

MINIMA OF VW CEPHEI OBSERVED IN SUMMER 1978
AND ACCURATE DETERMINATION OF A MEAN MINIMUM

ABSTRACT - 61 minima of VW Cephei were determined from visual estimates made by 7 GEOS observers in July and August 1978. The mean O-C, as related to ephemeris (1), is -0.0106 d. The accuracy reached (± 0.0012 d. at the 95 % level of confidence) can compare with the accuracy obtained from photoelectric observations made during the same period.

RESUMEN - 61 mínimos de VW Cephei fueron determinados a partir de las estimaciones visuales de 7 observadores del GEOS en Julio y Agosto de 1978. El O - C medio es -0.0106 d. respecto a la efemeride (1). La precisión obtenida sobre este valor (± 0.0012 d. con un nivel de confianza del 95 %) es comparable a la de las observaciones fotoeléctricas realizadas en la misma época.

RESUME - 61 minima de VW Cephei ont été déterminés à partir des estimations visuelles de 7 observateurs du GEOS en juillet et août 1978. L'O-C moyen est -0.0106 par rapport à l'éphéméride (1). La précision obtenue sur cette valeur (± 0.0012 j. au niveau de confiance 95 %) est comparable à celle des observations photo-électriques réalisées à la même époque.

RIASSUNTO - A partire da stime visuali di 7 osservatori del GEOS nei mesi di luglio e agosto 1978, son stati determinati 61 minimi di VW Cephei. L'O-C medio risulta -0.0106 g. rispetto all'effemeride (1). La precisione ottenuta su questo valore (± 0.0012 g. a livello di affidabilità del 95 %) è paragonabile a quelle delle osservazioni fotoelettriche realizzate all'epoca.

1. INTRODUCTION.

VW Cephei is a famous contact binary which has been the subject of many papers these late years : VAN'T VEER (1973), NIARCHOS (1979), CRISTESCU and al. (1979), PORETTI (1981)... Variations of the period have been observed, as well as oscillations of the secondary minimum around phase 0.5 , and changes in the shape of the light curve : HERSHEY (1975), PUSTYLNİK and SORGSEPP (1976), WALTER (1979)...

The ephemeris used in this paper is the one given by KUKARKIN (1976) :
Min. I = J.D. 2441880.8027 + 0.2783161 E (1)

2. OBSERVATIONS.

VW Cep was observed at the GEOS camp held at Chamaloc (Drôme, France) from 1978 July 27 to 1978 August 12. 7 observers sent their estimates, totalling 1580 visual measures which are analysed here.

A.FIGER	FGR	F - Paris
P.GUIRAUDOU	GUI	F - Montpellier
J.F.LE BORGNE	FLB	F - Toulouse
C.PAMPALONI	PMP	I - Firenze
E.PORETTI	POI	I - Arconate
P.RALINCOURT	RAL	F - Nantes
S.WABNITZ	WAB	I - Roma

Table 1 : List of observers

3. LIST OF MINIMA.

The minima were determined by the tracing-paper method, giving more attention, if necessary, to points near the minimum, so as to reduce the influence of possible irregularities in the light curve. For every minimum followed by each observer, at least 3 independent determinations were made, by at least 2 different persons.

The list of minima (i.e. means of these independent determinations) is given in table 2. The O-C's are related to ephemeris (1).

Date 1978	Hour U.T.	Prim. or Second.	HJD 244....	O - C (day)	Observer
27 JUL	21 29.4	I	3717.3949	- 0.0157	WAB
28	0 52.0	II	3717.5356	- 0.0142	WAB
28	0 58.8	II	3717.5403	- 0.0095	FGR
28	1 00.2	II	3717.5413	- 0.0085	RAL
28	21 11.2	II	3718.3823	- 0.0025	FGR
28	21 14.7	II	3718.3847	- 0.0001	RAL
29	0 09.8	I	3718.5063	- 0.0176	WAB
29	0 28.3	I	3718.5192	- 0.0047	RAL
29	0 28.4	I	3718.5192	- 0.0047	FGR
29	23 40.8	II	3719.4863	- 0.0117	WAB
29	23 47.4	II	3719.4909	- 0.0071	FGR
29	23 58.3	II	3719.4984	+ 0.0004	RAL
1 AUG	21 36.9	I	3722.4002	- 0.0201	WAB
1	21 55.7	I	3722.4133	- 0.0070	FGR
1	22 02.6	I	3722.4181	- 0.0022	RAL
2	1 11.3	II	3722.5491	- 0.0104	RAL
2	1 14.5	II	3722.5513	- 0.0082	FGR
3	0 11.5	I	3723.5077	- 0.0259	FLB
3	0 34.4	I	3723.5236	- 0.0100	WAB
3	0 37.5	I	3723.5257	- 0.0079	FGR
4	23 04.3	I	3725.4610	- 0.0208	POI
4	23 14.3	I	3725.4680	- 0.0138	WAB
4	23 15.5	I	3725.4688	- 0.0130	GUI
4	23 20.1	I	3725.4720	- 0.0098	RAL
4	23 23.5	I	3725.4744	- 0.0074	FLB
4	23 37.9	I	3725.4844	+ 0.0026	FGR
5	2 32.3	II	3725.6055	- 0.0155	POI
5	2 34.6	II	3725.6071	- 0.0139	FGR
5	22 37.4	II	3726.4423	- 0.0136	POI
5	22 39.0	II	3726.4435	- 0.0124	GUI

Date 1978	Hour U.T.	Prim. or Second.	HJD 244....	O - C (day)	Observer
5 AUG	22 39.4	II	3726.4437	- 0.0122	WAB
5	22 41.7	II	3726.4453	- 0.0106	RAL
5	22 47.6	II	3726.4494	- 0.0065	FGR
6	1 51.8	I	3726.5773	- 0.0178	FGR
6	1 56.0	I	3726.5803	- 0.0148	WAB
6	2 00.5	I	3726.5834	- 0.0117	RAL
6	2 02.2	I	3726.5846	- 0.0105	GUI
6	2 11.3	I	3726.5909	- 0.0042	POI
6	2 21.7	I	3726.5981	+ 0.0030	PMP
9	0 06.7	II	3729.5045	- 0.0129	RAL
9	0 15.4	II	3729.5105	- 0.0069	FGR
9	0 21.0	II	3729.5144	- 0.0030	POI
9	23 29.0	I	3730.4783	- 0.0132	FGR
9	23 31.8	I	3730.4802	- 0.0113	WAB
9	23 33.4	I	3730.4813	- 0.0102	POI
10	0 00.7	I	3730.5003	+ 0.0088	PMP
10	22 43.4	II	3731.4466	- 0.0190	GUI
10	22 56.7	II	3731.4558	- 0.0098	FGR
10	22 59.3	II	3731.4576	- 0.0080	WAB
10	23 00.3	II	3731.4583	- 0.0073	RAL
10	23 12.3	II	3731.4667	+ 0.0011	POI
11	2 11.7	I	3731.5913	- 0.0135	WAB
11	2 15.0	I	3731.5936	- 0.0112	RAL
11	2 25.2	I	3731.6006	- 0.0042	POI
11	2 26.1	I	3731.6013	- 0.0035	FGR
11	22 16.8	I	3732.4282	- 0.0115	WAB
11	22 20.3	I	3732.4307	- 0.0090	FGR
11	22 23.0	I	3732.4325	- 0.0072	POI
11	22 29.5	I	3732.4371	- 0.0026	GUI
12	1 33.3	II	3732.5647	- 0.0142	FGR
12	1 39.2	II	3732.5688	- 0.0101	POI

Table 2 : Minima of VW Cep

4. MEAN O-C.

4.1. Arithmetic mean.

The mean O-C of the 34 primary minima is - 0.0095 d. (± 0.0024 at the 95 % level of confidence) ; that of the 27 secondary minima is - 0.0091 (± 0.0020). The difference is too small to be significant, and this means that during the 15 days of observations the secondary minimum was practically at phase 0.5 . The overall O-C of the 61 minima is finally - 0.0093 d.

4.2. Weighted mean.

The procedure for calculation of the weighted mean has been described at large by PORETTI (1981). Using here the same notations, one gets the results listed in table 3.

Observer	FGR	WAB	RAL	POI	GUI	FLB	PMP
Number of minima	17	13	12	10	5	2	2
Mean O-C	- 0.0082	- 0.0134	- 0.0074	- 0.0088	- 0.0115	- 0.0166	+ 0.0059
Standard deviation s_i	0.0049	0.0032	0.0047	0.0066	0.0059	-	-
Probable error p_i	0.0012	0.0009	0.0014	0.0021	0.0026	-	-
Weight w_i	69	123	51	23	15	-	-

Table 3 : Standard deviations of the observers

From the values thus derived for the first five observers (more than 2 minima observed), the calculation of the weighted mean gives :

$$\overline{O-C}_w = - 0.0106 \text{ d.} \quad \text{with a probable error } p_w = 0.0006 \text{ d.}$$

5. CONCLUSION.

The following results are finally adopted :

$$\begin{array}{l} \text{Mean minimum : HJD 2443725.4712 } \pm 0.0012 \\ \text{O-C : } \quad \quad \quad - 0.0106 \pm 0.0012 \end{array} \quad \left. \vphantom{\begin{array}{l} \text{Mean minimum : HJD 2443725.4712 } \pm 0.0012 \\ \text{O-C : } \quad \quad \quad - 0.0106 \pm 0.0012 \end{array}} \right) (\pm 2 p_w \text{ at the 95 \% level)}$$

As a reference, minima of VW Cep observed photoelectrically have been sought in literature. It so happens that VW Cep had just been observed shortly before the period analysed here (NIARCHOS, 1979), and also shortly after (CRISTESCU and al. 1979). These observations are not numerous enough to make a calculation of error quite significant ; however, just for the sake of comparison, the mean O-C and the probable error were calculated, using the published instants of minima :

$$\begin{array}{ll} \text{NIARCHOS : } 3 \text{ minima JD from 2443678 to 680} & \overline{O-C} = - 0.008 \quad p = 0.0005 \\ \text{CRISTESCU: } 10 \text{ minima from } 766 \text{ to } 796 & \overline{O-C} = - 0.013 \quad p = 0.0007 \end{array}$$

These values are very consistent with those obtained in the present paper. It can then clearly be seen that the accuracy of the weighted mean ($p_w = 0.0006$) can compare with that of the photoelectric O-C's (0.0005 and 0.0007).

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