COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 3905

Konkoly Observatory
Budapest
8 July 1993
HU ISSN 0324 - 0676

BV photoelectric photometry of SN 1993J in NGC 3031 = M 81

SN 1993J was discovered in NGC 3031 = M81 on March 28, 1993 by Garcia (1993). Being the brightest supernova for northern hemisphere observers over the last 21 years, SN 1993J prompted for an extensive, world-wide effort to monitor its evolution over the widest spectral range.

We have performed BV photometry of SN 1993J during the initial test period of the new photoelectric photometer for the AFAM 0.45 m reflector (Associazione Friulana di Astronomia e Meteorologia, Udine, Italy). The photometer houses an uncooled 1P21 photomultiplier and standard UBV Johnson filters. Photometer operation, data-storage and data-reduction are performed on-line via connection to a PC.

The accurate evaluation of the photometer peformances is still underway. Tests on equatorial Landolt (1992) standard fields and open clusters from the Hoag *et al.* (1961) 1P21 UBV survey, do not show appreciable color terms in any of the three UBV bands. The photometer did not show departure from linearity or any orientation effect.

The AFAM 0.45 m telescope is located in Remanzacco, a sea-level site in the outskirts of Udine. The present telescope tracking and average seeing conditions force to adopt a default 15 arcsec diaphragm. The severe light pollution limits the 1P21-based observations to stars brighter than V$\sim$12.6 and B$\sim$13.7 to maintain the internal standard error $<$0.06 mag. We stopped the observations when the supernova approached these limits. The variable atmospheric cut-off for a sea-level site during the spring season suggested not to observe in the U band the supernova, the latter spectrum being dominated by strong and broad emission lines.

The observations of SN 1993J have been performed against three local comparison stars: HD 86677 (V=7.88, B=8.39), GSC4383-0308 (V=11.78, B=12.47), GSC4383-0928 (V=11.90, B=12.40). Photoelectric intercomparison of the adopted standards did not show detectable variability of them. We are investigating their photometric stability over the last $\sim$30 years on Asiago Schmidt photographic patrol plates (Manzocco *et al.* 1993). The resulting SN 1993J B,V magnitudes are reported in Table 1 for the given UT dates. The SN was observed in five more nights, but data reduction showed the latter

Table 1: AFAM 1P21 photoelectric photometry of SN 1993J in NGC 3031

Date	JD	V	σ_V	n	B	σ_B	n	Notes
1993-03-31.97	2449078.47	10.94	0.04	2	11.31	0.04	2	IAUC 5750
1993-04-01.02	2449078.52	10.90	0.05	1	11.30	0.04	1	IAUC 5750
1993-04-08.86	2449086.36	11.45	0.04	3	11.94	0.04	2	
1993-04-09.85	2449087.35	11.35	0.04	1	11.81	0.04	1	
1993-04-16.92	2449094.42	10.93	0.01	3	11.46	0.06	3	
1993-04-17.91	2449095.41	10.87	0.04	5	11.35	0.02	5	
1993-04-18.89	2449096.39	10.88	0.06	1	11.40	0.06	1	
1993-04-19.86	2449097.36	10.91	0.04	2	11.43	0.05	2	
1993-04-20.92	2449098.42	10.95	0.05	6	11.48	0.08	3	
1993-04-21.85	2449099.35	11.02	0.06	1	11.70	0.05	1	
1993-04-22.86	2449100.36	11.10	0.01	2	12.03	0.04	2	
1993-04-23.91	2449101.41	11.18	0.04	4	12.27	0.21	4	
1993-04-26.90	2449104.40	11.44	0.01	5	12.63	0.05	5	
1993-05-09.86	2449113.36	12.14	0.03	4	13.29	0.01	2	
1993-05-10.89	2449118.39	12.13	0.06	1	13.37	0.05	2	
1993-05-13.90	2449121.40	12.30	0.07	2	13.37	0.05	2	
1993-05-14.90	2449122.40	12.30	0.09	2				
1993-05-16.86	2449124.36	12.33	0.05	2	13.49	0.02	3	
1993-05-17.89	2449125.39	12.31	0.13	6	13.40	0.05	2	
1993-05-19.92	2449127.42	12.38	0.09	2	13.50	0.07	2	
1993-05-20.94	2449128.44	12.40	0.08	2	13.54	0.08	2	
1993-05-21.99	2449129.49	12.31	0.03	2				
1993-05-22.90	2449130.40	12.38	0.04	2				
1993-05-25.87	2449133.37	12.37	0.04	2	13.69	0.12	1	
1993-05-26.91	2449134.41	12.49	0.08	3	13.65	0.08	2	

not to be photometric and they have not considered further on.

The typical observing routine in each band was composed by 4 to 6 individual 10 sec integrations on: dark current, sky background, two comparison stars, the SN, the same two comparisons, sky background, dark current. One cycle typically lasts for 20 minutes. In Table 1, n is the number of such cycles performed in the given band. The listed magnitudes are the weighted averages of the SN magnitudes obtained from all cycles during the given night. The reported standard errors are *internal* to the system.

For all observations, a 15 arcsec diaphragm was used. To evaluate the contribution from the underlying NGC 3031 galaxy, we made extensive mesurements of a large portion of the background galaxy around the SN. The results suggest that the contribution of the galaxy background to the SN 1993J measurements are irrelevant given the sky brightness we experience at the AFAM observatory.

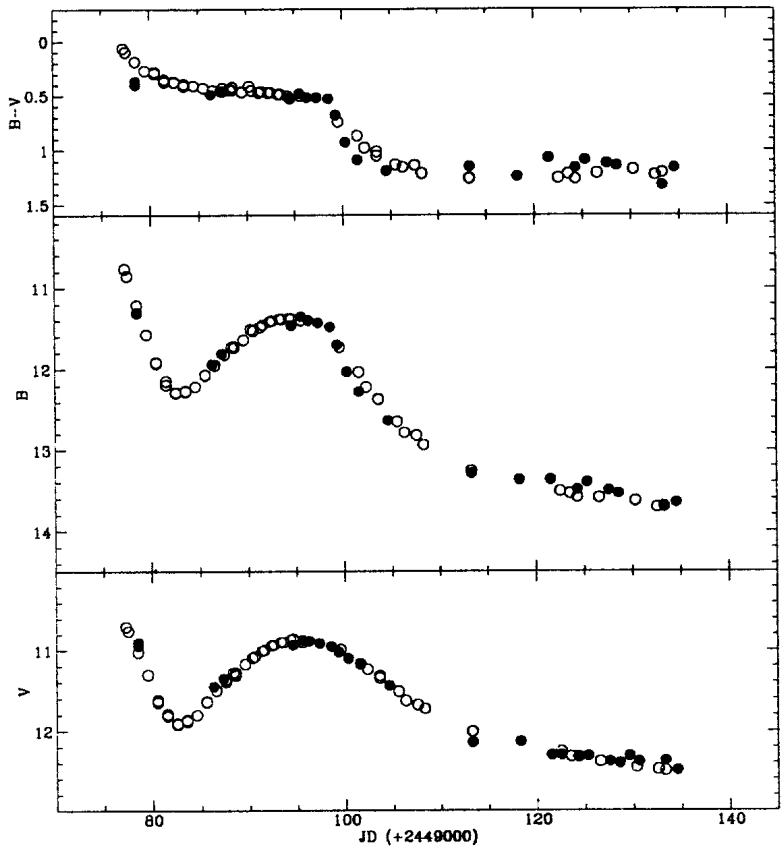

Figure 1. V, B and (B-V) lightcurves of SN 1993J. Filled circles: our data. Open circles: data from La Palma & RGO Observatories (Meikle *et al.* 1993).

The B,V and (B-V) lightcurves of SN 1993J are presented in Figure 1. The AFAM data are plotted as filled circles. For comparison, we have reported the measurements made at La Palma & Royal Greenwich Observatories (open circles) with a variety of telescopes and instruments as summarized by Meikle *et al.* (1993). The La Palma & RGO Observatories data have been retrieved via remote *ftp* connection to RGO as explained by Martin & Lewis (1993).

The agreement between the two sets of observations in Figure 1 is quite good in view of the peculiar, emission-line dominated spectrum of a supernova. The zero-points seem pretty similar. Some color differences are present at earliest phases and during the decline from second maximum. The noise in the observations contributes significantly to the differences at later phases.

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