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WW CEPHEI: ELEMENTS REDISCOVERED AND IMPROVED

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The Algol–type eclipsing binary WW Cep = 241.1928 Cephei was discovered by Schneller (1928) on photographic plates of Babelsberg Observatory. Later, Schneller (1931) published a list of individual photographic magnitudes ranging between $11^{\mathrm{m}}.0$ and $11^{\mathrm{m}}.8$, determined the time between first and last contact of the primary minimum as $\mathrm{D} = 4^{\mathrm{h}}.1$ and reported the following first elements:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2425098.527\ +\ 4^{\mathrm{d}}.60086 \times \mathrm{E}.$$

Metzger rediscovered the variable independently on the same photographic plates and found D= $0^{\mathrm{d}}.15$ and d= $0^{\mathrm{d}}.03$ (Staker, 1931). WW Cep was again investigated by Götz (1951) on plates of the Sonneberg Sky Survey. He submitted four minima timings and calculated new elements:

$$\mathrm{Min\,I} = \mathrm{HJD}\,2425029.495\ +\ 1^{\mathrm{d}}.53360 \times \mathrm{E}.$$

With these elements WW Cep is listed in the GCVS (1985). Šilhán (1982) reported that in a photographic and visual search the primary minimum could not be found. Lacy (1990) noted that his spectrograms are inconsistent with the ephemeris listed in the GCVS (1985). Photoelectric photometry by Lacy (1992) showed no sign of an eclipse at phase 0.0327. Using the photographic magnitudes published by Schneller (1931) together with the elements from the GCVS, a reduction to one cycle shows that seven measurements contradict the ephemeris used. In spite of all that, two BBSAG observers published 17 visual minima which follow quite well the published elements. These discrepancies made WW Cep a candidate for the observing program of the author.

The observations were made at his private observatory with an SBIG ST6 CCD–camera without filters attached to a 20 cm SC–telescope. WW Cep was observed on 20 nights between Apr. 1993 and Oct. 1994. The rather large scatter in the lightcurve is due to not always photometric weather conditions. The minima times were calculated using the Kwee – van Woerden (1956) method. From about two and a half thousand pictures over almost all phases the true period could be rediscovered. It is very near the original one suggested by Schneller. In the instrumental system the depth of the primary and secondary minima were found to be $0^{\mathrm{m}}.64$ and $0^{\mathrm{m}}.16$, respectively.

Using the minima from Parenago and Schneller together with the new observations, a least squares fit yields the following linear ephemeris. The visual observations by the BBSAG seem to be affected by systematic error and had to be excluded.

$$\begin{array}{lll} \mathrm{Min\,I} = \mathrm{HJD}\,2449662.4438 & + & 4^{\mathrm{d}}.60084540 \times \mathrm{E} \\ \qquad\qquad\qquad\qquad \pm 2 & & \qquad \pm 14 \end{array} \qquad (1)$$

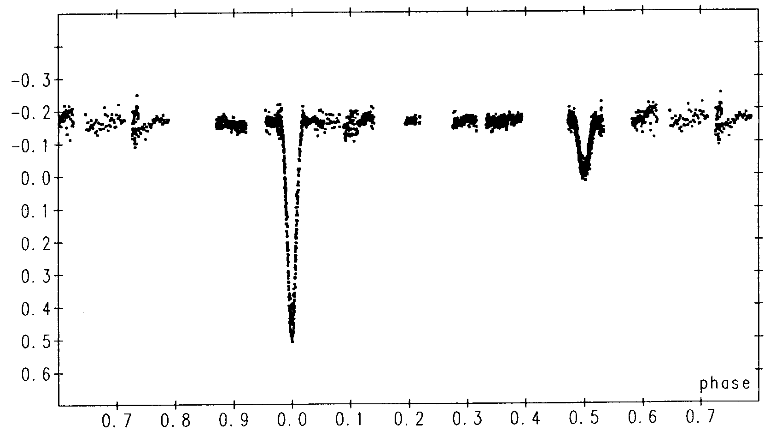

Figure 1: Differential light curve of WW Cep computed with respect to the new ephemeris (1).

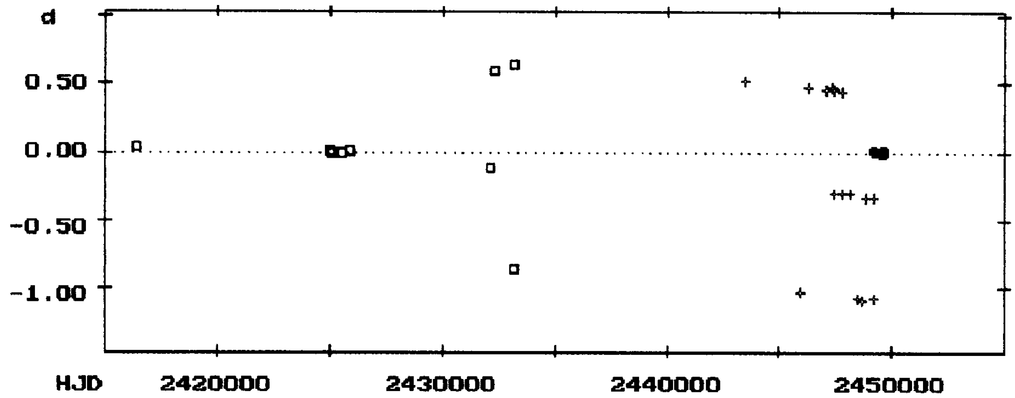

Figure 2: O–C–diagram for WW Cep computed with respect to the new ephemeris (1) using all available minima timings. • represents photoelectric, ∘ photographic series, + visual observations and □ photographic plate minima.

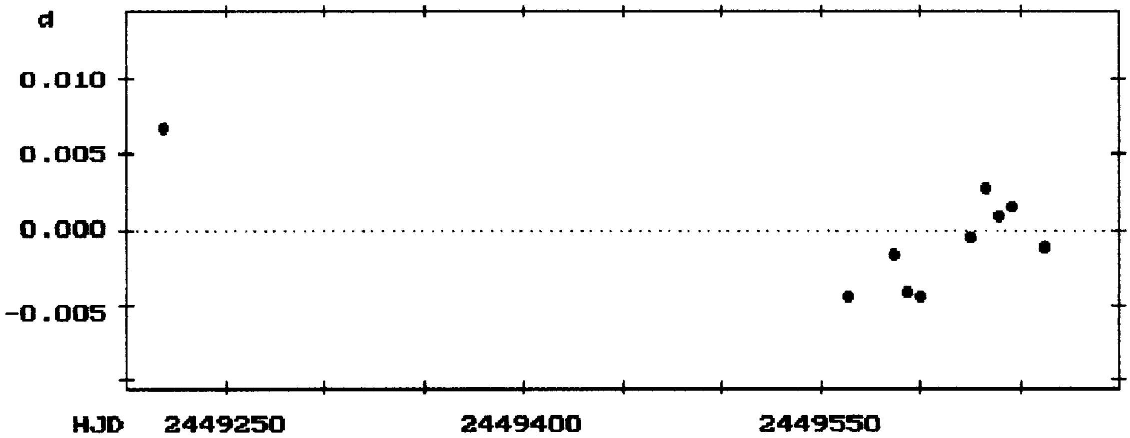

Figure 3: O–C diagram for WW Cep computed with respect to the new ephemeris (1) using only photoelectric observations.

Table 1. Observed times of minima for WW Cep, epochs and residuals computed with respect to the ephemeris (1) derived in this paper.

N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit	N	JD hel. 2400000+	W	T*	Epoch	(O–C)	Lit
1	16375.36	2	P	−7235.0	+0.03	[1]	20	47757.392	0	V::	−414.0	−0.302	[11]
2	25029.518	2	P	−5354.0	+0.000	[2]	21	48125.455	0	V::	−334.0	−0.306	[12]
3	25098.526	20	F	−5339.0	−0.004	[2]	22	48444.452	0	V::	−265.5	−1.068	[13]
4	25121.530	2	P	−5334.0	−0.004	[2]	23	48467.451	0	V::	−260.5	−1.073	[13]
5	25503.400	1	P:	−5251.0	−0.005	[2]	24	48490.456	0	V::	−255.5	−1.073	[13]
6	25908.280	1	P:	−5163.0	+0.001	[2]	25	48619.267	0	V::	−227.5	−1.085	[14]
7	32119.308	0	P::	−3813.0	−0.112	[3]	26	48852.363	0	V::	−176.0	−0.332	[15]
8	32292.554	0	P::	−3776.5	+0.602	[3]	27	49217.394	0	V::	−97.5	−1.068	[16]
9	33134.551	0	P::	−3593.5	+0.644	[3]	28	49218.4690	60	E	−97.5	+0.0068	[17]
10	33151.454	0	P::	−3589.5	−0.856	[3]	29	49220.435	0	V::	−96.0	−0.328	[16]
11	43509.335	0	V::	−1338.5	+0.522	[4]	30	49563.5213	60	E	−22.5	−0.0043	[17]
12	45932.434	0	V::	−811.5	−1.025	[5]	31	49586.5283	60	E	−17.5	−0.0016	[17]
13	46320.404	0	V::	−727.5	+0.474	[6]	32	49593.427	30	E:	−15.0	−0.004	[17]
14	47116.329	0	V::	−554.5	+0.453	[7]	33	49600.328	30	E:	−14.5	−0.004	[17]
15	47323.387	0	V::	−509.5	+0.473	[8]	34	49625.6366	60	E	−8.0	−0.0004	[17]
16	47392.381	0	V::	−494.5	+0.454	[9]	35	49632.5410	60	E	−7.5	+0.0027	[17]
17	47412.324	0	V::	−489.0	−0.306	[10]	36	49639.4405	60	E	−5.0	+0.0009	[17]
18	47415.390	0	V::	−489.5	+0.459	[9]	37	49646.3424	60	E	−4.5	+0.0016	[17]
19	47737.432	0	V::	−419.5	+0.442	[11]	38	49662.4427	60	E	0.0	−0.0011	[17]

[1]: Parenago (1934), [2]: Schneller (1931), [3]: Götz (1951), [4]: Peter (1978), [5]: Peter (1984), [6]: Peter (1985), [7]: Peter (1988a), [8]: Blättler (1988), [9]: Peter (1988b), [10]: Blättler (1989), [11]: Peter (1989), [12]: Peter (1990), [13]: Peter (1991), [14]: Peter (1992a), [15]: Peter (1992b), [16]: Peter (1994), [17]: this paper
*) P denotes pg plate min., E CCD min., F pg series and V visual estimates. Those marked with ':' got reduced weight while those marked with '::' were discarded.

It should be mentioned that plate E409 at epoch 2425505.468 (m = 11.13) of the list of photographic magnitudes by Schneller (1931), if significant, seems to indicate the descend to a secondary minimum. If this is true, the phase of min II would have been at phase 0.46 whereas the new measurements show min II at phase 0.5. Therefore WW Cep may be a system with apsidal motion.

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