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H_β PROFILES OF 25 CP STARS

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ABSTRACT I present the H_β profiles of 25 CP2 and CP4 stars, together with their equivalent widths. Surface gravities are estimated for stars with known effective temperature from the equivalent width of H_β.

INTRODUCTION

The Balmer lines are powerful tools to investigate the physical constitution of CP stars, since they are little influenced by the peculiar chemistry of those stars. T_{eff} and *log g* determine the shape of the Balmer lines, other parameters, as metal abundances, magnetic fields or even rotation have little influence and show up only in the very center of the line. Because of their large span in wavelength as well as in intensity, it is absolutely necessary to use spectra with high signal to noise ratio. Photographic observations are not well suited.

Accurate theoretical line profiles are necessary to serve as comparisons with the observed lines. They have been calculated for this work with the ATLAS8 program by R.L. Kurucz and BALMER by D.M. Pyper. A tenfold solar metal abundance was assumed to represent typical CP stars.

OBSERVATIONS

All observations have been carried out by the author with the 2.2m telescope at Calar Alto. The Coudé spectrograph was used with a dispersion of 17Å/mm to feed a CCD camera. 155 spectra for 25 CP2 and CP4 stars have been obtained. Each spectrum was carefully wavelength calibrated and continuum normalized. All spectra have then been shifted so that H_β is at its laboratory wavelength of 4861.33 Å. After this procedure all spectra for an individual star have been averaged.

RESULTS

Extraction of the H_β profile

From the averaged spectra an arbitrary number of representative points (intensity versus wavelength) were extracted interactively. From these points a smooth curve was constructed with a cubic spline data smoothing algorithm.

The amount of smoothing was also chosen interactively until best agreement of the extracted line with the actual spectrum was obtained. The resulting profiles and their equivalent widths are used in this work. Table I gives the extracted profiles in tabulated form.

Table I Residual intensity of H_β as a function of distance from line center.

$\Delta\lambda$	10 783	11 503	15 089	18 296	19 832	25 354	25 823	27 309	32 783
0.00	0.220	0.261	0.224	0.210	0.453	0.198	0.284	0.300	0.248
0.25	0.252	0.268	0.238	0.248	0.456	0.244	0.327	0.310	0.287
0.50	0.299	0.288	0.266	0.326	0.458	0.335	0.393	0.331	0.353
1.00	0.360	0.353	0.337	0.420	0.472	0.421	0.492	0.406	0.442
1.50	0.384	0.400	0.380	0.468	0.490	0.453	0.534	0.465	0.492
2.00	0.411	0.427	0.407	0.504	0.521	0.479	0.569	0.501	0.531
2.50	0.434	0.447	0.427	0.531	0.555	0.500	0.597	0.529	0.565
3.00	0.459	0.469	0.449	0.554	0.590	0.520	0.621	0.554	0.594
4.00	0.519	0.511	0.492	0.606	0.649	0.567	0.669	0.600	0.643
5.00	0.577	0.553	0.529	0.658	0.696	0.620	0.714	0.646	0.691
7.50	0.693	0.656	0.618	0.763	0.786	0.726	0.804	0.748	0.797
10.00	0.777	0.740	0.694	0.838	0.851	0.805	0.868	0.821	0.858
12.50	0.835	0.803	0.750	0.885	0.896	0.860	0.909	0.870	0.898
15.00	0.878	0.853	0.793	0.916	0.927	0.896	0.937	0.906	0.926
20.00	0.935	0.919	0.865	0.962	0.964	0.952	0.968	0.952	0.961
25.00	0.960	0.952	0.907	0.983	0.981	0.978	0.983	0.973	0.980
35.00	0.987	0.981	0.963	0.995	0.993	0.990	0.997	0.988	0.998
50.00	0.997	0.991	0.988	1.000	0.998	1.000	0.999	0.997	1.000
80.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE I (continued)

$\Delta\lambda$	112 185	137 909	164 429	170 000	173 650	175 744	176 232	177 710
0.00	0.197	0.179	0.326	0.356	0.192	0.347	0.166	0.420
0.25	0.222	0.233	0.333	0.359	0.235	0.362	0.219	0.425
0.50	0.270	0.315	0.341	0.368	0.312	0.395	0.304	0.432
1.00	0.345	0.382	0.374	0.406	0.403	0.477	0.384	0.456
1.50	0.380	0.410	0.427	0.453	0.441	0.531	0.437	0.504
2.00	0.410	0.439	0.465	0.485	0.479	0.560	0.479	0.548
2.50	0.428	0.466	0.490	0.511	0.507	0.583	0.514	0.581
3.00	0.451	0.492	0.516	0.542	0.532	0.607	0.542	0.608
4.00	0.506	0.547	0.560	0.598	0.586	0.658	0.589	0.661
5.00	0.555	0.598	0.599	0.646	0.643	0.710	0.628	0.709
7.50	0.660	0.689	0.696	0.738	0.749	0.810	0.713	0.797
10.00	0.747	0.750	0.773	0.803	0.833	0.873	0.775	0.856
12.50	0.812	0.799	0.834	0.851	0.884	0.913	0.816	0.896
15.00	0.860	0.840	0.880	0.887	0.917	0.937	0.854	0.926
20.00	0.924	0.909	0.937	0.936	0.960	0.965	0.904	0.962
25.00	0.955	0.950	0.962	0.961	0.979	0.980	0.936	0.980
35.00	0.986	0.987	0.983	0.987	0.994	0.991	0.975	0.992
50.00	0.998	1.000	0.996	0.998	1.000	0.998	1.000	0.998
80.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE I (continued)

$\Delta\lambda$	193 722	196 502	210 071	215 441	219 749	221 394	224 801	+24°3675
0.00	0.273	0.129	0.395	0.287	0.357	0.219	0.272	0.202
0.25	0.304	0.171	0.400	0.310	0.360	0.234	0.297	0.244
0.50	0.355	0.248	0.408	0.353	0.369	0.264	0.348	0.297
1.00	0.450	0.335	0.440	0.461	0.407	0.338	0.442	0.368
1.50	0.502	0.373	0.494	0.522	0.465	0.382	0.498	0.420
2.00	0.544	0.419	0.530	0.564	0.497	0.407	0.536	0.465
2.50	0.580	0.449	0.558	0.599	0.524	0.426	0.560	0.504
3.00	0.614	0.475	0.583	0.630	0.551	0.445	0.583	0.534
4.00	0.673	0.521	0.628	0.684	0.603	0.491	0.637	0.597
5.00	0.725	0.565	0.673	0.731	0.652	0.530	0.689	0.664
7.50	0.828	0.674	0.763	0.827	0.757	0.621	0.785	0.771
10.00	0.894	0.748	0.828	0.887	0.831	0.706	0.848	0.841
12.50	0.933	0.803	0.873	0.921	0.879	0.769	0.893	0.891
15.00	0.955	0.851	0.906	0.943	0.913	0.819	0.926	0.928
20.00	0.975	0.919	0.950	0.974	0.959	0.893	0.965	0.970
25.00	0.985	0.953	0.974	0.991	0.979	0.932	0.981	0.993
35.00	0.992	0.978	0.992	1.000	0.994	0.973	0.995	1.000
50.00	0.996	1.000	0.998	1.000	0.997	0.992	0.999	1.000
80.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Effective Temperatures

It is almost impossible to deduce T_{eff} and *log g* simultaneously. One of both parameters should be restricted by other means. I have chosen the $[u-b]$ versus T_{eff} calibration from Megessier (1988) to assign effective temperatures to the program stars. The reddening free index [u-b] is defined as

$$[u-b] = (u-b) - 1.84(b-y)$$

(Stroemgren, 1966). T_{eff} is then found by

$$\theta = 0.2620[u-b] + 0.1886$$

The calibration is restricted to Si type stars and $0.3 \leq \theta \leq 0.48$, it was however applied to all stars in the temperature range, regardless of their peculiarity type. All ubvy photometric data for the program stars have been taken from Renson, 1991.

Surface gravities

For stars with known effective temperatures *log g* can be estimated by comparison with theoretical profiles. For that purpose, profiles (and equivalent widths) for a grid with $7\ 000K \leq T_{eff} \leq 15\ 000K$, $\Delta(T_{eff}) = 200K$ and $3.0 \leq log\ g \leq 4.4$, $\Delta(log\ g) = 0.1$ have been calculated. In a contour plot of equivalent width of H_β depending on T_{eff} and *log g* the contour line at the equivalent width of a specific star uniquely defines possible combinations of T_{eff} and *log g*. T_{eff} given, *log g* is simply read from the contour plot. Figure 1 shows this process for 21 *Per*.

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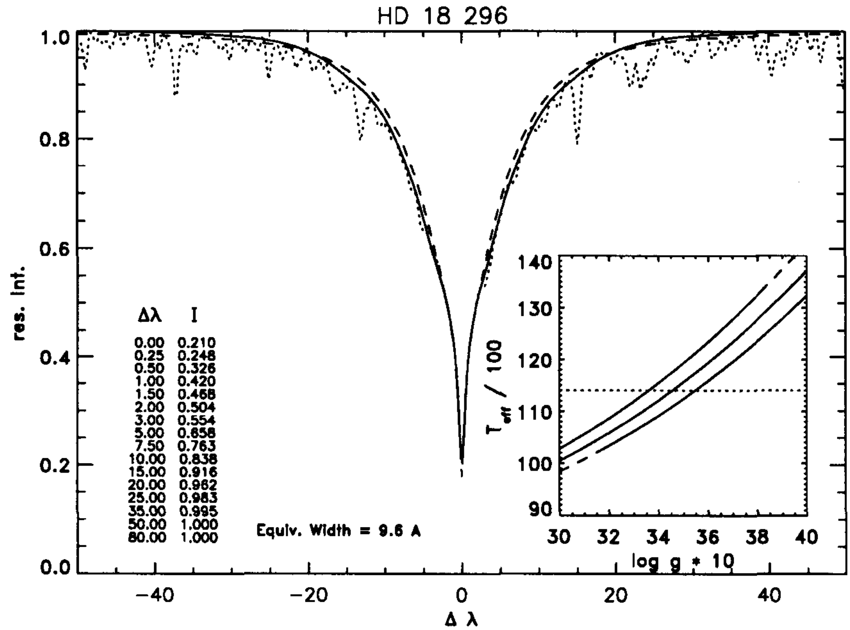

Figure 1: Mean spectrum of $21 Per$ (dotted line), extracted H_β profile (solid line) and theoretical profile with the adopted values of T_{eff} and *log g* (dashed line). The inset at lower right shows the contour of the equivalent width of H_β . The two dashed lines are at ±5% of the equivalent width. With a given temperature of 11400 K it follows $logg = 3.45$.

In Table II the results for the 25 observed CP stars are summarized. It shows the HD number, HR number and common name, the number of spectra co-added, [u-b] values and T_{eff} calculated from them, measured equivalent width of H_β and obtained *log g*. However, these results for *log g* should only be considered as very preliminary. Future work has to take into account all possible information on T_{eff} , not only the [u-b] calibration. For stars with $T_{eff} \lesssim 10\,000\ K$ it becomes more and more difficult to deduce *log g*. In these cases the other way, restricting *log g* with other information and determining T_{eff} is favorable. For a thorough discussion on comparison between photometric T_{eff} , *log g* determinations with spectroscopic H_β results, see North & Kroll, 1989.

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TABLE II Program stars and results. T_{eff} is calculated from [u-b], *log g* from the measured equivalent width of H_β

HD	HR	Name	#	[u-b]	Teff	Eq. w.	log g
10 783			3	0.999	11200	12.6	3.9
11 503	546	γ^2 *Ari*	11	1.088	11100	14.0	4.1
15 089	707	ι *Cas*	9	1.549		17.1	
18 296	873	21 *Per*	5	0.966	11400	9.6	3.45
19 832	954	56 *Ari*	8	0.610	14500	8.8	3.95
25 354			3	1.194		10.9	
25 823	1268	41 *Tau*	4	0.488	15900	8.2	
27 309	1341	56 *Tau*	4	0.574	14900	10.5	
32 633			2	0.756	13000	8.8	3.65
112 185	4905	ϵ *UMa*	4	1.443		13.6	
137 909	5747	β *CrB*	4	1.795		13.3	
164 429	6718		7	0.922	11700	12.3	4.0
170 000	6920	φ *Dra*	8	0.789	12700	11.2	4.05
173 650	7058		4	1.333		10.1	
175 744	7147		3	0.746	13100	8.4	3.6
176 232	7167	10 *Aql*	3	1.821		13.1	
177 410	7224		9	0.378		8.7	
193 722	7786		11	0.841	12300	7.9	3.3
196 502	7879	73 *Dra*	5	1.585		13.8	
210 071	8434		9	0.637	14200	9.8	4.1
215 441			1	0.751	13100	7.5	3.4
219 749	8861		7	0.974	11400	9.9	3.5
221 394	8933		7	1.447		15.8	
224 801	9080		4	0.818	12500	9.0	3.6
+24°3675			3	1.118	10500	9.3	3.1

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