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HIGH RESOLUTION PROFILES OF BALMER LINES IN FOUR LATE TYPE DWARFS

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Abstract. We present high resolution spectra of the first five Balmer lines in four late type dwarfs (CR Dra, CN Leo, CE Boo and BY Dra) observed during the night of 22/23 May 1997 from Observatorie de Haute Provence. Strong self-reversals are detected in Hα and Hδ line in all stars. We have determined the equivalent width of the observed Balmer lines which indicate that the position of transition region of these stars lies at around log m=-4.

1. INTRODUCTION

Late type K and M dwarfs show different levels of chromospheric activity, usually characterized by the strength of the HI Balmer lines, the CaII K and H and MgII k and h lines. Houdebine et al. (1995) found that when the transition region pressure decreases and the chromospheric temperature gradient decreases, the Balmer lines change rapidly from emission to strong absorption and then the profiles weaken and become narrower until the line totally disappear (zero Hα stars). The determination of atmospheric parameters using Hydrogen, Calcium and Magnesium lines is made difficult by the large optical thickness of these lines. Full radiative transfer calculations are necessary in order to understand the influence of different stellar parameters on formation of these lines.

Late type stars with Balmer lines in the emission very often show flare activity. Before we model the flare events in these very active stars we must first model their quiescent atmospheres.

2. OBSERVATIONS AND DATA REDUCTION

We have obtained high resolution spectra of four dKe and dMe stars in the wavelength range 3900-6800 Å using the ELODIE spectrograph on the 1.93m telescope at Observatorie de Haute Provence(OHP). ELODIE is a high resolution ($\frac{\Delta\lambda}{\lambda}$ = 45000) cross-dispersed, fibre-fed échelle spectrograph mounted in the Cassegrain focus of the telescope and which is primarely used for high precision radial velocity measurements. A detailed description of the instrument and it's capabilities can be found in Barrane et al. (1996).

Spectra were recorded on the back-illuminated Tek1024 CCD chip with a 24μm pixel size. Data were reduced using the standard ELODIE procedure which has: zero point correction using bias section, flat field correction using Tungsten lamp and order extraction following Baranne et al.(1996). Wavelength calibration has been achieved with a the Thorium-Argon lamp.

The basic parameters of observed stars (from Gliese and Jahreiss(1988)) together with the observation log are shown in Table 1.

Table 1

Star	Sp.	m_V	UT	T_{exp}(s)	S/N(5500Å)
CN Leo	dM0e	10.20	8.232	2800	46.2
CR Dra	dM1.5e	9.96	11.431	2700	59.3
CE Boo	dM0e	10.23	10.581	2700	47.2
BY Dra	K6Ve	8.89	12.231	1800	127.4

3. RESULTS AND DISCUSSION

Because of the low altitude of OHP and the relatively poor seeing conditions we were unable to achieve accurate flux calibration of our spectra. Another difficulty was a relatively low sensitivity of the spectrograph/CCD in the blue part of the spectra which decreased significantly the signal to noise ratio. We have normalised the spectra by dividing the flux by local continuum values. Normalised spectra are shown in Figs.1-5.

One can see from Fig. 1 that all stars show deep self-reversal in the Hα line. Smaller self-reversals are present in CR Dra, CE Boo and CN Leo for Hβ, Hγ and Hδ lines. These self-reversals are indications of a high pressure transition region. Lines in BY Dra are weaker compared to the continuum because of the higher photospheric temperature of this star which causes a smaller contrast effect.

Table 2

Star	Hα	Hβ	Hγ	Hδ	Hϵ
CN Leo	-0.67	-0.55	-0.14	-0.68	-1.01
CR Dra	-1.33	-1.69	-1.42	-1.52	-2.36
CE Boo	-1.01	-1.02	-0.92	-1.01	-1.32
BY Dra	-0.52	-0.122	-0.15	-0.48	-3.24

We have determined the equivalent width of five Balmer lines for all four stars by numerical integration using the formula $EW=\int(1-\frac{F_\lambda}{F_c})d\lambda$ where F_λ is flux at given wavelength and F_c is continuum flux. Results are shown in Table 2. One can see that in all stars the Hϵ line has a large equivalent width compared to the other lines. We identify two possible sources for this phenomenon: first the continuum level at 3970Å is very weak, so the contrast effect is very strong, and second a possibility of additional radiative pumping of transition (2-7) by extended wings of close, very strong Ca II H line. This last possibility requires careful modelling of radiative interaction between those two lines. Model atmospheres for observed stars will be presented elsewhere.

Fig. 1: Hα

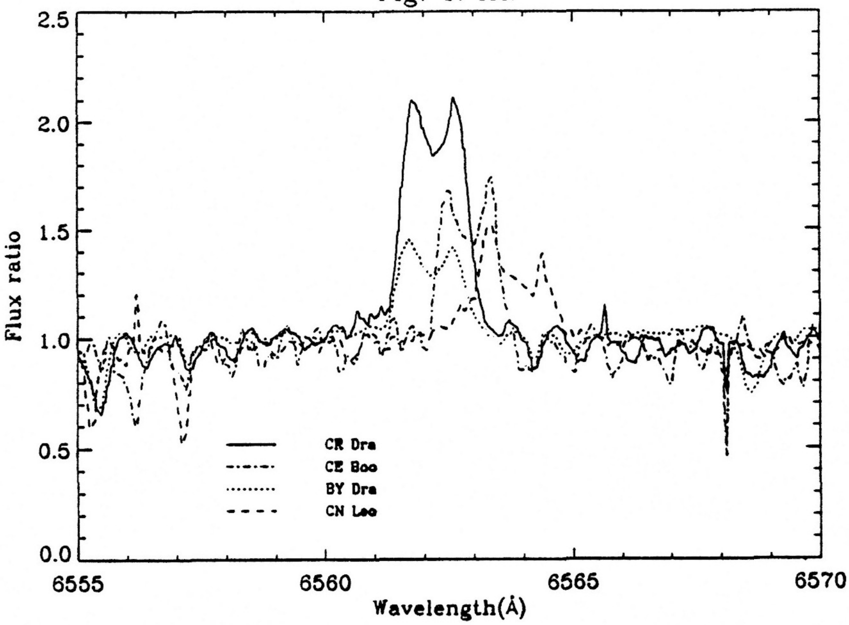
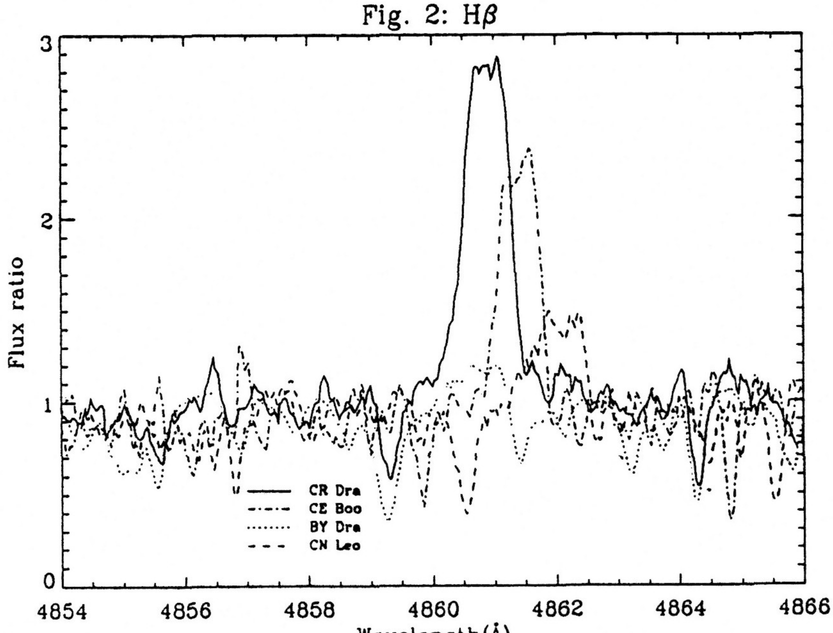


Fig. 2: Hβ



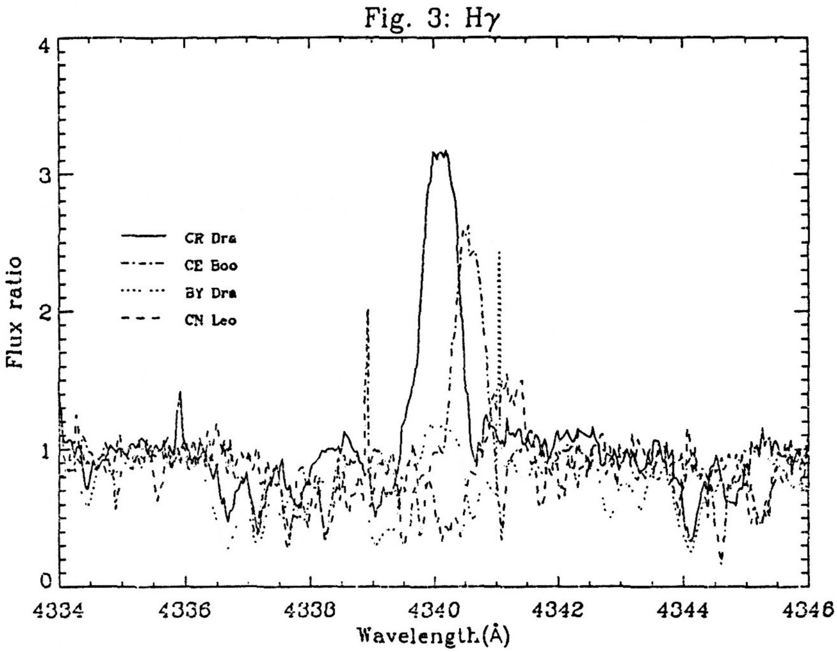


Fig. 3: Hγ
CR Dra
CE Boo
BY Dra
CN Leo
Flux ratio
Wavelength(Å)
0
1
2
3
4
4334
4336
4338
4340
4342
4344
4346

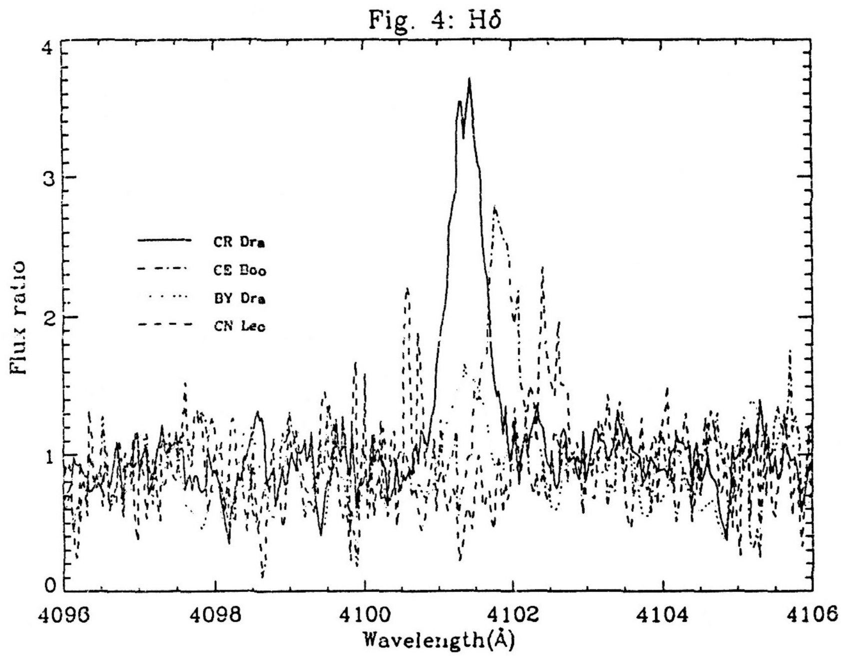
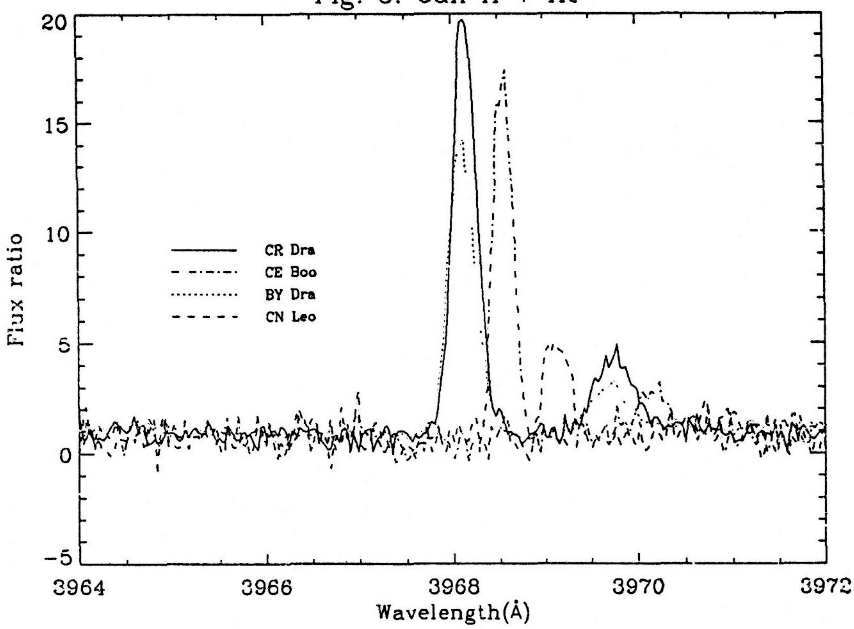


Fig. 4: Hδ
CR Dra
CE Boo
BY Dra
CN Leo
Flux ratio
Wavelength(Å)
0
1
2
3
4
4096
4098
4100
4102
4104
4106

Fig. 5: CaII H + Hϵ



From equivalent width of lines and previous work of Houdebine et al.(1995) we conclude that the transition region in these stars is positioned around $\log m_{tr}$=-4 which is characteristic for active late type dwarfs.

References

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