

## H $\alpha$ EMISSION IN F-K HIGH LUMINOSITY STARS

J.L. Climenhaga, B.L. Harris

Department of Physics, University of Victoria  
Canada

and

J. Smolinski

Polish Academy of Sciences, Copernicus Astronomical Center  
Poland

### RESUMEN

Investigamos la presencia y variabilidad de H $\alpha$  en emisión en supergigantes de alta luminosidad con tipo espectral de F a K. También determinamos el límite de  $M_V$  donde H $\alpha$  empieza a aparecer en emisión.

### ABSTRACT

We investigate the presence and variability of H $\alpha$  emission in very luminous F-K supergiants and determine the lower limit of  $M_V$  where H $\alpha$  begins to appear in emission.

*Key words:* STARS-EMISSION LINES

### 1. INTRODUCTION

In this study, we investigate the presence and variability of H $\alpha$  emission in very luminous F-K supergiants, and attempt to determine the lower limit of  $M_V$  where H $\alpha$  begins to appear in emission. Such a study was made for early type supergiants by Rosendhal (1973). Eight stars with very broad absorption lines were chosen. According to the relation between line widths and luminosity, they are all very luminous stars.

The basic information about these stars is given in Table 1. The data on spectral type and visual absolute

magnitude are taken from Smolinski (1971), Osmer (1972*b*) and Keenan (1973).  $M_V$  for HD 331777 was calculated using the linear correlation given by Osmer (1972*a*) between  $M_V$  and the equivalent width of the O I  $\lambda 7774$ . The number of spectra obtained for each star in the H $\alpha$  region ranged from 3 to 50 taken during the period from 1970 to 1979, and were obtained at the Dominion Astrophysical Observatory with the 48-inch telescope and the coude spectrograph providing a dispersion of 10 Å mm<sup>-1</sup>.

In columns 4 and 5 of Table 1 there is information concerning activity in H $\alpha$  and the shape of the H $\alpha$

TABLE 1

H $\alpha$  EMISSION IN F - K SUPERGIANTS

Star	Spectral type	$M_V$	Emission	H $\alpha$	Type
89 Her	F2 Ia	-7.1	a		R
HD 231195	F5 Ia	-8.30	s		B
HD 331777	F8 Ia	-8.10	s		B, C
$\rho$ Cas	F8 Ia	-8.40	s		BR
HD 217476	G0 Ia	-9.0	a		BR,R,C
HD 12399	F5 Ia	---	s		B
W Cep	K0 Ia	---	a		BR
HD 4817	K3 Ia	---	s		B

a - always visible.

s - sometimes visible.

B - emission on blue side only.

R - emission on red side only.

BR - emission on both sides.

C - emission at center.

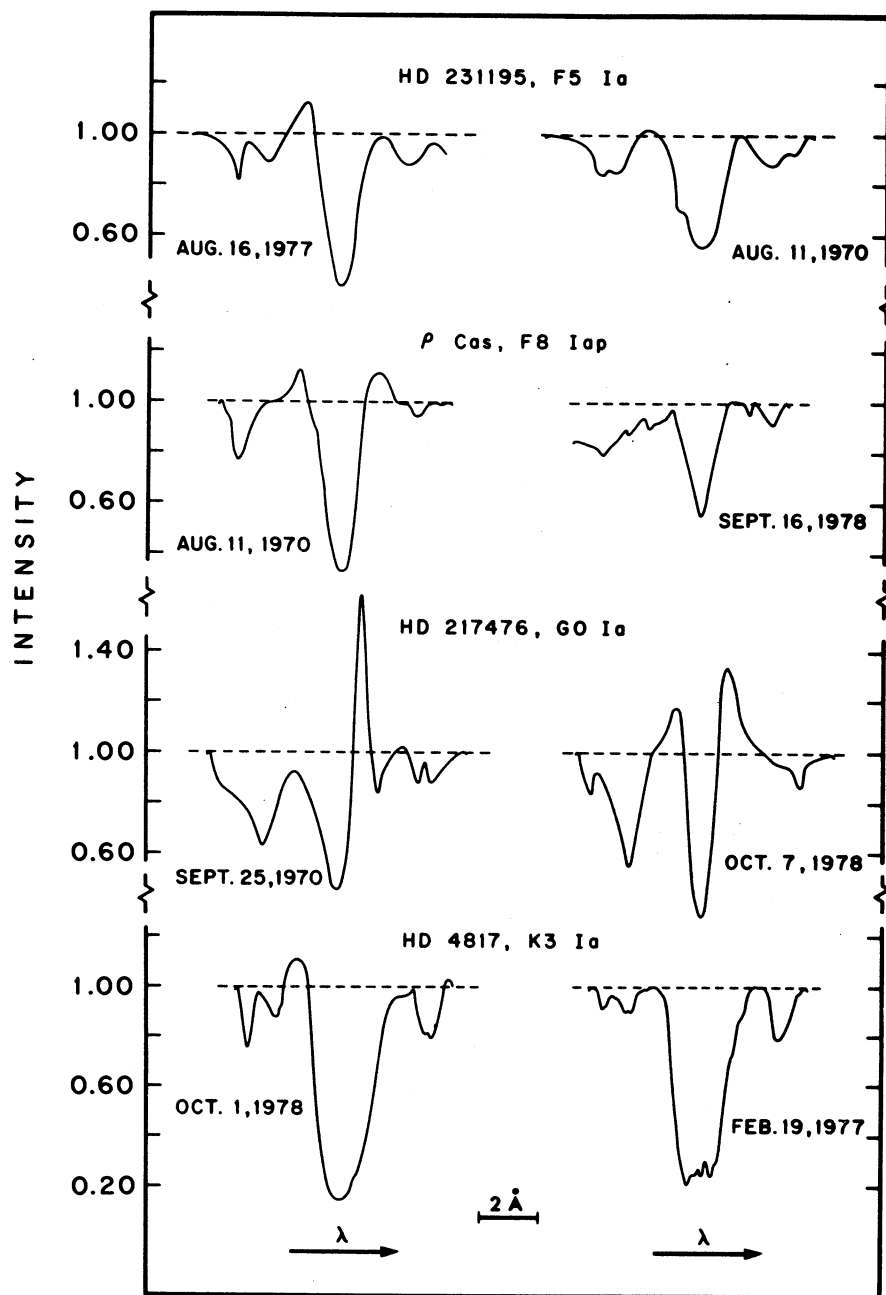


Fig. 1. Representative  $H\alpha$  line profiles in F-K supergiants. All stars show variable  $H\alpha$  profiles. The emission components are sometimes, but not always, present.

profile. As we can see, all 8 stars show  $H\alpha$  emission at certain times suggesting that all of these very luminous stars, emission is variable in intensity and shape, indicating considerable activity as can be seen in Figure 1, which shows representative  $H\alpha$  profiles for 4 of the stars.

At present, the time scale of such changes is not determined. The strongest emissions in  $H\alpha$  were observed in HD 217476 and  $\rho$  Cas, two of the most luminous

stars. Since no emission was detected in any of our spectra of supergiant stars with less broad lines than the 8 stars chosen for this study, the lower limit of  $M_V$  where emission occurs for F-K supergiants is estimated to be between 8 and 7. Rosendhal (1973) estimated lower limits of  $M_V$  for  $H\alpha$  emission in other spectral types and found a limit of  $M_V \simeq -5.8$  for B0-B1 stars, and  $M_V \simeq -6.8$  for B8-A3 stars.

The type of H $\alpha$  emission is given in column 5 of table 1, where B indicates emission on the blue side of absorption line R on the red side, BR on both sides, and C at the centre. As can be seen, some of our stars show H $\alpha$  emission of different types at various times. In particular, the very luminous supergiant HD 217476 (=HR 8752) shows considerable variability. It is interesting that this star is also a radio star, and according to recent ultraviolet observations, is a binary system (Stickland and Harmer 1978).

## REFERENCES

- Keenan, P.C. 1973, in *IAU Symp. No. 54, Problems of Calibration of Absolute Magnitudes and Temperatures of Stars*, eds. B. Hauck and B.E. Westerlund (Dordrecht: D. Reidel), p. 68.  
 Osmer, P.S. 1972a, *Ap. J. Suppl.*, **24**, 247.  
 Osmer, P.S. 1972b, *Ap. J. Suppl.*, **24**, 255.  
 Rosendhal, J.D. 1973, *Ap. J.*, **186**, 909.  
 Smolinski, J. 1971, in *Colloquium on Supergiant Stars*, ed. M. Hack, Osservatorio Astronomico di Trieste, p. 68.  
 Stickland, D.J. and Harmer, D.L. 1978, *Astr. and Ap.*, **70**, L53.

## DISCUSSION

*Mirabel:* Could you make further comments on the observations in radio of these objects? In particular, which radiotelescope was used, beamwidth and typical radio flux?

*Smolinski:* The survey observations were made jointly with P.A. Feldman and L.A. Higgs at 10.5 GHz with the 46-m telescope of the Algonquin Radio Observatory. The beamwidth was 2'.7, the flux density for the radio star HR 217476 (=HR 8752) was about 26 mJy. There are other observations for three objects at other frequencies.

*Niemela:* For those stars which are members of binary systems, do you have orbits and estimates of the masses?

*Smolinski:* Two of our stars (HR 8752 and 89 Her) are probably binary systems. The radial velocity curves are not yet well determined, so the orbital elements are only roughly known.

*Pişmiş:* (Comment) Your data showed clearly the expansion of the atmospheres. It might well be that the expansion is not isotropic and that the star is rotating or describing an orbit. In this case many of the variations you found could perhaps be explained, since this situation offers more degree of freedom in your model.

John L. Climenhaga and B.L. Harris: Department of Physics, University of Victoria, P.O. Box 1700, Victoria, BC V8W 2Y2, Canada.

John Smolinski: Copernicus Astronomical Center, 87-100 Torun, ul. Chopina 12/18, Polonia.

