6. *Photoelectric Observations of CC Andromedae*

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We carried out photoelectric observations of CC And for three nights from 30 September to 25 November, 1989 using the 40-cm Cassegrain reflecting telescope and the photon counting system in Fukuoka University of Education at Akama (33°48'N, 130°36'E), Fukuoka in Japan.

CC And observed in this work is known as a typical δ Scuti type pulsating star and its characteristic light variation is the long term modulation of period which causes variation of amplitude and shift of epoch and such modulation of CC And is known to be explained by the tidal effect of a binary model or rotation effect of a single star model.

We replaced the old DC photometric system since 1980 with the photon counting system to improve our photometric precision in our observatory. Here in order to examine our new photon counting system, CC And a typical pulsating star was selected because the photometric observations of CC And are known since 1950 but the long term modulation of period for this object can't be interpreted completely and then further photometric observations should be needed to justify which model may be conclusive among discussions by several authors.

Observations were carried out for three nights from 30 September to 25 November, 1989. Our new photon counting system is attached to the 40-cm Cassegrain reflecting telescope (F/13) and our detector is the uncooled type photomultiplier (1P21) made in Hamamatsu Inc., Japan and photon counter (C1230 which is made in Hamamatsu Inc., Japan) consists of pre-amplifier, discriminator and display. In every observation including the measurement on the UBV colors the integration time is one second and also the averages of photon counts for every ten measurements are taken as output of data and final photon numbers observed are represented for every second. Observing procedures are to measure the object, CC And every four minutes and the standard star of about fourth magnitude every 40 minutes. Using observation of the standard stars final observed brightness of the object is reduced after considering the atmospheric extinction and the air mass at the observing time. Considering fluctuations of our sky conditions and comparatively brighter standard stars selected in our measurements our limiting magnitude is concluded to be +9.8 of the V magnitude within precision of 0.03 through three nights of our observation, which seems to be poor results in view of up-to-date photometric observation because cooled type photometers are often available. Details of our instrumentation are shown in other article (Kawano and Hirai 1989). CC And has comparably short variation of about 4 hours in the color of the V magnitude and then the observation of this star seems to be suitable under unstable sky condition of our observatory. The light variation obtained in our observation should be real within our precision which seems to be limited to our sky condition not but for the shot noise. Standard stars in this observation are referred

Table I. Photometric observations of CC Andromedae

JD	V	B-V	JD	V	B-V
2447800. 07648	9.15	0.28	19076	9.32	0.26
07954	9.17	0.26	19450	9.27	0.30
08286	9.19	0.23	19715	9.27	0.30
08644	9.15	0.25	19982	9.25	0.29
08970	9.21	0.18	20245	9.25	0.24
09461	9.15	0.31	20506	9.25	0.30
09782	9.17	0.27	20769	9.25	0.24
10751	9.19	0.26	21434	9.25	0.26
11034	9.20	0.29	2447856. 04625	9.23	0.25
11341	9.25	0.24	04883	9.19	0.28
11651	9.29	0.26	05133	9.20	0.30
11946	9.22	0.32	05416	9.25	0.26
12249	9.24	0.29	05677	9.25	0.23
13754	9.30	0.35	05927	9.22	0.26
14170	9.33	0.30	06193	9.23	0.27
15990	9.29	0.38	06436	9.28	0.24
16420	9.34	0.33	06988	9.26	0.24
16729	9.36	0.30	07247	9.29	0.25
17061	9.32	0.32	08196	9.34	0.26
17335	9.33	0.28	08450	9.31	0.24
17612	9.33	0.28	08706	9.34	0.25
17898	9.30	0.31	08963	9.34	0.24
18186	9.28	0.27	09232	9.34	0.33
18654	9.27	0.30	09477	9.37	0.25
18934	9.29	0.26	09714	9.35	0.27
19208	9.29	0.22	09992	9.37	0.29
19493	9.23	0.26	10265	9.32	0.33
19799	9.27	0.19	10520	9.33	0.34
20075	9.16	0.31	10773	9.37	0.29
20365	9.27	0.26	11029	9.37	0.28
20634	9.21	0.25	11282	9.33	0.35
2447802. 09098	9.25	0.28	13667	9.28	0.25
09413	9.25	0.25	13918	9.24	0.27
10233	9.27	0.24	14196	9.28	0.24
10517	9.26	0.35	14398	9.22	0.27
10876	9.30	0.25	14683	9.23	0.24
11189	9.26	0.32	14928	9.20	0.30
12041	9.28	0.29	15175	9.22	0.25
12432	9.28	0.31	15412	9.16	0.25
15902	9.34	0.34	15673	9.19	0.27
16177	9.31	0.32	15926	9.18	0.25
16806	9.32	0.32	16184	9.22	0.28
18410	9.32	0.33	16488	9.21	0.26
18791	9.30	0.29	16734	9.22	0.23

Fig. 1a. The Light Variation of CC Andromedae 30 Sept. 1989.

Fig. 1b. The Color Index of the B-V 30 Sept. 1989.

to Okayama Astrophysical Observatory (Watanabe 1989).

Observed data are shown in Table I. The observation time is mainly limited for the sky condition of our local observatory. The object, CC And ($\alpha=00^h38^m19^s$, $\delta=+41^\circ44'.1$ (1900)) is a typical δ Scuti type pulsating star with period of 0.124 907 8 day and epoch of JD 2434604.958 and the light variation is from 9.46 to 9.80 of B magnitude (referred to General Catalogue of Variable Star 1971, so called as GCVS).

Fig. 2a. The Light Variation of CC Andromedae 2 Oct. 1989.

Fig. 2b. The Color Index of the B-V 2 Oct. 1989.

In Table I observational results are shown for three nights, 30 Sept., 2 Oct. and 25 Nov. The first column is for JD, the second for the V magnitudes, and the last for the color index of B-V. Figs. 1a, 2a and 3a represent the light curve of the V-color in our measurement against JD or phases referred to GCVS. Solid curves in figures are based on calculations using the formulae of the empirical light variation referred to Fitch (1960). Every observation covered at least around one period of light variation of CC And and our observing times limited by sky nearly equal the period of this star but observations of light

Fig. 3a. The Light Variation of CC Andromedae 25 Nov. 1989.

Fig. 3b. The Color Index of the B-V 25 Nov. 1989.

minimum were obtained completely. Comparatively the observation of 2 Oct. seems to be poor one among our observation nights due to unstable sky. According to Figs. 1a, 2a and 3a the amplitudes, Δm of light variation are varied from $\Delta m=0.19$ (30 Sept.) to 0.20 (25 Nov.) through 0.13 (2 Oct.) of which these variation of amplitudes had been found by Fitch (1960) and such long term modulation of period (10.466 days) is discussed by Fitch (1967) and Leung and Wehlau (1967).

Our results of variation of amplitudes seem to correspond to empirical formulae shown by Fitch (1967) (compare our observations with solid curve in Figs. 1a, 2a and 3a). Phase (marked in the upper side of abscissa) based on epoch of CC And in figures are referred to GCVS and the differences between solid curve on basis of empirical curve and our observation which are plotted against the phase referred to GCVS are due to the long period modulation in light curve of CC And according to Fitch (1967). In Figs. 1b, 2b and 3b the variation of the B-V are plotted against each phase and poor quantity of the B-V in Figs. 1b, 2b and 3b is mainly due to poor measurement on the B color. Spectroscopic type is F3 IV-V and the observed B-V is varied from 0.4 to 0.2, which seems to be consistent with $B-V=+0.32$ (Allen 1973). Near minimum CC And becomes redder compared with one in maximum. As we didn't make any spectroscopic observation this time, any information about radial velocity is not available for present discussion.

The astronomical meaning of the δ Scuti type is reviewed by Kukarkin (1975). Solid curve in Figs. 1a, 2a and 3a seem to represent our observations but according to Leung and Wehlau (1967) Fitch's third and fourth term among four Fourier terms discussed in the article by Fitch (1976) have no effect of luminosity. Kukarkin (1975) discussed that such modulation of period in light variation as CC And, the δ Scuti type star is never interpreted completely and there are the binary stars model and the single star model to explain the δ Scuti type star. Further observations of the δ Scuti type star should be needed by both photometric and spectroscopic methods.

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