LIGHT VARIATIONS OF THE B STAR HR 7556

(Letter to the Editor)

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Abstract. On the basis of new UBV photometry this paper reports on the discovery of the variability of the B star HR 7556. The ellipsoidal character of the light curve indicates that it is probably a long period ($P \sim 40^d$) interacting binary. This interpretation has been confirmed by available radial velocity data.

1. Introduction

During a project initiated in 1993 with the main purpose to monitor long period interacting binaries (W Ser stars) in the northern sky, HR 7556 (= HD 187640) was used as a comparison star. However, it turned out that this star is variable itself. In spite of the relatively high brightness, there are only very few observations reported in the literature.

Attention was called to the possible light variation for the first time by Grygar and Kohoutek (1969). On the basis of that paper the star was included in the NSV Catalogue (Kukarkin *et al.*, 1982) with the number NSV 12454. Since then variability of this star has not been dealt with comprehensively. There even were some authors who used it as a standard star.

However, in addition to Grygar and Kohoutek's article there were some signs that HR 7556 might not be a constant star. Albitzky and Shajn (1933) had already concluded, from their radial velocity measurements, that this star probably is a spectroscopic binary with an amplitude of 47 km s^{-1}. But they had only 5 spectra and because of the faint visual magnitude of HR 7556 for their equipment this statement was uncertain. Their assumption was at last confirmed by Hube (1970).

The spectral type assigned to HR 7556 is a bit confusing: the earliest sources give the spectral class B8 (see e.g. HD Catalogue) and then Osawa (1959) classified it as a B3III star. Lately it was identified as a B5V spectrum by Cowley (1972). On the basis of the UV spectrum, Cucchiard *et al.* (1977) determined its spectrum as gB6. Such a contradiction is not unusual among the early type stars, however all of the above facts suggest that it is worthwhile searching for variability in this star.

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TABLE I

UBV measurements of HR 7556. Data obtained at the 1 m telescope are marked with a star and the uncertain values with a colon

HJD 2440000+	V	$B-V$	$U-B$
9126.5410	6.253:	–0.070:	–0.556:
*9171.4045	6.287	–0.109	–0.511
*9172.3905	6.286	–0.115	–0.501
*9176.4102	6.265:	–0.105:	–0.511:
*9203.3619	6.239	–0.119	–0.508
*9204.3807	6.239	–0.120	–0.503
9505.4424	6.291	–0.095	–0.557
9517.4570	6.250	–0.120	–0.530
9519.3975	6.228	–0.110	–0.522
9545.3965	6.288	–0.074	–0.535
9545.4932	6.284	–0.123	–0.560
9562.3730	6.282	–0.111	–0.582
9563.3076	6.280	–0.099	–0.557
9565.3965	6.255	–0.083	–0.545
9565.5361	6.258	–0.068	–0.534
9573.3877	6.225	–0.064	–0.578
9574.5059	6.228	–0.088	–0.534
9577.3379	6.238	–0.094	–0.532
9577.5313	6.232	–0.090	–0.580
9579.5322	6.259	–0.102	–0.523
9608.3125	6.249	–0.087	–0.559
9609.2930	6.234	–0.079	–0.552
9614.2803	6.229	–0.115	–0.537
9666.2393	6.259	–0.105	–0.527
9682.2646	6.257	–0.098	–0.531

2. Observations

HR 7556 has been observed photoelectrically mainly with the UBV photometer attached to the 50 cm Cassegrain telescope and also with $UBV(RI)_c$ photometer attached to the 1 m RCC telescope at the Mátra Mountain Station of the Konkoly Observatory since the summer of 1993. The characteristics of the photomultiplier and filter combinations of the 50 cm telescope are given by Szabados (1977). The comparison star was HD 188170 (= BD+28°3513, A0) and the check was HR 7640 (= HD 189395, B9III-IV). The V magnitude and colour indices of the comparison star were taken from Harmanec *et al.* (1994), viz. $V = 7^{\mathrm{m}}.373$, $B-V = -0^{\mathrm{m}}.095$, $U-B = -0^{\mathrm{m}}.365$.

The individually observed values are given in Table I. Each magnitude listed there is the result of 6 or 8 integrations of about 10 s duration. The average standard deviations of the individual observations are better than $0^m.01$, $0^m.01$ and $0^m.015$ in the V, B and U respectively. The uncertain observational data are marked with a colon and those which were obtained at the 1 m telescope with a star. Average first-order extinction coefficients were used ($\Delta X_{\max} = 0.0036$) and the colour-dependent extinction corrections were omitted during the standard reduction process because of the tiny values of the instrumental colour indices ($|\Delta(b-v)_{\max}| = 0.02$). The estimated error of the transformation due to the applied extinction coefficients and telescope constants are less than $0^m.01$.

3. Discussion

Since we have only very few observations and were not able to presuppose anything concerning the behavior of the light variation a PDM algorithm was chosen for a first period search. Such methods are very efficient for finding periods in the case of very few unevenly spaced data as was demonstrated by Stellingwerf (1978). The search was carried out with the most sensitive bin structure (5,5), with the calculation mode rough cut and with a range of significance 0.1 (90%). In this case peaks were found in the spectrum of the V light curve at $P_1 = 41^d.9$ and $P_2 = 37^d.8$ corresponding to nearly sinusoidal variations.

We used a Fourier method (Deeming, 1975) for the more detailed analysis. Period analysis of such small amount of data is very sensitive to homogeneity errors in photometry, therefore a homogeneous batch of data was used, obtained from the 50 cm telescope in one season (9517–9614) by removing the doubtful data. The strongest peak in the spectrum of these data is at $P = 19^d.52$.

In Figure 1 the V phase diagram is shown for this period. It has to be noted that the B curves show similar structure but with a higher variance. The U curves is, as usual, the worst, but the periods are undoubtedly recognizable. The total amplitudes of light variations are about $0^m.08$, $0^m.06$ and $0^m.07$ in V, B and U, respectively, they were determined by fitting the least squares sine curves. Because of the variance and the few points one can regard the amplitudes as roughly identical.

It has to be mentioned that there is a significant difference between the earlier observed values and the present average brightness. It might be that there are some transformation problems but this discrepancy ($0^m.2$ in V) seems to be too large. Unfortunately, the exact dates of these old observations are unknown so it was not possible to compare these points with our data. Variability on a long timescale cannot be excluded either, but many more data are needed.

The character of the light variation is ellipsoidal. It can be explained by the well-known geometrical effect: the rotation of an elliptically deformed star due to the tidal distortion of a Roche-lobe filling companion in an interacting binary. The

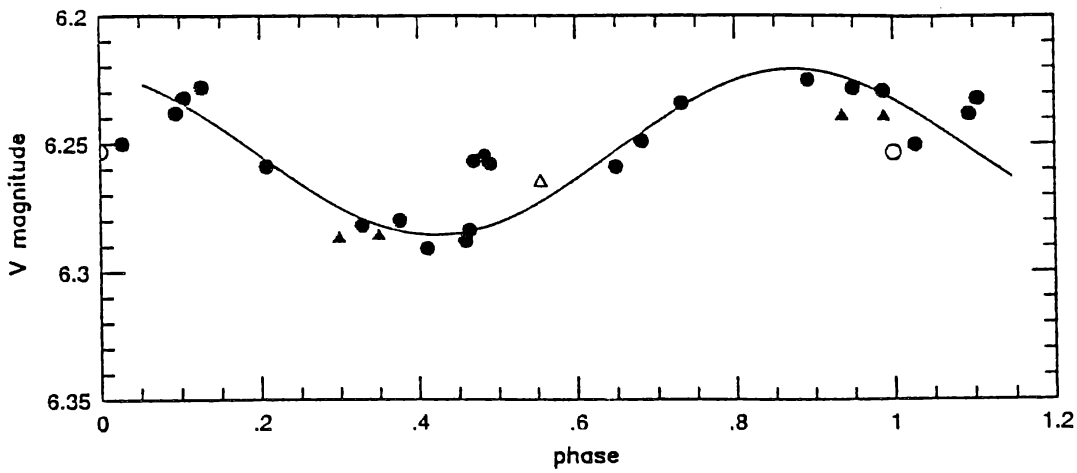

Fig. 1. *V* phase diagram of HR 7556 for $P = 19^d.52$; circles mean 50 cm, triangles 1 m telescope observations and open symbols the uncertain measurements. The least squares sine curve is shown as solid line.

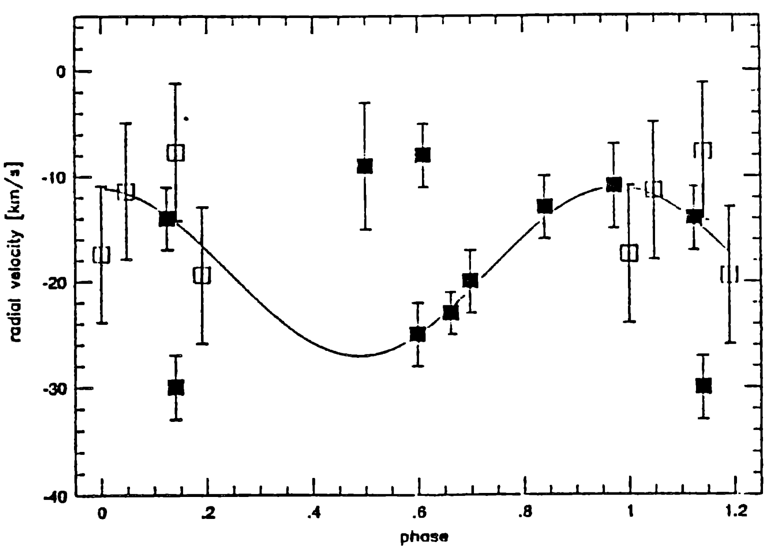

Fig. 2. Radial velocity phase diagram of HR 7556 for $P = 39^d.04$. Observations by Hube (1970) (filled squares) and by Albitzky and Shajn (1933) (open squares). The bars correspond to errors given by these authors.

minimum of the light curves was calculated by a third degree polynomial fitting with the double of the photometric period. This way, the following ephemeris was determined

$$\text{HJD(min)} = 2449134.7394 + 39.04 \times E$$

The radial velocity curve folded with this period is shown in Figure 2. Remarkably, the search for periods in the radial velocity data themselves (using both Hube's homogeneous and the complete sets) gave it very doubtfully but at about 40^d.

In summary, HR 7556 is a new member of the group of ellipsoidal variables. For the better understanding of this star – for confirming or rejecting the above sketched picture – many more observations are needed both photometrically and spectroscopically.

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