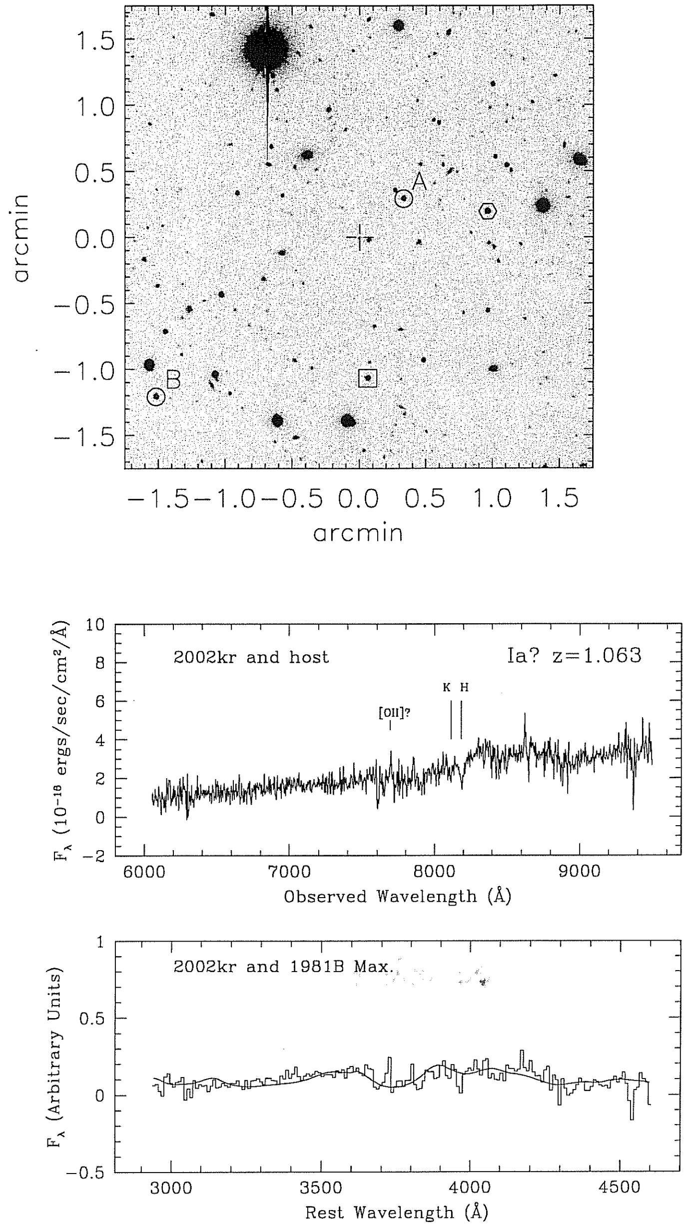


Fig. 39. Finding chart and spectrum of SN 2002kr (SuF02-060)

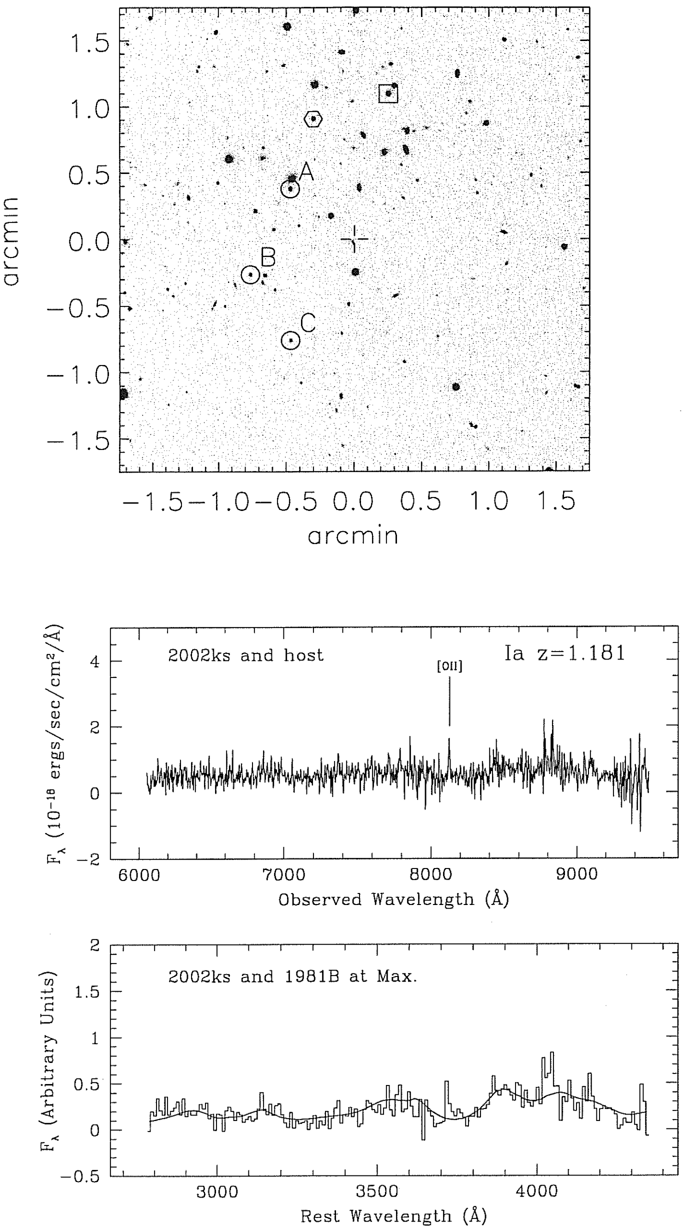


Fig. 40. Finding chart and spectrum of SN 2002ks (SuF02-065)

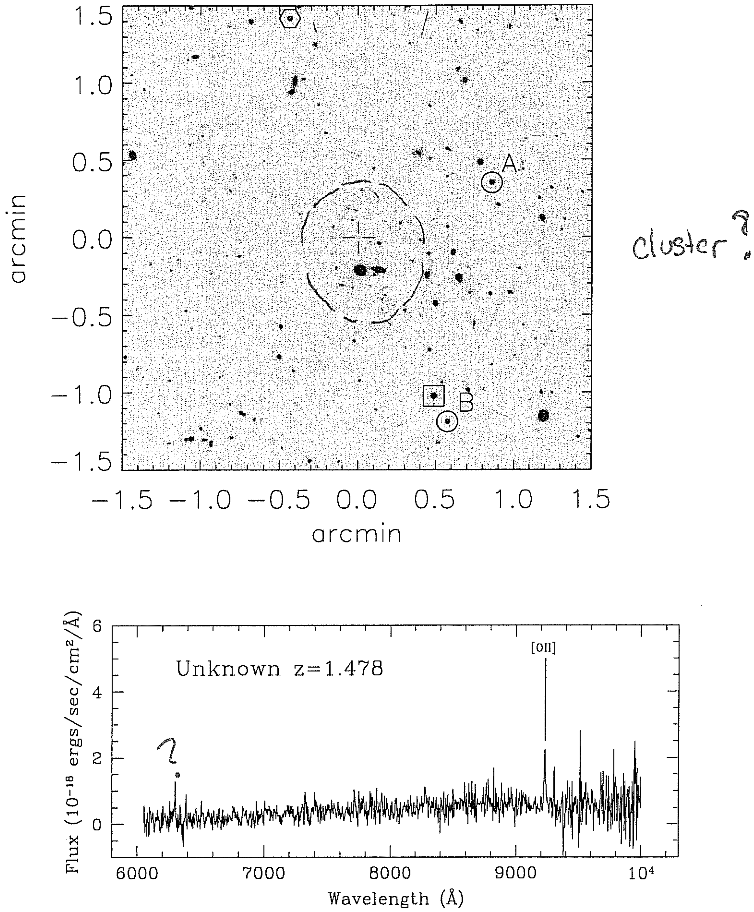


Fig. 41. Finding chart and spectrum of SuF02-081

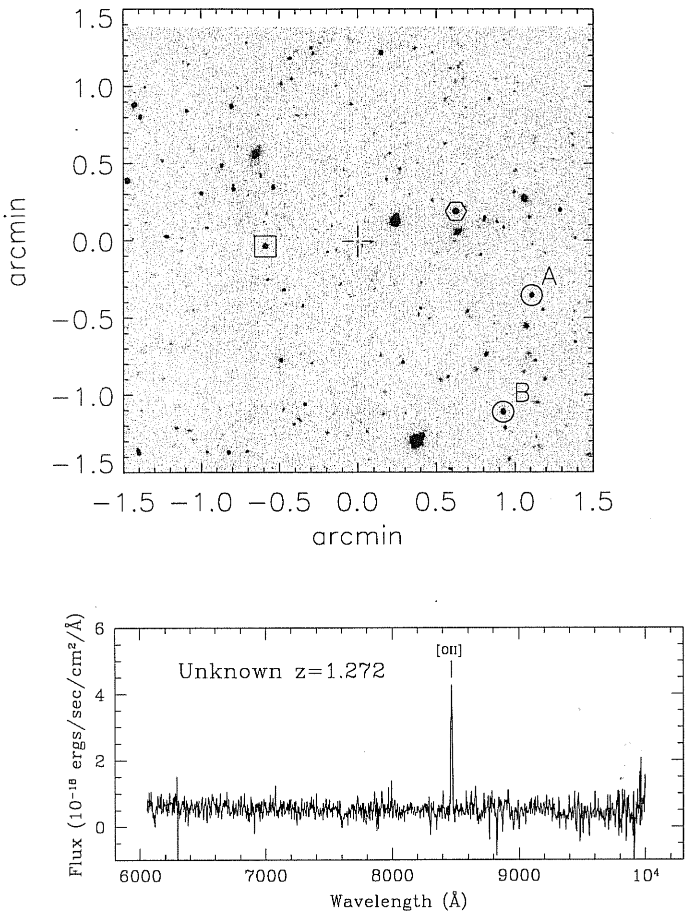


Fig. 42. Finding chart and spectrum of SuF02-083