THE ALGOL-TYPE ECLIPSING BINARY GSC 3002-0454

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Abstract

Photographic, visual, and CCD photometry indicate that the star GSC 3002-0454 in Ursa Major is an Algol-type eclipsing binary, range 12.8–15.0 V, period 1.8559010 days. Secondary minimum is 0.10V. Eclipse duration is about 0.34 day, and the eclipse is total with an interval of constant light at minimum lasting about 0.04 day.

1. Introduction

Variability of GSC 3002-0454 was discovered by Williams (2001) on two photographs taken with the 25-cm astrograph at Indiana University's Goethe Link Observatory, which showed the variable at 13.4 and <15.0 ptg. The variable's position is RA $10^h\ 29^m\ 51.97^s$, Dec +39° 56' 28.0" (J2000). A finding chart appears in Figure 1.

Subsequent investigation by Williams on 142 Harvard College Observatory patrol plates found 15 dates on which the variable was fainter than maximum (Table 1). The variable was clearly an Algol-type eclipsing binary with a deep primary minimum. But on the 15 Harvard plates during minima the variable was only a few tenths of a magnitude fainter than maximum or invisible, below the faint limit of 14.0–14.5 ptg. This photographic material therefore provided only approximate times of minima, and repeated attempts to calculate a unique period were unsuccessful due to the large uncertainties.

2. Observations

New observations were needed to solve the period problem, so Baldwin and Guilbault undertook regular visual monitoring. They eventually caught five minima, including Baldwin's key observation of minima only two nights apart. By fitting together observations of rising and descending branches from different nights, the visual data revealed the period near 1.856 days and permitted future minima to be predicted for the benefit of CCD observers.

Kaiser and Samolyk obtained CCD timings of three primary minima, and Lubcke was able to observe the shallow secondary minimum (Table 2). All of these light curves indicate that there is an interval of constant light at minimum with a duration of about 0.04 day (Figure 2). Aided by a much-improved period, Henden made CCD observations with the 1-m reflector at the U.S. Naval Observatory's Flagstaff Station to determine precise BVRI magnitudes of the comparison and check stars (Table 3) and the variable at maximum and at mid-eclipse of both the primary and secondary minima (Table 4).

3. Results

GSC 3002-0454 is an Algol-type eclipsing binary with a range of 12.75–14.95V in primary minimum. The secondary minimum at phase 0.5 is 0.10 V deep. Our observations indicate that the minima are about 0.34 day (0.18 P) in duration, and eclipses are total with an interval of constant light of about 0.04 day.

As noted above, the photographic and visual observations in Table 1 occur at some time during an eclipse but do not represent times of mid-eclipse. Nonetheless, the long time span of the observations allows the period to be calculated with considerable precision. To improve the result, we selected only the photographic and visual observations that show the variable at least 1 magnitude fainter than maximum, 14.4 or fainter photographic, 13.8 or fainter visual. These 14 times were combined with the CCD timings in a least squares solution, using nominal weights of 1 for the photographic and visual data and 10 for the CCD timings. The resulting period was combined with the CCD timing having the smallest internal error to obtain the following light elements:

$$\begin{aligned} \text{Min. I}_{\text{(hel.)}} = \text{JD}\ & 2451603.7691 + 1.8559010\,\text{E} \\ & \pm 0.0001 \quad \pm 0.0000005 \end{aligned} \tag{1}$$

The observed minus calculated (O-C) residuals in Tables 1 and 2 were calculated from Equation 1.

4. Acknowledgements

We are grateful to Indiana University's Link Observatory, Harvard College Observatory, and the U. S. Naval Observatory for use of their facilities during different phases of this project.

Reference

Williams, D. B. 2001, *Inf. Bull. Var. Stars*, No. 5084.

Table 1. Observations of GSC 3002-0454 during primary minima.

JD 2400000+	*Magnitude*	*Type*	*O-C(d)*	*Observer*
25290.813	<14.2	ptg	+0.008	H
26532.588	14.7	ptg	+0.186	H
27374.884	<14.8	ptg	-0.098	H
28961.655	14.6	ptg	-0.122	H
29429.655	14.4	ptg	+0.191	H
31084.864	<14.5	ptg	-0.064	H
34072.774	14.5	ptg	-0.154	H
42485.727	14.4	ptg	0.000	H
44996.764	<14.5	ptg	+0.002	H
45289.892	14.2	ptg	-0.102	H
45757.717	14.2	ptg	+0.036	H
46438.810	<14.2	ptg	+0.013	H
46492.646	<14.5	ptg	+0.028	H
46878.712	14.1	ptg	+0.067	H
47264.629	<14.5	ptg	-0.044	H
49801.651	<15.0	ptg	-0.038	L
50545.836	<12.8	vis	-0.070	B
50573.730	<12.8	vis	-0.014	B
50575.586*	<13.8	vis	-0.014	B
51486.885*	14.3	vis	+0.038	G
51497.935**	14.5	vis	-0.048	B

**brightness increasing from this point*
***brightness decreasing to this point*
H = Harvard Observatory, L = Link Observatory, B = Baldwin, G = Guilbault

Table 2. CCD timings of minima.

JD 2400000+		*min.*	*O-C(d)*	*Observer*
51551.802	±0.003	I	-0.002	K
51603.7691	±0.0001	I	0.0000	K
51629.7502	±0.0002	I	-0.0015	S
51656.667	±0.002	II	+0.005	L

K = Kaiser, L = Lubcke, S = Samolyk

Table 3. Comparison and check stars (errors less than 0.02 mag.)

GSC	*V*	*B-V*	*V-R*	*R-I*
3002-0277	13.24	0.50	0.30	0.29
3002-0289	12.81	0.91	0.51	0.43

All observations by Henden

Table 4. Variable GSC 3002-0454 (errors less than 0.01 mag.)

Phase	*V*	*B-V*	*V-R*	*R-I*
Maximum	12.75	0.64	0.40	0.39
Minimum I	14.95	1.26	0.75	0.72
Minimum II	12.85	0.62	0.37	0.36

All observations by Henden

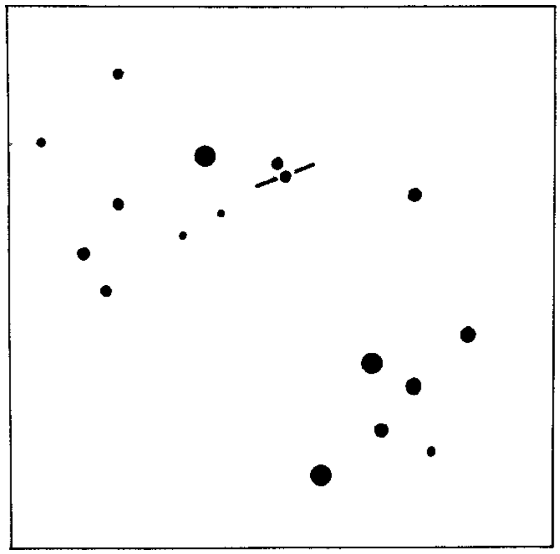

Figure 1. Finding chart for eclipsing binary GSC 3002-0454. North up, East left, field 30 arcmin.

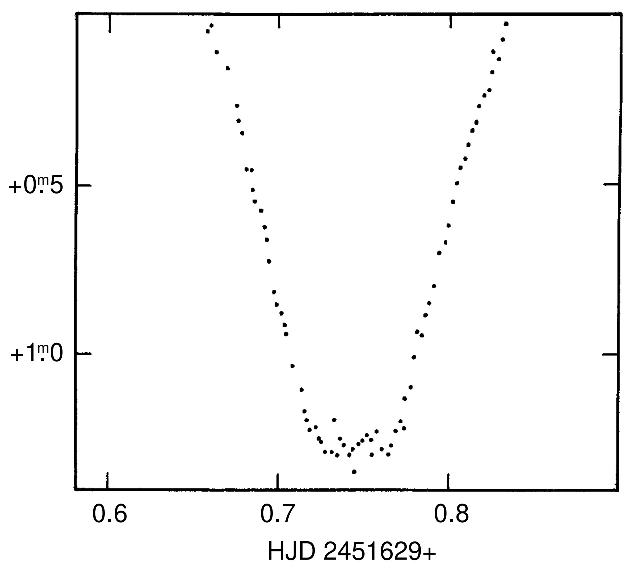

Figure 2. Primary minimum of GSC 3002-0454, unfiltered CCD observations by G. Samolyk, Milwaukee Astronomical Society Observatory.