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PHOTOELECTRIC PHOTOMETRY OF THE ECLIPSING BINARY STAR CQ CEPHEI

CQ Cephei (HD 214419=BD+56°2818) is an eclipsing binary system with a period of ~1.64 days. The binary nature of CQ Cep was discovered by McLaughlin and Hiltner (1941). First photoelectric light curves were obtained by Hiltner (1950). Leung et al. (1983) analyzed Hiltner's V light curve and their NIV 4058 Å radial velocity curve with the Wilson - Devinney method. Their analysis showed that the system has a contact configuration. One component is a WN7 and the other is probably a massive early type star (O7).

This eclipsing binary was observed photoelectrically at the Ege University Observatory on 19 nights in 1991 and 12 nights in 1992. The observations were made with the 48 cm Cassegrain reflector. An unrefrigerated EMI 9781A photomultiplier tube and B, V filters which are very close to the standard UBV system were used. BD+56°2815 was selected as comparison and BD +56°2813 as check star. The comparison star was found to be constant in brightness during the period of observations. A total 1511 observational points were obtained in each colour. All the differential magnitudes (in the sense variable minus comparison) were corrected for the atmospheric extinction.

Gaposchkin (1944) discovered the changes of period and analysed photographic observations made in the years 1901 to 1942. He interpreted the shortening of period as the effect of a third body. Semeniuk (1968) proved the shortening of period, however, she pointed out the linear light elements which satisfy the observations made in the interval 1945-65. The period variation and possible causes of it was discussed and interpreted due to the mechanism of mass transfer and loss from the WR component by several authors (Kreiner and Tremko, 1983, 1985). According to their analyses, the period of CQ Cep was decreasing over a long time.

During the observations 7 primary and 3 secondary times of minima were obtained which are given in Table I. These primary times of minima with other photographic and photoelectric ones taken from Kreiner and Tremko (1983, 1985) are used in O−C analysis. The $(O-C)_1$ values were computed using the following light elements given by Kreiner and Tremko (1983):

$$\text{Hel. Min. I J.D.} = 2432456^{\text{d}}.668 + 1^{\text{d}}.6412438 \times E \qquad (1)$$

The $(O-C)_1$ diagram of CQ Cep is shown in Figure 1. As it is clearly seen from the figure, CQ Cep shows a parabolic variation indicating a continuous decrease in the period. Using the times of minima plotted in Figure 1, quadratic light elements have been calculated by the weighted least squares method as follows:

$$\begin{array}{l} \text{Hel. Min. I J.D.} = 2432456^{\text{d}}.694 + 1^{\text{d}}.6412481 \times E - 9.29 \times 10^{-10} \times E^2 \qquad (2) \\ \qquad\qquad\qquad\quad \pm 2 \qquad\quad \pm 2 \qquad \pm 36 \end{array}$$

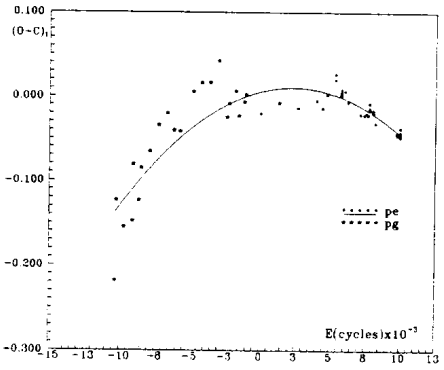

Figure 1. O−C diagram for CQ Cep

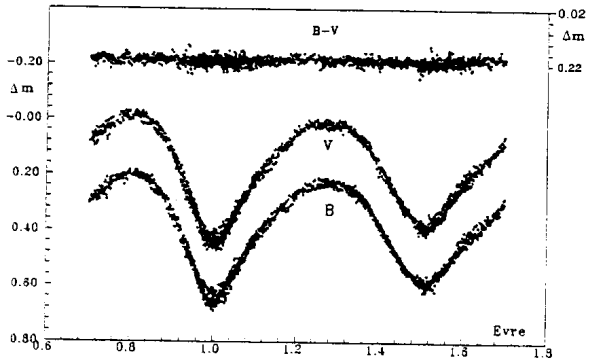

Figure 2. Differential B and V light and B−V colour curves of CQ Cep

Table I
Times of minima of CQ Cephei

J.D. Hel. 2400000+	Method	Min	E	$(O-C)_1$	$(O-C)_2$
48437.4352	pe	I	9737	−0.0437	−0.0026
48506.3667	pe	I	9779	−0.0444	−0.0027
48515.4053	pe	II	9784.5	—	—
48524.4189	pe	I	9790	−0.0459	−0.0040
48826.4066	pe	I	9974	−0.0471	−0.0026
48844.4651	pe	I	9985	−0.0422	0.0023
48849.3938	pe	I	9988	−0.0373	0.0073
48872.3633	pe	I	10002	−0.0452	−0.0003
48876.4868	pe	II	10004.5	—	—
48881.4112	pe	II	10007.5	—	—

Table II. B and V magnitudes of comparison and check stars

Star	V	B	Spectral T.
BD+56°2815 (comparison)	$8^m.66\pm0.01$	$8^m.86\pm0.01$	A0
BD+56°2813 (check)	$8^m.26\pm0.01$	$8^m.66\pm0.01$	A3

Table III. B and V magnitudes of CQ Cep

Colour	Min. I.	Max. I	Min. II	Max. II
V	$9^m.09$	$8^m.68$	$9^m.05$	$8^m.64$
B	$9^m.51$	$9^m.09$	$9^m.45$	$9^m.06$

The period of the system is decreasing with the amount of 0.0036 ± 0.001 second per year.

The light and colour curves are given in Figure 2. The phases in Figure 2 were calculated with the following linear light elements:

$$\text{Hel Min. I J.D.} = 2448524^d.423 \pm 2 + 1^d.6412299 \pm 2 \times E \qquad (3)$$

These elements were obtained from quadratic light elements and may be used in near future. The shape of light curve is typical of β Lyrae type. The magnitudes of comparison, check and variable stars were transformed to standard UBV system and given in Tables II and III.

There are large asymmetries in the light curves. The primary and secondary maxima occur at phases $\sim$0.27 and $\sim$0.81, respectively. Primary eclipse is narrower than the secondary. Secondary minimum occurs at phase $\sim$0.511. In 1992 observations, the primary minimum is deeper by $\sim0^m.02$ than that of the 1991 observations. In Figure 1, the scattering of our observations near the primary is $\sim0^m.05$.

The photometric analysis of the V light curve is in progress and will be published elsewhere.

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ERRATUM

In the No. 3950 issue of the IBVS one of the references was incorrectly given. On page 2, the third ephemeris is based on Oprescu et al. (1991) and the correct reference is:

Oprescu, G., Suran, D. M., and Popescu, N., 1991, *Inf. Bull. Var. Stars*, No. 3560

G. OPRESCU