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# FINAL CLASSIFICATION OF THE BRIGHT VARIABLE STAR WW CMa

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The brightness variability of the star BD $-21°$ 1424 was discovered by Hoffmeister (1933). This star preliminarily designated as 176.1932 was characterised with a short period in the discovery note. Florja (1937a) observed the star visually but his 42 brightness estimates obtained on 21 nights (in 1933 and 1935) were inconclusive: in Florja (1937b) he remarked 'that confirmation of variability is still required'. Parenago (1939), however, determined a period of 5.7660 days based on the analysis of Florja's visual data, and without explicitly stating that 176.1932 CMa is a Cepheid, the English translation of the Russian title of this communication (On the period of 15 Cepheids) implies this classification. Interestingly enough, Joy (1937) already included this variable among his sample in his seminal study of radial velocity of Cepheids in spite of the fact, that no hint at the Cepheid nature of this star was available in the literature at that time. Soon after, a new suggestion emerged: Kanda (1938) classified this star as an RR Lyrae type variable with a period of 0.499355 day.

The photographic magnitudes based on the Dushanbe (Stalinabad) plate archive, however, contradicted both period values (Erleksova, unpublished). Therefore, though the compilers of the first edition of the General Catalogue of Variable Stars classified this star (designated as WW Canis Maioris in the meantime) as a Cepheid variable characterised with Parenago's (1939) elements (Kukarkin & Parenago 1948), in the subsequent editions of the GCVS no definite type of variability has been assigned to this rather bright star, though the editors mention rapid variations in its brightness.

While it was classified among classical Cepheids, several studies involved WW CMa in the Cepheid sample investigated from statistical point of view. The first reliable photoelectric data published by Irwin (1961) were decisive: neither the shape, nor the amplitude resembled typical Cepheids, in addition, the $B-V$ colour index remains practically constant. The classification of this variable star as a Cepheid became untenable.

Decades later, new reliable photometric data became available thanks to the ASAS project (Pojmanski & Maciejewski 2004). The long and homogeneous observational series covering the interval 2000-2009 clearly indicated that WW CMa was originally misclassified. In fact, it is an eclipsing binary, as is correctly referred to in the ASAS on-line catalogue quoting an orbital period of 2.5163 days. This value was refined by Sebastian Otero who determined a period of 2.51636 days from the same data (VSX, 2010).

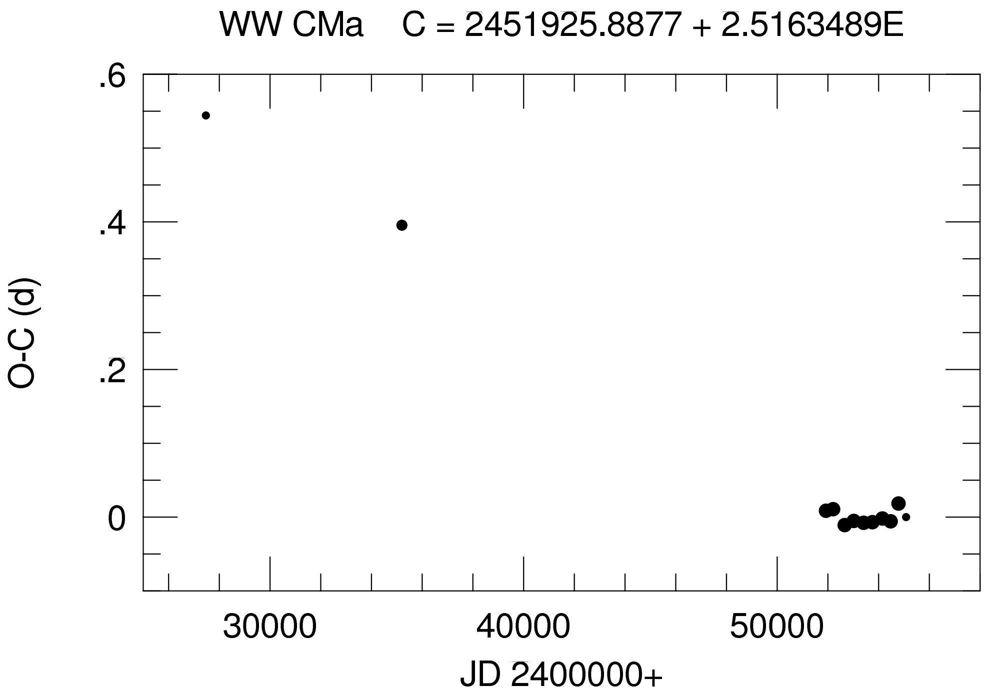


**Figure 1.** $O - C$ diagram of WW CMa

To facilitate the correct classification of this bright variable star, here I revise and improve the orbital period and discuss the available information on WW CMa. The early and the modern photometric data have been subjected to an $O - C$ analysis. The ASAS data provide a reliable normal light curve so the normal maxima for earlier data have been determined by fitting Florja's (1937a) and Irwin's (1961) observations to this normal curve. Moreover, the ASAS data have been divided into annual segments. The resulting moments of normal maxima, the epoch, the $O - C$ value and its weight in the least squares fit, as well as the source of the observations are listed in Table 1. The tabulated $O - C$ values have been calculated by using the ephemeris:

$$C = 2451925\overset{\mathrm{d}}{.}8877 + 2\overset{\mathrm{d}}{.}5163489E.$$

This period has been obtained by a least squares fit to the ASAS normal maxima. The $O - C$ diagram in Figure 1 clearly indicates that the orbital period of WW CMa is not stable on the time scale of decades: between JD 2430000 - JD 2450000 it was 2.5163 days, i.e., shorter than in the last decade. The pattern of the $O - C$ values cannot be approximated with a parabola implying a continuous period change, so the underlying physical mechanism causing the instability of the orbital period can be the episodic mass loss/exchange.

WW CMa was a target in the sample of ASAS eclipsing variables with the aim at searching for chromospheric activity (Parihar et al. 2009). They observed this binary star on JD 2 453 267 and did not find any chromospheric emission. In addition, Parihar et al. (2009) determined the spectral types of the components from the 2MASS colour indices of WW CMa ($J - H = 0.31$ , $H - K = 0.08$ , $V - J = 1.15$; Cutri et al. 2003). The resulting spectral types are: G0V+G6V, i.e., both components are nearly solar type stars.

Table 1: $O - C$ residuals of WW CMa

| JD$_\odot$ 2 400 000 + | $E$ | $O - C$ d | $W$ | Data source |
|---|---|---|---|---|
| 27470.0369 | −9719 | 0.0603 | 1 | Florja (1937a) |
| 35200.1131 | −6647 | 0.0629 | 2 | Irwin (1961) |
| 51925.8963 | 0 | 0.0000 | 3 | ASAS |
| 52205.2131 | 111 | 0.0075 | 3 | ASAS |
| 52663.1671 | 293 | −0.0051 | 3 | ASAS |
| 53020.4943 | 435 | 0.0075 | 3 | ASAS |
| 53408.0095 | 589 | 0.0125 | 3 | ASAS |
| 53755.2665 | 727 | 0.0201 | 3 | ASAS |
| 54150.3382 | 884 | 0.0327 | 3 | ASAS |
| 54474.9434 | 1013 | 0.0352 | 3 | ASAS |
| 54784.4785 | 1136 | 0.0654 | 3 | ASAS |
| 55083.9056 | 1255 | 0.0528 | 1 | ASAS |

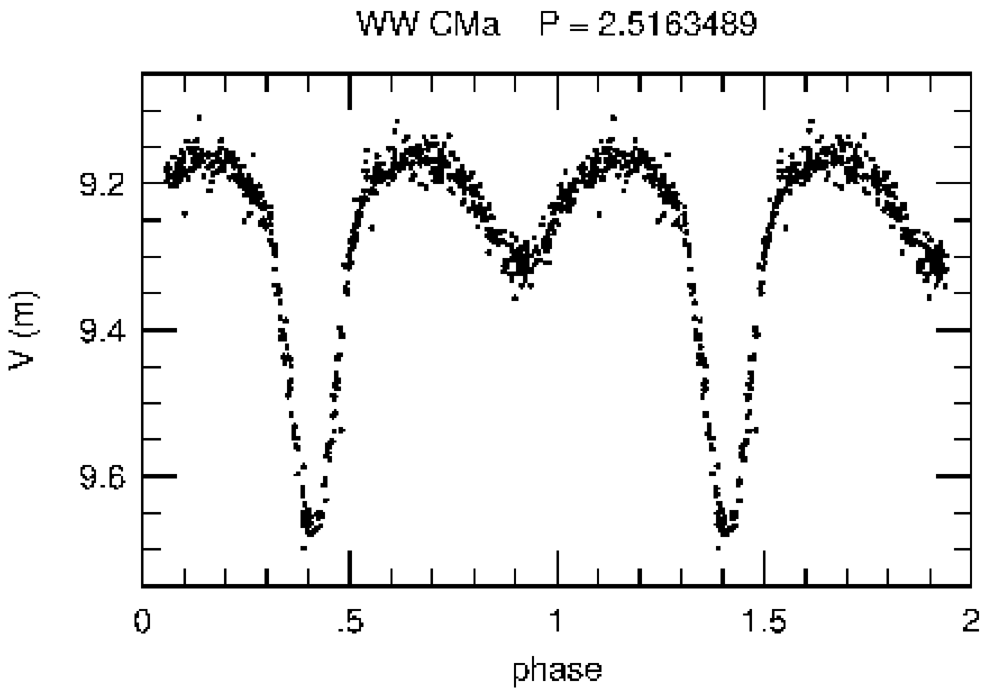


**Figure 2.** Photometric phase curve based on the ASAS data

The eclipsing light curve folded on the accurate period of 2.5163489 days is plotted in Fig. 2 based on the ASAS photometry (the outlying points have been omitted).

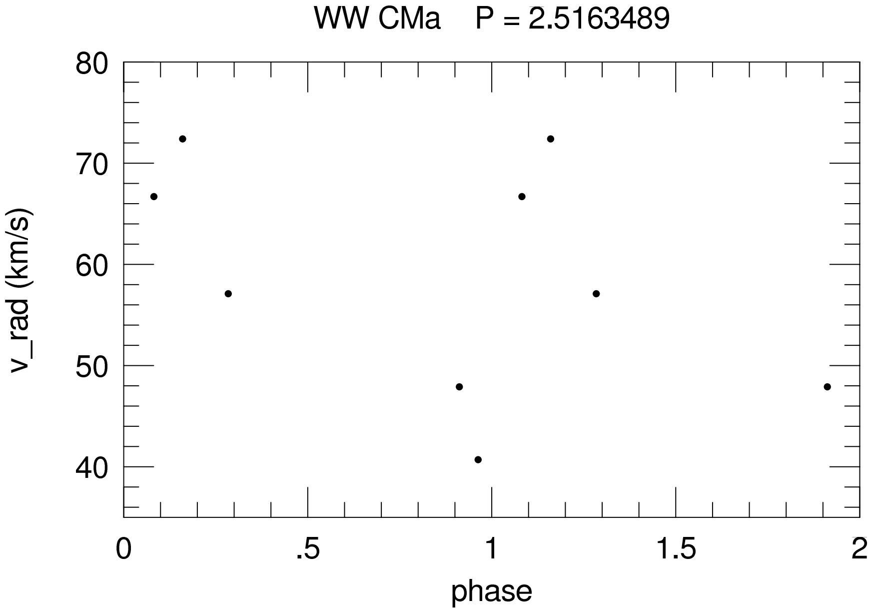


**Figure 3.** Radial velocity phase curve based on Joy's (1937) data

The radial velocity data published by Joy (1937) are plotted in Fig. 3. When plotting these data, the proper phase shift deduced from Fig. 1 has been taken into account but the same period was used for folding the data as for the photometric phase curve. The radial velocity phase curve is compatible with the orbital effect. However, a new series of accurate radial velocities is necessary to determine the orbital elements of this binary system formed by solar type stars.

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