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# THE VARIABLE STAR BD +31°0849

The star BD +31°0849 (R.A.=$5^h02^m15^s$, Decl.=+31°15'49", 2000.0) was discovered as variable during routine photoelectric UBV observations of astrometric standard stars (Oja, 1991). It was put on the observation programme of the Kvistaberg 40 cm Cassegrain telescope (T40), and later it was observed also with the 60 cm Cassegrain telescope (T60) of the Royal Swedish Academy of Sciences at Observatorio Astrofísico del Roque de los Muchachos on la Palma, and a few times with the 2.5 m Nordic Optical Telescope (NOT), also on La Palma. At the small telescopes conventional one-channel photometers, equipped with UBV filters, were used, while at NOT the Turku Observatory five-channel UBVRI photo-polarimeter was utilized.

The nearby B9 star BD +31°0845 = HD 32036 (R.A.=$5^h01^m46^s$, Decl.=+31°46'41", 2000.0) was chosen as local standard, and it was always observed immediately before or after the variable (except the five earliest observations that established the variability). The observations were made interspersed with observations of other stars belonging to other programmes; for every night extinction coefficients were derived in magnitude as well as the colours by means of primary standards with well-known magnitudes and colours. The data have been transformed to the normal UBV system (Johnson, 1955); the red and infrared colours observed with NOT are on Landolt's (1983) system. Altogether 120 observations were gathered between Nov. 19, 1988 and March 12, 1992.

The resulting data for the local standard BD +31°0845 are

V=7.719,
B−V=0.131,
U−B=−.114,
V−R=0.112,
R−I=0.126.

The V measurements of BD +31°0849 have been referred to the measurement of the local standard nearest in time (except the five first measurements, when no local standard was yet chosen); the colour indices are referred to all standards measured during the actual nights. The mean errors of the measurements, as calculated from the deviations of the individual measurements from their means for constant stars measured during the same runs, are given in Table 1. The individual data have been deposited as file No. 281E in the archives of unpublished data of IAU Commission 27.

The observations were run through a period-searching program (Oja, 1987). The best period found is 0.603500 days; half that value also satisfies the data quite well. The light curve of BD +31°0849 is shown in Figure 1, where the phase is defined as the decimal part of (HJD −2448000)/0.603500.

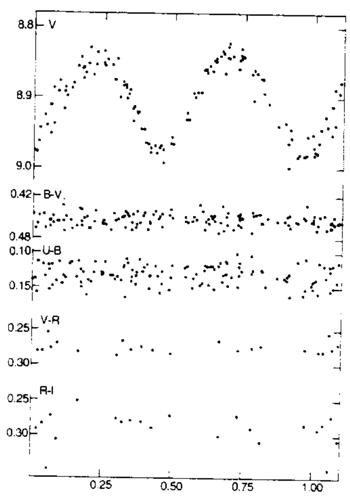


Figure 1. The light-curve of BD +31°0849

Table I. Mean error of a single measurement

| | V | B−V | U−B | V−R | R−I |
|---|---|---|---|---|---|
| T 40 | .014 | .009 | .011 | | |
| T 60 | .009 | .007 | .010 | | |
| NOT | .010 | .007 | .008 | .007 | .018 |
| Average | .011 | .008 | .010 | .007 | .018 |

Table II. Characteristics of the light-curve

| | | | |
|---|---|---|---|
| Phase of primary minimum | 0.455, | magnitude | 8.979 |
| Phase of secondary minimum | 0.954, | magnitude | 8.977 |
| Phase of first maximum | 0.696, | magnitude | 8.837 |
| Phase of second maximum | 0.233, | magnitude | 8.848 |
| Total amplitude | 0.142 | | |

A Fourier fit to the data yields

$$V = 8.905 + 0.0064 \times cos(F) - 0.0670 \times sin(2F) + 0.0048 \times sin(3F) + 0.0029 \times cos(3F) + 0.0018 \times sin(4F) - 0.0061 \times cos(4F) \quad (1)$$

F=phase−29.8°

The mean errors of the coefficients of the trigonometric terms are about 0.0017, the dispersion of the observations 0.012. This value is very near the average for a V measurement of a field star (Table 1), but a lower value would be expected here, because the measurements are relative to a close-by standard. Probably minor variations of the light-curve are involved, but there is no obvious trend depending on observing season. The maxima and minima (as derived from eq.(1)) are characterized in Table 2. The minima are very similar and occur with a phase difference of 0.5, while the maxima seem to differ in form. Appointing the marginally deeper minimum for primary minimum, the resulting ephemeris is

$$\text{HJD (primary minimum)} = 2448384.1004 + 0.603500 \times \text{E} \qquad (2)$$

The colours of the star show no change with time; the averages are $\langle B-V \rangle = 0.454 \pm .001$, $\langle U-B \rangle = 0.132 \pm .001$, $\langle V-R \rangle = 0.276 \pm .002$, $\langle R-I \rangle = 0.286 \pm .004$. The corresponding mean errors of a single measurement are $\pm .009$, $\pm .014$, $\pm .008$, and $\pm .018$ in good agreement with the data in Table 1, except for U−B where probably transformation difficulties are responsible for the higher value. The constancy of the colours excludes pulsation (with half the period adopted) as cause of the variability; the star obviously is an EW eclipsing variable. The equal depth of both minima indicates a system of two equal components, the low amplitude an inclination considerably below 90°.

Objective prism spectra of BD +31°0849 were secured with the 100/135/300 cm Schmidt telescope at the Kvistaberg Observatory. Altogether five prism-crossed-by-grating exposures are available, two taken on Dec. 30, 1991, three on Dec. 28, 1992. The spectra were recorded in a self-recording microphotometer, and line-depths in the Uppsala system (Ljunggren and Oja, 1961) were derived. The mean result is

$$\begin{aligned} H\gamma &= 38.1 \pm 2.9 \\ H\delta &= 40.6 \pm 3.0 \\ G &= 15.5 \pm 3.2 \\ K &= 67.7 \pm 5.0 \\ G/Hr &= 0.42 \pm .09. \end{aligned} \qquad (3)$$

There is some indication of variations in the line-intensities, as the lines come out fainter in 1992 than in 1991. The result (3) corresponds to spectral type F2, $(B-V)_0 = .36 \pm .03$, $E(B-V) = .09$; hence $E(U-B) = .06$ and $(U-B)_0 = .07$. The star is located just below the Hyades (B−V) versus (U−B) relation, indicating a slightly negative $\delta(U-B)$ ($\delta(U-B) = -.04 \pm .04$, corresponding to $(B-V) \approx .34$ for a Hyades star, if one extrapolates the correction table by Wildey et al., 1962). The data satisfy Eggen's (1967) period–colour relation near its lower boundary.

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