

Letter to the Editor

UBVRI photometry of SN 1994D in NGC 4526

H. Wu¹, H.-J. Yan^{1,2}, and Z.-L. Zou¹

¹ Beijing Astronomical Observatory, Chinese Academy of Sciences, 100080 Beijing, China

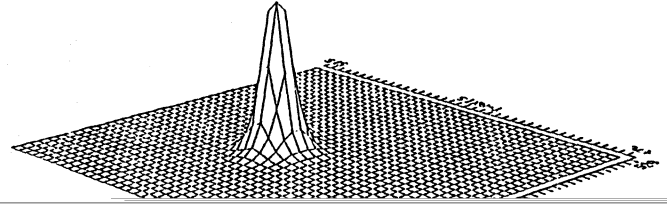
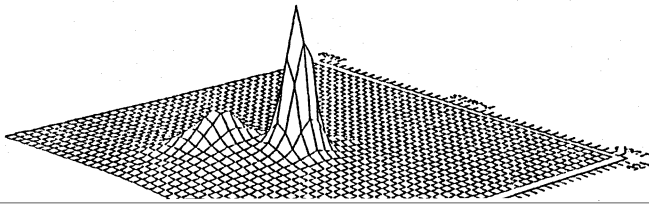
² Department of Physics, Tianjin Normal University, 300074 Tianjin, China

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Abstract. In this paper, we present UBVRI photometric results of SN 1994D which covers the period from March 11 to April 4. All these data were obtained with a field of view of 58'x58'. From March 11 to April 4, 1994, 17 nights were used to observe the source, covering the first night under the influence of U. D.

Table 1. Magnitudes of SN 1994D

UT (March)	U (mag)	UT (March)	B (mag)	UT (March)	V (mag)	UT (March)	R (mag)	UT (March)	I (mag)
11.72	12.61	11.70	13.01	11.69	13.00	-	-	-	-
12.72	12.22	12.68	12.76	12.64	12.75	12.61	12.61	12.63	12.64
12.77	12.23	12.82	12.71	12.85	12.67	-	-	12.88	12.59
14.67	11.78	14.65	12.30	14.64	12.31	14.63	12.16	14.63	12.20
14.73	11.73	14.76	12.30	14.77	12.28	14.78	12.18	14.78	12.24
14.82	11.73	14.84	12.25	14.84	12.29	14.85	12.15	14.85	12.23
15.61	11.60	15.65	12.12	15.66	12.16	15.67	12.01	15.68	12.18
15.74	11.55	15.71	12.13	15.73	12.18	15.73	11.98	15.69	12.20
15.82	11.62	15.81	12.09	15.80	12.15	15.79	12.01	15.79	12.12
16.79	11.49	16.81	12.04	16.82	12.05	16.83	11.92	16.84	12.11
17.78	11.41	17.76	11.94	17.76	12.01	17.83	11.86	17.84	12.11
18.60	11.46	18.58	11.93	18.57	11.92	18.56	11.85	18.60	12.01
18.76	11.41	18.81	11.89	18.83	11.93	18.84	11.85	18.85	12.15
19.78	11.36	19.82	11.89	19.83	11.88	19.84	11.79	19.84	12.10
22.67	11.44	22.75	11.89	22.74	11.90	22.78	11.80	22.79	12.10
23.66	11.61	23.64	11.93	23.64	11.88	23.63	11.81	23.66	12.17
24.73	11.66	24.77	11.94	24.78	11.95	24.79	11.87	24.77	12.32
25.61	11.68	25.64	12.07	25.65	11.94	25.66	11.92	25.66	12.47
25.67	11.68	25.71	12.07	25.71	11.93	25.72	11.95	25.72	12.41
26.65	11.80	26.60	12.13	26.59	12.05	26.58	11.95	26.58	12.57
-	-	26.70	12.16	26.69	11.98	26.69	11.94	26.68	12.45
28.64	12.04	28.62	12.28	28.61	12.02	28.61	12.08	28.60	12.60
29.67	12.17	29.76	12.36	29.77	12.20	29.78	12.32	29.79	12.78
32.66	12.59	32.73	12.65	32.72	12.38	32.75	12.36	32.75	12.68
35.62	13.10	35.59	13.15	35.55	12.50	35.57	12.57	35.52	12.63



3. Results

Table 1. presents the final photometric results. We simply give the magnitude for each image we have taken. Fig. 3 shows the plot of our data with that of others.

The error embedded in our data is mainly introduced by three sources. First, the flat-field corrections may bring about 2% uncertainty; Second, the magnitudes of our reference stars have an accuracy of 0.07, 0.03, 0.03, 0.03, and 0.02 mag in U, B, V, R, and I, respectively. The third error comes from the method of background determination, which are 2%-4% in the U, B, V, and R-bands and could be as large as 15% in the I-band. So the final internal error estimate is about 0.08 mag in U, 0.05 mag in both B and V, 0.06 mag in R, and 0.10-0.20 mag in I.

Table 2 displays the color of the supernova. We averaged each night's data. The data are plotted in Fig. 4.

Table 2. Color of SN 1994D

UT(in March)	U-B	B-V	V-R	V-I
11.7	-0.40	0.01	-	-
12.7	-0.51	0.02	0.10	0.10
14.7	-0.54	-0.01	0.13	0.07
15.7	-0.52	-0.05	0.17	0.00
16.8	-0.56	-0.01	0.14	-0.06
17.8	-0.53	-0.07	0.15	-0.10
18.7	-0.47	-0.02	0.07	-0.15
19.8	-0.53	-0.02	0.09	-0.22
22.7	-0.45	0.00	0.10	-0.20
23.6	-0.32	0.05	0.06	-0.30
24.8	-0.29	-0.01	0.08	-0.37
25.7	-0.39	0.14	0.00	-0.51
26.6	-0.34	0.13	0.07	-0.49
28.6	-0.24	0.27	-0.06	-0.61
29.8	-0.19	0.17	-0.12	-0.58
32.7	-0.06	0.27	0.02	-0.30
35.6	-0.06	0.65	-0.07	-0.13

Our observation started about 9 days before maximum brightness came, and extended more than two weeks after then. With so nicely sampled data, we can determine position of the maximum brightness properly. Table 3 shows the results. The peak B magnitude is in good agreement with the mean value of 11.82 ± 0.08 for the supernovae found in E/S0 galaxies in the Virgo cluster (Leibundgut and Tammann 1990).

Table 3. Magnitudes and dates in maximum

	U	B	V	R	I
date(in March)	19.6	20.4	22.0	20.6	19.6
magnitude	11.39	11.86	11.85	11.77	12.04

Before the supernova reached the maximum, the brightness increased quickly at -0.18, -0.16, -0.15, -0.15 and -0.14 mag/day in U, B, V, R and I, respectively. Af-

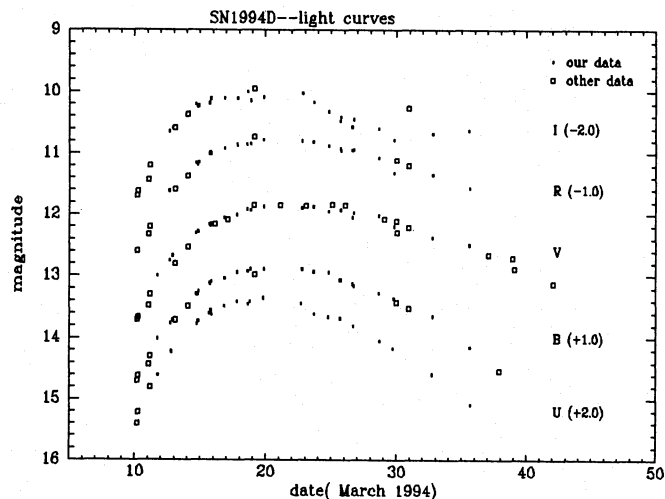


Fig. 3. The light curves of SN 1994D in U, B, V, R, and I. The solid points are our data and open ones are from other sources (Shanks and Croom 1994; Walker 1994; Heraudeau et al. 1994; Mikuz et al. 1994a and 1994b; Argyle and Morrison 1994) Magnitude scale is according to the V-band, and the U, B, R, and I are shifted by +2, +1, -1, -2 mag, respectively.

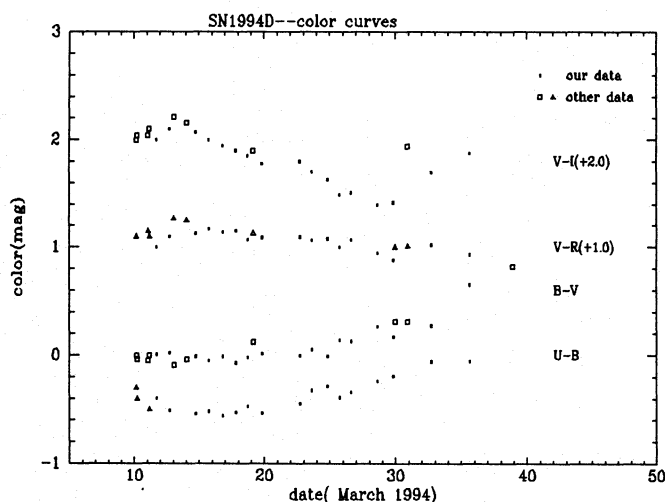


Fig. 4. The colors of SN 1994D. Solid points are ours and open ones from the literature. Only V-R and V-I have been shifted +1 and +2 mag respectively. B-V and U-B use original scale.

ter the maximum, the brightness declined with a rate of 0.110, 0.087, 0.057, 0.056 and 0.080 mag/day in U, B, V, R and I, respectively, which was somewhat slower than the rate of brightness increase. The decline rates are high in U, a little slower in B, which is the same as the mean rate 0.087 mag/day (Barbon et al. 1973), and slow in V and R. The light curves of SN 1994D fall 1.23 and 0.78 mag during the first 15 days after maximum in B and V, respectively, and the width of the V light curve measured

one magnitude below maximum is approximately 27 days. All these are not so much different from the value of the light curve templates for SNe Ia of Leibundgut (1988), where the decreases are 1.22 and 0.64 mag for B and V, and the width of V curve is about 33 days, and quite similar to SN 1989B (Barbon et al. 1990) in NGC 3627 and SN 1981B (Buta and Turner 1983) in NGC 4536, which are classified as normal Ia supernovae (Branch et al. 1993). We could not find out the change of decline rate, since we didn't observe the supernova long enough.

The light curves for U-B and B-V colors increased even after the maximum, while that for V-R and V-I colors declined after then. The U-B evolution indicates that the supernova was quite blue after it exploded, about 0.1 mag bluer than that of SN 1981B. The increase of B-V is also similar to SN 1981B, which B-V was nearly 0.0 and went

1979b), 30.49 ± 0.25 (de Vaucouleurs and Olson 1984), and 29.96 ± 0.5 which can be deduced from Hanes' (1977) paper by using the weighted mean apparent magnitude of the globular clusters in NGC 4526 and the mean absolute magnitude in our galaxy, but somewhat different from 31.47 ± 0.37 (de Vaucouleurs and Olson 1982), 31.13 (Tully 1988) and 29.30 (Bottinell et al. 1984). According to Branch and Miller (1993), its small distance to us and the low luminosity would classify SN 1994D as a member of the subluminoous group.

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