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THE VARIABLE PERIOD OF V366 CASSIOPEIAE

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V366 Cas (spectr. G1) = GSC 3681.494 = CSV 122 = S 3875 was discovered by Hoffmeister (1949). He announced it as a short periodic variable star between $10\overset{m}{.}5$ and $11\overset{m}{.}0$ (pg.). Further investigations on sky patrol plates were done by Perova (1957). She found the star to be of W UMa type and gave first elements including a period of $0\overset{d}{.}7292714$. These elements could be confirmed in an early paper by Berthold (1978). Using the minima given by Perova and 17 new ones using sky patrol plates of Hartha Observatory, the following refined ephemeris has been derived:

$$\text{Min I} = \text{HJD } 2435075.461 + 0\overset{d}{.}72927425 \times \text{E}. \quad (1)$$

With these elements V366 Cas is listed in the fourth edition of the GCVS (Kholopov et al., 1985).

F.A. recently made CCD photometry with a SBIG ST6 camera without filters attached to a 20-cm SC–telescope, from which 14 minima times using the Kwee–van Woerden algorithm (Kwee, van Woerden 1956) could be derived. We also obtained a CCD–based light-curve given in Fig. 2. Since the amplitudes in Min I and Min II differ less than the scattering from night to night, we were not able to unambiguously distinct between the respective minima. We therefore left the definition of the primary minimum (Min I) unchanged.

In order to check the long–term behaviour of the period and to bridge the gap between the Hartha plates and the CCD measurements, additional observations on 279 sky patrol plates of Sonneberg Observatory were performed by T.B. They cover a period of time between J.D. 2441039 and 2450370. In order to obtain more accurate minimum times, we calculated mean lightcurves of 5 consecutive subsections using ephemeris (1) and thus, derived times of normal minima.

As comparison stars the ones given in the paper of Perova were used. However, we derived new photographic magnitudes based on the Harvard–Groningen SA8:

Perova	GSC	mpg	Perova	GSC	mpg
a	3681.374	11.40	b	3681.1033	12.44
c	3681.493	12.64	d	3681.988	12.98

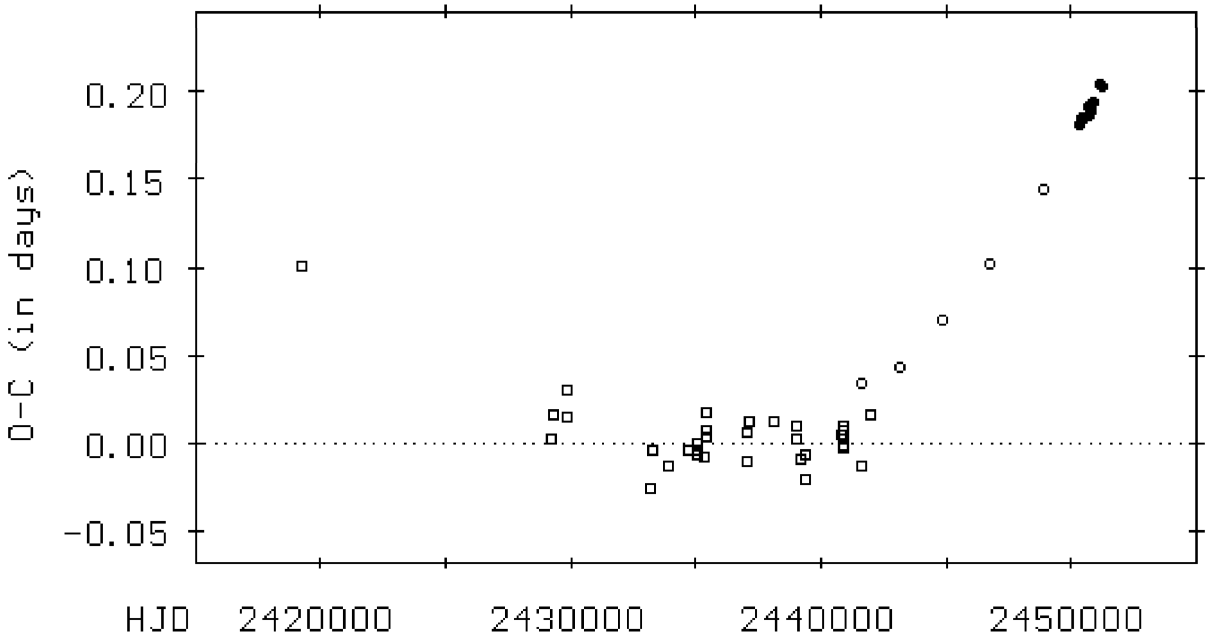

Figure 1. $O - C$ diagram of all available minima according to ephemeris (1). Symbols are identified as follows: □ : Photographic minima, ○ : Photographic normal minima of Berthold (this paper) and ● : CCD minima.

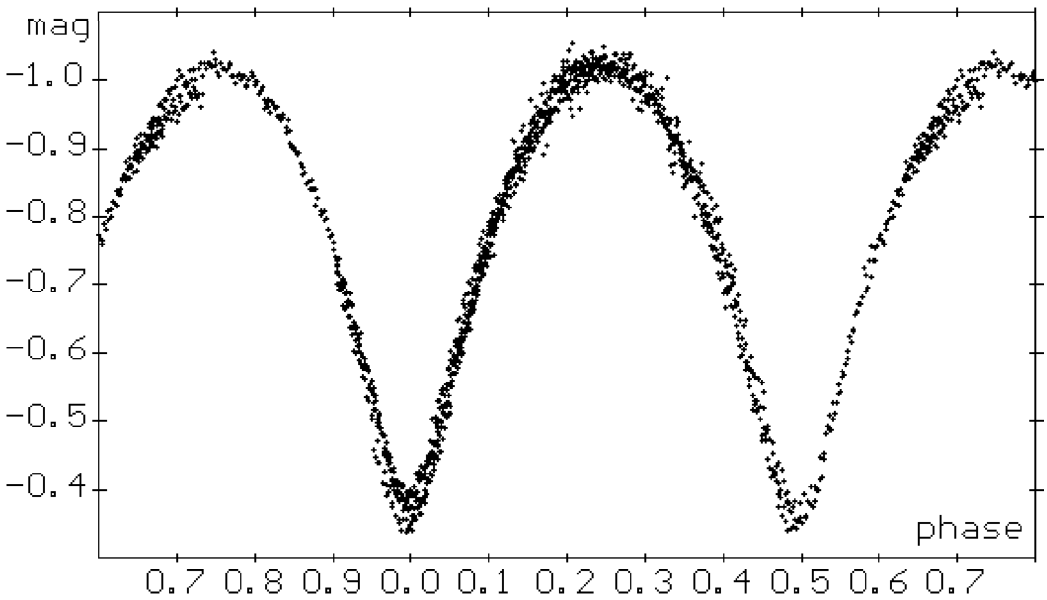

Figure 2. CCD light curve of V366 Cas, according to elements (3).

Table 1: Times of minima for V366 Cas, epochs and residuals computed according to the ephemeris (2) and (3), respectively.

JD hel. 2400000+	W	T*	Epoch_2	$O-C_2$	Ref.	JD hel. 2400000+	W	T*	Epoch_3	$O-C_3$	Ref.
19255.415	1	P	−21693.0	+0.089	[1]	41567.495	2	F	−11976.0	+0.024	[3]
29166.519	1	P	−8102.5	−0.004	[1]	41598.442	1	P	−11934.5	−0.024	[2]
29287.228	1	P	−7937.0	+0.011	[1]	41973.318	1	P	−11420.5	−0.002	[2]
29848.419	1	P	−7167.5	+0.025	[1]	43138.360	2	F	−9822.0	+0.001	[3]
29879.397	1	P	−7125.0	+0.009	[1]	44847.442	2	F	−7479.5	−0.005	[3]
33183.333	1	P	−2594.5	−0.030	[1]	46706.393	2	F	−4930.5	−0.010	[3]
33209.244	1	P	−2559.0	−0.008	[1]	48888.424	2	F	−1938.5	−0.010	[3]
33856.466	1	P	−1671.5	−0.017	[1]	50301.4298	10	E	0.0	−0.0013	[4]
34681.285	1	P	−540.5	−0.006	[1]	50379.4651	10	E	107.0	+0.0001	[4]
35075.455	1	P	0.0	−0.009	[1]	50380.5592	10	E	108.5	+0.0003	[4]
35076.190	1	P	1.0	−0.003	[1]	50423.2229	10	E	167.0	+0.0006	[4]
35077.280	1	P	2.5	−0.007	[1]	50716.3925	10	E	569.0	−0.0038	[4]
35363.517	1	P	395.0	−0.010	[1]	50718.5845	10	E	572.0	+0.0003	[4]
35394.522	1	P	437.5	+0.001	[1]	50728.4295	10	E	585.5	−0.0001	[4]
35401.455	1	P	447.0	+0.006	[1]	50739.3669	10	E	600.5	−0.0020	[4]
35431.365	1	P	488.0	+0.015	[1]	50754.3192	10	E	621.0	−0.0001	[4]
37016.431	1	P	2661.5	+0.005	[2]	50755.4130	10	E	622.5	−0.0002	[4]
37044.492	1	P	2700.0	−0.011	[2]	50756.5069	10	E	624.0	−0.0003	[4]
37082.437	1	P	2752.0	+0.011	[2]	50863.3481	10	E	770.5	+0.0002	[5]
38142.437	1	P	4205.5	+0.012	[2]	51100.373	5	E:	1095.5	+0.006	[4]
39024.484	1	P	5415.0	+0.002	[2]	51177.3098	10	E	1201.0	+0.0031	[4]
39035.430	1	P	5430.0	+0.009	[2]	51185.3316	10	E	1212.0	+0.0028	[4]
39146.261	1	P	5582.0	−0.010	[2]						
39381.441	1	P	5904.5	−0.020	[2]						
39389.476	1	P	5915.5	−0.007	[2]						
40825.429	1	P	7884.5	+0.005	[2]						
40851.312	1	P	7920.0	−0.001	[2]						
40853.503	1	P	7923.0	+0.002	[2]						
40856.426	1	P	7927.0	+0.008	[2]						
40863.357	1	P	7936.5	+0.011	[2]						
40924.238	1	P	8020.0	−0.002	[2]						

* P denotes photographic minima, F photographic normal minima and E CCD observed minima. Those marked with ':' got reduced weight.

[1]: Perova (1957), [2]: Berthold (1978), [3]: Berthold: this paper, [4]: Agerer: this paper, [5]: Diethelm (1998)

As it is clearly to be seen, the period of V366 Cas is significantly changing. For describing such a behaviour, two different approaches can be made: (1) we assume the period was constant during certain periods of time with distinct period jumps in between, (2) we apply a continuously increasing changing period with a quadratic $O-C$ fit.

Assuming two consecutive constant periods, the following set of linear elements can be derived:

From JD 2427500 (approx.) to JD 2441000 (approx.):

$$\begin{array}{l} \text{Min I} = \text{HJD } 2435075.464 + 0\overset{\text{d}}{.}72927385 \times E. \\ \qquad\qquad\qquad\qquad\qquad \pm 2 \qquad\qquad\quad \pm 42 \end{array} \tag{2}$$

From JD 2441000 (approx.) to JD 2451185 (last observed minimum):

$$\begin{array}{l} \text{Min I} = \text{HJD } 2450301.4311 + 0\overset{\text{d}}{.}72928857 \times E. \\ \qquad\qquad\qquad\qquad\qquad\quad \pm 3 \qquad\qquad\quad \pm 13 \end{array} \tag{3}$$

If Perova's first moment of minimum is correct, it is obvious that a further change has occurred sometimes in the first third of this century.

Alternatively – and the $O-C$ diagram suggests this strongly – a weighted quadratic least squares fit is also possible to achieve that yields the following elements:

$$\begin{array}{c} \text{Min I} = \text{HJD } 2435075.449 + 0\overset{\text{d}}{.}72927554 \times E. \\ \pm 1 \qquad\qquad \pm 15 \end{array} \tag{4}$$

Based on the quadratic elements we can derive the rate of change of the period as $dP \sim 7\overset{\text{d}}{.}6 \times 10^{-10}$ per orbital revolution. Under the assumption that this change is caused by mass exchange between the stars, the mass transfer proceeds from the less massive component to the more massive component since the period increases. If we knew the stellar masses we were able to derive the mass transfer rate $|\delta m|$ using the well-known relation (Kopal, 1978)

$$\frac{dP}{P} = 3\left(1 - \frac{m_1}{m_2}\right)\frac{|\delta m_1|}{m_1}, \tag{5}$$

where m_1 (more massive component) and m_2 represent the stellar masses. Although the CCD light-curve (Fig. 2) clearly indicates a close binary system and that one or both stars must be heavily distorted, an estimate of the mass ratio is hard to achieve. Provided the stars are similar and, thus, assuming a mass ratio in the order of 0.9 and (roughly) a solar mass for both components (spectrum G1), we obtain a mass transfer rate of $1.75 \times 10^{-6} M_{\odot}/\text{yr}$.

The improved electronic version of the GCVS (Kholopov et al. 1998) lists only 4 other objects of similar periods (0.65...0.85 days) and spectra between F8 and G5 showing W-UMa-like lightcurves: VY Cnc, UZ CMi, RS Col, and ER Vul. Although described as EW/DW, this classification is erroneous in at least one case (RS Col). Insufficiently studied until today, UZ CMi might be also a contact binary (Giuricin, Mardirossian and Mezzetti 1983). ER Vul, on the contrary, is a short-period RS CVn-type star. This makes V 366 Cas an interesting case to which more attention should be paid. We therefore suggest time-resolved spectroscopy and multicolor CCD photometry of this object.

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