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### AN H $\alpha$ SURVEY OF SOUTHERN HEMISPHERE ACTIVE CHROMOSPHERE STARS

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# ABSTRACT

We have obtained moderate resolution  $H\alpha$  spectrograms of 27 southern hemisphere F-K stars with known or suspected Ca II emission, selected from the lists of Hearnshaw, Weiler and Stencel, and Bidelman and MacConnell. Our purpose was to search for the presence of  $H\alpha$  emission, which would be characteristic of stars with extreme levels of chromospheric activity (e.g., V711 Tau, FK Com). Two objects were found to have  $H\alpha$  emission as strong as V711 Tau. Seven others had a very weak or absent  $H\alpha$  absorption line, either partially or completely filled by chromospheric emission. These nine stars of exceptional activity should be observed at a variety of resolutions and wavelengths.

Subject headings: stars: chromospheres — stars: emission-line — stars: late-type

## I. INTRODUCTION

Because of the variety of extraordinary phenomena exhibited by active chromosphere objects, discovery of new, bright surface-active stars is of considerable importance. Since Ca II emission is a well-known signature of chromospheric activity, serving even as one of the points of definition of the class of RS CVn binary stars, Hearnshaw (1979) and later Weiler and Stencel (1979) presented lists of F to K, III to V stars which showed such emission on objective prism spectra (Houk and Cowley 1975; Houk 1978). These stars were suggested as RS CVn candidates. There were difficulties in establishing the strength of the Ca II emission, due to the unknown effects of an overlying continuum from possible binary companions, or of overlapping spectra on the original objective prism plates. Thus, the mere presence of Ca II emission on the objective prism plates may give no real clue as to the degree of surface activity of the star. Hearnshaw (1979) dealt with this problem by obtaining moderate resolution slit spectrograms of the H and K region in some of the brighter stars in his list. This permitted a better estimate of emission intensity and hence surface activity; several new RS CVn systems were discovered as a result. Weiler and Stencel, using only the objective prism data, assigned a probability grade to each star, reflecting the likelihood that the star was a bona fide member of the RS CVn class. However, additional photometry and high-resolution spectroscopy would of course be necessary to establish these candidates as RS CVn's.

We have obtained spectroscopic observations of an additional 27 Ca II emission stars that permit us to unambiguously identify the most chromospherically active stars in this sample. By observing the H $\alpha$  line, rather than H and K, we are able to distinguish nine of these stars that are likely to be observational targets as interesting as the extremely surface active objects V711 Tau or FK Com.

## II. OBSERVATIONS

Spectroscopic observations of 27 southern hemisphere Ca II emission objects were obtained at Mount John University Observatory during 1981 May-June. A 60 cm telescope, Cassegrain spectrograph and Varo singlestage image tube were used to obtain spectrograms with a dispersion of 100 Å mm<sup>-1</sup>, covering the wavelength region  $\lambda\lambda 5000-7000$ . The resolution of the spectrograms was ~ 3 Å; in the spectra of standard stars H $\alpha$ was a strong absorption feature, easily visible at this resolution. The stars observed were selected from the lists of Ca II emission objects published by Hearnshaw (1979), Weiler and Stencel (1979), and Bidelman and MacConnell (1973). The objects we observed and the appearance of the H $\alpha$  line are given in Table 1. The designation "filled" in column (5) of Table 1 denotes that little or no H $\alpha$  absorption feature was visible, the line being strongly affected by (presumably chromospheric) emission.

TABLE 1 Ha Survey Results

			H + K	
HD	Sp. Type <sup>a</sup>	$m_v$	Emission	Hα
(1)	(2)	(3)	(4)	(5)
61245	K1 III	7.0	Weak	Absorption
86005	K2 IIIp	7.7	Weak	Emission
94389	K1 III + F	8.1		Absorption
102077	K0/1 Vp	9.2	Moderate	Filled
103855	G8 IIIp	8.4	Weak	Absorption
106013	K0 IVp	8.0	Weak	Absorption
109473	K4/5 IIIp	8.5	Weak	Absorption
110861	G8 V	9.6	Weak	Absorption
117600	K2 IV/Vp	9.2	Weak	Absorption
129351	G8/K0 Vp	9.7	Moderate	Absorption
134692	KlIVp	8.2	Weak	Absorption
139084	K1 III + F	7.4	····	Filled
142710	G6 Vp	9.7	Moderate	Absorption
146550	F6/8Vp	10.1	Weak	Absorption
156026	K8 V	6.7		Absorption
161460	K0 Vp	8.8		Absorption
173397	K0 Vp	8.5	Weak	Absorption
174429	K0 III/IV	7.9	Strong	Absorption
181943	G8 IV	9.3		Filled
182776	K2 III	8.3		Filled
192356	G6/8 IV/Vp	9.4	Weak	Absorption
202134	KI III	7.7		Filled
202746	K2 Vp	9.4	Weak	Filled
203251	K2 III + F	8.3		Absorption
204128	K1 III CN IVD	8.7	Moderate	Emission
214257	G8/K1 III/IVn	9.4	Moderate	Absorption
219025	K2 IIIp	8.3	Moderate	Filled
	• :			

<sup>a</sup>From Houk and Cowley 1975, Houk 1978, or Bidelman and MacConnell 1973.

### III. DISCUSSION

Of 27 stars surveyed, two (HD 86005, HD 204128) showed H $\alpha$  as an emission feature above continuum, with estimated equivalent width 1-2 Å. Seven other stars showed a filled feature at  $H\alpha$ , while the remainder showed an apparently normal absorption line at this resolution. It is significant that among the recognized

RS CVn stars, H $\alpha$  emission above continuum is quite rare (see e.g., Bopp and Talcott 1978), but when such emission is present it is a signature of exceptionally high surface activity. The best examples in this regard are V711 Tau (= HR 1099) and UX Ari, which show H $\alpha$ emission and are also strong radio, UV, and soft X-ray sources. Furthermore, of the four RS CVn systems that have been detected as transient hard X-ray sources (Garcia *et al.* 1980), three are known to be H $\alpha$  emitters (Collier 1982). The correlation between  $H\alpha$  emission and surface activity extends to stars of lower luminosity also: all the dMe stars (where the "e" denotes the presence of Balmer emission) show stellar flare activity, and the quiescent H $\alpha$  emission strength is well correlated with the frequency of photometric flaring (Gershberg and Shakovskaya 1971).

Alternatively, another group of chromospherically active objects with  $H\alpha$  in emission is the FK Com stars (Bopp and Stencel 1981). These rapidly rotating (though apparently single) G to K giants show very strong chromospheric and transition-region emission in the UV; FK Com itself appears to exceed ordinary RS CVn systems by as much as an order of magnitude in the normalized flux from such lines (Bopp and Stencel 1981).

We conclude, therefore, that the nine objects with  $H\alpha$ clearly in emission are the most chromospherically active stars in this group, resembling V711 Tau and possibly FK Com. As such, these stars are of exceptional interest to observers. With V < 10, these objects should be observed at a variety of wavelengths and spectral resolutions. Of particular optical interest would be the determination of photometric (rotational) periods and the use of high-resolution spectroscopy to determine orbital periods and measure  $v \sin i$ .

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