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CCD PHOTOMETRY OF ECLIPSING BINARY AL OPHIUCHI

The eclipsing binary AL Ophiuchi (= GSC 0999.155; $\alpha(2000) = 17^{\rm h}26^{\rm m}45\overset{\rm s}{.}4$, $\delta(2000) = +12°57'56''$) is a neglected, rather faint binary near α Oph. Its V magnitude given in the *Guide Star Catalogue* is $13\overset{\rm m}{.}05$. Unfortunately, this variable has not been studied photometrically for more than 20 years and the light elements of this system are not given in the GCVS.

Variability of this star with amplitude 14.1 – 15.0 mag was discovered photographically by Reinmuth (1926) in Heidelberg. The spectral type of AL Oph was measured by Bond and Tifft (1974) during their spectroscopic survey of some high-latitude blue variables. They found a spectrum of G5. Meinunger (1981) concluded that AL Oph belongs to the W UMa type and the amplitude is too small for the period determination from the older photographic measurements. Recently, the variability of AL Oph was examined on the plates of the Odessa Observatory by V.I. Marsakova (Andronov 1996) and several weakenings were obtained. This star was also measured by Paschke (1996). All previous measurements lead to uncertain conclusions about its type and light elements.

The present CCD photometry of AL Oph was carried out during 14 nights in the period from June to November 1996 at the Ondřejov Observatory, Czech Republic, using a 65cm reflecting telescope with a CCD-camera (SBIG ST-6) in the primary focus. The measurements were done using the standard Cousins R filter with exposure time from 45 to 120 s. Two nearby stars GSC 0999.1235 ($V = 11.6$ mag) and GSC 0999.388 ($V = 12.8$ mag) on the same frame as AL Oph served as a comparison and check stars (Figure 1). Some of the observations were done through thin clouds. The CCD data were reduced using software developed by P. Pravec and M. Velen (Pravec et al. 1994). No correction of relative magnitudes was allowed for airmass due to the proximity of the comparison star to the variable (46 arcsec). Deviations caused by differential extinction in the broad-band filter for different colours of stars should not be significant. Due to preliminary period close to one sidereal day, the primary minima were observable only before the end of June 1996. On August 25 we obtained a flat secondary minimum and, fortunately, in November 21 LŠ observed a part of the descending branch to the primary minimum.

The times of minimum and period were determined using a new method of iterative least squares polynomial fitting. The method for a minimum determination was developed especially for processing of precise lightcurves with partial coverage of both branches. This is a typical result of non-automatical CCD observations, when several objects are followed and for a particular object we obtain groups of consequent images separated by large time intervals. This method should provide also more reliable results in the case when the number of points on each branch differs. We suppose only the symmetry of the minimum.

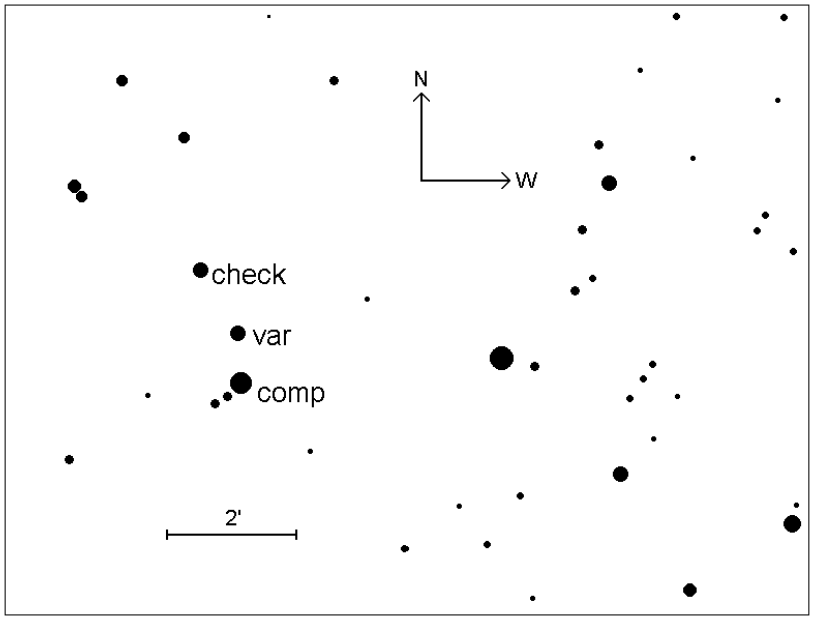

Figure 1. Finding chart of AL Oph. The comparison and check stars are also plotted

Table 1. New times of minimum of AL Oph

JD Hel.– 24 00000	Error [days]	Min. type	$O-C$ [days]	Epoch	N
50250.3865	0.0004	Pri.	+0.0006	7.0	16
50252.3717	0.0003	Pri.	–0.0002	9.0	25
50321.3896	0.0009	Sec.	+0.0038	78.5	65

Similar way of solution – double iteration connected with the least squares fitting – can be used for determination of light elements from several night observation. We choose a symmetrical feature on the lightcurve (primary minimum), estimate period and basic light minimum. Then we fit a low-order polynomial like in the case of simple minimum determination. Varying the period we find a minimum residual corresponding to the best period. Using this method we can determine the precise value of period in the case of AL Oph, where we have only two primary minima with low accuracy in a short time interval (see Table 1). We derived the following linear light elements for the current use:

$$\begin{aligned} \text{Pri.Min.} = \text{HJD } 24\ 50243.4348 + 0^{\text{d}}.993005 \times \text{E.} \\ \pm 0.0003 \pm 0.000025 \end{aligned}$$

Observed times of minima are presented in Table 1. In this table, N stands for the number of observations used in the calculation of the minimum time, the other symbols are self-explanatory. Figure 2 shows the composite differential R light curve during the summer 1996. The light amplitude in R colour for primary minimum according to our measurement is $A_1 = 0.56 \pm 0.02$ mag, for secondary minimum we found $A_2 = 0.10 \pm 0.02$ mag. The duration of both minima seems to be about 2 hours. New measurements of this system are necessary to improve the above given elements.

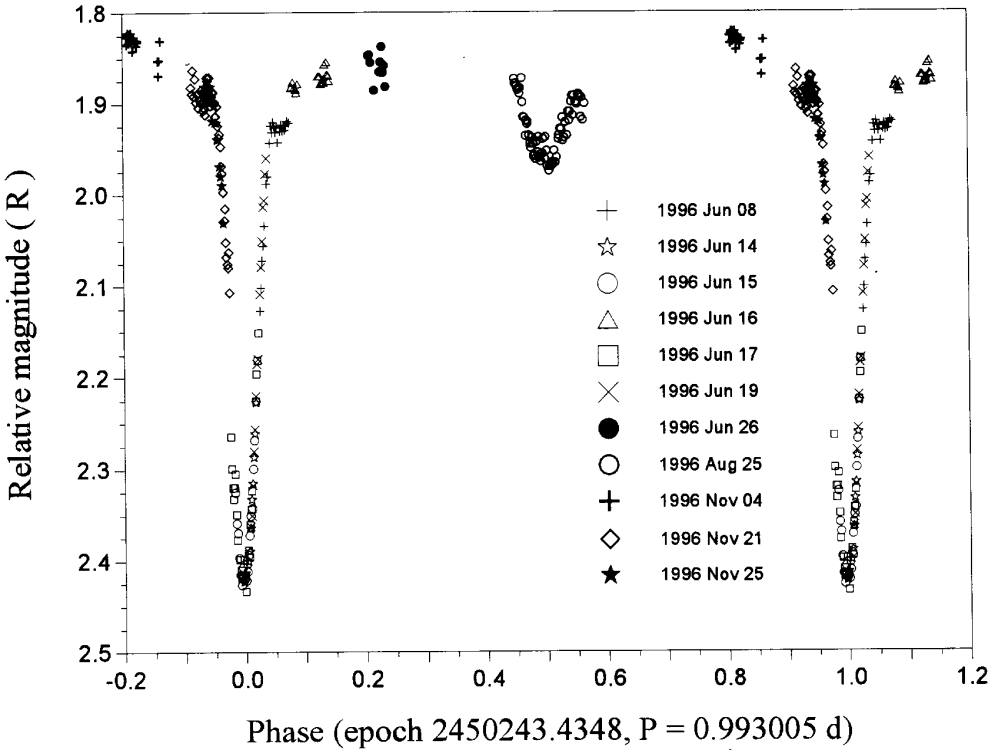

Figure 2. Composite differential R-light curve of AL Oph obtained in 1996

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References:

Andronov, I., 1996, private communication
Bond, H.E., Tifft, W.G., 1974, *PASP*, **86**, 981
Meinunger, L., 1981, *Mitteilungen Ver. Sterne*, **9**, 59
Paschke, A., 1996, private communication
Pravec, P., Hudec, R., Soldán, J., Sommer, M., Schenkl, K.H., 1994, *Experimental Astronomy*, **5**, 375
Reinmuth, K., 1926, *Astronomische Nachrichten*, **226**, 193