ECLIPSING BINARY UW BOOTIS

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(Received 1 December, 1986)

Abstract. Photometric observations of primary minimum in U, B, and V filters have been discussed. The amplitude of variation in all the three filters is $0^m.66$. We do not find variations in the period and its revised value is $1^d.0047115$.

1. Introduction

The variability of UW Bootis = BD + 47°2134 was discovered photographically by Ceraski (1929). Blažko (1930) has given a period of 3^h while Guthnick and Prager (1936) mention that Dombrovsky has reported the light curve to be of W UMa type with a period of $0^d.4401$. Rügemer (1934) has found it to be of Algol type. Gaposchkin (1939) gave a period of $1^d.0047152$ based on photographic minima. The amplitudes of light variation at primary and secondary minima are mentioned as $1^m.03$ and $0^m.09$, respectively. Pierce (1951) has reported 140 visual observations. Dworak (1975) has catalogued the absolute magnitude and parallax for the system. Brancewicz and Dworak (1980) have determined various parameters for UW Boo. Kholopov (1985) has listed it as a semidetached eclipsing binary of spectral type F0. Many visual times of minima have appeared in the *BBSAG Bulletins*.

2. Observations

The star UW Boo was observed on 104-cm Sampurnanand telescope of the Uttar Pradesh State Observatory in U, B, and V filters using an EMI 6094S photomultiplier cooled to −20 °C. BD + 47°2132 and BD + 47°2128 were observed as comparison stars. We have chosen BD + 47°2132 as our final comparison star. Pierce (1947) has also mentioned BD + 47°2132 as constant star of spectral type F5. Table I lists the differential U, B, and V magnitudes (comparison − variable) transformed to standard UBV system of Johnson and Morgan. The errors of observations in U, B, and V filters are, respectively, 0.011, 0.011, and 0.034 mag.

3. Light Curve and Period

The magnitude of UW Boo as given in the BD catalogue is 9.5. Gaposchkin (1939) has given its photographic magnitude at maximum as 10.37. She has also given the depth of primary minimum as $1^m.03$ based on 950 photographic observations and the same range is quoted in the literature to date. If we examine the mean light curve given by her, we find the depth of primary minimum to be around $0^m.7$. The present observations

Astrophysics and Space Science **133** (1987) 291–296.

TABLE I

Standard differential magnitudes of UW Bootis

J. D. (Hel.)	Phase	ΔU	J. D. (Hel.)	Phase	ΔU
2442540.1549	−0.1967	$+0^m.304$	2442540.3879	+0.0352	$+^m.003$
.2017	−0.1501	+0.277	572.2027	+0.7008	+0.268
.2168	−0.1351	+0.278	.2086	+0.7067	+0.271
.2216	−0.1303	+0.281	.2141	+0.7122	+0.270
.2267	−0.1252	+0.283	.2178	+0.7159	+0.273
.2313	−0.1206	+0.299	.2256	+0.7236	+0.278
.2362	−0.1158	+0.255	.2318	+0.7298	+0.270
.2431	−0.1089	+0.269	.2370	+0.7350	+0.263
.2529	−0.0991	+0.237	.2426	+0.7406	+0.282
.2835	−0.0687	+0.052	.2487	+0.7466	+0.275
.2890	−0.0632	+0.019	.2548	+0.7527	+0.264
.2956	−0.0566	−0.059	.2592	+0.7571	+0.284
.3002	−0.0521	−0.097	.2647	+0.7626	+0.252
.3059	−0.0464	−0.167	.2691	+0.7669	+0.267
.3108	−0.0415	−0.217	.2750	+0.7728	+0.258
.3201	−0.0322	−0.279	.2796	+0.7774	+0.258
.3207	−0.0317	−0.298	.3045	+0.8022	+0.243
.3278	−0.0246	−0.353	.3089	+0.8065	+0.247
.3368	−0.0156	−0.378	.3137	+0.8113	+0.269
.3426	−0.0099	−0.404	.3196	+0.8172	+0.272
.3474	−0.0051	−0.360	.3235	+0.8211	+0.264
.3522	−0.0003	−0.334			
.3571	−0.0046	−0.292	2443281.2506	+0.4237	+0.322
.3621	−0.0096	−0.253	.2513	+0.4244	+0.285
.3687	−0.0161	−0.199	.2913	+0.4642	+0.293
.3746	−0.0220	−0.118	.3054	+0.4783	+0.280
.3807	−0.0281	−0.072	.3083	+0.4812	+0.295

J. D. (Hel.)	Phase	ΔB	J. D. (Hel.)	Phase	ΔB
2442540.1540	−0.1976	+0.278	2442572.2016	+0.6997	+0.302
.2026	−0.1492	+0.296	.2095	+0.7076	+0.321
.2161	−0.1358	+0.302	.2149	+0.7130	+0.312
.2212	−0.1307	+0.304	.2170	+0.7151	+0.320
.2263	−0.1256	+0.297	.2248	+0.7228	+0.328
.2308	−0.1211	+0.309	.2310	+0.7290	+0.328
.2357	−0.1163	+0.269	.2364	+0.7344	+0.318
.2426	−0.1094	+0.285	.2418	+0.7398	+0.323
.2520	−0.1000	+0.250	.2493	+0.7472	+0.325
.2829	−0.0693	+0.099	.2554	+0.7533	+0.314
.2885	−0.0637	+0.050	.2598	+0.7577	+0.318
.2948	−0.0574	−0.022	.2653	+0.7631	+0.328
.2997	−0.0526	−0.058	.2698	+0.7676	+0.313
.3052	−0.0471	−0.132	.2757	+0.7735	+0.332
.3100	−0.0423	−0.173	.2805	+0.7783	+0.329
.3171	−0.0352	−0.240	.3041	+0.8018	+0.300
.3215	−0.0309	−0.269	.3080	+0.8056	+0.321
.3270	−0.0254	−0.308	.3129	+0.8105	+0.302
.3360	−0.0164	−0.357	.3180	+0.8156	+0.281
.3419	−0.0106	−0.353	.3228	+0.8204	+0.306

Table I (continued)

J. D. (Hel.)	Phase	ΔB	J. D. (Hel.)	Phase	ΔB
.3467	−0.0058	−0.346			
.3515	−0.0010	−0.327	2443281.2502	+0.4233	+0.287
.3565	+0.0040	−0.278	.2521	+0.4252	+0.277
.3613	+0.0088	−0.233	.2920	+0.4649	+0.249
.3678	+0.0152	−0.171	.2935	+0.4664	+0.264
.3738	+0.0212	−0.112	.3059	+0.4788	+0.258
.3798	+0.0272	−0.047	.3076	+0.4805	+0.273
.3869	+0.0342	+0.112			

J. D. (Hel.)	Phase	ΔV	J. D. (Hel.)	Phase	ΔV
2442540.1534	−0.1982	+0.120	2442572.2011	+0.6992	+0.225
.2033	−0.1485	+0.131	.2100	+0.7081	+0.247
.2156	−0.1363	+0.126	.2157	+0.7138	+0.236
.2208	−0.1311	+0.119	.2164	+0.7145	+0.235
.2258	−0.1261	+0.106	.2241	+0.7221	+0.263
.2304	−0.1215	+0.122	.2304	+0.7284	+0.263
.2349	−0.1170	+0.124	.2355	+0.7335	+0.247
.2421	−0.1099	+0.117	.2412	+0.7392	+0.241
.2517	−0.1003	+0.068	.2498	+0.7477	+0.253
.2818	−0.0704	−0.083	.2561	+0.7540	+0.245
.2879	−0.0643	−0.139	.2605	+0.7584	+0.232
.2940	−0.0582	−0.196	.2659	+0.7637	+0.242
.2990	−0.0532	−0.259	.2702	+0.7680	+0.235
.3044	−0.0479	−0.310	.2761	+0.7739	+0.253
.3093	−0.0430	−0.362	.2808	+0.7786	+0.270
.3167	−0.0356	−0.427	.3036	+0.8013	+0.201
.3221	−0.0303	−0.468	.3072	+0.8049	+0.256
.3263	−0.0261	−0.495	.3124	+0.8100	+0.232
.3352	−0.0172	−0.530	.3171	+0.8147	+0.236
.3413	−0.0111	−0.540	.3223	+0.8199	+0.244
.3460	−0.0065	−0.535			
.3509	−0.0016	−0.497	2443281.2497	+0.4228	+0.129
.3560	+0.0035	−0.463	.2527	+0.4258	+0.120
.3606	+0.0081	−0.417	.2925	+0.4654	+0.044
.3664	+0.0138	−0.364	.2930	+0.4659	+0.070
.3727	+0.0201	−0.316	.3065	+0.4794	+0.090
.3790	+0.0264	−0.249	.3071	+0.4800	+0.084
.3864	+0.0337	−0.178			

(Figure 1) show that the primary minimum is symmetrical and its depth is $0^m.66$ in all the U, B, and V filters. We feel that the depth determined from the mean light curve of Gaposchkin (1939) is much near to the depth ($0^m.7$) found from the present observations. It is difficult to explain the difference of $0^m.37$ between the depth of primary minimum reported by her and the present work. This discrepancy might be due to the ten-point means of the photographic observations for a primary minimum at the extreme limit of its swing (cf. Figure 4 of Gaposchkin, 1939).

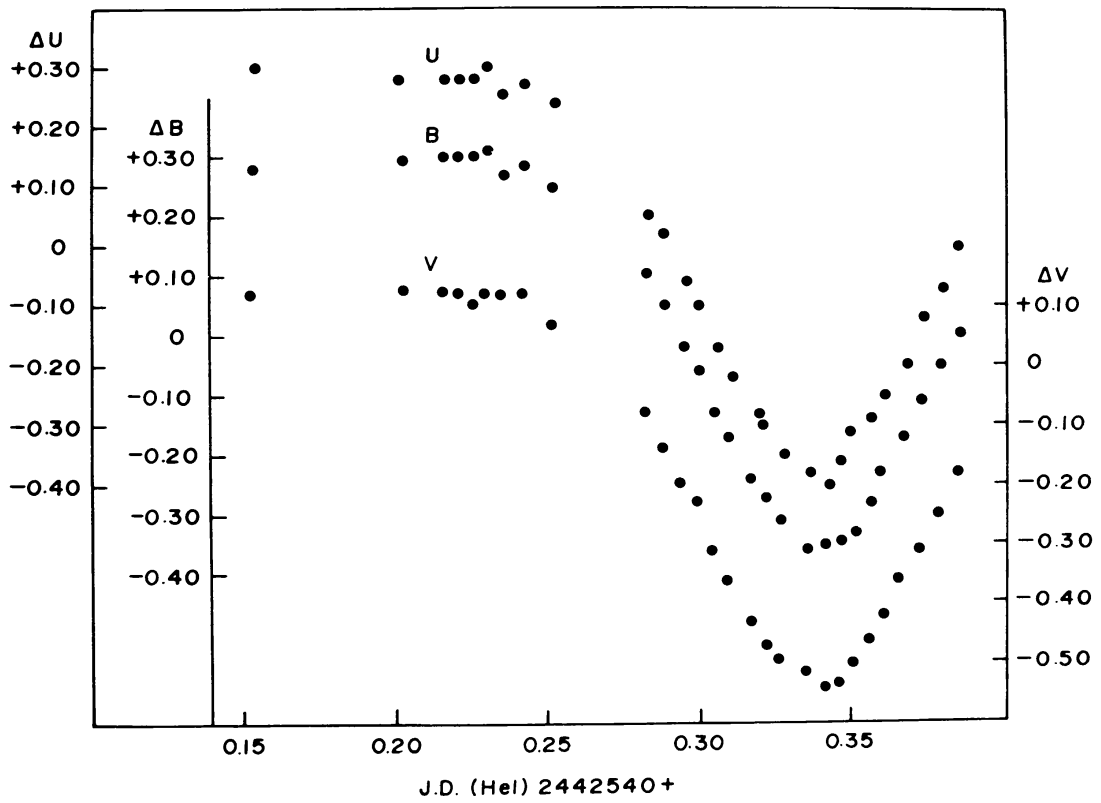

Fig. 1. Primary minimum of UW Bootis.

The total duration of the eclipse determined from the present observations is $0.20P$. Kholopov (1985) has given the total duration of eclipse as $0.14P$ which is about 1.45 hr shorter than the present value. We reexamined Gaposchkin's (1939) mean light curve and found the duration of the primary minimum to be $0.2P$ which is in agreement with our observations.

Gaposchkin (1939) has recommended this star as an interesting object for a study of period changes. This recommendation is based on the fact that combination of photographic observations showed phase shift in the primary minima with a range of $0.1P$. It has been concluded that perhaps the period of oscillation of the primary minimum is ten years though the observations were too scanty to determine this with certainty. In the above light we have collected all the available times of minima and analysed them. The mean value of our time of minima in U, B, and V filters determined by using Kwee and Van Woerden (1956) method, has been given in Table II along with other times of minima. A straight line fits to these times of minima well and the following ephemeris results:

$$\text{Pri. Min.} = \text{J.D. (Hel.)}\,2442540.3525 + 1^{d}.0047115E\,.$$
$$\pm\, 0.0024 \pm 3 \times 10^{-7}$$

TABLE II

Times of primary minima of UW Boo

J.D. (Hel.) 2400000 +	*E*	O–C	Reference
26893.298	– 15574	0^d.3228	*Astron. Nachr.* **258**, 161, 1936
28798.930	– 13677	0.0170	*SAC*, No. 47
35702.288	– 6806	0.0021	*GCVS* **1**, 91, 1969
41070.453	– 1463	– 0.0066	*SAC*, No. 47, 88, 1976
41904.361	– 633	– 0.0092	*ibid*, No. 46, 1975
42128.428	– 410	0.0072	*ibid*, No. 48, 1977
42404.710	– 135	– 0.0065	*BBSAG Bull.* **19**, 1975
42404.715	– 135	– 0.0015	*ibid.*
42540.346	0	– 0.0066	Present study
42561.428	21	– 0.0235	*BBSAG Bull.* **22**, 1975
42569.485	29	– 0.0042	*ibid.* **23**, 1975
42974.390	432	0.0020	*ibid.* **29**, 1975
42988.423	446	– 0.0309	*ibid.*
42990.459	448	– 0.0043	*ibid.*
42992.465	450	– 0.0077	*ibid.*
45115.435	2563	0.0067	*ibid.* **60**, 1982
45116.433	2564	0.0001	*ibid.*
45946.336	3390	0.0113	*ibid.* **74**, 1984
46174.399	3617	0.0048	*ibid.* **76**, 1985
46174.407	3617	0.0128	*ibid.* **77**, 1985
46175.401	3618	0.0021	*ibid.* **76**, 1985
46175.409	3618	0.0101	*ibid.*
46176.418	3619	0.0124	*ibid.*
46180.421	3623	– 0.0014	*ibid.*
46180.436	3623	0.0136	*ibid.*

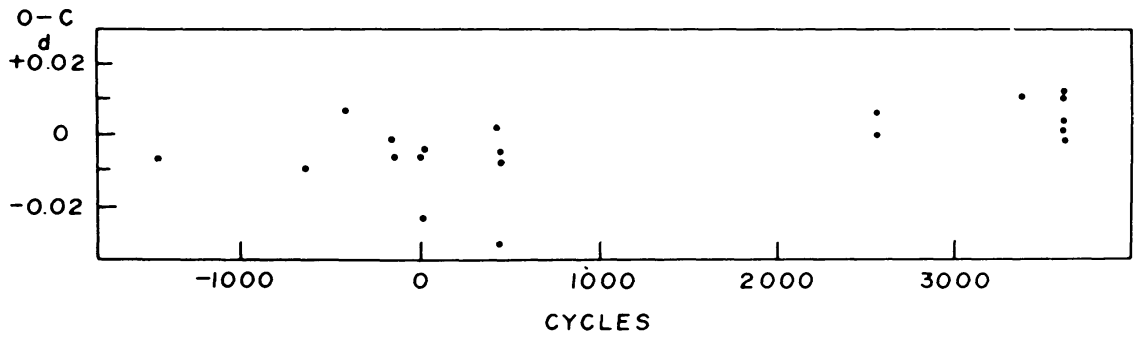

Fig. 2. (O–C) diagram of UW Bootis.

The O–C values calculated from the above ephemeris have also been listed in Table II and are plotted in Figure 2. The O–C value of 0^d.323 at cycle – 15547 being too large, has not been used for determining the period, also O–C values at cycles – 15574, – 13677, and – 6806 have not been shown with a view to compress the figure. From

Figure 2 we have concluded that the period of UW Boo is constant and we do not find the reported oscillations of the primary minimum with a period of ten years though there are no observations between cycles 450 to 2536, corresponding to a duration of 5.8 yr.

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