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UBV photometry of two eclipsing binary stars

U. S. Chaubey and Mahendra Singh
Uttar Pradesh State Observatory, Manora Peak, Naini Tal 263 129

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Abstract. *UBV* light curves of the eclipsing binary systems V364 Cas and MM Cas are presented. A total of eight photoelectric times of minimum light for these stars were derived.

The UBV photometric data of V364 Cas show that the orbital period of the system given by Perova (1957) should be doubled. The secondary minimum falls at $0^{p}.5$.

Key words : eclipsing binaries—UBV light curves—light elements

1. Introduction

In this paper we present *UBV* light curves of the eclipsing binary stars V364 Cas and MM Cas along with photometric ephemerides of the systems. Published photometric ephemerides for both the stars are based on old photographic light curves. No photoelectric light eurves of these two stars have yet been published. All the photoelectric observations of both the stars were made with the 104-cm and 56-cm telescopes of the Uttar Pradesh State Observatory. The observational technique and data reduction procedures were the same as used earlier (Chaubey 1982).

2. Eclipsing binary V364 Cas

The star V364 Cas (BD + 49° 226, BV = 1) was detected photographically as an Algol type variable ($P = 0^{d}.77$) by Perova (1957). The photographic light curve of Perova shows a primary eclipse more than half a magnitude deep and no secondary eclipse. The photometric ephemerides for the system reported by various investigators differ from each other (Wood *et al.* 1980). In 1980 October–December the 56-cm (f/13) reflector of the Uttar Pradesh State Observatory was used to obtain 495 three-colour observations of the system. The photometer was equipped with a refrigerated 1P21 photomultiplier and with standard *UBV* filters. The comparison star used was BD + 49° 229, which is less than half a degree from the variable. For all the observations a diaphragm 15 arcsec in diameter was used to exclude the nearby stars. In addition, nine standard stars were observed to reduce

the data in the standard *UBV* system. The standard errors of our observations are $0^m.03$, $0^m.02$ and $0.^m02$, respectively, in *U*, *B* and *V* filters.

From the observed three-colour photometric data, four times of minimum light have been derived. The minimum light times along with their depths in *U*, *B* and *V* filters are given in table 1; wherein the second and third columns represent, respectively, the cycle number and *O*−*C* values computed from the ephemeris (Perova 1957)

$$\text{M (E) JD (Hel)} = 2434333.298 + 0^d.771534\ E. \qquad ...(1)$$

Table 1. The times and the observed depths of minimum light of the eclipsing binary star V364 Cas

JD (Hel)	Cycles	*O*–*C*	Depths		
			U	*B*	*V*
2444 519.075	13202	− $0^d.014$	—	—	—
2444 528.334	13214	− $0^d.014$	$0^m.738$	$0^m.670$	$0^m.701$
2444 555.337	13249	− $0^d.015$	$0^m.657$	$0^m.660$	$0^m.663$
2444 559.195	13254	− $0^d.014$	$0^m.742$	$0^m.663$	$0.^m697$

It can be seen from table 1 that in both *U* and *V*, but not in *B*, the depths of minimum light observed by us at the odd and even cycles are different from each other. This suggests that the period given by Perova (1957) is half of the actual orbital period of the system. The eclipse duration ($D = 5^h.6$) and the constant light outside the primary eclipse, *i.e.* the absence of the secondary eclipse lend support to our conclusion. The differences in the photometric ephemerides of the system observed by the earlier investigators may be due to this wrong choice of orbital period of the system. Using all the observed minima, the following ephemeris for the system V364 Cas has been derived

$$\text{M (E) JD (Hel)} = 2444519.0752 + 1^d.5430694\ E. \qquad ...(2)$$

The observed *U*, *B* and *V* light curves of the system are given in figure 1, which shows that orbit of the eclipsing star V364 Cas is circular.

Furthermore, using the method given by Popper (1956) we have determined the colour indices of the individual stars from the observed $U-B$ and $B-V$ colour indices outside the eclipse and within the eclipses. A plot of these colour indices $U-B$ and $B-V$ of both the stars in colour-colour diagram suggests that both the stars are equally reddened, $E(B-V) = 0^m.28$, main-sequence stars. Their spectral types are A6 and A9 respectively. The spectral type of the hotter star is in good agreement with the A7 in the classification given by Wood *et al.* (1980).

3. Eclipsing binary MM Cas

MM Cas ($\alpha_{1980} = 0^h53^m.4$ and $\delta_{1980} = +\ 54°\ 20'.5$) is a favourite eclipsing binary for the observers because its orbital period is short ($P = 1^d.16$), primary eclipse is deep ($\Delta V = 1^m$), and entire duration is brief ($D = 6^h$). The only published light curve of the system is that of Perova (1958) and is based on the photographic observations. The steep slope and a relatively large duration of totality ($d = 2^h$) of the primary eclipse as can be seen in the photographic light curve make it an

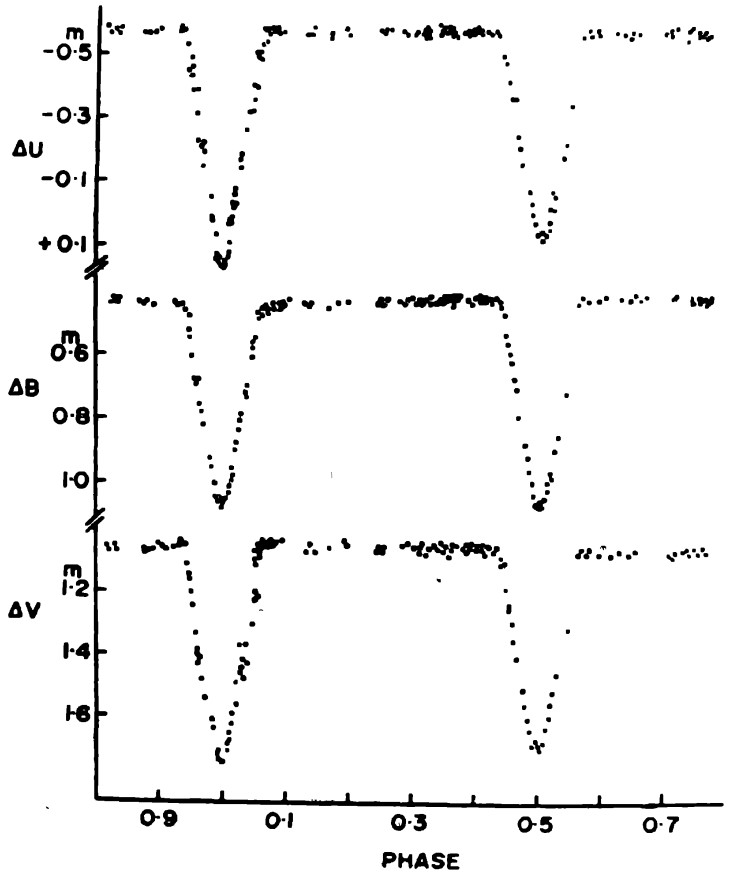

Figure 1. The *UBV* light curves of V364 Cas.

interesting object for photoelectric photometry. This system was observed on 13 nights in the years 1980 through 1982 with the 104-cm telescope of the Uttar Pradesh State Observatory. The telescope was equipped with a EMI 6094S photomultiplier and *UBV* filters. The comparison star used was an anonymous nearby star ($\alpha_{1980} = 0^h\ 53^m.6$ and $\delta_{1980} = +\ 54^\circ\ 20'.6$). A chart of the variable's surroundings is given in figure 2; wherein stars marked *v* and *c* are the variable and comparison, respectively.

From the observed *UBV* data, four primary minima were determined using the method of chord bisection. These times of primary minimum light are listed in table 2, wherein the second and third columns represent the cycle number and $O-C$ values based on the ephemeris (Perova 1958)

$$\text{M(E) JD (Hel)} = 2435401.483 + 1^d.15847\ E. \qquad ...(3)$$

Table 2. The times of primary minimum light of MM Cas

JD (Hel)	Cycles	$O-C$
2444 544.154	7892	+ 0^d.026
2444 581.227	7924	+ 0^d.028
2444 881.270	8183	+ 0^d.027
2444 917.183	8214	+ 0^d.028

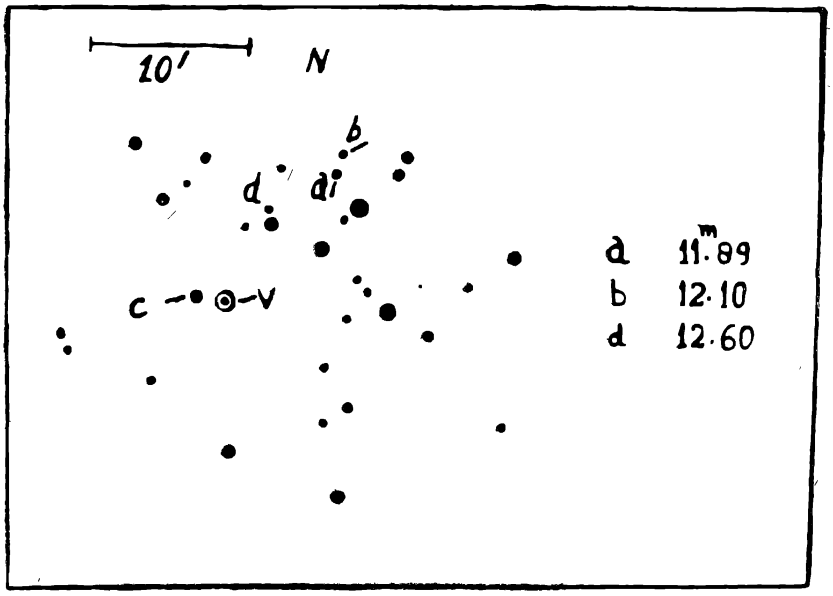

Figure 2. Finding chart of MM Cas and the comparison star.

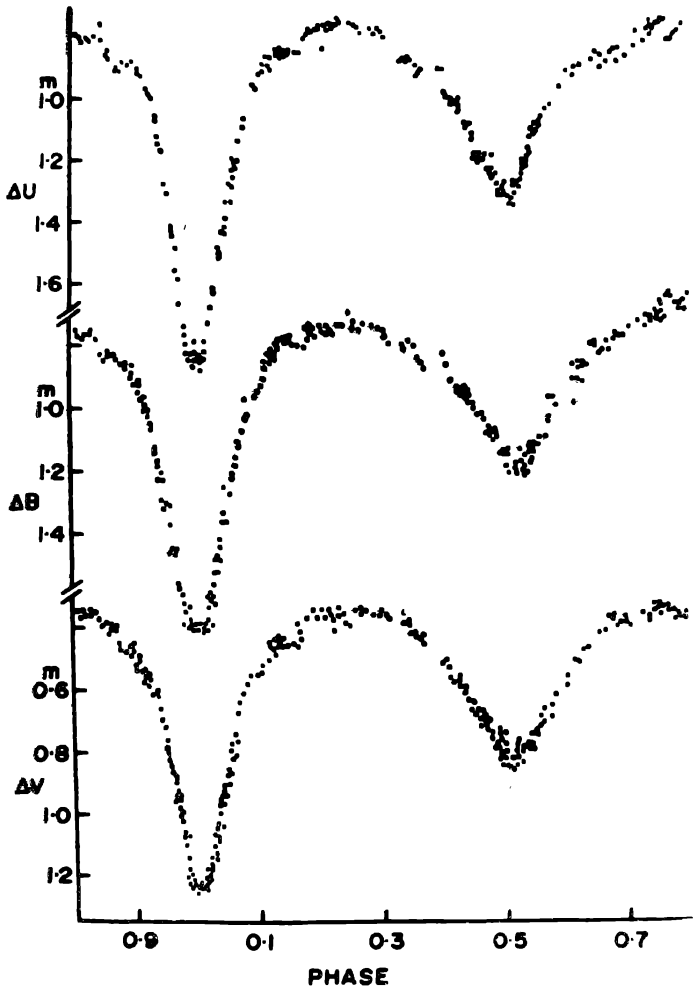

Figure 3. The *UBV* light curves of MM Cas.

Using all the observed minima, the following new ephemeris for the system MM Cas has been derived :

$$M\,(E)\ JD\ (Hel) = 2444581.227 + 1^d.1584704\ E. \qquad ...(4)$$

The observed *UBV* light curves based on this new ephemeris are given in figure 3.

It can be seen from figure 3 that there are brightness fluctuations in the light curves, which seem to be enhanced during the secondary minimum and disappear during the central phase of the primary minimum. This behaviour may be due to an intrinsic variability of the hotter component which is totally eclipsed durlng the primary minimum.

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