HYDROGEN LINES IN B-e STARS ENVELOPES

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ABSTRACT. The investigation of Balmer Hα and Hβ line profiles for 28 Be and Be-shell stars have been carried out. The emission profiles of stars were obtained by subtracting from "A Be star atlas" photospheric line profiles which were computed from Kurucz models and corrected from gravity and rotation. The relationships between emission-line widths, equivalent widths and rotational velocity for 28 B-e stars confirm the origin of envelope these stars from rotational mass loss, consistent with a rotating, equatorial disk. The smaller emission disks shown the weak Hα emission lines, the biggest – the strong one.

Key words: Be-stars, envelope, emissions lines, profiles

I. Introduction

Be-stars with emission hydrogen lines and luminosity classes III-V widely have been investigating during several decades. They represent about 20 percent of B stars. Studies of Be emission-line profiles permit to obtain the knowledge about the structure and dimensions of the stellar envelope. This paper includes the following distinction from early published work. We have taken all types of Be stars for our study from spectral type B2 to B8 including "shell stars" and "pole-on stars" on northern and southern hemispheres. The hydrogen absorption-line profiles from the underlying star were computed using Kurucz model atmospheres (Kurucz 1979) with correction of stars rotation and were subtracted from the observed Balmer emission lines. The aides of this paper is to describe and present the dynamical parameters of envelopes for wide class of Be stars.

II. Atmospheric models and processing

Be stars are distinguished from normal stars of the same spectral type by statistically greater values of the mass loss and by greater variability in the stellar wind. The amplitude of the variations is such that they cannot be interpreted as perturbations, and the conclusion is clear that the mass flux is highly variable in these stars. The strong variability of the mass flux could create a favorable condition for the formation of their cool envelope. The emission lines in Be stars exhibit a great variety of profiles. They most often exhibit a shallow, more or less central reversal. The intensity and width vary with time, but the emission intensity generally exhibits much greater variations than the line width. Emission profiles without a central reversal are also observed, as well as profiles with three emission peaks (Doazan, 1982). In spite of variability of these stars we find possible to determine the relationships between some parameters of stellar envelopes.

The 28 Be stars for this work have taken from "A Be star atlas" (Doazan et al., 1991). The Balmer lines Hα and Hβ were observed in the spectrum of each star by V.Doazan and collaborator at the Haute-Provance Observatory with CCD camera ISIS (resolution 0.18 Å and S/N=150). The list of stars is presented on table 1.

Effective temperature have taken from adopted parameters for our main-sequence models, (Slettebak et al., 1992); logarithms of gravity from dependents:

$$\lg g = 4\lg T_{eff} + 0.4M_{bol} + \lg(M/M_{\odot}) - 12.5$$

The observational profiles of hydrogen lines have been correct for the effects of photospheric absorption. The models of the photospheric Balmer line profiles for the rotating B star that lies in the middle of Be star envelope have been subtracted from observed profiles. The Balmer models permit to calculate the profiles of hydrogen lines for each models using effective temperature, gravity and metal abundance. The rotation of the star was corrected by Gray algorithm (1980). All the profiles were approximated with aid by cubic spline. For resulting profiles were determined emission-line width and equivalent width. An example of this procedure is shown on Figure 1 for Hα line in the spectrum of the star HD 29866.

The Be "shell stars" have the central absorption component V-shaped, because the Be star disk projected against the stellar photosphere. Therefore we corrected these effect in a completely artificial way by extrapolating these Balmer emission profiles. The extrapolated profiles have no astrophysical basis.

The statistical character of work and results means, that each star was taken in the separate moment of time for all class of Be stars.

III. Conclusions

On the pictures 1-6 is shown the relationships between emission-line widths and rotational velocity, equivalent widths and rotational velocity, emission-line widths and equivalent widths. The values of emission-line widths (FWHM) plotted against rotational velocity ($v \sin i$) in Figures 2, 3. The both Balmer lines show a correlation that large emission widths correspond to large rotational velocities. These Figures means that Be stars shows a rapid rotation and forming a nebulous ring which gives an emission lines. Such correlation was first demonstrating by Struve (1931), than other astronomers e.g. Slettebak at al. (1992). The emitting envelope has an axial symmetric, like Struve-model of Be stars.

The values of emission-line widths (FWHM) plotted against equivalent widths (EW) in Figures 4, 5. The stars with $v \sin i < 101$ km/s are designated by triangles, with $v \sin i > 101$ km/s by filled circles. The correlation permit to do the same conclusion concerning emitting envelope, but no conclusion that stronger emission lines are narrower from the star than the weaker lines.

The values of emission-line equivalent widths (EW) plotted against rotational velocity ($v \sin i$) in Figures 6,7. An absence of correlation for Hα and a presence for Hβ can point on inhomogeneous structure of envelope so as radiation in the Hβ line origin in more deeper layers of the emitting disk, then in Hα line.

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References

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Table 1: List of stars

Star	Sp.class	$v \sin i$	T_{eff}	$\log g$
HD 6811 42 And	B6.5IIIe	80	13500	4.0
HD 25940 48 Per	B4Ve	200	17000	3.90
HD 29866 HR1500	B8IVne	300	11750	3.88
HD 32343 11 Cam	B3Ve	100	19000	3.92
HD 32991 105 Tau	B3Ve	200	19000	3.88
HD 37490 Ome Ori	B2IIIe	160	22400	3.92
HD 42054 HR2170	B5Ve	220	15500	3.91
HD 45995 HR 2370	B2IVe	250	22400	3.89
HD 54309 HR2690	B2IVe	200	22400	3.92
HD 56014 27 CMa	B3IIIepsh	150	19000	3.89
HD 56139 Ome CMa	B2.5Ve	80	20300	3.91
HD 58050 OT Gem	B2Ve	140	22400	3.92
HD 58343 HR 2825	B3Ve	< 40	19000	3.89
HD 58715 Bet CMi	B8Ve	245	11750	3.98
HD 67536 HR 3186	B2.5Vne	290	20300	3.91
HD 78764 HR 3642	B2IVe	120	22400	3.92
HD 89890 HR 4074	B3IIIep	70	19000	3.88
HD 93563 HR 4221	B8IIIesh	280	11750	3.98
HD100673 A Cen	B9Ve	125	10600	3.98
HD120991 HR 5223	B2IIIep	70	22400	3.92
HD124367 HR 5316	B4Ve	300	17000	3.90
HD127972 Eta Cen	B2IVe	350	22400	3.92
HD134481 Kap Lup	B9Ve	160	10600	3.98
HD157042 Iot Ara	B2.5IVe	320	20300	3.91
HD164284 66 Oph	B2IV-Ve	240	22400	3.92
HD167128 HR 6819	B3IIIe	50	19000	3.89
HD203467 6 Cep	B2.5Ve	150	20300	3.91
HD217891 Bet Psc	B5Ve	100	15500	3.91

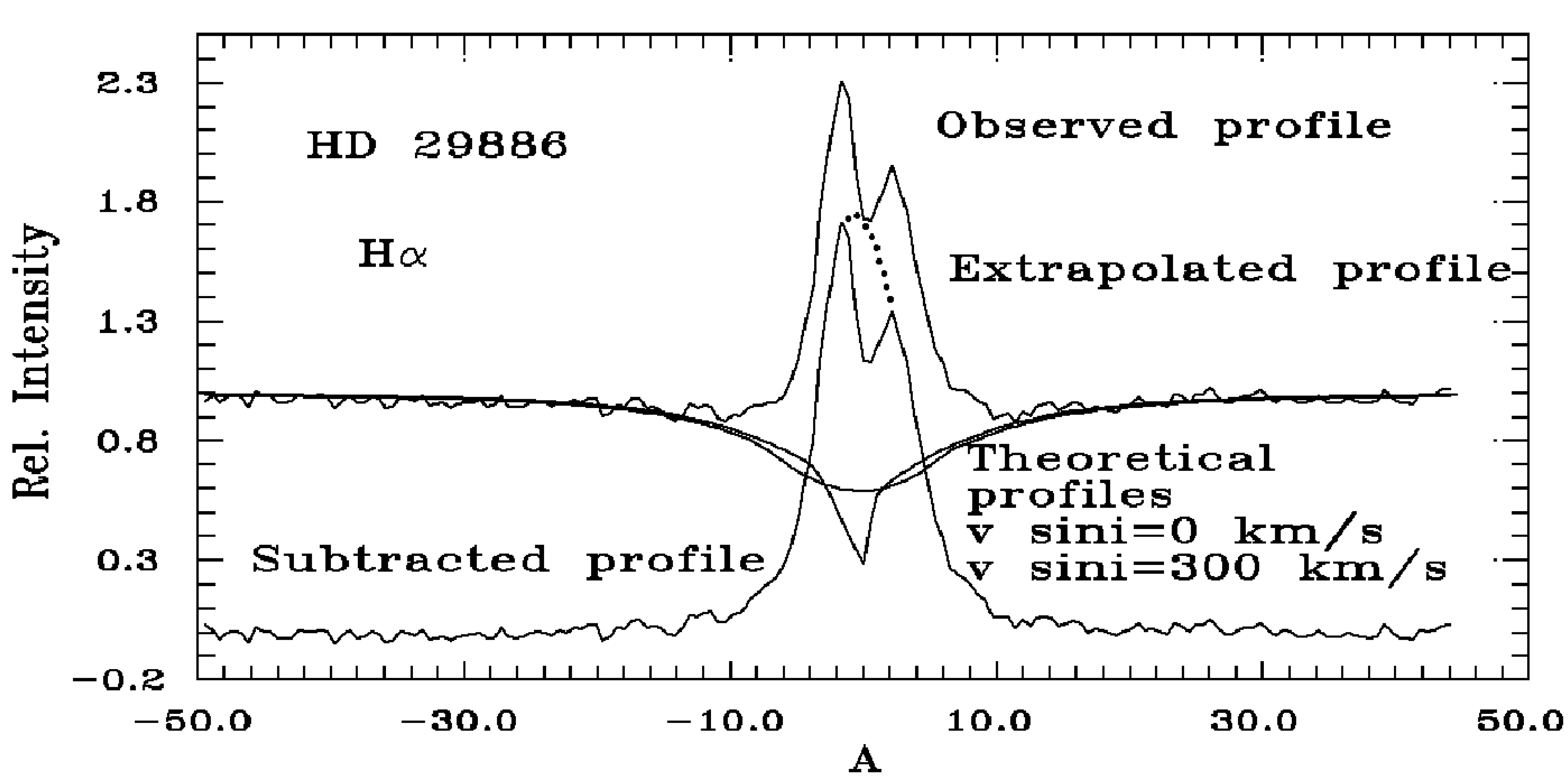

Figure 1. Example of the subtraction procedure for HD29866.

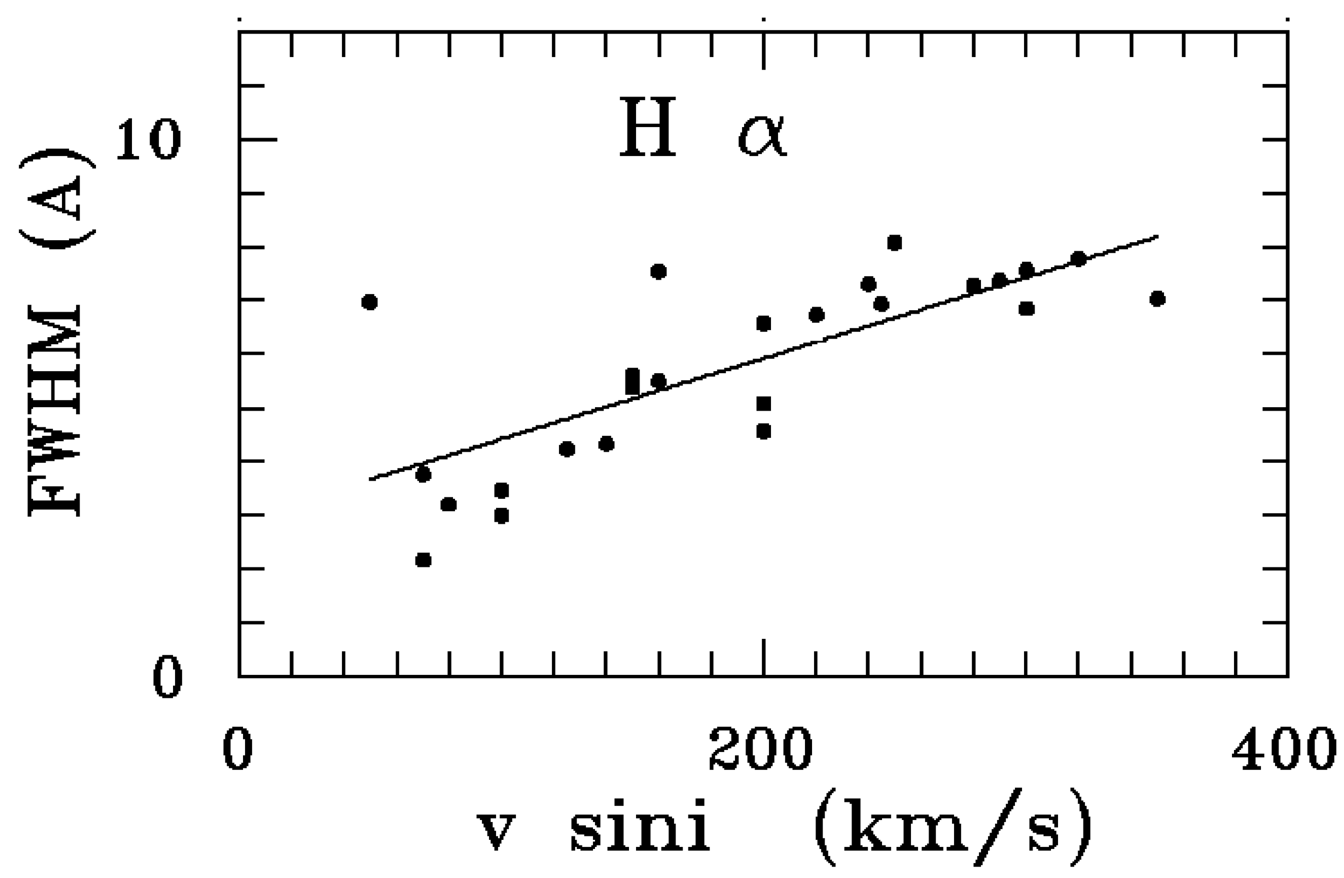

Figure 2. Hα emission-line widths vs. $v \sin i$. Correlation coefficient r=0.72± 0.14

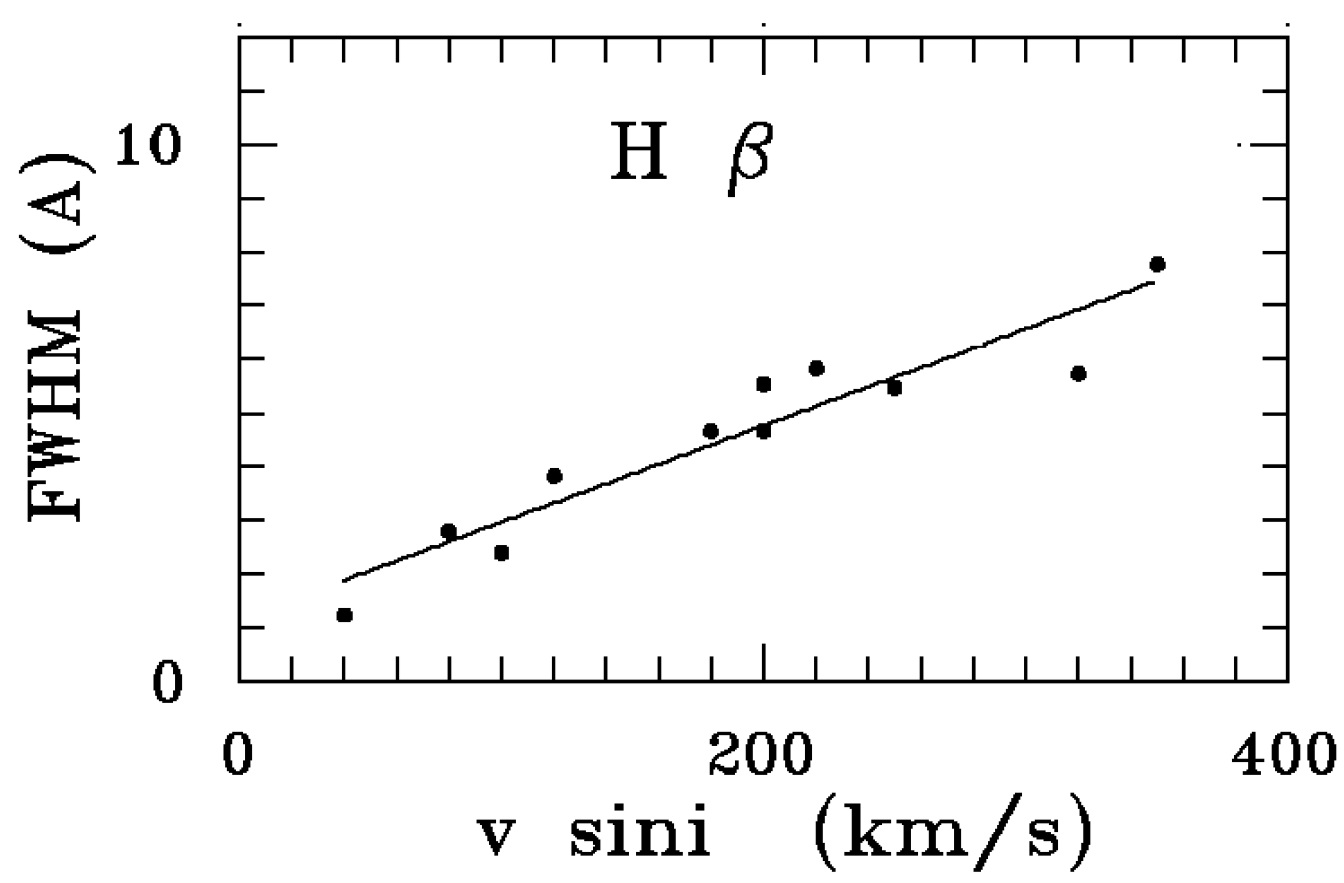

Figure 3. Hβ emission-line widths vs. $v \sin i$. Correlation coefficient r=0.86± 0.17

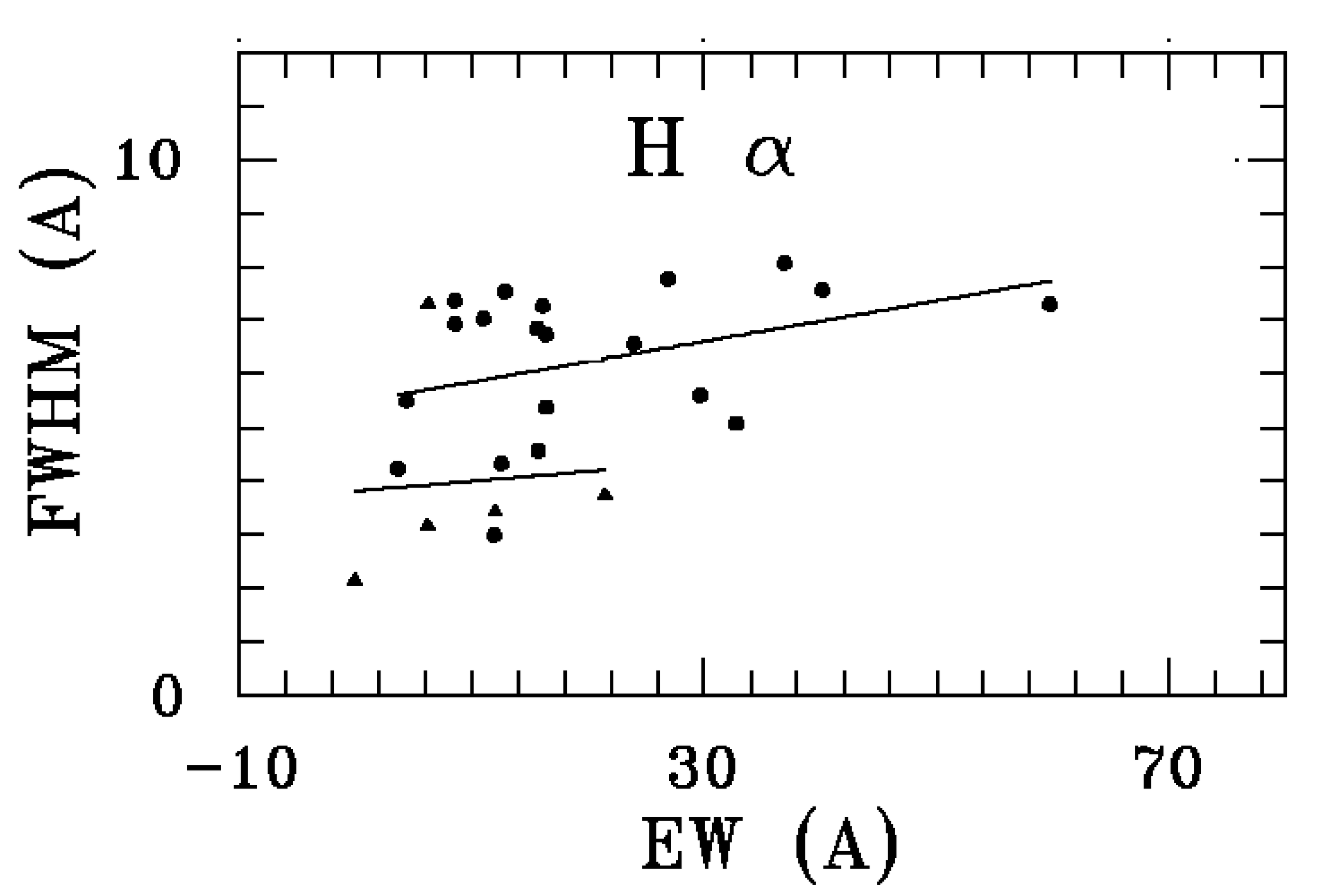

Figure 4. Hα emission-line widths vs. equivalent widths. Stars with $v \sin i$ >101 km/s are designated by filled circles, and $v \sin i$ <101 km/s by filled triangles.

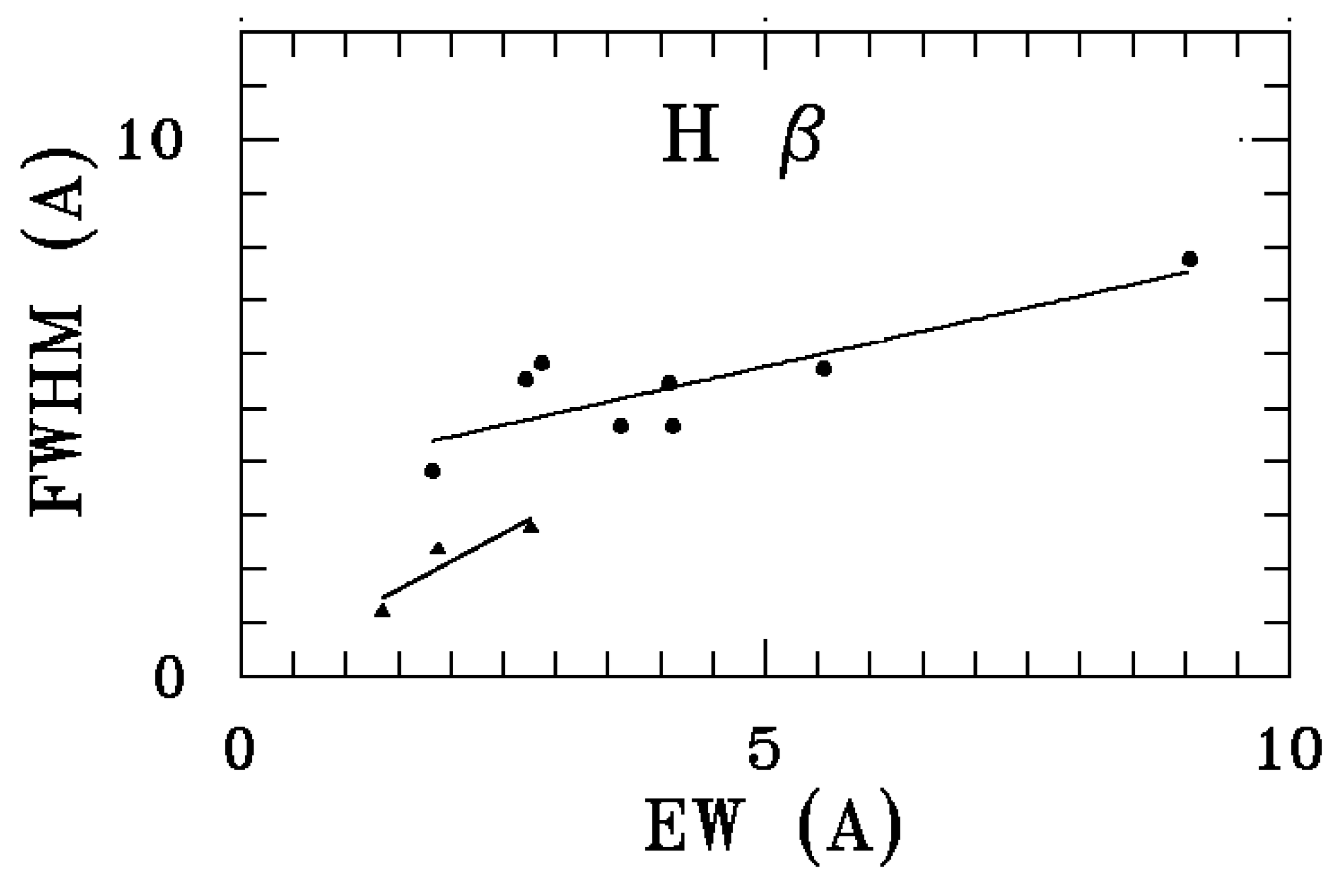

Figure 5. Hβ emission-line widths vs. equivalent widths. Stars with $v \sin i > 101$ km/s are designated by filled circles, and $v \sin i < 101$ km/s by filled triangles.

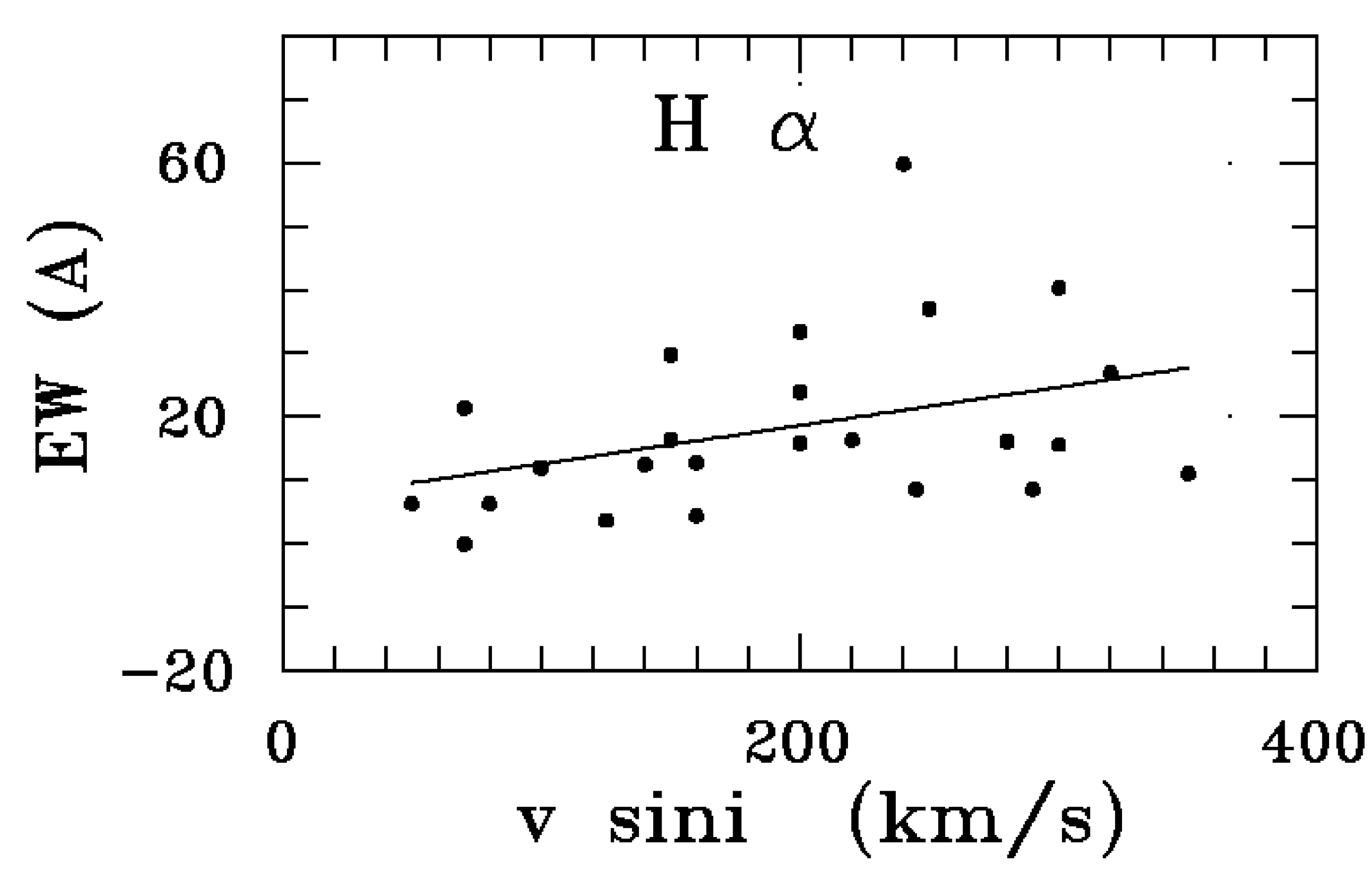

Figure 6. Hα emission-line equivalent widths vs. $v \sin i$. Correlation coefficient r=0.37± 0.19

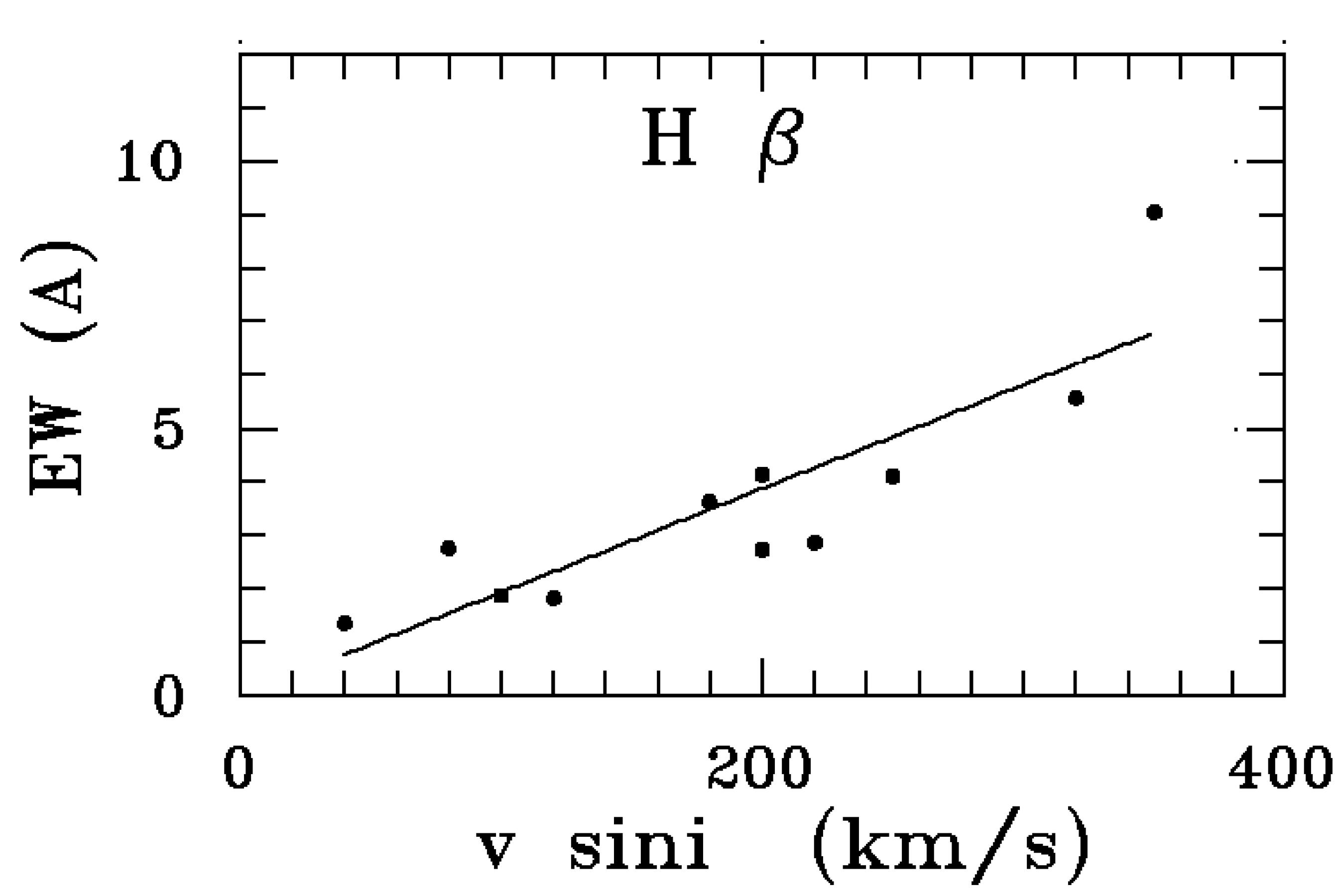

Figure 7. Hβ emission-line equivalent widths vs. $v \sin i$. Correlation coefficient r=0.79± 0.20