A TRANSIENT SHOCK-WAVE IN THE SHELL OF THE Be STAR HD 184279

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1 INTRODUCTION

HD 184279 (V1294 Aql) has presented in the past an emission spectrum on the first terms of the Balmer series, and shell absorptions on the hydrogen and neutral helium lines. Their variations have been reported by Merrill (1952), Merrill and Lowen (1953) and Svolopoulos (1975). Ballereau and Hubert-Delplace (1982) evidenced long-term V/R variations with an amplitude of $\sim$100 km s^{-1}. Short-term photometric variations are irregular (Tempesti and Patriarca, 1976), while long-term variations are correlated with radial velocity (RV) of shell lines (Horn et al., 1982). Ballereau and Chauville (in preparation) extended the spectroscopic observations until 1984 and confirmed the pseudo-periodic variations, the last half-period ranging over 3.4 years (April 1, 1980-August 1, 1983).

2 OBSERVATIONS

Table 1 lists six spectra taken in the blue range (12.3 Å mm^{-1}, Observatoire de Haute-Provence) between July 12 and August 1 1985 with corresponding RV of Balmer lines (emission and absorption, the latter being averaged over three consecutive lines), neutral helium lines (mean value of the 13 main lines), FeIII λ4419.6Å, MgII λ4481.2Å and the stellar component of CaII K line. Table 2 gives half-depth widths of shell lines for Hβ, Hγ, Hδ and Hε (in km s^{-1}). Figure 1 shows the evolution of Hδ line profile.

Table 1 indicates that all shell line RVs were strongly positive, and close to maximum observed in 1979 (Ballereau and Hubert-Delplace, 1982). Hδ profiles were strongly blue-winged, as in 1979. We also note that night-to-night RV variations affected the five elements. Balmer progression was positive for 4 spectra, negative from $\overline{H11}$ for GB 8886 and entirely negative for GB 8906.

In addition to these short-term RV variations, we observe on some spectra a double structure of Balmer series. According to Figure 1, it seems that this doubling began on July 14 (JD 2446261.456) and appeared clearly on July 27. On July 31, the blue component was completely separated from the regular one. The day after, it had completely vanished. Measurements listed in Table 2 show that dephasing exists between half-depth widths of the first Balmer lines. If we assume that this phenomenon originates from a shock-

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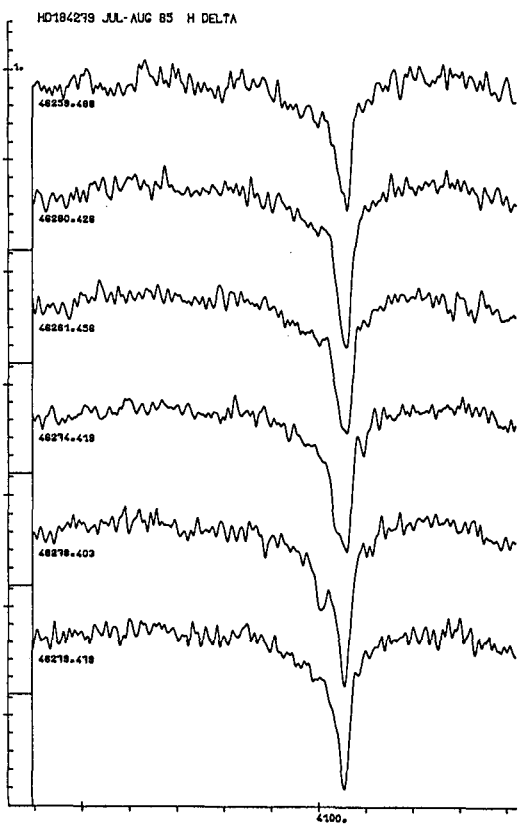
Table 1: Radial velocity (in km s^{-1}) of main shell lines. For GB 8906 and GB 8922, the second line gives the RV of the shock-wave component.

Plate	Julian Day 2440000+	Emission Line Hβ	Emission Line Hγ	Shell Absorption Core H8H9H10	H11H12H13	H16H17H18	H22H23H24	HeI	FeIII	MgII	CaII
GB 8886	6259.487	-85.	-81.	77.0	90.7	69.3		88.7	81.1	101.1	
GB 8890	6260.426	-80.	-94.	79.3	90.9	95.3	104.9	90.1	94.2	116.8	90.2
GB 8897	6261.456	-81.	-94.	84.1	94.7	99.5	107.2	91.2	89.5	81.1	105.7
GB 8906	6274.419	-86.	-96.	83.3	73.4	71.3		80.8	81.0	108.9	56.6
				30.6	23.3	10.5	22.5	-150.7			
GB 8922	6278.403	-77.		80.7	89.8	100.2		81.0	84.1	78.3	
				-118.5	-103.8	-112.1	-108.7				-119.2
GB 8926	6279.479	-83.	-86.	75.5	78.5	82.0	94.0	77.8	82.9		

Table 2: Half-depth width (in km s^{-1}) of the four main Balmer lines.

Plate	Hβ	Hγ	Hδ	Hε
GB 8886	129.5	174.1	160.1	215.2
GB 8890	148.0	153.3	151.3	169.9
GB 8897	148.0	163.7	173.2	222.0
GB 8906	166.5	162.3	182.0	206.2
GB 8922	120.3	140.9	153.5	179.0
GB 8926	131.4	140.9	153.5	154.1

Figure 1: Successive Hδ profiles of HD 184279 before, during and after the development of the shock-wave.



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wave progressing from the star's surface toward the external layers of the shell, this dephasing agrees with the fact that this shock-wave affects first the higher terms of Balmer series.

3 DISCUSSION

This transient phenomenon - appearance, development and disappearance of a discrete component with strong negative RV in shell lines of Balmer series - spread over 5 days (4 days for the entire development, JD 46274-46278). We do not know accurately its limits in time, the uncertainty being about 0.5 - 1 day. Moreover, we cannot determine whether the velocity of this wave is constant or increases linearly, nor according to which law. Lastly, it is impossible to say if this phenomenon affects the whole star, or only a part of its surface. If we assume a shock-wave with an increasing velocity from 0 to 140 km s^{-1} (as measured on Hβ, JD 46278.403) during 4 days and if we choose for this star $R_*/R_\odot = 6.8$ (Underhill, 1982), the distance covered by this wave would be about 5 R_*. Ballereau and Chauville (in preparation) determined, from RV variations measured on Hβ between 1976 and 1984, the internal and external semi-major axis of the elliptical-rotating disk surrounding this star, and found 2.1 R_* and 15.1 R_* . The distance covered by this assumed shock-wave is effectively comprised between these two values.

REFERENCES

Ballereau, D. and Hubert-Delplace, A.M.: 1982, p. 171 in: Be Stars, IAU Symposium n° 98, eds M. Jaschek, H.-G. Groth, Reidel, Dordrecht.

Horn, J., Hudec, R., Koubsky, P.: 1983, Inf. Bull. on Var. Stars n° 2304.

Merrill, P.W.: 1952, Astrophys. J. 115, 47.

Merrill, P.W. and Lowen, A.L.: 1953, Astrophys. J. 118, 18.

Svolopoulos, S.N.: 1975, Astron. Astrophys. 41, 199.

Tempesti, P. and Patriarca, R.: 1976, Inf. Bull. on Var. Stars n° 1164.

Underhill, A.: 1982 in: B Stars with and without Emission Lines, Underhill A., Doazan V., eds CNRS and NASA.

DISCUSSION FOLLOWING BALLEREAU

Sareyan:

In iota Her (which is not a Be star, but a member of the so-called 53 Per type of variables) we have been observing such a component appearing in the wing of the SiIII 4552 Å line, over a time scale under one hour. So I wonder about the real time constants involved in line profile variations - can you comment on this?

Ballereau:

If a component appears in the wing of SiIII 4552 Å line during one hour only, the time scale is about 100 times less than in HD 184279. The evolutive phenomenon which originates such a transient component must be less important and the distance covered very short.

Waelkens:

Are you sure that the time scale of the feature you are discussing is not less than the time interval between your observations?

Ballereau:

From the observations, we cannot ascertain whether the transient blueward component, observed with a low radial velocity, is the same 4 days later with a much higher radial velocity. Unfortunately, we have no observations between these two dates. But my assumption, according to which the phenomenon is the same, fits with the distance calculated and the shell model previously determined.

Harmanec:

The doubling of the HI absorption lines you found is reminiscent of such phenomena observed for some other early B stars for example AX Mon or KX And, notably, known binaries. For KX And, Stefl 1986 (unpublished thesis) found the doubling is limited to certain orbital phases.

Ballereau:

The doubling of hydrogen and other element lines in a binary system is a well-known phenomenon, when the orbits are correctly oriented for the observer. In the case of AX Mon, doubling of hydrogen lines has been observed by P.W. Merrill. The binary system KX And presents more complicated Balmer line widening and duplication (M. Floquet, private communication). For HD 184279, the doubling of H lines is not produced by a double system, but a real transient phenomenon, which already occurred in 1976. At this epoch, doubling concerned both hydrogen and neutral helium lines, whereas in 1985 it affected only the first element.

Collins:

Why should I believe that this event represents an ejection rather than a traveling "blip" or "wiggle"?

Ballereau:

It is impossible to decide, with so few observational data, whether the phenomenon observed is an ejection of matter followed over a 4-day interval, or a shock-wave which is produced by an outburst (isotropic or not).