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XX CEPHEI: NEW TIMES OF MINIMUM AND A STUDY OF THE PERIOD

The A8 single-spectrum (Struve, 1946) eclipsing system XX Cephei, was observed photoelectrically with the 60 cm telescope at Loiano (Bologna). Nine new times of minimum, derived by the Kwee-Van Woerden's method are reported in Table I, along with the standard errors, the number of single observations used in the determination of the minima and the colour of the observations (columns 1, 2, 3 and 4, respectively).

Table I

	J.D. hel (-2400000)	sigma	n	colour
I	40506.4019	.0002	86	blue
I	40866.3467	.0004	8	blue
I	40866.3485	.0006	8	yellow
I	40887.3841	.0007	18	blue
I	40887.3841	.0007	19	yellow
I	41539.4973	.0003	36	blue
I	41539.4972	.0002	39	yellow
II	41608.443	.003	30	yellow
II	41622.476	.001	44	yellow

Several authors pointed out a variability of the orbital period (Fresa, 1953; Lavrov, 1957; Koch and Koch, 1962; Kopal, 1965). The presence of an apsidal motion was suspected by Fresa (1953). In his classical paper Kopal (1965) indicated the possibility of an apsidal motion and , on the basis of Iljasova (1946), Struve (1946), and Fresa's (1953) data he was able to calculate a value U/P=10000 ± 1200. With the present data we can rule out this possibility. Table II collects these data, with no claim of completeness. We underline the fact that any argument founded on the analysis of the secondary minimum must be considered with caution. This minimum is in fact very shallow, about $0\overset{m}{.}03$ in blue and yellow colours, according to our well observed light-curve.

The period, however, appears not to be constant: in fact the primary minima cannot be represented by a unique linear relation. For the first sixteen minima (Table II) a least squares solution gives:

$$\text{Min.} = \text{JD } \underset{\pm .8}{2425096.449} + \underset{\pm .4}{2\overset{d}{.}337340} \cdot E \qquad (1)$$

For the remaining ones the least squares linear ephemeris turns out to be:

$$\text{Min.} = \text{JD } \underset{\pm .5}{2441539.4917} + \underset{\pm .5}{2\overset{d}{.}3373059} \cdot E \quad (-4801 \leq \bar{E} \leq 643) \qquad (2)$$

The best fit with our own observations (1969-1973) is obtained with the ephemeris:

$$\text{Min.} = \text{JD } \underset{\pm .6}{2441539.4971} + \underset{\pm 2}{2\overset{d}{.}337321} \cdot E \qquad (3)$$

In these solutions the minima are weighted with the criterion of inverse proportionality to the squares of mean errors, when published; in the other cases the weights were attributed on the basis of subjective considerations (photoelectric, photographic or visual observations; number of points, etc.). The O-C values (Fig.1) correspond to (2).

A parabolic-like fit does not improve the run of the residuals and in this case one must assume the old visual or photographic data to be affected by large errors; this, however, is not reasonable because the primary minimum is deep (about 1^m) and, following our observations, symmetric. Some unreasonably great residuals can be found even by using the linear ephemerides of (1) and (2) but in this cases there is not a serious systematic trend. This can perhaps be accounted for with some variation of the light-curve. Our photoelectric light-curves (unpublished) do no agree with those of Iljasova (1946) and Fresa (1953, 1956) but are consistent with those of Schneller (1930) and Lavrov (1957). In all cases these variations, if real, are neither drastic nor rapid.

Table II

XX Cephei (Min.=JD 2441539.4917+$2\overset{d}{.}3373059 \cdot E$)

JD HEL	SIGMA	E	O-C	REFERENCE
2414931.400		-11384	-.201	LAVROV,1959
15291.350		-11230	-.196	,,
17196.190		-10415	-.261	,,
19255.410		-9534	-.207	,,
25124.470		-7023	-.122	,,
25131.500		-7020	-.104	,,
25442.365		-6887	-.101	,,
25484.436		-6869	-.101	TSESEVITCH,1954
25851.405		-6712	-.089	KOCH AND KOCH,1962
25858.417		-6709	-.089	,,
28574.398		-5547	-.058	LAVROV,1959
28595.433		-5538	-.059	,,
28607.148		-5533	-.030	,,
28810.469		-5446	-.055	,,
28920.332		-5399	-.045	,,
29775.889		-5033	.058	,,
30318.100		-4801	.014	,,
30589.228		-4685	.014	,,
30603.229		-4679	-.008	,,
30610.250		-4676	.001	,,
30617.284		-4673	.023	,,
32059.37		-4056	-.009	KOCH AND KOCH,1962
32204.285		-3994	-.007	,,
32232.33		-3982	-.010	,,
32612.09		-3819.5	-.062	,,
32954.561		-3673	-.006	,,
33099.464		-3611	-.016	,,
33134.51		-3596	-.030	,,
33155.555		-3587	-.020	,,
33445.426		-3463	.025	LAVROV,1959
33587.97		-3402	-.007	,,
33889.494		-3273	.005	,,
34039.078		-3209	.001	,,
34041.415		-3208	.001	,,
34060.114		-3200	.001	,,
34061.302		-3199.5	.021	KOCH AND KOCH,1962
34062.451		-3199	.001	LAVROV,1959
34088.162		-3188	.002	,,
34387.337		-3060	.001	,,
34394.349		-3057	.001	,,
34457.455		-3030	.000	,,
34543.921		-2993	-.014	KOCH AND KOCH,1962
34623.395		-2959	-.009	,,
34630.415		-2956	-.000	,,
34768.319		-2897	.002	LAVROV,1959
34903.883		-2839	.003	KOCH AND KOCH,1962
34949.468		-2819.5	.010	,,
34983.350		-2805	.001	LAVROV,1959
35240.452		-2695	-.000	KREINER,1971

Table II (cont.)

JD HEL	SIGMA	E	O-C	REFERENCE
2435247.468		-2692	.004	KOCH AND KOCH,1962
35275.510		-2680	-.002	,,
36285.234		-2248	.006	LAVROV AND LAVROVA,1973
37255.205		-1833	-.005	,,
37790.450		-1604	-.003	DUEBALL AND LEHMANN,1965
37790.451		-1604	-.002	,,
37921.349		-1548	.007	,,
38087.315	.001	-1477	.024	OBURKA,1964
38295.3105		-1388	-.0006	,,
38302.3209		-1385	-.0021	KORDYLEWSKY,1964
38727.708		-1203	-.005	ROBINSON,1965A
38739.392		-1198	-.007	LAVROV AND LAVROVA,1973
38786.138		-1178	-.007	,,
39057.265		-1062	-.008	AHNERT,1967
39057.274		-1062	.001	POHL AND KIZILIRMAK,1966
39057.280		-1062	.007	,,
39080.649		-1052	.003	ROBINSON,1965B
39087.650		-1049	-.008	ROBINSON,1966A
39094.664		-1046	-.006	,,
39183.520		-1008	.033	ROBINSON,1966B
39384.502	.005	-922	.006	CZERLUNCZAKIEWICZ & FLIN,1968
39384.508	.005	-922	.012	,,
39433.569		-901	-.010	ROBINSON,1967
39702.379		-786	.010	LOCHER,1967
39737.446		-771	.017	KIZILIRMAK AND POHL,1968
39821.582		-735	.010	BALDWIN,1973
40090.360		-620	-.002	LAVROV AND LAVROVA,1973
40097.373		-617	-.001	KIZILIRMAK AND POHL,1970
40139.442		-599	-.003	,,
40237.617		-557	.005	BALDWIN,1973
40473.660		-456	-.020	,,
40506.4019	.0002	-442	-.0006	THIS PAPER
40513.419		-439	.005	KIZILIRMAK AND POHL,1970
40520.426		-436	-.000	KIZILIRMAK AND POHL,1971
40737.789		-343	-.007	BALDWIN,1975
40742.471		-341	.001	,,
40859.339		-291	.003	,,
40866.3473	.0003	-288	-.0003	THIS PAPER (*)
40887.3841	.0005	-279	.0007	THIS PAPER (*)
41060.344		-205	.000	LAVROV AND LAVROVA,1973
41060.351		-205	.007	LOCHER AND DIETHELM,1971
41214.61	.01	-139	.004	MEYER,1972
41303.429		-101	.005	LAVROV AND LAVROVA,1973
41359.525		-77	.006	,,
41380.560		-68	.005	,,
41420.294		-51	.005	,,
41448.340		-39	.003	,,
41490.414		-21	.006	PETER,1972
41539.4972	.0002	0	.0055	THIS PAPER (*)

Table II (cont.)

JD HEL	SIGMA	E	O-C	REFERENCE
2441608.443	.003	29.5	.001	THIS PAPER
41622.476	.001	35.5	.010	THIS PAPER
41628.309		38	-.000	DIETHELM,1972
41628.317		38	.008	LAVROV AND LAVROVA,1973
41649.359		47	.014	PETER,1975A
42439.340		385	-.014	LOCHER,1975
42439.383		385	.029	DIETHELM,1975
42453.383		391	.005	PETER,1975B
43042.399		643	.020	PETER,1976

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POHL,E.,KIZILIRMAK,A., ASTRON.NACHR.,289,191,1966.
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REMARK:

(*) THIS TIME OF MINIMUM IS THE WEIGHTED MEAN OF TWO-COLOURS MINIMA

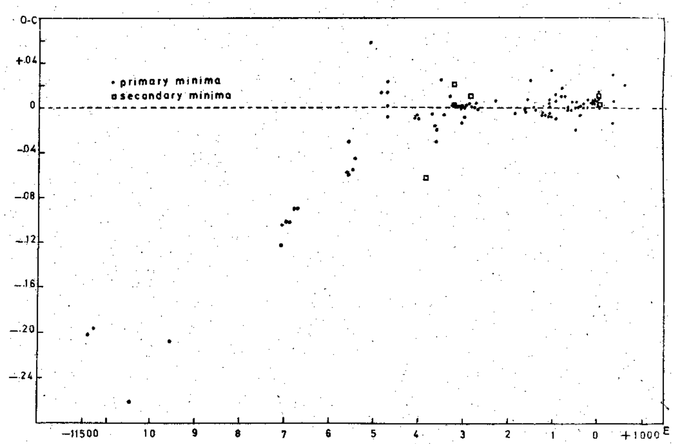

Figure 1 Residuals of XX Cep

In conclusion, we believe that changes of period in XX Cep are real and presently these are better interpreted by two jumps approximately at epochs -4800 and -450. Nevertheless accurate photoelectric observations of primary minimum (easily observable) will possibly evidence a smooth variation of the period which, if this is the case, is now masked by the large residuals.

We should like to thank Mrs. A. Tura who collected the data in Table II.

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Erratum

nton Paschke reports a probable typing error in IBVS 1325. The time of the minium of XX Cep observed by R. Diethelm in 1975 (as printed in IBVS 1325: 42439.383 iethelm 1975) should be 42439.370 according to the BBSAG Bulletin No. 20.

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The Editors