WIND CHARACTERISTICS OF THE O7 n STAR HD 217086 IN THE CEP OB 3 ASSOCIATION.

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ABSTRACT

The O7 n star HD 217086 which provides the ionization of the H II region S 155 A and is the brightest member of the Cep OB 3 association, has been observed in the ultraviolet with IUE. From an analysis of the UV spectra we determine a terminal velocity of 3560 ± 100 km s^{-1} and a mass loss rate of $(4.2\ ^{+2.8}_{-1.7})\ 10^{-7}\ M_{\odot}\ yr^{-1}$. A comparison is made with the stars of similar spectral type.

1. INTRODUCTION

The Cepheus OB 3 association is one of the youngest known group of stars within 1 kpc from the Sun and is associated with a complex of ionized, neutral and molecular matter that has been the subject of several recent studies in the radio and infrared. In particular various regions have been indicated as illustrative of different stages of star formation (Sargent, 1979; Beichman et al., 1979).

Within this frame we have observed with IUE the four brightest stars of the association with the aim of: i) studying the properties of the interstellar medium (extinction, interstellar absorption lines) in the area, ii) deriving the detailed properties (temperature, mass loss rate, far UV continuum) of the star HD 217086 which is the main energy source for the H II region S 155 A (Felli et al., 1978) and possibly also of the related IR emission and molecular radiation, iii) studying the possible interaction of stellar winds with the surrounding medium.

Here we report about the determination of mass loss rate of HD 217086.

C. Chiosi and R. Stalio (eds.), Effects of Mass Loss on Stellar Evolution, 41–44.

2. OBSERVATIONS

The star HD 217086 (V = 7.64, B-V = + 0.63, E(B-V) = 0.95) has been classified of spectral type O7 n by Garrison (1970), O7 V n by Walborn (1971) and O6.5: by Conti and Alschuler (1971). The star belongs to the younger subgroup in which the association is subdivided (Blaauw, 1964), whose expansion age is 1-3 10^5 yr (Garmany, 1973; Sargent, 1979).

We have observed HD 217086 with the IUE satellite in the low resolution mode (~ 7 Å) with both the short and the long wavelength cameras and at high resolution (~ 0.15 Å) with the short wavelength camera. The low resolution spectra display a highly reddened continuum with strong absorption lines of interstellar origin (low ionization ions) and of stellar/circumstellar origin, essentially N V λ 1240 A, Si IV λ 1400 A, C IV λ 1550 A and N IV λ 1719 A. The C IV line shows a very pronounced P Cygni profile while the other lines appear essentially in absorption. The C IV absorption component, which in the low dispersion spectrum is already well resolved, in the high resolution spectrum appears very broad and extends up to a velocity of $v_{edge} = 3560 \pm 100$ km s^{-1}. Moreover, comparatively narrow components (Δv (full width at half maximum)$\sim 0.055\ v_{edge}$) of both lines of the doublet are recognized at $v = 0.68\ v_{edge}$. In addition to C IV, the high resolution spectrum shows the profiles of the Si IV 1400, N IV 1719, O IV 1340 A lines. They all present blue shifted absorption with very little or absent emission component. The λ 1240 N V doublet cannot quantitatively be studied because the line is seriously affected on the short wavelength side by a very broad absorption of interstellar Lyα.

3. ANALYSIS OF THE P CYGNI LINES

We have derived the edge velocity of the various lines shown in Table 1. The edge velocity of C IV is the largest and appears rather well defined. In the following we shall assume its value of 3560 ± 100 km s^{-1} as terminal velocity for all ions. The observed line profiles have been matched with the atlas of theoretical P Cygni profiles by Castor and Lamers (1979). The parameters describing the theoretical profiles are β (exponent in the velocity law) γ or α (exponents in opacity laws), T the total optical depth or T', the optical depth between $v/v_\infty = 0.20$ and $v/v_\infty = 1.00$. The best fit values of these parameters are presented in Table 1. As for the ionization structure we have used for Si IV the results of Gathier et al. (1980). The ionization fraction of C IV has been assumed to be intermediate between those of Si IV and N V, and the latter were taken again from Gathier et al. (1980). For the excited lines of N IV and O IV, the ionization and excitation has been estimated with analogy to ζ Puppis (Lamers and Morton, 1976) adopting a radiation temperature of 35000 °K.

The resulting mass loss rates are given in Table 1. We obtain $<\log \dot{M}> = -6.38$, equivalent to $\dot{M} = 4.2\ (^{-1.7}_{+2.8})\ 10^{-7}\ M_\odot\ yr^{-1}$.

https://doi.org/10.1017/S0252921100094550 Published online by Cambridge University Press

Table 1. Wind properties of HD 217086

Ion	λ (A)	v_{edge} (km s^{-1})	Parameters ($\beta = 0.5$)	T	T'	$\dot{M}(M_\odot\ yr^{-1})$
C IV	1548.19 1550.77	3560	$\gamma \simeq 1$	4	2.6*	5.0 - 7
Si IV	1393.76	2150	$\gamma \simeq 1$	0.08	0.05	2.2 - 7
N IV	1718.77	730	$\alpha \simeq -2$	∿0.4	-	7.4 - 7
O IV	1338.60	2900	$\alpha \simeq -2$	∿0.4	-	3.7 - 7

* Adopted 2.9 because of contribution from shell components.

We compare now this result with data from the following selection of recent papers on mass loss from early type stars: Abbott et al. (1980), Conti and Garmany (1980), Hutchings and von Rudloff (1980), Gathier et al. (1980), Tanzi et al. (1981). Extracting from these papers the stars of spectral type O6 - O8 III-V, we have the data of Table 2.

Table 2. Mass loss from O6-O8 III-V stars

Star	Sp Type	v_∞ (km s^{-1})	$\dot{M}(M_\odot\ yr^{-1})$	Technique	Source
HD 48099	O 6.5 V	3500	$2\ 10^{-8}$	C IV, N V	1
HD 54662	O 6.5 V	2500	$9\ 10^{-9}$	C IV, N V	1
BD-15 4920	O 6 p	-	$\leq 3\ 10^{-7}$	I R	2
HD 159176	O7 V +O7 V	-	$2\ 10^{-7}$	I R	2+
HD 37043	O 8.5 III	2360[3]	$3\ 10^{-7}$	I R	2

1 = Conti, Garmany (1980); 2 = Tanzi et al. (1981); 3 = Snow, Morton (1976); + = single star.

We see that the velocity of HD 217086 (3560 ± 100 km s^{-1}) is consistent with that observed in similar stars and actually the largest so

https://doi.org/10.1017/S0252921100094550 Published online by Cambridge University Press

far measured in this spectral interval. The mass loss rate we obtain for HD 217086 (5 10^{-7} from C IV ; 4.2 M_o yr^{-1} as average value) is consistent with, and actually a little larger than, values from Tanzi et at. (1980) and instead is definitely larger than values obtained for HD 48099 and HD 54662 by Conti and Garmany (1980). This is important in view of the order of magnitude discrepancy between the two sets of values in Table 2.

REFERENCES

Abbott, D.C., Bieging, J.H., Churchwell, E.D., and Cassinelli, J.P.: 1980, Astrophys. J. 238, pp. 196-202.

Beichman, C.A., Becklin, E.E., Wynn-Williams, S.G.: 1979, Astrophys. J. (Letters) 232, L47-L51.

Blaauw, A.: 1964, Ann. Rev. Astr. Ap., 2, pp. 213-246.

Castor, J.I.,and Lamers, H.J.G.L.M.: 1979, Astrophys. J. Suppl. 39, pp. 481-511.

Conti, P.S., Alschuler, W.R.: 1971, Astrophys. J. 170, pp. 325-344.

Conti, P.S., Garmany, C.D.: 1980, Astrophys. J. 238, pp. 190-195.

Felli, M., Tofani, G., Harten, R.H., and Panagia, N.: 1978, Astron. Astrophys. 69, pp. 199-211.

Garmany, C.D.: 1973, Astron. J. 78, pp. 185-191.

Garrison, R.F.: 1970, Astron. J. 75, pp. 1001-1006.

Gathier, R., Lamers, H.J.G.L.M., and Snow, T.P.: 1980, preprint.

Hutchings, J.B., and von Rudloff, I.R.: 1980, Astrophys. J. 238, pp. 909-918.

Lamers, H.J.G.L.M., and Morton, D.C.: 1976, Astrophys. J. Suppl. 32, pp. 715-736.

Sargent, A.I.: 1979, Astrophys. J. 233, pp. 163-181.

Snow, T.P. Jr., and Morton, D.C.: 1976, Astrophys. J. Suppl. 32, pp. 429-465.

Tanzi, E.G., Tarenghi, M., and Panagia, N.: 1981, this conference.

Walborn, N.R.: 1971, Astrophys. J. Suppl. 23, pp. 257-282.