

HD 6226: a new bright B variable with occasional brightenings. Is it an unrecognized Be star?

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Abstract. An analysis of differential UBV measurements of HD 6226 secured between 1982 and 1995 at Hvar, and combined with the Hipparcos satellite H_p photometry, led to the finding that this unfrequently observed star is a new variable, characterized by occasional brightenings accompanied by the reddening of the $B - V$, and blueing of the $U - B$ index. We note that such behaviour was found for several Be stars like QR Vul or σ Cas and it would be of interest to check whether also HD 6226 is not an unrecognized Be star. A period analysis of the photometric data indicates a possibility that the brightenings may occur periodically, with a period of 481.3 d. However, this finding needs to be tested since several other possible periods were also detected. Moreover, there is no a priori reason to believe that the brightenings must occur in regular intervals. If there is indeed a 481-d periodicity, then the nearest brightening should occur around Nov. 27, 1998. A spectroscopic study of the star will be crucial for a better understanding of its nature but further photometric monitoring is also very desirable.

Key words: stars: HD 6226 – stars: emission-line – stars: variables: other

1. Present knowledge about HD 6226

HD 6226 (BD+46°245, SAO 36891) is a remarkably little studied bright B star. Guetter (1968) classified the star as B2IV-V while Bidelman, Ratcliff & Svolopoulos (1988) give B3III. Andrews (1968) derived the strength of the $H\alpha$ line of HD 6226 from his photoelectric measurements and did not suspect the star to be an emission-line object.

The radial velocity (RV) of the star is probably variable (Plaskett & Pearce 1931 mention that the lines are good for measurements) but there are only four individually published velocities. The mean observed RVs quoted in GCRV range from -48 to 60 km s^{-1} . Moreover, it seems that also the Ca II K line

varies so that the object can in fact be a double-line spectroscopic binary.

To the best of our knowledge, there are only two published determinations of the mean UBV values of the star, both based on all-sky observations: Guetter (1974) observed the star between March 1973 and January 1974 and gives

$$V = 6^m 81, B - V = -0^m 04, \text{ and } U - B = -0^m 59$$

while Deutschman, David & Schild (1976) derived

$$V = 6^m 82, B - V = -0^m 03, \text{ and } U - B = -0^m 58$$

from their observations secured from January 1973 to January 1974.

2. Analysis of the Hvar UBV observations

Between 1982 and 1990, 370 UBV observations of HD 6226 were secured with the 0.65-m reflector of the Hvar Observatory, Croatia with 3 additional observations obtained on one night in 1995. The star was originally observed as one of the check stars in the course of the Be-star observing program, initiated and coordinated by Harmanec, Horn & Koubský (see Harmanec, Horn & Koubský 1981 and the consecutive reports in the Be star Newsletters Nos. 3 to 12; for the final report on the Be-star observations at Hvar, see Pavlovski et al. 1997).

When we noted that HD 6226 is variable, we continued its observations along with the Be stars σ Cas = HD 4180 and φ And = HD 6811, relative to HR 189 (HD 4142). HR 289 (HD 6114) was chosen as the new check star and was usually observed with the same frequency as the variable. The only exception was the night HJD 2446689 when 4 Per (HD 12303) and 2 Per (HD 11291) served as the comparison and check, respectively.

The observations were carefully reduced to the standard UBV system by Harmanec, Horn & Juza (1994) with the help of the reduction program HEC22 and the Hvar data archives of individual differential observations were made available in digital form by Harmanec et al. (1997).

Perryman et al. (1997) have now published 89 individual photometrically reliable Hipparcos H_p measurements of the star which also show clear evidence of variability and can be con-

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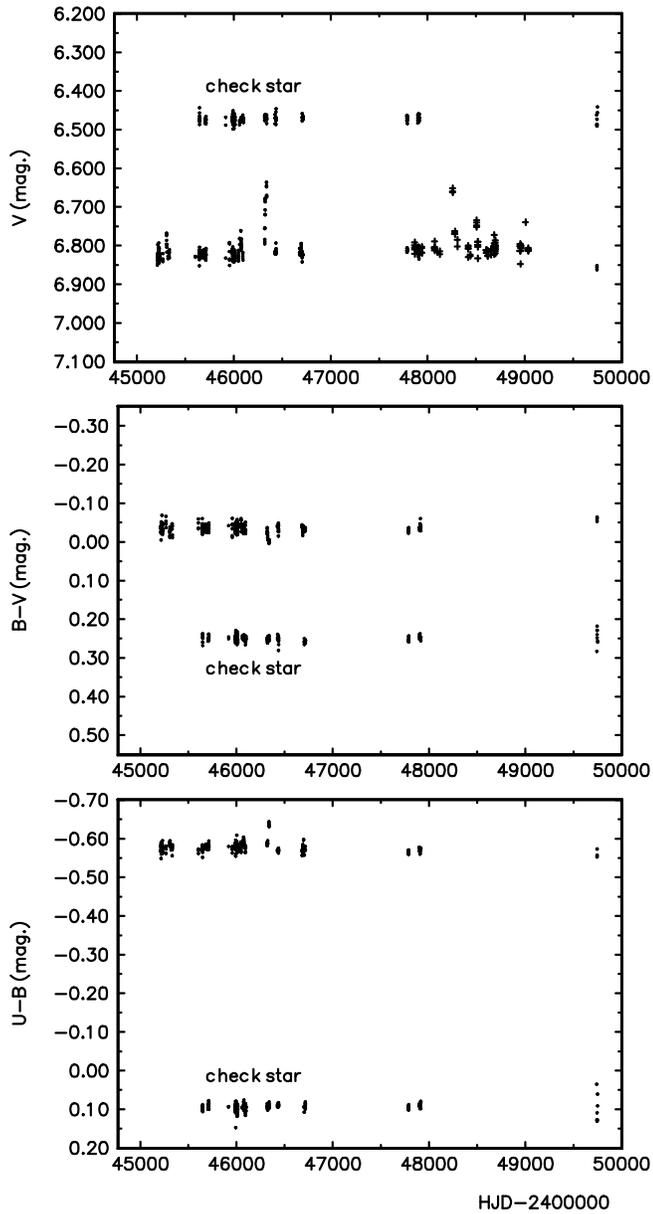


Fig. 1. *UBV* observations of HD 6226 plotted vs. time: Hvar data are shown by dots, Hipparcos H_p observations by plusses

veniently combined with our own data since the H_p magnitude is close to Johnson V .

Fig. 1 is the plot of the V and H_p magnitudes and the $B - V$ and $U - V$ colour indices of HD 6226 vs. time, based on all individual measurements. Corresponding data for the check star HR 289 are also plotted there. The overlap between Hvar and Hipparcos measurements shows that there is no significant zero-point shift between these two data sets. It is seen that there are periods when the brightness of HD 6226 varies little (within some $0^m.04$) but these stable periods are occasionally interrupted by brightenings of a variable amplitude amounting up to $0^m.2$. This is the behaviour reminiscent of some other Be stars like QR Vul = HD 192685 or α Cas = HD 4180 (Horn et al. 1985,

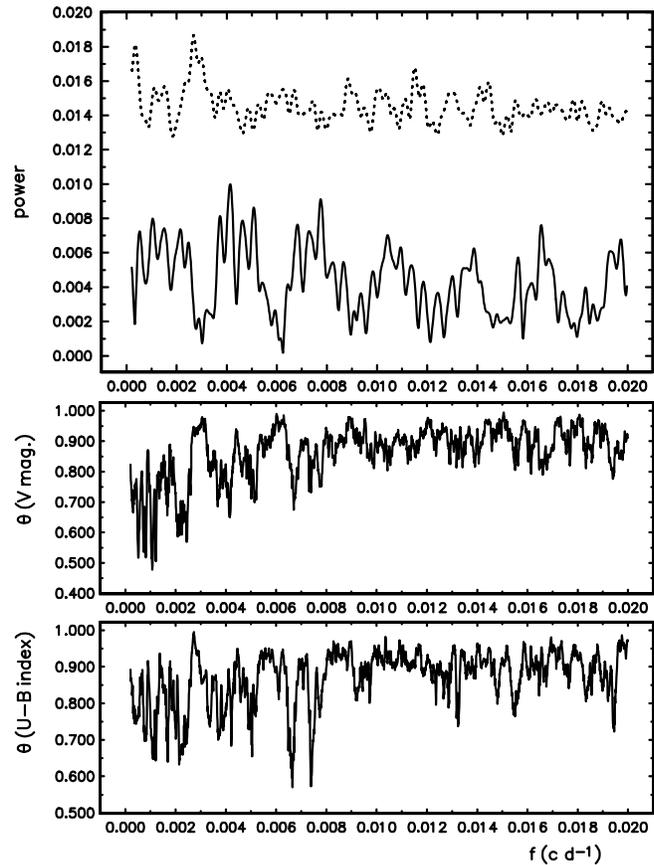


Fig. 2. Deeming's (1975) and Stellingwerf's (1978) PDM periodograms of the light and colour variations of HD 6226: *Upper panel:* Fourier (Deeming) periodogram of combined V data; the dotted line shows the spectral window of the data, normalized to the highest peak of the periodogram and shifted for 0.012; *Central and bottom panels:* PDM periodograms of combined V and Hvar $U - B$ data

Pavlovski et al. 1983, 1997). Having no spectral observations at our disposal, we cannot say whether or not the brightenings of HD 6226 were accompanied by the appearance of the Balmer emission lines as it was the case of QR Vul. It is clear, however, from Fig. 1 that the brightening of the star is accompanied by the reddening of $B - V$, and blueing of the $U - B$ index. This formally indicates an increase of the photometrically derived radius since in the colour-colour diagram the star moves away from the main sequence towards to giant sequence. This behaviour is typical for the formation of an envelope around a Be star seen under some intermediate inclination (not too close to equator-on view) – see Harmanec (1983, 1994). Fig. 1 also shows that the comparison or check star itself could be suspected of microvariability, but we warn that individual 10-s integrations are shown for the Hvar data, without any data editing. For HD 6226 it seems that a slow cyclic variation can be suspected during the periods between large brightenings.

Since little is still known about the character of similar brightenings, we carried out a period analysis to see whether the variations of HD 6226 are (semi-)regular or not. To this

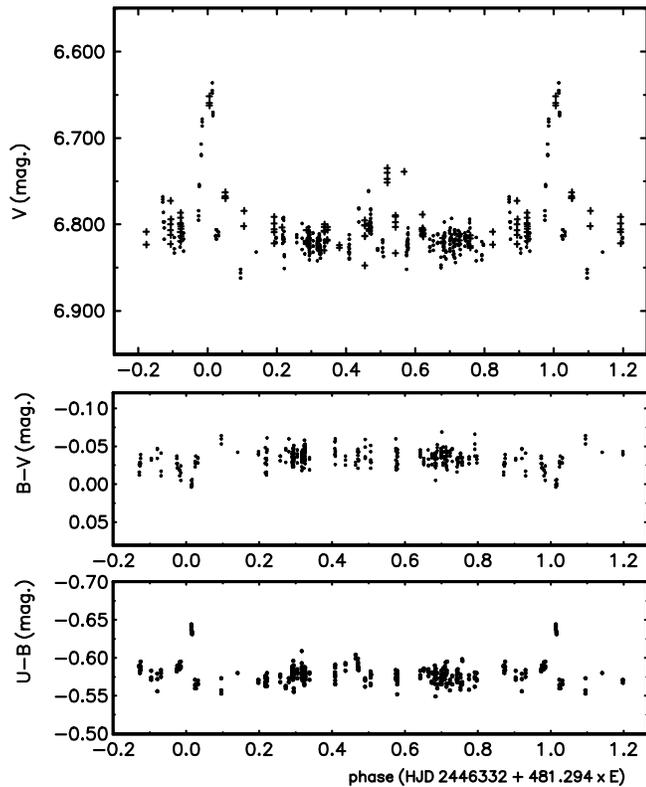


Fig. 3. A phase plot of photometric variations of HD 6226 for the 481-d period: Hvar data are shown by dots, Hipparcos H_p measurements by plusses

end, we used both, the PDM technique (Stellingwerf 1978) (10 bins and 4 “covers”) and Fourier periodograms (Deeming 1975) to search for periodicity over the range of periods from 50 to 5000 d. Fig. 2 show the periodograms for the V magnitude and $U - B$ colour index.

It is seen that the results of the two period-searching techniques differ. This is not surprising since Fourier technique prefers roughly sinusoidal variations while the PDM is more sensitive to non-sinusoidal light curves. Yet, one can find some common periods in both periodograms. If one ignores the longest detected periods (these basically sort the data in phase in such a way as to avoid their phase overlaps), one of the best detected periods is $481^d.294$ which brings the two major brightenings into the same phase interval. The phase diagram for this period is shown in Fig. 3.

Other possible periods include 935 d, 240 d (a half of the 481 d period if one wants to bring all brightenings into the same interval of phases) and 149.4 d.

There may also be some rapid variations of a small amplitude but our data contain too few night series to allow us a meaningful investigation of their reality and possible nature.

It is clear that systematic spectroscopic monitoring of HD 6226 is urgently needed. Without spectroscopic observations at hand it seems meaningless to speculate about the nature and/or causes of the light and colour variations of HD 6226.

Rather, we appeal to other observers to continue observations of this interesting star and especially to check on the possible regularity of its brightenings. If the phenomenon occurs regularly with the 481-d period, then the nearest brightening should occur around Nov. 27, 1998.

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