ΑΝΑΚΟΙΝΩΣΙΣ ΜΗ ΜΕΛΩΝ

ΑΣΤΡΟΝΟΜΙΑ.— **Photoelectric Photometry of Selected Galactic Cepheids. I. Two-Color Observations of 6 Cepheid Variables** *, *by K. Bahner*[1] *and L. N. Mavridis*[2]. Ἀνεκοινώθη ὑπὸ τοῦ Ἀκαδημαϊκοῦ κ. Ἰ. Ξανθάκη.

1. INTRODUCTION

Starting with the pioneer work of Eggen (1951) a great number of photoelectric observations of cepheid variables have been carried out during the last twenty years. In most of these programs, however, an effort was made to increase the number of the stars observed by measuring only the points considered absolutely necessary for a relatively good determination of the light and color curves. In this way rich material for the study of the structure and rotation of the Galaxy with the help of cepheid variables has been obtained.

The determination of as complete and accurate as possible light and color curves of cepheid variables on the other hand, could also be of considerable interest, for example from the following points of view:

a) For a more thorough study of the relations existing between the form and amplitude of the light and color curves and the period. These relations could then be used for a better separation between the population I and population II cepheids in the disk of the Galaxy as well as for an eventual subdivision of these two groups of cepheids into further subgroups.

b) For a control of the stability of the periods and, after reobservation of the same stars at a later time, of the form of the light and color curves. This information could be of great value for the determination of the time scale of the cepheid phaenomenon.

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As a contribution to this second approach, an effort has been made to determine complete and accurate light and color curves (B, V) for the following 18 galactic cepheids with $2^d < P < 17^d$ (Bahner and Mavridis, 1960): RT, RX, SY Aur; RW Cam; SU Cas; VZ, CD Cyg; V, X, Y, Z, RR, BG Lac; RV Ori; SV, AW Per; U Vul (as the period is nearly equal to 8^d the light and color curves are incomplete); TU Cas (numerous observations; the cepheid shows beat phaenomena).

In the present paper, a description is given of the methods of observation and reduction used during the measurement of all the 18 cepheids mentioned above (sections 2 - 4) followed by the results obtained for the 6 cepheids CD Cyg; X, Z, RR Lac; U Vul and TU Cas (section 5). In forthcoming papers the results obtained for the remaining 12 cepheids as well as a discussion of the entire material will be given.

2. OBSERVATIONS

The observations described here have been obtained mostly in 1956/57 and 1957/58, and to a small part, in 1958/59, with the reflector of the Landessternwarte Heidelberg-Königstuhl (aperture 72 cm, f/17). The photometer, mounted at the Nasmyth focus, used an unrefrigerated 1 P21 photomultiplier and was fitted with the Schott filters GG 11, 2 mm for the green resp. BG 12, 2 mm + GG 13, 2 mm for the blue region (at that time we preferred this narrower blue passband to the one given by the standard B filter). The photocurrent was measured by means of a DC amplifier and a strip chart recorder.

Since the sky conditions at Heidelberg are not very favorable to good photometry, we had to use a strictly differential method. Close to each variable V, two comparison stars A, B were selected; after some tryouts we adopted a symmetrical measuring sequence (A b, v V v, b, b, v B v, b, b, v, V v, b, b, v A v, b) which within 25 minutes gives two essentially independent differences V - A, V - B for the same instant, and a difference A - B of half weight, both in v and (b - v), where v and b are visual and blue magnitudes in the instrumental system. Many of the nights used were not photometric, and the A - B values served as a check against gross errors. On some nights, more than one observation of the same cepheid were made. In these cases only one of the comparison stars was usually measured during the additional observations.

3. REDUCTIONS

The differences in air mass between variable and comparison stars were always quite small. The v magnitudes were reduced assuming that the second order term in the v extinction coefficient is zero. The somewhat larger scatter in the v differences of comparison pairs having large color differences can only to a small part be caused by a neglected k''_v. Over the years, for some pairs, small systematic deviations were observed; the assumption of a slowly changing color term in the instrumental system can explain only part of these differences, and no such correction was applied. The mean errors for one observation of a comparison pair v difference are between $0^m.007$ and $0^m.012$.

For the (b — v) colors, the observations were reduced with the relation

$$\Delta (b - v)_o = \Delta (b - v)_X - k''_c X \Delta (b - v)_o$$
$$\simeq \Delta (b - v)_X [1 - k''_c X] ,$$

X is the air mass. The second order coefficient k''_c was determined for each night using all the comparison star observations; the resulting values were between zero and $-0^m.05$. The typical mean error for one observation of a comparison pair color difference is $0^m.009$.

No observation showing reasonable deflections was excluded. If the deviation from the mean comparison star difference was more than $0^m.04$, or the difference between the symmetrial halves of a cepheid observation surpassed $0^m.025$, or the observation was incomplete because of clouds, it was marked uncertain.

4. PHOTOMETRIC SYSTEM

On a few good nights, the comparison stars were observed together with stars which have high weight in Tab. 9 of Johnson et al. (1966). The stars representing the B, V-system cover an adequate range in color and position in the sky. From these observations, a magnitude transformation

$$V = v_o - 0.085 (b - v)_o + \text{const.}$$

was derived. The rms value of one difference V (Heidelberg) minus V (Catalogue) is $0^m.02$.

In the reduction of the color observations to zero air mass, a graphical method was used which may be of interest for quick-look purposes even today. We assume that

$$(b - v)_O = (b - v)_X - k_C X, \quad \text{and}$$
$$k_C = k'_C + k''_C \, (b - v)_O .$$

In a Cartesian system with $(b - v)_O$ as abscissa and k_C as ordinate, all admissable pairs of $(b - v)$ and k_C for an observation $(b - v)_X$, X are on a straight line, the slope of which depends on X. The lines for several observations of the same star should intersect in one point. The second of the above equations is a straight line through these points, leaving the smallest possible residuals in $(b - v)_O$ at the intersections with the «observation lines». The influence of small changes in the extinction line, and the disagreement in the observations, are easily seen in this way.

The Heidelberg color system does not transform very well to (B—V). For main-sequence stars, the transformation is not linear. The transformation for supergiants is different from the dwarf relation; owing to the lack of nonvariable red supergiants[1], the transformation is uncertain by one or two hundredths of a magnitude. Obviously, other observers must have experienced similar difficulties in defining a cepheid color system. We adopted $B - V = 0^m.40 + 0.90 \, (b - v)_O$.

From a rough comparison with the «Cepheid Standard System» of Mitchell et al. (1964), it would seem that our magnitudes are $0^m.02$ or $0^m.03$ too bright and our colors $0^m.01$ or $0^m.02$ too red. A more detailed comparison will be made for each variable in the later papers of this series. As a consequence of our differential method, light and color curves for each variable relative to its comparison stars are better defined than the magnitudes and colors of the comparison stars in a common system or this system in the B, V frame.

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1. The star BS 8752, HD 217476, G0Ia, is slightly variable according to our observations.

5. RESULTS

The results obtained for the 6 cepheids CD Cyg; X, Z, RR Lac; U Vul and TU Cas are given in Table I. The columns give the heliocentric Julian Date, the phase computed with the help of the epoch and period given in Kukarkin et al. (1969) *, the V magnitude and the B — V color. A colon (:) indicates that the value given is of lower weight. The corresponding light and color curves are given in Fig. 1 - 6.

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ΠΕΡΙΛΗΨΙΣ

Οἱ συγγραφεῖς ἐξετέλεσαν φωτοηλεκτρικὰς παρατηρήσεις εἰς δύο χρώματα (B, V) διὰ 18 γαλαξιακοὺς κηφείδας μὲ περιόδους περιλαμβανομένας μεταξὺ 2 καὶ 17 ἡμερῶν. Αἱ παρατηρήσεις ἐξετελέσθησαν διὰ τοῦ κατοπτρικοῦ τηλεσκοπίου διαμέτρου ἀντικειμενικοῦ 72 ἑκ. τοῦ Ἀστεροσκοπείου τῆς Ἀϊδελβέργης. Εἰς τὴν παροῦσαν ἐργασίαν περιγράφονται κατ' ἀρχὴν αἱ μέθοδοι παρατηρήσεως καὶ ἀναγωγῆς, αἱ ὁποῖαι ἐχρησιμοποιήθησαν κατὰ τὰς παρατηρήσεις τῶν 18 τούτων κηφειδῶν. Ἐν συνεχείᾳ παρέχονται τὰ ἐξαγόμενα τῶν παρατηρήσεων διὰ τοὺς 6 κηφείδας CD Cyg, X, Z, RR Lac, U Vul καὶ TU Cas. Τὰ ἐξαγόμενα τῶν παρατηρήσεων διὰ τοὺς ὑπολειπομένους 12 κηφείδας θὰ δοθοῦν εἰς ἐργασίας, αἱ ὁποῖαι θὰ δημοσιευθοῦν προσεχῶς.

* The phases φ and ψ given for the cepheid TU Cas were computed with the help of the epochs and periods given by Oosterhoff (1957).

Μετὰ τὴν ἀνωτέρω ἀνακοίνωσιν, ὁ Ἀκαδημαϊκὸς κ. **Ἰ. Ξανθάκης** εἶπε τὰ κάτωθι:

Οἱ κηφεῖδαι εἶναι, ὡς γνωστόν, περιοδικοὶ μεταβλητοὶ ἀστέρες, δηλαδὴ ἀστέρες τῶν ὁποίων ἡ λαμπρότης μεταβάλλεται περιοδικῶς μετὰ τοῦ χρόνου, ἔλαβον δὲ τὸ ὄνομά των ἐκ τοῦ ἀστέρος δ τοῦ ἀστερισμοῦ τοῦ Κηφέως, ὁ ὁποῖος ἀνήκει εἰς τὴν κατηγορίαν ταύτην. Ἡ μελέτη τῶν ἀστέρων τούτων, τῶν ὁποίων αἱ περίοδοι περιλαμβάνονται μεταξὺ 1 καὶ 50 ἡμερῶν, παρουσιάζει ἰδιαίτερον ἐνδιαφέρον διὰ τὴν Ἀστρονομίαν διὰ τοὺς ἑξῆς λόγους:

1) Ἐκ τῆς μελέτης τῶν κηφειδῶν δυνάμεθα νὰ ἔχωμεν λίαν χρησίμους πληροφορίας ὡς πρὸς τὴν δομὴν καὶ ἐξέλιξιν τῶν ἀστέρων ἐν γένει, δεδομένου ὅτι συμφώνως πρὸς τὰς συγχρόνους ἀντιλήψεις, ὅλοι οἱ ἀστέρες τῶν ὁποίων ἡ μᾶζα εἶναι μεγαλυτέρα ὡρισμένου ὁρίου, καθίστανται κατὰ τὴν διάρκειαν τῆς ἐξελίξεώς των ἐπὶ ἓν χρονικὸν διάστημα κηφεῖδαι.

2) Οἱ κηφεῖδαι μᾶς ἐπιτρέπουν νὰ προσδιορίσωμεν τὰς ἀποστάσεις τόσον ἐντὸς τοῦ Γαλαξίου μας ὅσον καὶ μεταξὺ τοῦ Γαλαξίου μας καὶ τῶν λοιπῶν γαλαξιῶν καὶ νὰ καθορίσωμεν οὕτω τὴν κλίμακα τῶν διαστάσεων τοῦ ὁρατοῦ Σύμπαντος. Πράγματι, συμφώνως πρὸς τὴν γνωστὴν σχέσιν περιόδου - λαμπρότητος ἡ λαμπρότης ἑνὸς κηφείδου εἶναι συνάρτησις τῆς περιόδου του. Συνεπῶς ἐκ τῆς περιόδου ἑνὸς κηφείδου, ἡ ὁποία προσδιορίζεται εὐκόλως, δυνάμεθα νὰ ὑπολογίσωμεν τὴν ἀπόλυτον λαμπρότητά του καὶ ἐξ αὐτῆς τὴν ἀπόστασιν τοῦ κηφείδου. Ἡ μέθοδος αὕτη ἐφηρμόσθη λίαν ἐπιτυχῶς ὑπὸ τῶν Shapley καὶ Hubble καὶ ἔδωσε τὴν κλίμακα τῶν διαστάσεων τοῦ Γαλαξίου μας καὶ τοῦ ὅλου ὁρατοῦ Σύμπαντος. Πλὴν ὅμως, ὅπως ἀπέδειξε πρό τινων ἐτῶν ὁ Baade, ἡ σχέσις περιόδου - λαμπρότητος δὲν εἶναι ἑνιαία δι' ὅλους τοὺς κηφείδας, ἀλλὰ εἶναι διάφορος διὰ τοὺς κηφείδας τοῦ ἀστρικοῦ πληθυσμοῦ I καὶ ἄλλη διὰ τοὺς κηφείδας τοῦ ἀστρικοῦ πληθυσμοῦ II. Ἡ ἀνακάλυψις αὕτη τοῦ Baade, ἡ ὁποία εἶχεν ὡς συνέπειαν τὸν διπλασιασμὸν τῶν διαστάσεων τοῦ ὁρατοῦ Σύμπαντος, ἤνοιξε νέας κατευθύνσεις εἰς τὴν μελέτην τῶν κηφειδῶν. Οὕτω, ἤρχισε μία συστηματικὴ προσπάθεια διὰ τὴν ὑποδιαίρεσιν τῶν κηφειδῶν τῶν ἀστρικῶν πληθυσμῶν I καὶ II εἰς περαιτέρω ὑποομάδας μὲ διαφόρους ἰδιότητας καὶ ἐνδεχομένως διαφόρους σχέσεις περιόδου - λαμπρότητος. Ὡς κύριον δὲ κριτήριον διὰ τὴν ταξινόμησιν ταύτην προβλέπεται ὅτι θὰ χρησιμοποιηθῇ ἡ μορφὴ τῆς καμπύλης φωτὸς τῶν κηφειδῶν.

Ἐκ τῶν ἀνωτέρω καθίσταται σαφὲς ὅτι διὰ νὰ δυνηθῶμεν νὰ μελετήσωμεν τὰ κύρια προβλήματα τὰ σχετικὰ μὲ τοὺς κηφείδας πρέπει νὰ διαθέτωμεν λεπτομερεῖς καὶ λίαν ἀκριβεῖς καμπύλας φωτὸς δι' ὅσον τὸ δυνατὸν περισσοτέρους ἐκ τῶν ἀστέρων τούτων. Μάλιστα δὲ διὰ νὰ καταστῇ δυνατὸν νὰ χρησιμοποιηθῇ τὸ ὑλικὸν τοῦτο καὶ διὰ τὴν μελέτην τῶν μεταβολῶν τῆς περιόδου καὶ τῆς μορφῆς τῆς καμπύλης φωτὸς τῶν κηφειδῶν πρέπει αἱ καμπύλαι αὗται νὰ προσδιορισθοῦν κατὰ δύο χρονικὰς περιόδους ἀπεχούσας ἀπ' ἀλλήλων κατὰ ὡρισμένα ἔτη.

Οἱ κ. κ. Bahner καὶ Μαυρίδης προέβησαν εἰς τὸν φωτοηλεκτρικὸν προσδιορισμὸν λεπτομερῶν καὶ λίαν ἀκριβῶν καμπυλῶν φωτὸς εἰς δύο χρώματα (B, V) διὰ 18 γαλαξιακοὺς κηφείδας μὲ περιόδους περιλαμβανομένας μεταξὺ 2 καὶ 17 ἡμερῶν.

Δι' ἕκαστον κηφείδην ἐχρησιμοποιήθησαν δύο γειτονικοὶ ἀστέρες συγκρίσεως καὶ κατὰ τὸν τρόπον τοῦτον κατέστη δυνατὸν νὰ αὐξηθῇ σημαντικῶς ἡ ἀκρίβεια τῶν παρατηρήσεων. Αἱ παρατηρήσεις ἐγένοντο διὰ τοῦ ἀνακλαστικοῦ τηλεσκοπίου διαμέτρου ἀντικειμενικοῦ 72 ἑκατοστῶν τοῦ Ἀστεροσκοπείου τῆς Ἀϊδελβέργης. Εἰς τὴν παροῦσαν ἐργασίαν παρέχονται τὰ ἐξαγόμενα τῶν παρατηρήσεων διὰ 6 κηφείδας.

Τὰ ἐξαγόμενα τῶν παρατηρήσεων διὰ τοὺς ὑπολοίπους 12 κηφείδας θὰ δοθοῦν εἰς προσεχεῖς ἀνακοινώσεις.

T A B L E I

THE CEPHEID PHOTOMETRY

TU Cas

Comparison Stars: + 51° 103, + 50° 61

Phase φ: E = 2420000, $P^{-1} = 0.4674437 \ d^{-1}$

Phase ψ: E = 2420000, $P^{-1} = 0.19118 \ d^{-1}$

$JD_{Hel.}$	Phase φ	ψ	V	B — V
2435707.574	0.407	0.974	7.915	0.731
725.462	.768	.394	7.052	0.365
725.503	.787	.402	7.081	0.372
732.516	.065	.742	7.794	0.714
734.458	.973	.114	7.444	0.523
735.386	.407	.291	7.981	0.758
735.428	.427	.299	7.997	0.775
735.538	.478	.320	8.046	0.786
738.384	.808	.864	7.587	0.573
738.595	.907	.905	7.610	0.585
740.555	.823	.279	7.108	0.385
741.562	.294	.472	7.980	0.781
758.387	.159	.688	7.886	0.739
758.533	.227	.716	7.908	0.752
798.432	.878	.344	7.260	0.537
802.387	.726	.100	7.762	0.617
825.341	.456	.489	8.060	0.786
847.306	.723	.688	7.397	0.475
855.270	.446	.211	7.974	0.774
2436080.519	.737	.274	7.480	0.512
080.532	.743	.276	7.402	0.484
080.563	.758	.282	7.252	0.435
080.570	.761	.283	7.211	
080.574	.763	.284		0.406
080.577	.764	.285	7.192	
080.588	.770	.287	7.149	
080.592	.771	.288		0.390
080.595	.773	.288	7.138	
080.606	.778	.290	7.108	
080.610	.780	.291		0.373
080.613	.781	.292	7.100	
080.622	.785	.293	7.081	0.370
086.509	.537	.419	8.075	0.784
089.478	.925	.986	7.540	0.552
089.527	.948	.996	7.547	0.562

T A B L E I (continued)

TU Cas (continued)

JD$_{Hel.}$	Phase φ	Phase ψ	V	B — V
2436089.602	0.983	0.010	7.555	0.563
091.431	.838	.360	7.183	0.410
101.466	.529	.278	8.038	0.757
114.403	.576	.752	7.856	0.666
114.474	.609	.765	7.773	0.626
114.502	.622	.770	7.740	0.614
114.551	.645	.780	7.680	0.593
116.469	.542	.147	7.996	0.748
116.521	.566	.156	8.001	0.752
119.378	.902	.703	7.592	0.599
119.444	.933	.715	7.640	0.631
119.521	.969	.730	7.682	0.660
121.426	.859	.094	7.367	0.478
121.502	.895	.109	7.357	0.479
123.456	.808	.482	7.242	0.436
132.415	.996	.195	7.474	0.552
132.471	.022	.206	7.525	0.565
138.358	.774	.331	7.062	0.360
138.490	.835	.357	7.180	0.414
142.492	.706	.122	7.825	0.646
144.443	.618	.495	7.950	0.696
144.480	.635	.502	7.832	0.646
144.534	.661	.512	7.639	0.561
145.362	.048	.670	7.785	0.696
145.469	.098	.691	7.849	
174.279	.565	.199	8.015	0.757
174.511	.673	.243	7.936	0.696
198.355	.819	.802	7.554	0.563
198.410	.845	.812	7.582	0.570
200.271	.715	.168	7.790	0.633
200.424	.786	.197	7.302	0.446
232.246	.661	.281	7.963	0.700
232.296	.685	.290	7.866	0.654
245.268	.748	.770		

TABLE I (continued)

X Lac

Comparison Stars : + 56° 2872, + 55° 2809

E = 2436814.00, $P^{-1} = 0.1836527054\ d^{-1}$

$JD_{Hel.}$	Phase	V	B — V
2435707.494	0.787	8.473	0.984
707.601	.807	8.448	0.956
711.476	.518	8.518:	
716.530	.447	8.473	1.023
721.377	.337	8.389	0.982
721.445	.349	8.404	0.977
723.340	.697	8.559:	
725.529	.099	8.192	0.867
731.487	.194	8.258:	0.912:
734.411	.731	8.559	0.992
735.467	.925	8.230	0.850
741.447	.023	8.174	0.856
741.535	.039	8.175	0.847
757.470	.965	8.193	0.847
761.459	.698	8.537:	0.998:
826.289	.604	8.546:	1.047
859.264	.660	8.568:	1.037:
860.268	.845	8.380	0.920:
2436022.551	.648	8.527:	1.038:
024.558	.017	8.159	0.853
086.434	.381	8.427	0.997
101.450	.138	8.234	0.884:
113.461	.344	8.385	0.991
114.454	.527	8.514	1.043
116.445	.892	8.275	0.876
119.425	.439	8.465	1.026
120.455	.629	8.544	1.037
124.394	.352	8.395	1.001
132.429	.828	8.395	0.945
137.418	.744	8.510	1.011
138.461	.935	8.215	0.848
140.295	.272	8.342:	
145.450	.219	8.290	0.929
174.239	.506	8.517	1.029
193.254	.998	8.175	0.851
199.303	.109	8.206	0.869
200.319	.296	8.362	0.958
507.388	.690	8.539	1.021
514.303	.960	8.196:	0.828:
539.424	.573	8.546	1.041
556.334	.679	8.555	1.029
596.259	.011	8.181	0.842
599.253	.561	8.545	1.064
611.240	.763	8.504:	0.993:

T A B L E I (continued)

RR Lac

Comparison Stars : + 55° 2791, + 55° 2796

E = 2433537.37, P^{-1} = 0.1558557 d^{-1}

$JD_{Hel.}$	Phase	V	B — V
2435694.528	0.205	8.682	0.908
716.424	.618	9.157	1.144
725.420	.020	8.433	0.742
731.509	.969	8.432	0.733:
732.401	.108	8.564	0.818
738.393	.042	8.461	0.760
738.569	.069	8.494	0.793
740.525	.374	8.883	1.016
741.484	.524	9.073	1.118
761.438	.634	9.158	1.133
787.331	.669	9.180:	1.140
802.291	.001	8.427	0.739
825.297	.586	9.141	1.115
826.320	.746	9.170	1.107
827.275	.895	8.710:	
859.280	.883	8.785:	0.850:
872.255	.905	8.648	0.814
2436018.516	.701	9.180	1.129
020.522	.013	8.433	0.760
024.519	.636	9.166	1.143:
025.518	.792	9.088	1.035
026.538	.951	8.440:	0.751
086.484	.294	8.786:	0.983
089.508	.765	9.133:	1.063:
108.530	.730	9.181:	1.105
114.425	.649	9.178	1.136
116.379	.953	8.471	0.748
119.398	.424	8.924	1.040
120.369	.575	9.118	1.128
121.379	.733	9.195	1.105
124.475	.215	8.704	0.930
132.389	.449	8.965:	1.050:
138.447	.393	8.880	1.015
144.410	.322	8.824	0.992
172.305	.670	9.200:	1.144:
173.379	.837	8.963	0.975
174.326	.985	8.421	0.724
193.235	.932	8.541	0.773
199.243	.868	8.838	0.910
231.275	.860	8.863	0.922
233.256	.169	8.636	0.874
542.242	.326	8.836	1.001
597.250	.900	8.690	0.847
602.255	.680	9.195	1.132
604.245	.990	8.434:	0.730:

T A B L E I (continued)

U Vul

Comparison Stars : + 20° 4210, + 20° 4215

E = 2420141.642, P^{-1} = 0.12514586 d^{-1}

$JD_{Hel.}$	Phase	V	B — V
2435960.588	0.676	7.041	1.356
2436009.498	.796	7.224	1.476
018.440	.916	7.354	1.514
018.552	.917	7.376	1.517
019.448	.042	7.419	1.517
020.448	.167	7.267	1.397:
022.466	.419	6.812	1.213
023.457	.543	6.899	1.273:
024.456	.668	7.009	1.357
025.452	.793	7.229	1.456
026.563	.932	7.384	1.539
075.400	.044	7.445	1.501:
086.347	.414	6.804	1.188
091.386	.044	7.445	1.512
102.330	.414	6.806	1.192
112.338	.666	7.025	1.360
117.305	.288	6.846	
117.312	.289		1.173
119.298	.538	6.909	1.272
124.327	.167	7.258	1.389
426.420	.973	7.416	1.534
443.401	.098	7.397	1.478
447.379	.595	6.923	1.269
448.421	.726	7.152	1.425
449.349	.842	7.285	1.505
540.236	.216	7.111	1.309
541.216	.339	6.770	1.168
542.214	.464	6.876	1.253
545.225	.841	7.297	1.509:

T A B L E I (continued)

Z Lac

Comparison Stars : $+55^{\circ}$ 2791, $+55^{\circ}$ 2796

E = 2434575.780, $P^{-1} = 0.091862541$ d^{-1}

$JD_{Hel.}$	Phase	V	B — V
2435694.577	0.776	8.493	1.170
700.548	.324	8.440	1.297
707.420	.955	8.042:	0.956
707.457	.959	8.029	0.936
721.473	.246	8.305	1.233
725.393	.606	8.796	1.400
740.491	.993	7.872	0.884
741.515	.087	8.132	1.052
757.417	.548	8.800	1.441
758.305	.630	8.781	1.374
759.347	.725	8.577	1.194
761.413	.915	8.268	1.054
787.303	.294	8.402:	1.260
802.312	.672	8.722	1.298
826.320	.878	8.355	1.072
855.225	.533	8.786	1.421:
856.229	.625	8.785	1.360
860.236	.993	7.890	0.868
2436018.534	.535	8.761	1.421
019.560	.629	8.782:	1.360
023.501	.991	7.876	0.874
023.548	.996	7.875	0.872:
025.530	.178	8.198	1.154
026.522	.269	8.324:	1.255
073.453	.580	8.791:	1.405:
089.494	.054	8.036	1.013:
108.530	.802	8.418:	1.124
113.438	.253	8.326	1.232
114.425	.344	8.472	1.335
116.379	.523	8.764	1.428
119.398	.801	8.445	1.138
119.490	.809	8.431	1.131

T A B L E I (continued)

Z Lac (continued)

$JD_{Hel.}$	Phase	V	B — V
2436120.369	0.890	8.323	1.079
120.474	.900	8.285	1.065
121.379	.983	7.899	0.893
123.424	.171	8.190	1.138
124.475	.267	8.338	1.261:
132.389	.994	7.888:	0.893
132.458	.000	7.855:	0.886
137.377	.452	8.677	1.415
142.472	.920	8.241	1.031
144.414	.099	8.139	1.068
145.415	.191	8.236	1.165
172.305	.661	8.750	1.329
174.340	.848	8.359	1.082
198.299	.049	8.031	0.988
199.243	.135	8.177	1.090
200.292	.232	8.294	1.207
231.275	.078	8.117	1.051
426.434	.006	7.870:	
443.440	.568	8.799	1.430
447.406	.932	8.181	0.996
448.382	.022	7.909	0.920
448.495	.032	7.950	0.941
448.576	.040	7.981	0.961
507.359	.440	8.663	1.390:
539.397	.383	8.553	1.367
540.277	.464	8.700	1.419
541.243	.552	8.808	1.438
541.362	.563	8.812	1.421
545.253	.921	8.242	1.054
556.301	.936	8.158	1.000
597.250	.697	8.659	1.266:
608.241	.707	8.608:	1.253:

T A B L E I (continued)

CD Cyg

Comparison Stars : + 33° 3734, + 33° 3716

E = 2436848.21, P^{-1} = 0.0585775725 d^{-1}

$JD_{Hel.}$	Phase	V	B — V
2435960.568	0.004	8.299:	0.944:
2436009.547	.873	9.194:	1.418:
018.464	.395	8.987	1.534:
019.468	.454	9.097	1.616
020.469	.513	9.195	1.642
022.486	.631	9.410	1.686
023.478	.689	9.460:	1.689
024.477	.748	9.428	1.646
025.472	.806	9.334	1.534
026.455	.864	9.207	1.446
027.436	.921	9.229	1.408
073.395	.613	9.384	1.696:
075.444	.733	9.442	1.644:
080.469	.028	8.375	1.007
086.395	.375	8.940	1.519
089.361	.548	9.264	1.693
091.409	.668	9.447	1.702
101.406	.254	8.735	1.364
102.350	.309	8.824	1.446
112.384	.897	9.248	1.438:
113.358	.954	8.944	1.248
114.327	.011	8.334	0.967
116.335	.129	8.540	1.159
117.356	.188	8.638	
119.318	.303	8.817	1.431
120.342	.363	8.918	1.511
121.326	.421	9.023	1.579
124.357	.598	9.359	1.705
132.363	.067	8.431	1.063:
144.293	.766	9.417	1.622
198.275	.928	9.183:	1.383:
199.214	.983	8.406	0.968:
199.266	.986	8.354	0.967
200.241	.044	8.422	1.024:
267.669	.993		0.947:
267.679	.994	8.335	
507.279	.029	8.384	1.010
540.214	.958	8.889	1.214
540.254	.961	8.848	1.185
540.290	.963	8.810	1.179
556.274	.899	9.249	1.446

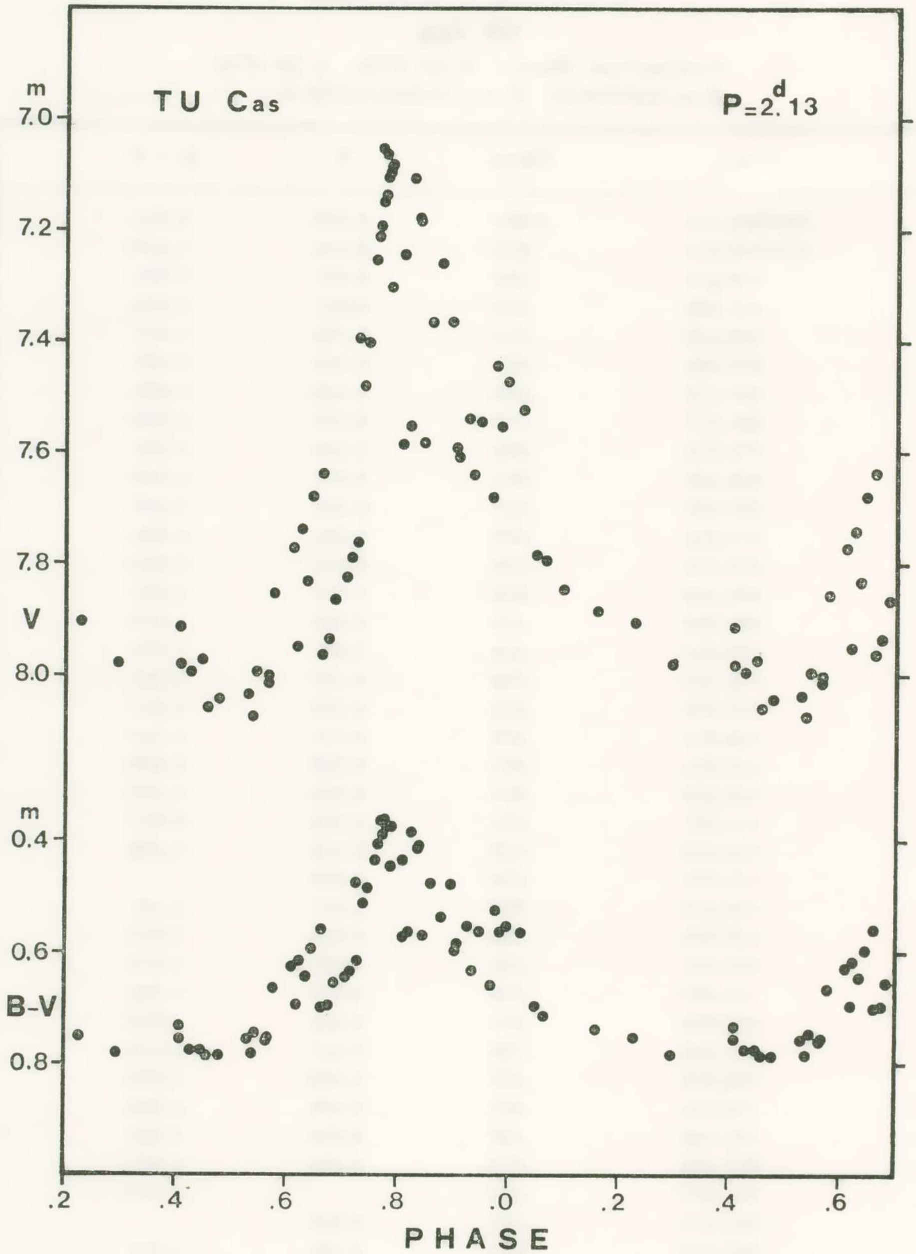

Fig. 1. Light and color curve of the cepheid TU Cas.

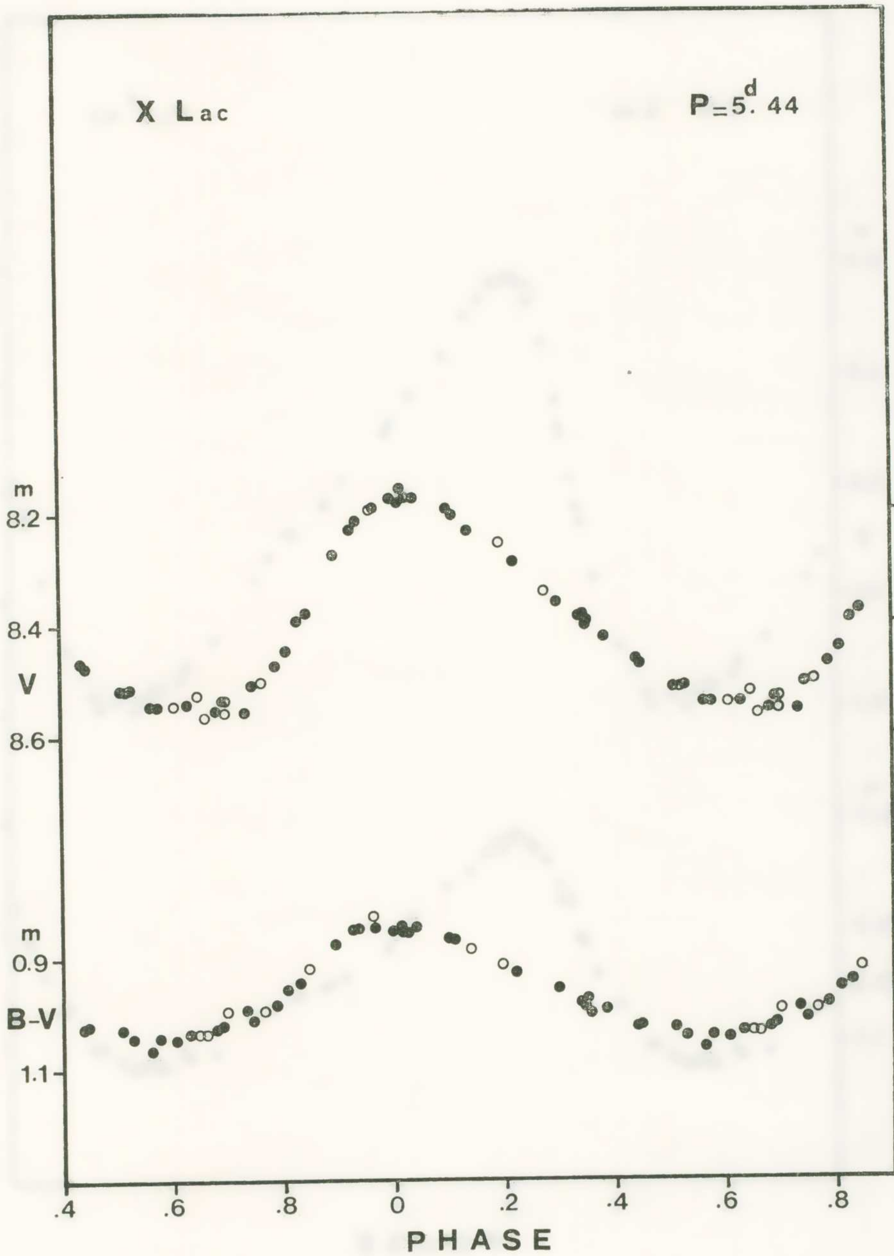

Fig. 2. Light and color curve of the cepheid X Lac.

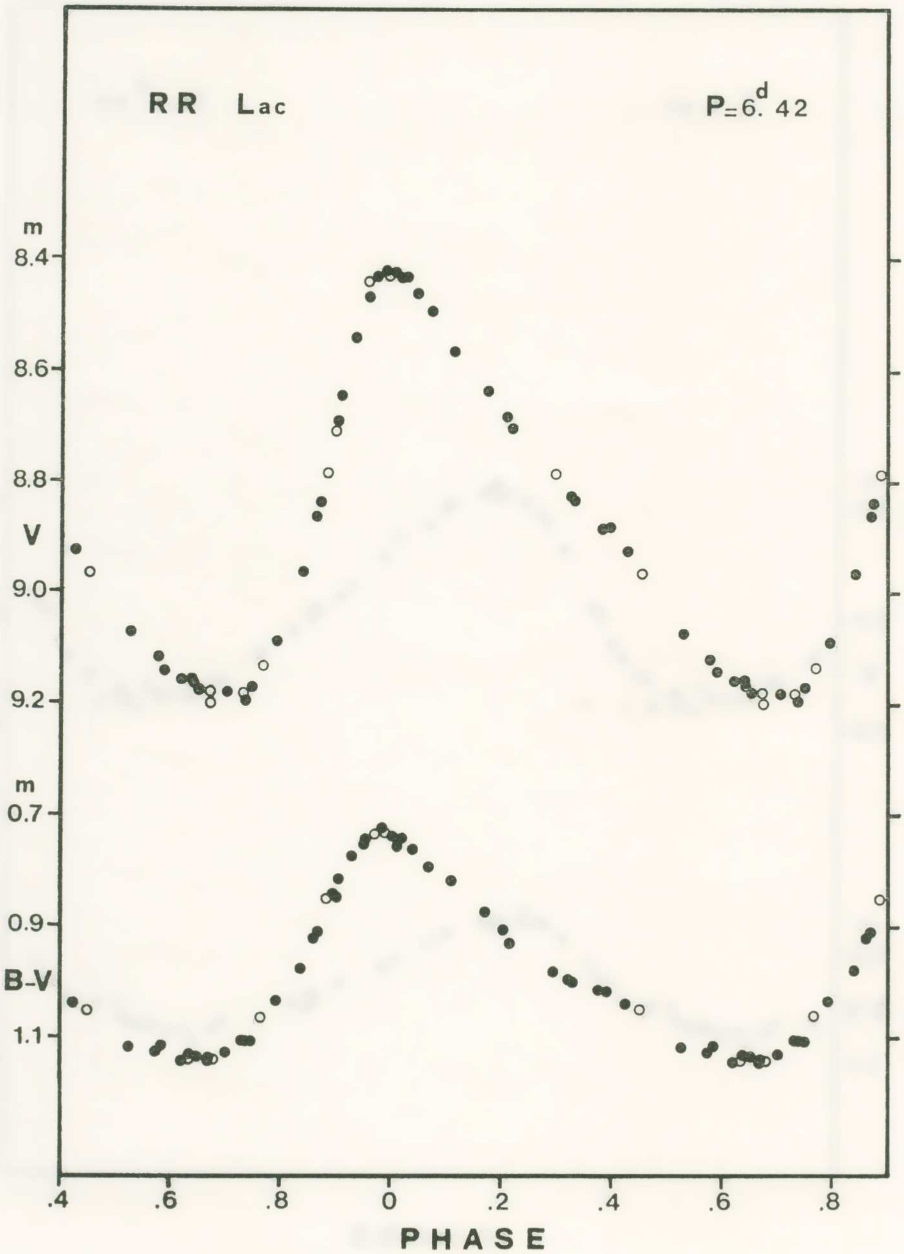

Fig. 3. Light and color curve of the cepheid RR Lac.

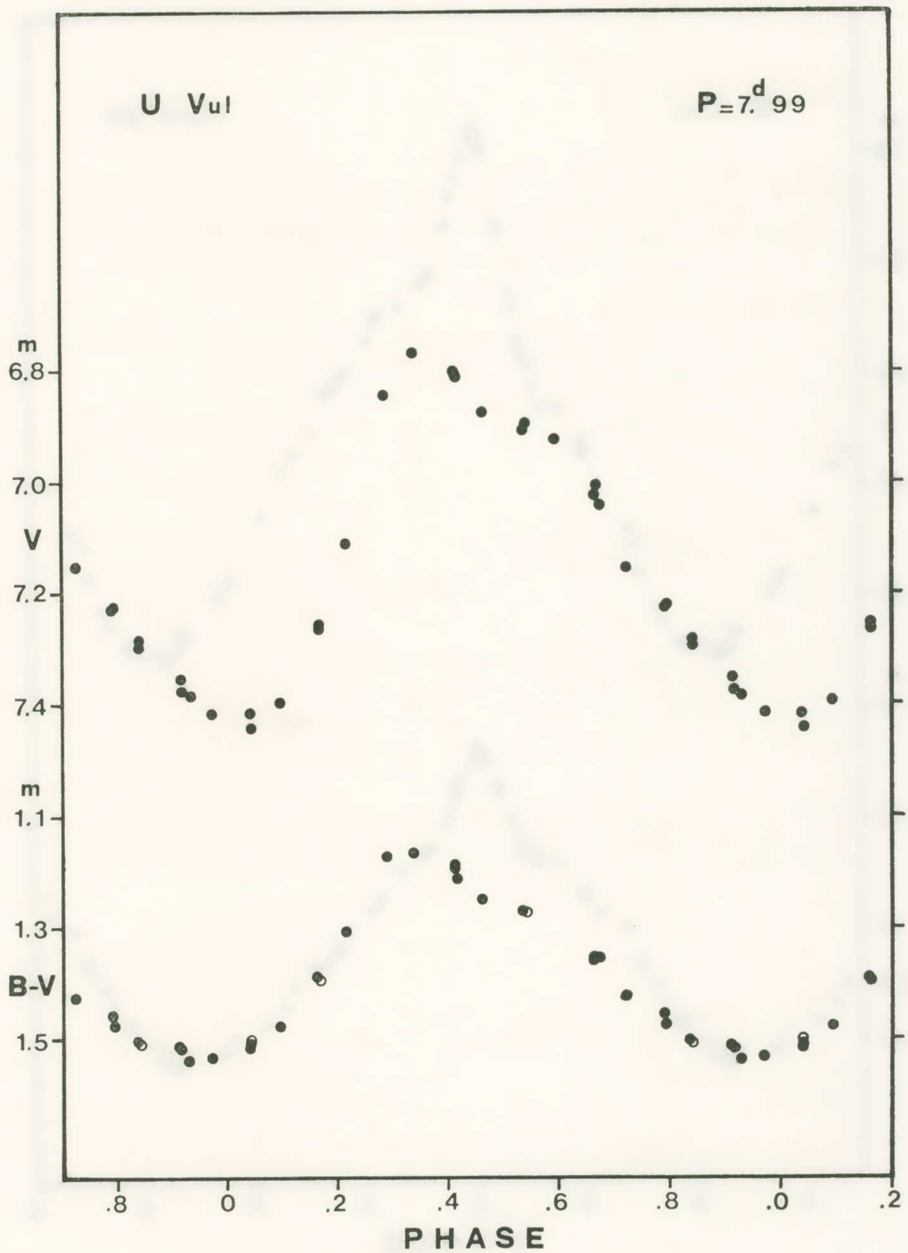

Fig. 4. Light and color curve of the cepheid U Vul.

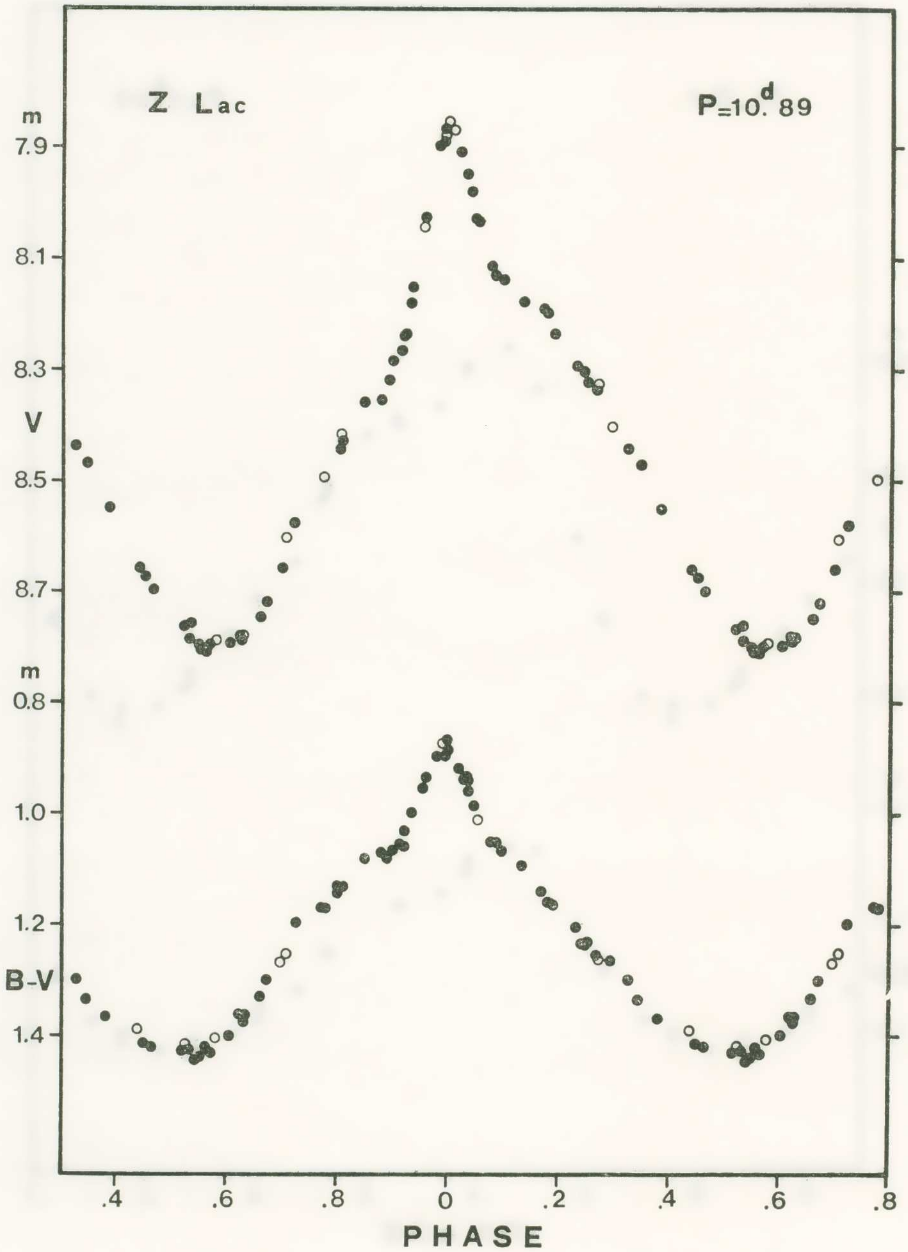

Fig. 5. Light and color curve of the cepheid Z Lac.

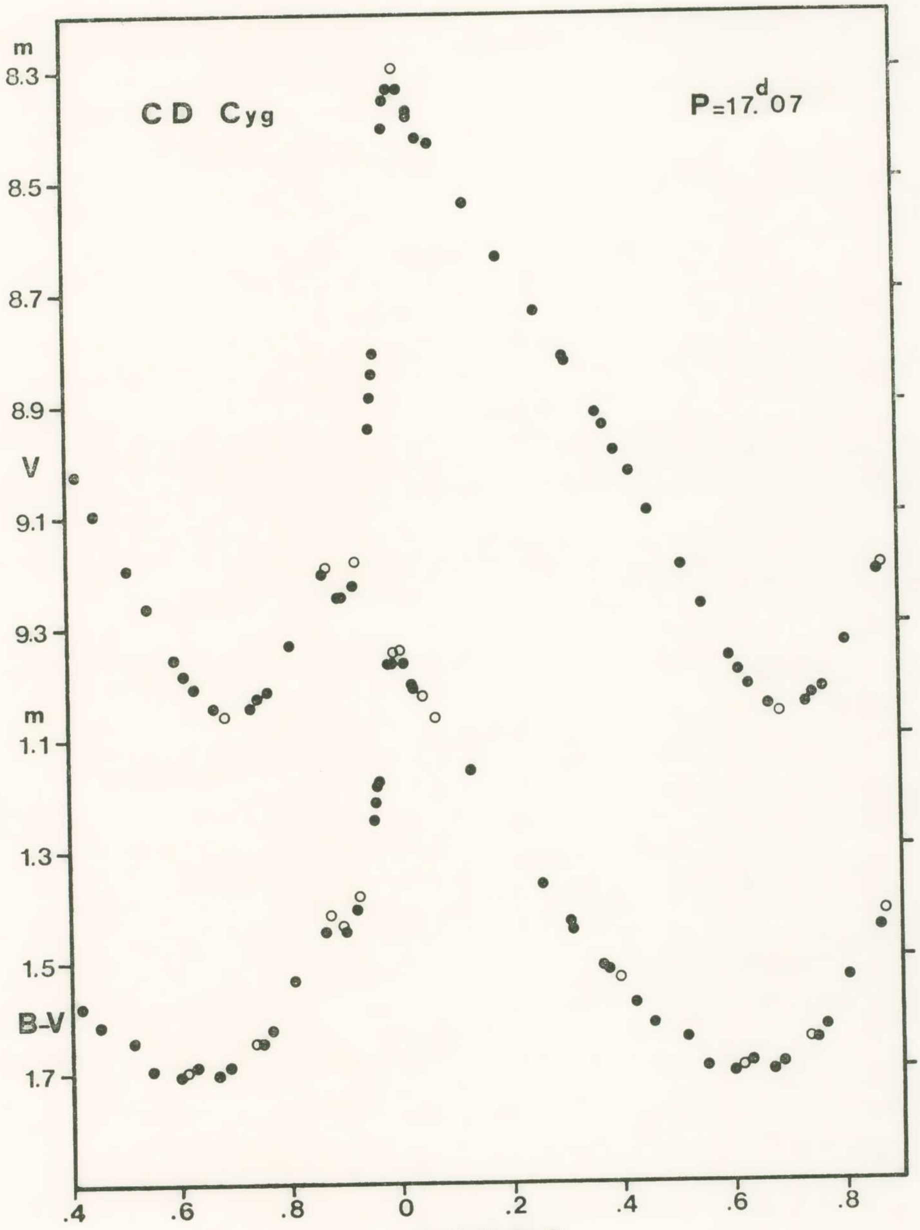

Fig. 6. Light and color curve of the cepheid CD Cyg.