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ON THE PECULIAR FLICKERING ACTIVITY OF HR 2492[1]

Be stars are known to be variable with periods of the order of one day and with amplitudes of a few percent in light and radial velocity. Baade (1984) mentions HR 2492 = HD 48917 = 10 CMa as an example displaying prominent short-period spectroscopic variations ($P = 1\overset{d}{.}36$). Associated periodic photometric variations with $P = 1\overset{d}{.}35$ were reported by Dachs & Lemmer (1989) and also by Balona et al. (1992), who obtained a period twice as much, viz. $P = 2\overset{d}{.}63$.

Photometric variability on time scales between a few days and several years with typical amplitudes of $0\overset{m}{.}1$–$0\overset{m}{.}2$ in $uvby$ are reported by Sterken et al. (1996). Two types of variability are seen, viz. a quasi-regular oscillation with $P = 87\overset{d}{.}9$ (increasing amplitude towards redder wavelengths), and a superimposed very-long-term trend that, if it is periodic, has a cycle length of the order of several years. Moreover, random short-term variability is added on the $87\overset{d}{.}9$ oscillation.

All measurements of HR 2492 discussed here were obtained by one observer in a single observing run using a stable instrumental configuration (Danish 50cm telescope at La Silla) in the framework of the Long-term photometry of variables project (LTPV, Sterken 1993). The measurements were obtained differentially using two nearby comparison stars (see Table 1 for the details). Each measurement consisted of one uninterrupted integration of 40 s (simultaneously in the u, v, b and y bands); for the sky background one single 25-s integration was secured for the program star and for both comparison stars (sequence APB). The night when the flare was observed occurred close to full moon, however, all sky background measurements have very consistent values and the deviating point can not readily be attributed to spurious light coming from the moon. HR 2492 has the highest count rate of the three stars, still it displayed the highest internal variance throughout the whole observing run, indicating the presence of steady high-frequency variations in the photon flow that could be characterised by flickering with (very occasional) flaring. It would be interesting to undertake high-speed photometric measurements of this star.

Figure 1 shows a differential $b-y$, c_1 diagram for HR 2492 and three other Be stars investigated by Sterken et al. (1996). Except for HR 2492, the variations in $b-y$ and c_1 are moderate (but not small, see the scale in c_1). The variations of both indices are huge in the case of HR 2492, with a most interesting single excursion in $b-y$ on HJD 2446425.66, where the $b-y$ index suddenly becomes $0\overset{m}{.}2$ redder. This effect is solely due to a spike that is visible in the y band as a sudden brightening of $0\overset{m}{.}13$; this jump can also be seen in the non-differential data in the instrumental system (Figure 2), and is—according to the low mean errors on the successive integrations—without any doubt of non-instrumental origin (note that evident observational mistakes—such as centering errors or observing in cloudy weather—tend to diminish light in all passbands rather than produce spikes). We

[1] BASED ON OBSERVATIONS OBTAINED AT THE EUROPEAN SOUTHERN OBSERVATORY, LA SILLA, CHILE

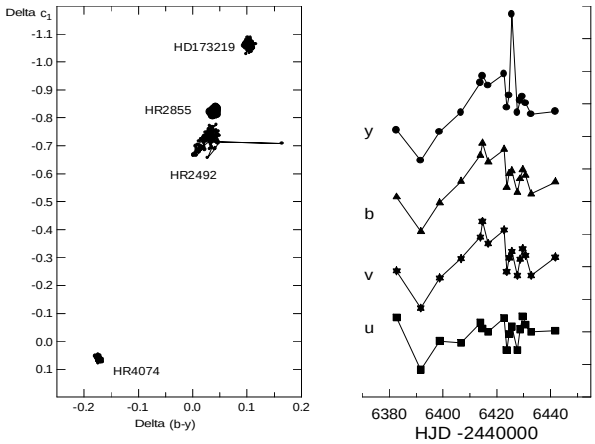

Figure 1. Differential $b-y$, c_1 diagram for HR 2492 and three other Be stars (indices relatively to their respective comparison stars) with similar records of observation (left). *uvby* differential magnitudes of HR 2492 around JD 2446425 causing the outlying $b-y$ data point; tick marks on the magnitude axis are $0\overset{\mathrm{m}}{.}05$ apart (right)

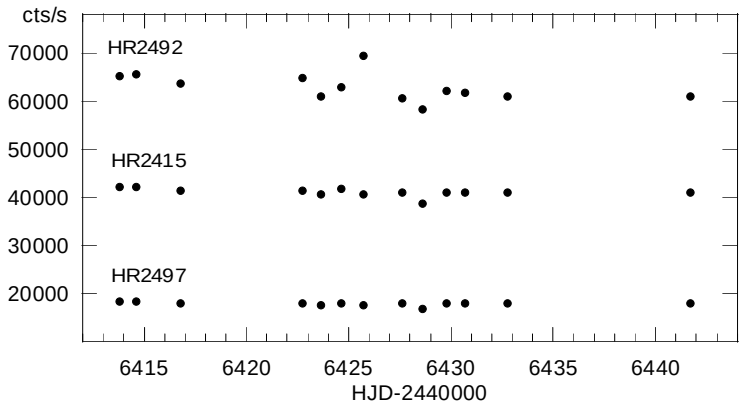

Figure 2. y count rates of HR 2492 and comparison stars HR 2415 and HR 2497

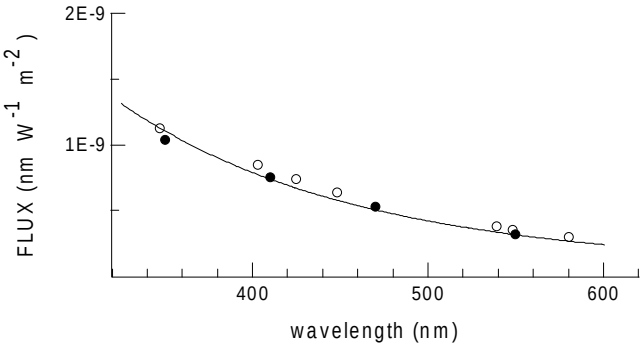

Figure 3. 17 500 K blackbody energy distribution for HR 2492. Filled circles are from (dereddened) *ubvy* data, open circles represent $UBVB_1B_2V_1$G photometry (see text)

find additional support for our conclusion from an investigation of the amount of variance seen in the counts of successive 1–second integrations recorded during observations. That variance, as a rule, is a very good indicator of the goodness-of-sky quality and should be of the same order of magnitude for the comparison stars as for the program star, provided that the sky transparency is stable and that the photon noise is similar for all stars involved. In the case of HR 2492 this internal dispersion amounts to more than twice the overall mean error obtained from comparison-star data covering more than 8 years. Note that the peculiar measurement on HJD 2446425.66 is not listed in Manfroid et al. (1991) because it was removed by an automatic filtering procedure checking for occasional outliers in the data.

The interpretation of the observed phenomenon is not straightforward, especially because the flare has been seen in one passband only. One could, for example, compare the observed $0\overset{\mathrm{m}}{.}2$ excursion in $b-y$ with the strong and abrupt reddening $\delta(b-y) = 0\overset{\mathrm{m}}{.}7$ of 28 CMa reported by Mennickent et al. (1994), though that case is different, since the flare was related to a strong fading. An example of an equally unexplainable but opposite situation is given by Ventura et al. (1995), who observed a strong U-band flare (with associated micro-activity) in the light output of the dM3.5e star V 1054Oph, whereas no flare in V was seen.

Using $E_{B-V} = 0.236$ derived from Geneva colours, we dereddened our mean $uvby$ data (Table 1) and the Geneva photometry from Rufener (1988). Figure 3 shows the results, together with a blackbody energy distribution corresponding to 17500 K (Waters et al. 1987). There is no sign of the presence of a red companion, and unpublished $JHKLM$ photometry collected by one of us (C.S.) confirms that in the near-infrared region there is no excess radiation of the sort expected from a cool companion. Waters et al. (1987) discussed the infrared excesses at 12, 25 and 60 μm of a total of 59 Be stars. For 57 stars in this sample—among which HR 2492—the infrared excesses can be completely attributed to a circumstellar equatorial disk.

In spite of the absence of a red companion HR 2492 could be a binary containing a close compact secondary (white dwarf or neutron star). This companion should be surrounded by a classical accretion disk which always acts as an effective reprocessor of energy from short to longer wavelengths. Therefore, the observed flare could be caused by a reprocessed X-ray burst into optical wavelengths (through the procedure of absorption of part of the infalling X-rays and consequent heating with emission of most of its energy beyond λ540–560nm, the y passband). Transient X-ray radiation is liberated whenever potential energy is released in an strong accidental accretion event onto the surface of a compact companion.

Table 1. Program (P) and comparison stars (A, B): average $y(V)$, $b-y$, m_1, c_1 magnitudes and their overall standard deviations σ based on the non-differential nightly mean values for each star. N denotes the total number of observations of each star. The results are based solely on data belonging to System 7 taken during a time interval of more than 8 years (Sterken et al., 1993, see also Sterken, 1993)

LTPV	HR	MK	$y(V)$	$b-y$	m_1	c_1	N	σ_y	σ_{b-y}	σ_{m_1}	σ_{c_1}
P4004	2492	B2III(e)	5.235	−0.008	0.040	−0.039	139	.051	.016	.013	.025
A4004	2415	B8V	5.626	−0.031	0.115	0.871	226	.007	.003	.005	.006
B4004	2497	B8IV	6.537	−0.046	0.121	0.492	192	.008	.003	.004	.007

Note that strong wavelength-dependence of spectral features is not uncommon in systems with accretion disks. An extreme example is β Lyrae, where a disk is present together with—at right angles to it—supplementary elongated clouds of ionised material, as inferred Nordsieck et al. (1995) and—independently—by Harmanec et al. (1996). In the β Lyrae system the visual and ultraviolet light emissions are shifted in polarisation angle, consequently disabling detection of flare events in different passbands.

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