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BVR$_C$I$_C$Hα PHOTOMETRIC EVOLUTION OF NOVA 2007 IN M 33

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Abstract. The BVR_CI_C and Hα light curves of Nova 2007, located in the galaxy M 33, are presented. They display the fastest decline ever observed for a nova in this galaxy ($\Delta B = 0.40 \pm 0.01$ mag/day). Color indices of the nova match those of its counterparts in the Galaxy. The nova was discovered when it was already two magnitudes down from maximum (estimated to have occurred on September 13 at $B = 15.5$ mag).

Key words: stars: novae – galaxies: individual (M 33)

1. INTRODUCTION

The recorded appearance of a nova in the Pinwheel Galaxy (M 33) is a rare event. Sharov (1983) summarized that only 14 novae have been discovered in M 33 to date. Williams & Shafter (2004) in a carefully planned search in Hα from 1995 to 2002 found just six novae. Estimates of the M 33 nova production rates are quite uncertain and range from 0.45 (Sharov 1993) to 2.5 (Williams & Shafter 2004) or 4.6 yr^{-1} (Della Valle et al. 1994). Most of M 33 novae have very poorly sampled light-curves, frequently containing just a couple of single-band photometric points (e.g., Carpenter 1929; Rosino & Bianchini 1973; Williams & Shafter 2004) and even fewer have spectroscopic information. Nova 2007 (hereafter M33-N2007) was discovered in M 33 by F. Kabashima and K. Nishiyama (cf. Nakano 2007) on unfiltered CCD images exposed on September 18.63 UT. Spectroscopic confirmation was provided by Wagner et al. (2007), who found that the spectrum was dominated by broad Balmer and He I emission lines. Later a similar, though more detailed, description of the spectrum was provided by Shafter et al. (2007).

2. OBSERVATIONS

A BVR_CI_C comparison sequence around M33-N2007 was calibrated against Landolt's equatorial standards by observations obtained on three independent photometric nights with the Sonoita Research Observatory (Arizona) 0.35 m Celestron C14 robotic telescope using Optec filters and a SBIG STL-1001E CCD camera, 1024×1024 array, 24 μm pixels $\equiv 1.25''$/pix. The sequence is identified in Figure 1

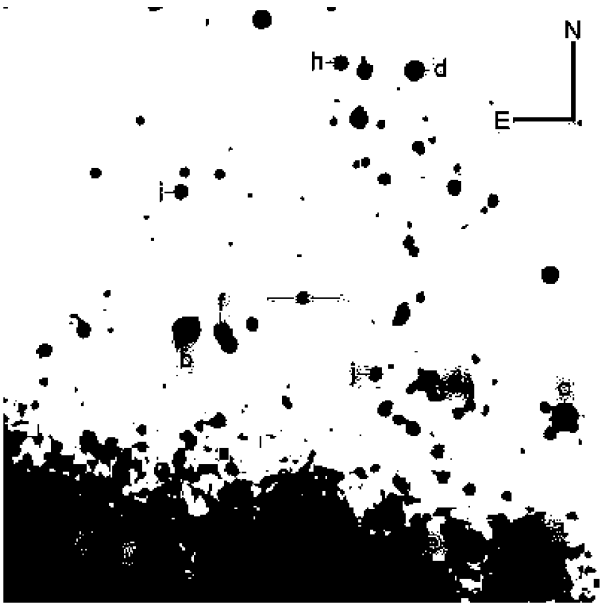

Fig. 1. R_C-band image identifying the nova in the center and the comparison sequence listed in Table 1.

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BVR_CI_C Hα observations of M33-N2007 were obtained with the 0.5 m f/8 Ritchey-Chretien telescope operated on top of Mt. Zugna by Museo Civico di Rovereto (Trento, Italy) and equipped with Optec filters and Apogee Alta U42 CCD camera, 2048×2048 array, 13.5 μm pixels $\equiv 0.70''$/pix. BVR_C observations were acquired also with the 0.6 m, f/3.3 robotic telescope of the Črni Vrh Observatory (Slovenia), equipped with Omega filters and a Finger Lake Instruments 1024S CCD camera, 1024×1024 array, 24 μm pixels $\equiv 2.5''$/pix. The nova photometry has been calibrated against the photometric sequence of Table 1, and it is reported in Table 2, together with BR_C photometry from Nakano (2007a,b) re-calibrated against the same photometric sequence (the original data used USNO-B1 data for surrounding field stars).

Two Hα observations were also obtained through a 50 Å wide interference filter centered at 6560 Å. Assuming m(Hα)$-R_C$=0.0 for the stars of the photometric sequence in Table 1, we obtained for the nova m(Hα)=17.50±0.02 on September 21.035, and m(Hα)=17.40±0.03 on September 23.877 UT. They confirm the Williams & Shafter (2004) findings that in M 33 novae decline very slowly in Hα and show $B-m$(Hα) ≈ 2 mag.

3. RESULTS

The light curve of M33-N2007 is presented in Figure 2. It is one of the best ever obtained for a nova in M 33, and the only multi-band one.

It is characterized by a very fast decline, amounting to $\Delta B = 0.40 \pm 0.01$ mag/day (which is the slope of the least-squares fit plotted as a solid line in Figure 2). This agrees with the optical spectrum being characterized by the He I and N II and not Fe II emission lines (cf. Williams 1992). None of the previously observed M 33 novae declined faster than M33-N2007 (their decline rates show a bi-

Table 1. Photometric comparison sequence identified in Figure 1.

	V	±	B–V	±	V–R_C	±	V–I_C	±
a	14.081	0.018	1.124	0.030	0.694	0.012	1.285	0.014
b	14.164	0.013	0.651	0.033	0.364	0.011	0.726	0.012
c	14.558	0.013	0.807	0.092	0.448	0.012	0.858	0.010
d	15.502	0.013	0.754	0.047	0.430	0.039	0.834	0.021
e	15.594	0.019	0.514	0.039	0.341	0.031	0.670	0.034
f	16.300	0.031	0.695	0.093	0.385	0.033	0.835	0.040
g	16.459	0.036	1.035	0.088	0.630	0.045	1.158	0.068
h	16.739	0.041	0.113	0.084	0.149	0.033	0.334	0.063
i	17.005	0.017	0.521	0.066	0.327	0.064	0.728	0.025
j	17.519	0.036	0.140	0.096	0.284	0.027	0.172	0.029

Table 2. BVR_CI_C photometry of the nova. a = Nakano (2007a,b), b = Črni Vhr and c = Mt. Zugna observations. HJD = heliocentric JD – 2454300.

HJD	date (UT)	B	±	V	±	R_C	±	I_C	±	
63.001	09-19.501	17.6				16.7				*a*
64.006	09-20.506	18.3				17.0				*a*
64.440	09-20.935	18.51	0.03	18.50	0.08	17.56	0.07			*b*
64.540	09-21.035	18.49	0.02	18.32	0.02	17.53	0.01	17.48	0.03	*c*
64.631	09-21.126	18.52	0.03	18.35	0.03	17.53	0.04			*b*
65.417	09-21.912	18.43	0.05	18.64	0.13	17.68	0.05			*b*
65.430	09-21.925	18.57	0.03	18.45	0.03	17.69	0.02	17.55	0.03	*c*
66.561	09-23.056	19.15	0.04	18.71	0.03	18.00	0.04	17.69	0.03	*c*
66.629	09-23.124	18.89	0.03	18.79	0.05	17.99	0.06			*b*
67.382	09-23.877			18.94	0.07	18.22	0.03	17.86	0.03	*c*
67.631	09-24.126	19.54	0.09	19.15	0.08	18.41	0.07			*b*
76.357	10-02.852	19.67	0.16	19.66	0.15	19.13	0.12			*b*

modal distribution, centered at $\Delta B = 0.06$ and 0.25 mag/day). Using calibrations summarized by Warner (1995), a $\Delta B = 0.40 \pm 0.01$ mag/day rate corresponds to an absolute magnitude $B \approx -9.3$. At the M 33 distance and foreground reddening (840 kpc and $E_{B-V} = 0.08$, cf. Mateo 1998), M33-N2007 should have peaked to $B \approx 15.5$. The dashed line in Figure 2 is a hand-drawn extrapolation to the B_{max} = 15.5 maximum, that could have occurred around September 13, i.e. five days before the nova was actually discovered. The mean colors of M33-N2007 during the period of our observations (on average eight days past and $\Delta B = 3$ mag down from the estimated maximum) are B–$V = +0.20 \pm 0.02$, V–$R_C = +0.80 \pm 0.03$, V–$I_C = 0.96 \pm 0.05$, R_C–$I_C = 0.22 \pm 0.06$ (the uncertainty is the error of the mean). The reddening-corrected color $(B\text{–}V)_0 = -0.05$ is in a good agreement with van den Bergh & Younger (1987), who found for the Galactic novae on average $(B\text{–}V)_0$ = $+0.23 \pm 0.06$ at maximum, and $(B\text{–}V)_0 = -0.02 \pm 0.02$ two magnitudes down from it.

The last observation (October 2) in Figure 2 shows a flattening of the decline and blueing of the colors. Other M 33 novae have been observed to glitch, even re-brightening, in their late-time B-band (or equivalent m_{pg}) light-curves, for example, Novae 1974 and 1982 (cf. Della Valle et al. 1994). The M33-N2007 astrometric position (with respect to UCAC stars in the field) is (J2000) α = 01 33 58.65, δ = +30 57 34.3 (±0.2 arcsec on both coordinates).

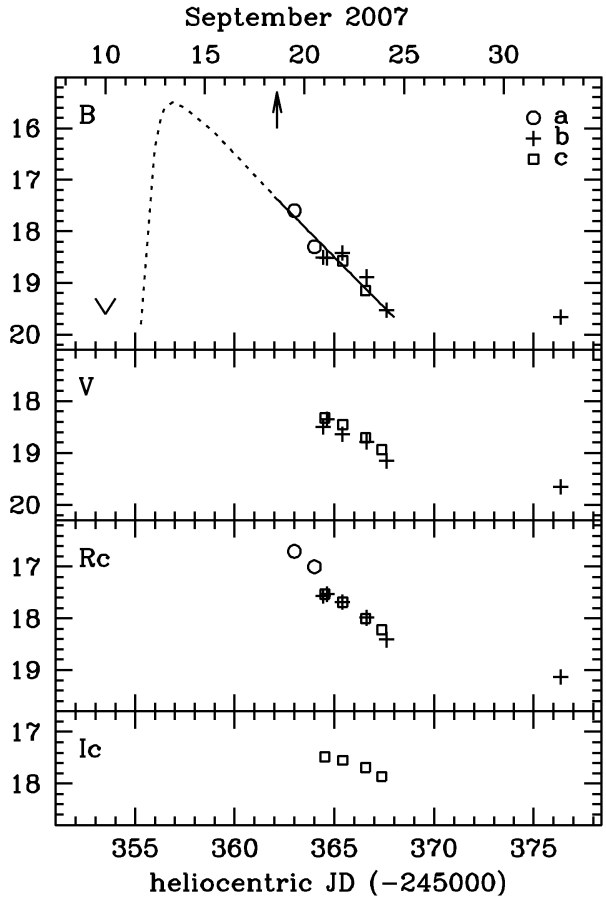

Fig. 2. BVR_CI_C light-curves of the nova. The symbol 'v' marks the negative observation reported by Nakano (2007) and the arrow the date of discovery; *a*, *b* and *c* are identified in Table 2.

REFERENCES

Carpenter E. F. 1929, PASP, 41, 118
Della Valle M., Rosino L., Bianchini A., Livio M. 1994, A&A, 287, 403
Mateo M. 1998, ARA&A, 36, 435
Nakano S. 2007a, CBET, 1074
Nakano S. 2007b, CBET, 1080
Rosino L., Bianchini A. 1973, A&A, 22, 461
Shafter A. W. et al. 2007, The Astronomer's Telegram, 1225
Sharov A. S. 1983, Sov. Astron. Lett., 9, 252
van den Bergh S., Younger P. F. 1987, A&AS, 70, 125
Wagner R.M. et al. 2007, CBET, 1080
Warner B. 1995, *Cataclysmic Variable Stars*, Cambridge Univ. Press
Williams R. E. 1992, AJ, 104, 725
Williams S. J., Shafter A. W. 2004, ApJ, 612, 867