A PHOTOELECTRIC LIGHT CURVE AND PERIOD STUDY FOR CC CASSIOPEIAE

RICHARD BINZEL
PATRICK HARTIGAN
Macalaster College
St. Paul, MN 55105

Abstract

CC Cassiopeiae is an eclipsing binary star of small amplitude. An approximate ephemeris was determined soon after its discovery, but the system has been largely neglected, and the initial ephemeris has never been adequately verified. Sixty-five photoelectric observations of CC Cassiopeiae were made from August, 1978 through January, 1979. Results indicate that the existing ephemeris requires revision. A new ephemeris is found to be:

J.D. MIN (Hel.) = 2443818.279 + 3.368867*E

Introduction

CC Cassiopeiae, $\alpha = 03^h06^m.2$, $\delta = +59°11'$ (1900) was discovered to be an early type spectroscopic binary star by Pearce (1927). In the following year, Pearce determined the spectroscopic orbital elements for this star based on 22 spectrograms obtained at the Dominion Astrophysical Observatory. Pearce found an approximate orbital period of 3.36897 days, and suggested that this star could very well be an eclipsing binary. This conjecture was verified by Guthnick and Prager (1930), who established a Beta Lyrae type variation, noted that the minima were nearly equal with an amplitude around 0.1 magnitude, and also obtained a time of minimum for the system.

Since then, CC Cassiopeiae has been largely neglected, with only a photographic light curve being obtained by Gaposchkin (1953), 43 uvby observations by Hilditch and Hill (1975), and three recent timings of minimum by Srivastava (1979). A photoelectric timing of minimum was sought in order to check the accuracy of Guthnick and Prager's elements.

Data

Sixty-five photoelectric observations of CC Cassiopeiae were obtained on 30 different nights from August 13, 1978, to January 31, 1979. The equipment is described by Hartigan (1980).

SAO 023846 was used as the comparison star and was observed before and after each variable reading. A value of V = 7.98 was determined for this star from established standard stars. CC Cassiopeiae's magnitude was calculated differentially with respect to SAO 023846, with atmospheric extinction being ignored due to the proximity of the two stars.

Guthnick and Prager's elements are given as:

J.D. MIN (Hel.) = 2426000.30 + 3.36897*E (1)

Phases were calculated using (1). Data for each observation are given in Table 1 and plotted in Figure 1.

TABLE 1

Individual V Magnitudes for CC Cassiopeiae

J.D.(Hel.) 2,443,000 +	Phase	V	J.D.(Hel.) 2,443,000 +	Phase	V
734.848	.0860	7.169	801.702	.9300	7.195
740.797	.8520	7.299	801.775	.9516	7.200
741.742	.1324	7.154	801.827	.9671	7.181
749.778	.5176	7.192	804.704	.8213	7.275
749.865	.5434	7.151	804.786	.8456	7.264
750.781	.8153	7.266	809.672	.2959	7.220
752.744	.3982	7.179	809.747	.3181	7.262
754.716	.9835	7.188	811.644	.8812	7.204
754.787	.0046	7.195	811.732	.9073	7.186
754.858	.0256	7.173	813.706	.4932	7.163
755.730	.2845	7.209	813.738	.5027	7.147
756.693	.5703	7.155	816.722	.3884	7.174
773.715	.6228	7.170	816.744	.3950	7.214
773.786	.6439	7.178	819.710	.2753	7.183
773.851	.6632	7.145	820.738	.5805	7.159
774.740	.9271	7.180	820.765	.5885	7.161
774.829	.9535	7.197	820.795	.5974	7.124
775.803	.2426	7.189	837.752	.6306	7.156
775.833	.2515	7.196	837.785	.6404	7.155
776.742	.5213	7.176	881.678	.6691	7.175
779.767	.4191	7.199	881.726	.6833	7.189
782.658	.2772	7.214	881.789	.7020	7.187
782.774	.3116	7.257	888.801	.7835	7.257
782.830	.3282	7.242	905.579	.7634	7.219
789.733	.3774	7.227	905.600	.7697	7.227
789.772	.3890	7.217	905.610	.7726	7.223
793.679	.5486	7.130	905.631	.7789	7.245
793.709	.5575	7.122	905.641	.7818	7.253
794.686	.8475	7.261	905.659	.7872	7.293
794.709	.8544	7.250	905.669	.7902	7.289
794.763	.8704	7.227	905.693	.7973	7.280
794.801	.8817	7.219	905.700	.7994	7.258
794.837	.8923	7.197			

Analysis

Since the primary minimum was not covered on any single night, the tracing paper method was used to determine a time of minimum, which we conclude occurred at phase 0.817 ± 0.01. Choosing a date near the middle of the observing period corresponding to a phase of 0.817, we have a heliocentric time of minimum equal to J.D. 2443818.166 .

Since the amplitude of light variation for CC Cassiopeiae is approximately 0.15 visual magnitudes, photographic estimates of minimum are difficult to obtain with sufficient accuracy, and we thus consider only the available photoelectric timings. Using Guthnick and Prager's ephemeris, Srivastava obtained O-C values of -0.219, -0.285, and -0.420 days. Since the last two values show considerable scatter, and separated by only ten days, they can be averaged. Known photoelectric timings of minimum are listed in Table 2. Using a method illustrated by Baldwin (1973) to revise CC Cassiopeiae's period, we obtain the following ephemeris:

$$J.D.\ MIN\ (Hel.) = 2443818.279 + 3.368867*E \qquad (2)$$

O-C values using equation (2) are listed in the last column of Table 2.

TABLE 2

Available Photoelectric Times of Minimum

Author	Observed Minimum J.D.(Hel.)	O-C (eqn. 1)	O-C (eqn. 2)
Guthnick and Prager	2426000.30	0	$-0^d.041$
Srivastava	2439122.219	$-0^d.219$	$+0^d.141$
Srivastava	2439469.089	$-0^d.353$	$+0^d.017$
Hartigan and Binzel	2443818.166	$-0^d.617$	$-0^d.113$

Equation 2 agrees well with all available photoelectric data with the possible exception of Hilditch and Hill's work. Their light curve, reproduced in Figure 2, shows eclipses occurring at phases 0.32 and 0.82 in 1975, close to the predicted phases. The eclipse at 0.32 seems to be the primary although equation 2 predicts it to be the secondary. We note however, that there are only four points near phase 0.82, so it is possible that this eclipse is indeed the deeper of the two.

The shape of the light curve indicates that the eclipses are probably partial. The eclipses were too shallow to be detected visually.

The authors would like to thank Sherman Schultz, Macalester College Observatory Director, for his supporting work. This research was sponsored in part by a NASA Viking Prize Grant.

REFERENCES

Baldwin, M. E. 1973, JAAVSO 2, 7.

Gaposchkin, S. 1953, Harvard Annals 113, No. 2.

Guthnick, P. and Prager, R., 1930, Astr. Nach. 239, 5713.

Hartigan, P. 1980, JAAVSO, in press.

Hilditch, R. and Hill, G. 1975, Mem RAS 79, 107.

Pearce, J. 1927, Publ. DAO, IV, No. 6,67.

Srivastava, J. B. 1979, Inf. Bull. Var. Stars, No. 1571.

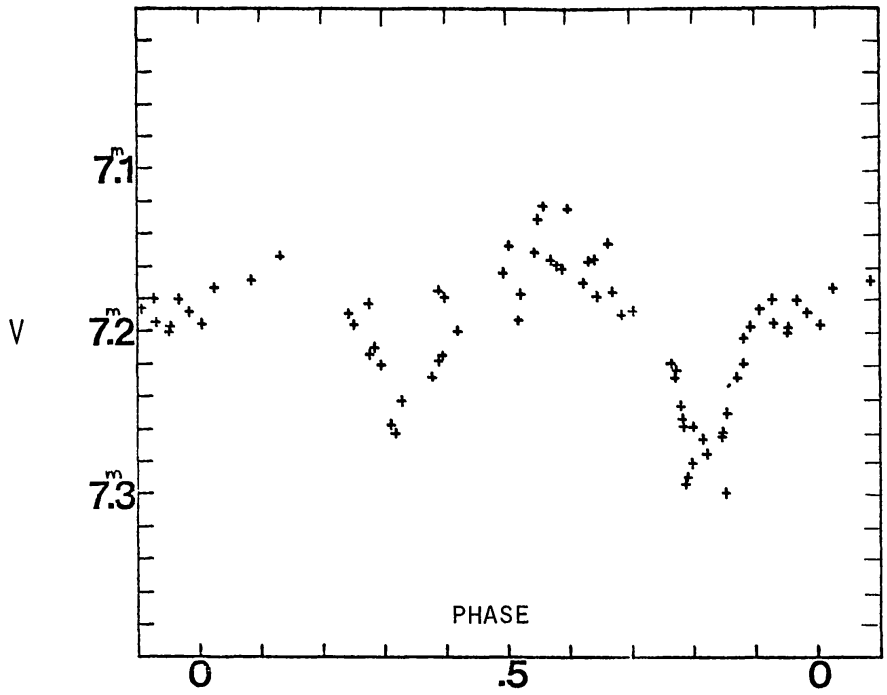

Figure 1. A photoelectric light curve for CC Cassiopeiae using Guthnick and Prager's ephemeris to determine phases.

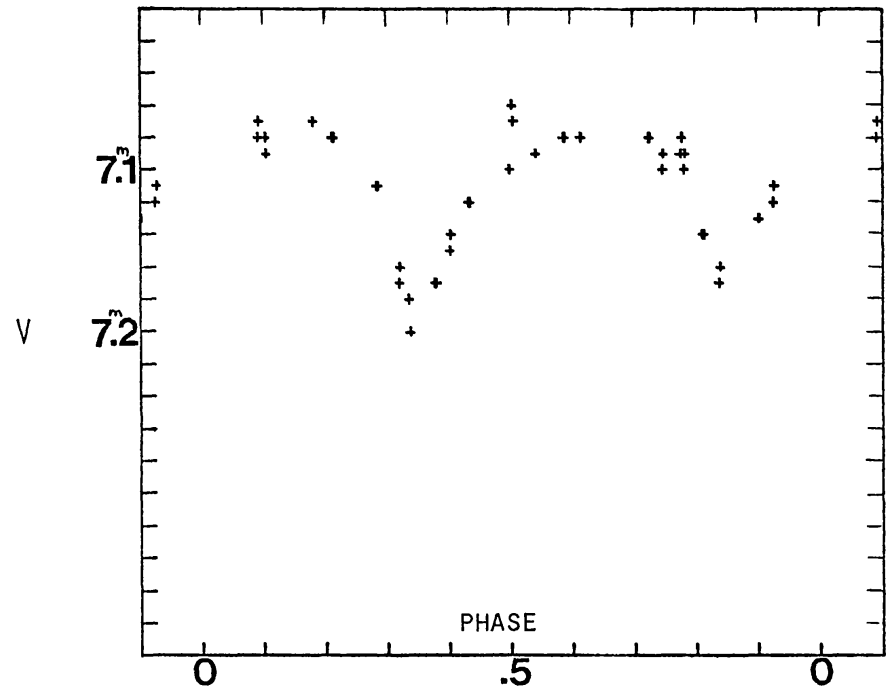

Figure 2. Hilditch and Hill's 1975 photoelectric light curve using Guthnick and Prager's ephemeris to determine phases.