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THE DISCOVERY OF APSIDAL MOTION IN THE BINARY SYSTEM α CrB

The first photoelectric light curve of the eclipsing binary α CrB (P=$14^{d}_{.}36$, e=0.37, A0+G6) was obtained by Stebbins (1928). It showed a shallow ($\simeq 0^{m}_{.}1$) primary minimum. The secondary minimum was detected by Kron and Gordon (1953; hereafter referred to as KG) in the near infrared band λ_{eff} = 7230 Å. The depth of this minimum is only $0^{m}_{.}02$. Koch (1973) has shown that the star must have appreciable apsidal motion, mostly relativistic. Ebbighausen (1976) tried to detect this effect, but his attempt failed due to insufficient accuracy of the spectrographic determination of ω. We have estimated the theoretical value of the periastron advance using equations from Sterne (1939) and Rudkjobing (1959) and the parameters of the system from Tomkin and Popper (1986). The relativistic part of the periastron advance is $\dot{\omega}_{rel}$= $0^{\circ}_{.}0046$/year and the part due to the tidal and rotational distortion of the stars supposing synchronous rotation of the components is $\dot{\omega}_{clas}$ = $0^{\circ}_{.}0014$/year. The sum of these values corresponds to a time shift of the secondary minimum by nearly 17 minutes in 40 years that elapsed from the epoch of KG observations in 1946-1948. This value seems quite measurable and does not differ from Koch's result. But taking into consideration the high rotational velocity of the primary component $v\sin i$=110 km/sec (Slettebak et al., 1975) and supposing i=90°one can obtain $\dot{\omega}_{class}$ + $\dot{\omega}_{rel}$ $\simeq$ $0^{\circ}_{.}0206$/year – even three times greater than Koch's value.

Our observations were carried out with the pulse counting photometer equipped with an EMI 9863 (S-20 cathode) and 48 cm reflector in the mountain station of Moscow University near Alma-Ata (altitude 3000 m). To reduce the flux from this bright star (V=$2^{m}_{.}23$) and to make the atmospheric correction easier, we used two narrow interference filters centered on $\lambda_{1,2}$ = 4600, 7500 Å (compare with Stebbins λ_{eff} = 4600 Å and KG). Most of the observations were made in the 7500 Å filter. We have used HD 135 502="C" as prime standard and HD 143 761 as the check star. These stars proved to be constant within the probable error of an observation $\sigma = \pm 0^{m}_{.}005$ during all the years 1986-1992. But α CrB itself has shown variability between minima. Some nights it had δ Sct-like oscillations with a quasi period of 40 minutes and an amplitude near $0^{m}_{.}01$. To reduce the influence of this variability, we have calculated the corrections for every observational night. Folding the observations of appropriate phases in computer memory we have obtained the individual times of mean primary and mean secondary minima for all observational sets including KG and Stebbins data, see Table 1. To obtain the precise periods for both minima we processed all observations with the Jurkevich algorithm. The resulting formula for primary minima is:

$$JD_{hel} = 2\,447\,346.1168 + 17^{d}_{.}359\,900\,16 \times E$$
$$\pm 13$$

(Our observations in 7500 Å folded with this period are shown in Figure 1.)

for secondary minima:

$$JD_{hel}=2\,447\,010.3923+17\overset{d}{.}359\,920\,3\times E$$
$$\pm 3\,0$$

The difference between these periods proves the existence of an apsidal motion with the period U=46000±8000 years or $\dot{\omega}_{obs}$ = 0°.0078±0°.0012/year. One can see that the observed value is 2.6 times smaller than the theoretical one. We cannot explain such discrepancy now and more observations in infrared, especially after the year 2000 are badly needed.

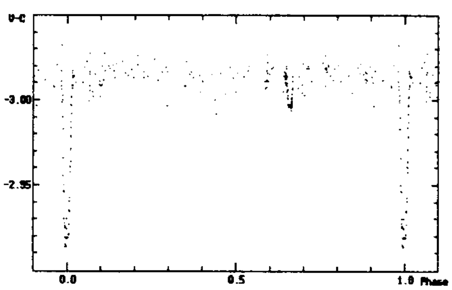

Figure 1. Light curve of Alpha CrB

Table 1

Min I JD_{hel}2 400 000+	O−C	Min II JD_{hel}2 400 000+	O−C	Author
23 163.7754 ±10	+0.0015	–	–	Stebbins
32 329.8019 ±6	0.0000	32 410.6976 ±30	−0.0017	Kron, Gordon
47 346.1168 ±6	0.0000	47 010.3923 ±25	0.0000	Volkov

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References:

Ebbighausen, E. G., 1976, *Publ. Dom. Astrophys. Obs., Victoria, B. C.*, **14**, 411
Koch, R. H., 1973, *Astrophys. J.*, **183**, 275
Kron, G. E., and Gordon, K. C., 1953, *Astrophys. J.*, **118**, 55 (KG)
Rudkjobing, M., 1959, *Ann. Astrophys.*, **22**, 111
Slettebak, A., Collins, G. W., Boyce, P. B., White, N. M., and Parkinson, T. D., 1975, *Astrophys. J. Suppl.*, **29**, 137
Stebbins, J., 1928, *Publ. Washburn Obs*, **15**, 41
Sterne, T. E., 1939, *Mon. Not. R. Astron. Soc.*, **217**, 305
Tomkin, J., and Popper, D. M., 1986, *Astron. J.*, **91**, 1428