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LIGHT ELEMENTS AND A PRELIMINARY SOLUTION FOR THE LIGHT CURVE OF THE ECLIPSING BINARY GSC 1534.0753

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The ROTSE1 CCD survey (Akerlof et al., 2000) has discovered many new variables, a large number of which are eclipsing binary stars. A group of AAVSO members using CCD, visual and photographic observations have observed GSC 1534.0753 = ROTSE1 J170250.47. In this note we report the results of our investigation which include precision light elements and a light curve, as well as standard $UBVRI$ magnitudes for the variable and comparison stars. We also present a preliminary solution for the light curve using the Wilson–Devinney program.

Baldwin began a program of intensive visual monitoring of the star. A total of 69 observations were made over 24 nights. The star was seen in eclipse on five nights and from these observations preliminary light elements were determined. At the same time, Guilbault and Hager examined 211 photographic plates at the Harvard College Observatory. These photographic data enabled the elements to be further refined so that CCD observations could commence.

Lubcke observed the system with a 0.28-m Schmidt–Cassegrain telescope (SCT) equipped with an ST9E CCD camera from his private observatory. Billings used a 0.35-m SCT with a AP-7 CCD to observe the star at secondary minimum. The star was observed from JD 2451748 to JD 2451777 in the V passband. A total of 517 CCD observations were made and from these data five times of primary minimum and three times of secondary minimum were extracted. The times of primary minimum from all sources appear in Table 1.

From the Harvard minima listed above a period of $0^{\rm d}.5111552$ was determined. The exposure time of the plates was generally one hour and the mid-point of the exposure is the time of minimum. The CCD minima were determined with the computer program *AVE* (Barbera, 2000) which uses the Kwee–van Woerden (1956) method. In order to refine the period further, a least squares solution was applied to all minima shown in

Table 1: Times of primary minimum, GSC 1534.0753

HJD 2400000 +	Error ±	Epoch	$O-C$	Observer	Type
43335.669	-	−16494	−0.002	Harvard	ptg
43659.740	-	−15860	−0.004	Harvard	ptg
43960.833	-	−15271	+0.018	Harvard	ptg
44045.671	-	−15105	+0.004	Harvard	ptg
44540.474	-	−14137	+0.009	Harvard	ptg
45170.699	-	−12904	−0.021	Harvard	ptg
45556.633	-	−12149	−0.010	Harvard	ptg
45618.490	-	−12028	−0.003	Harvard	ptg
45963.513	-	−11353	−0.010	Harvard	ptg
46028.456	-	−11226	+0.016	Harvard	ptg
46590.729	-	−10126	+0.018	Harvard	ptg
46612.652	-	−10083	−0.039	Harvard	ptg
46674.543	-	−9962	+0.002	Harvard	ptg
46937.806	-	−9447	+0.020	Harvard	ptg
46999.649	-	−9326	+0.013	Harvard	ptg
47084.489	-	−9160	+0.001	Harvard	ptg
47085.496	-	−9158	−0.014	Harvard	ptg
51748.7831	0.0009	−35	−0.001	Lubcke	CCD, V filter
51763.6073	0.0009	−6	−0.000	Lubcke	CCD, V filter
51764.6315	0.0015	−4	+0.002	Lubcke	CCD, V filter
51766.6744	0.0002	+0	−0.000	Lubcke	CCD, V filter
51767.6961	0.0002	+2	−0.001	Lubcke	CCD, V filter

Table 1. The CCD minima were weighted as 100 and the photographic minima were weighted as 1. From that analysis we extracted the best period and combined with the most accurate time of minimum to yield the following light elements:

$$\text{Min. I} = \text{HJD } 2451766.6744 + 0^{\text{d}}.51115576 \times E.$$
$$\pm 0.0001 \quad \pm 0.00000005$$

The CCD observations in the V passband were folded using the elements above and the phased and normalized V light curve is shown in Figure 1. For the purpose of illustration the brightness of the variable is expressed in light units rather than magnitudes. The light curve varies continuously between eclipses and indicates that GSC 1534.0753 is a Beta Lyrae (EB) type eclipsing binary with one or both of the components being highly ellipsoidal.

In the instrumental system our V-filtered observations indicate that the star fades from a maximum of $11^{\text{m}}.94 \pm 0.01$ to $13^{\text{m}}.09 \pm 0.01$ at primary minimum. A secondary eclipse with a depth of $0^{\text{m}}.50 \pm 0.01$ occurs at phase 0.50.

From the US Naval Observatory's Flagstaff Station, Henden used the 1.0-m telescope and an SITe/Tektronix 1024×1024 CCD to observe the field of GSC 1534.0753. On four photometric nights observations were made in the $UBVRI$ bandpasses with magnitude and color errors less than $0^{\text{m}}.01$. The comparison (GSC 1534.1027) and check (GSC 1534.0962) stars were standardized as follows:

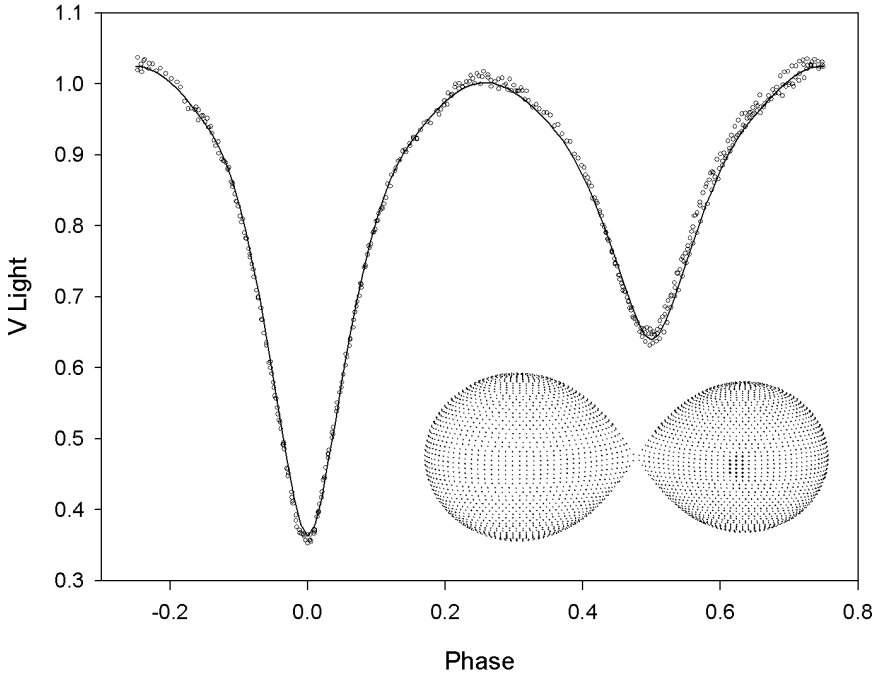

Figure 1. Phased and normalized V light curve and star figures based on the preliminary solution

Table 2: Comparison stars

Star	RA (J2000) DEC		V	$B-V$	$U-B$	$V-R$	$R-I$
Comp.	17:02:54.93	+21:36:36.5	12.451	0.609	0.081	0.354	0.336
Check	17:02:29.25	+21:44:40.8	12.607	0.589	0.281	0.378	0.348

Extensive photometric information about all stars within 5 arcmin of the variable is available in Henden (2000). Using these stars, and again with errors less than $0\overset{\mathrm{m}}{.}01$, the magnitude and color indices of GSC 1534.0753 at four different epochs were determined as:

HJD 2400000 +	Phase	V	$B-V$	$U-B$	$V-R$	$R-I$
51754.6881	0.4494	12.324	0.723	0.247	0.405	0.358
51757.6891	0.5784	12.256	0.765	0.319	0.445	0.399
51761.7423	0.6489	12.084	0.765	0.315	0.446	0.388
51791.6953	0.9497	12.656	0.861	0.571	0.500	0.451

The colors suggest that the primary star is approximately spectral type G8 with a temperature of 5300 K using the Flower (1996) tables.

Terrell used the latest version of the Wilson–Devinney program (Wilson and Devinney, 1971; Wilson, 1979) to arrive at a preliminary solution for the system parameters. Inspection of Figure 1 shows that the system has a noticeable O'Connell effect (Davidge and Milone, 1984). To model this asymmetry in the maxima, two spots were used on the hotter component. While the available data are insufficient to reliably determine the

properties of any spots in the system, the solution illustrates the nature of the asymmetries. Table 3 shows the parameters of the best-fit solution which should be regarded as provisional until further data, in particular radial velocities, can be obtained. As seen in Figure 1, the solution shows the system to be in marginal contact with the less-massive star eclipsed at primary minimum. The poor thermal contact suggests that the system may be a B-type W UMa system (Lucy and Wilson, 1979).

Table 3: Solution parameters

Parameter	Value	Std. deviation
i	82.°6	0.°12
T_1	5300 K	
T_2	4483 K	5 K
Ω	4.190	0.017
M_2/M_1	1.28	0.01
$(L_1/L_2)_V$	1.96	

Table 4: Spot parameters

Star	Co-Latitude (rad)	Longitude (rad)	Radius (rad)	Temperature factor
1	1.57	1.0	0.10	1.20
1	1.57	6.0	0.15	0.88

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