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Transition to a Be Phase in HD 17520

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ABSTRACT. HD 17520, an O9 V star, has undergone a transition to a Be-type star over the past decade. I report observations taken between 1985 October and 1991 December which show the strengthening of the Hα emission. I discuss the line-profile variations, and offer no new insights into the Be phenomenon. For spectroscopic observers, this is a warning, since HD 17520 has been used as a spectrophotometric standard star.

I. INTRODUCTION

HD 17520 (BD+56°0553) is an O9 V spectral standard in the low-resolution spectral atlas of Jacoby et al. (1984). It is also a spectrophotometric standard star (Whiteoak 1966) in the KPNO *IRS Standard Star Manual* (Barnes and Hayes 1982). Spectral types in the literature range from O8 to O9. Since 1983 October I have used this star as a spectrophotometric standard for low-dispersion spectral observations at KPNO. During this time the star has developed Hα emission, and has become a Be star.[2]

HD 17520 is a suspected variable star (NSV 955), with possible 1% variations in V and $b-y$ (Morrison 1975). Hardorp et al. (1959) classified it (LS I+60°268) as OBce. This does not necessarily indicate Balmer continuum emission (Stephenson 1965), and indeed Irvine (1975) claims that the ce classification is meaningful only for spectral types B0–B2. HD 17520 is not included in the compilation of Be stars by Jaschek and Egret (1982); to the best of my knowledge, HD 17520 has not previously been identified as a Be star.

HD 17520 (ADS 2165) is a visual pair with 0."3 separation and $\Delta m=0.0$ mag (Aitken 1932). Walborn (1973) noted that the spectrum of the secondary was "present," but did not go into more detail. The star may be associated with the double-cluster h and χ Persei (Wildey 1964), which contains many Be stars (Waelkens et al. 1987). Sharpless (1954) identified it as one of the exciting stars of the H II region IC 1848.

For Be star afficionados, this paper is a birth announcement. HD 17520 has undergone a transition to a Be-type star. For spectroscopic observers, this paper carries a warning: HD 17520, a spectrophotometric standard star, has undergone a transition to a Be-type star over the past decade. My purpose is primarily to draw attention to the variability of this spectrophotometric standard star. These meager observations add little new to the vast store of observational data on Be stars.

2. OBSERVATIONS

The spectrum of HD 17520 in the Jacoby et al. atlas was obtained between 1980 December and 1981 December. At that time, the Hα line was in absorption (Fig. 1), with an equivalent width of 2.3 Å. In their discussion of Oe and Of stars among a large sample of O stars, Conti and Leep (1974) make no mention of HD 17520 as having anomalous Hα.

I made 13 observations of the Hα region of this star at five epochs over the 6-year period 1985 October 25 through 1991 December 17 (Table 1). I used the 2.1-m reflector with either the IIDs or the GCAM spectrographs for most of the observations. The 1989 January data were obtained using the IRS on the No. 2 0.9-m telescope. I used KPNO grating 36 with the IIDS, 35 with the IRS, and 47 with the GCAM setups. The Hα region (the red spectra) were observed in first order, typically through a GG495 order-sorting filter. The spectral resolution at Hα is about 3 Å with the IIDS, 2 Å with the GCAM, and $\approx$10 Å with the IRS setup. HD 17520 has $v \sin i=90$ km s^{-1} (Conti and Ebbets 1977), and so the lines are not expected to be resolved in these spectra.

I also obtained spectra in the $\lambda\lambda$3800–4200 Å region between 1983 October 15 and 1990 December 10. The blue spectra were obtained in second order, using the $CuSO_4$ filter. These spectra have about twice the spectral resolution of the Hα spectra. No spectral changes over the years are visible.

In addition, I observed the Hβ and Hγ lines during the 1989 January IRS run. The lines showed no evidence for emission cores at 5 Å resolution.

I reduced and calibrated the data using the KPNO mountain reduction and the IIPS system for the early data, and with the IRAF ONEDSPEC package for later data. I use the IDL-based ICUR spectral analysis package for data analysis and spectral measurements.

3. MEASUREMENTS

The Hα region spectra are displayed in Fig. 1. The IRS spectrum is not displayed, because the low spectral resolu-

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[2]Slettebak (1987) pointed out that stars exhibiting the Be phenomenon (emission in one or more Balmer lines) can rightly be called Be stars. ζ Ophiuchi, O9.5 V, is considered a Be star. The Be phenomenon is seen in stars of spectral types O8 through early F, with a peak frequency at about B2. My calling HD 17520 a Be star is meant to draw attention to the phenomenon, not to the spectral type.

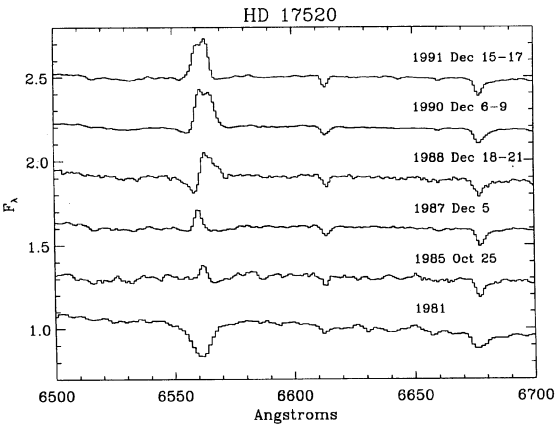

FIG. 1—The evolution of the Hα line of HD 17520 from 1980 through 1991. The emission has increased with time. A P Cygni profile is evident in 1988 December, and the emission may be centrally reversed in 1990–1991. The spectra are normalized to the mean flux level, and offset by 0.3 units. The last three spectra are sums of individual spectra taken on three nights. Individual pixels span 1.4 Å in the 1981 spectrum, and about 0.9 Å in the later spectra.

tion washes out most of the features. It is clear that the Hα line has gone into emission during the past decade, and is becoming stronger. The line profile has changed significantly as well. Line measurements are summarized in Table 2.

The Hα line was in absorption in the spectrum in the Jacoby et al. atlas. By 1985 October, 4–5 years later, the line was nearly completely filled in, with a narrow emission core. It is difficult to tell whether the depression longward of the emission core is a redshifted absorption, or the red wing of the photospheric absorption line. This spectrum is somewhat noisy, as the spectrum was obtained solely for use as a spectrophotometric standard. The spectrum obtained in 1987 shows a weak, narrow emission line superposed on a broad, symmetric absorption. The absorption may be the wings of the photospheric absorption line. This emission is blueshifted by about 2 Å with respect to the stellar photosphere (as defined by the He I λ6678 Å line); all the other emission centroids are redshifted by between 0 and 1 Å.

By 1988 December there was a definite P Cygni line profile at Hα. The net emission equivalent width was only 0.15 Å, because of the prominent blue absorption. The

TABLE 1
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Red spectra date		Blue spectra date
	IIDS	1983 October 15–18
1985 October 25	IIDS	1985 October 22, 24
1987 December 05	IIDS	
1988 December 18, 20, 21	IIDS	1988 December 22
1989 January 18, 21	IRS	1989 January 19, 23
1990 December 6, 8, 9	GCAM	1990 December 7, 10
1991 December 15–17	GCAM	

TABLE 2
Hα Measurements

Date	W_λ(Hα)[a] all	W_λ(Hα)[a] emission	FWHM[b] (Å)	Offset[c] (Å)
1980–1981	2.3	···	···	+0.7
1985 October	0.07	−0.17	2.7	−0.5
1987 December	−0.01	−0.48	3.6	+2.0
1988 December	−0.15	−0.70	5.2	−1.1[d]
1989 January	···	−0.50	11.0	−1.1
1990 December	−1.57	−1.78	8.3	+0.0
1991 December	−1.66	−1.66	7.2	+0.7

[a]The equivalent width of Hα, in Å. The *all* column refers to the entire Hα line; the *emission* column refers only to the portion of the line above the continuum.
[b]Observed full width at half-maximum of the emission component only, uncorrected for instrumental width. The 11 Å wide line in 1989 January reflects the low resolution of our IRS setup.
[c]Offset of the emission centroid from the rest wavelength. Formal errors are about ±0.5 Å, except ±0.7 Å in 1980–81.
[d]Offset of the pixel containing the peak emission.

emission line was quite broad. There were no significant variations in the line profile over the three days.

In 1990 the line showed only a weak blueshifted absorption. The emission was double-peaked (or centrally reversed). The *V/R* value varied from 1.09 to 1.30 to 1.18, with the red peak staying constant (Fig. 2). There were no detectable velocity shifts. The blue side of the line was steeper than the red.

One year later (Fig. 3), the red side of the line was steeper than the blue side. The blue absorption was weak, but still present. The line was narrower, and shifted to the blue relative to the 1990 profile by about 0.9 Å. In both 1990 and 1991 the *V* and *R* peaks were separated by about 4 Å.

4. DISCUSSION

Over the past decade the Hα line of one component of HD 17520 has filled in and gone into emission. On average, the emission equivalent width has increased by 2 Å every 5

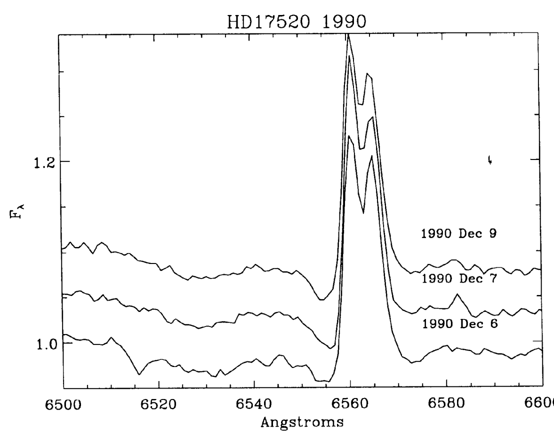

FIG. 2—Individual profiles from 1990 December, showing small line profile variations on time scales of 24–28 h. Spectra are normalized to their continuum fluxes, and offset.

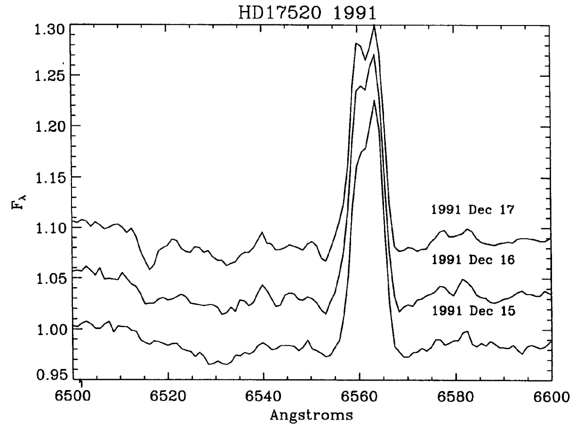

FIG. 3—As Fig. 2, but for the 1991 December observations.

years. There was no detectable change in the He I λ6678 Å line, or in the higher Balmer lines, as the star changed from O9 V to a star exhibiting the Be phenomenon. Such transitions from B (or O) to Be (or Oe) spectra are common (Jaschek et al. 1980).

Jaschek et al. suggest that in an early-type star where only Hα is seen in emission, the Be phase is unstable and the cycle of variation is short. This seems to be in accord with these observations. The transition time scale for HD 17520 is of order 10 years or more. The short-time-scale variability in the line profile is common (e.g., Barker 1983).

Dachs (1987) states that in all B-to-Be transitions, the emission first appears as a double-peaked profile with the peak separation of order $2v \sin i$. We missed the years when the emission first became visible, but here the incipient, weak emission profile was a single unresolved peak. Only later did the profile become double-peaked.

Observers should note that variability is not a desirable trait in a standard star. Since the Be emission arises high in the stellar atmosphere, it is unlikely that this change will significantly alter the optical spectral flux distribution of the star, so HD 17520 may still be a good spectrophotometric standard (although it is a suspected variable star). Others may wish to check this. Nonetheless, it is disconcerting when so mundane an object as a standard star decides to become variable.

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