EVIDENCE FOR EXTENDED CHROMOSPHERES AND TRANSITION ZONES IN THE UV SPECTRA OF FK COMAE STARS

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ABSTRACT. The chromospheres and transition zones of the fast rotating giants of the FK Comae type can be studied by analysing their ultraviolet emission line spectra. From relative line intensities, electron densities of the order of 10^{10} to 10^{11} cm^{-3} are found for the region where the Si IV emission arises. The sizes of the chromospheres and transition regions can be inferred from the emission measure distribution, and a temperature-height relation can be found on the assumption that hydrostatic equilibrium holds. We find the atmospheres of these stars to be clearly more extended than those of normal giant stars, and the flux in the higher excitation chromospheric and transition zone lines (e.g. C II, C IV, Si IV) is significantly stronger than in other stars of similar spectral type. Indeed, the location of these stars in the standard rotation-activity-correlation diagrams places them close to or even above the saturation limit for main sequence stars.

At present there are four stars known which are fast rotating, apparently single late type giants which have been named after the prototype object as FK Comae type stars (Bopp and Stencel 1981). The other members of the group are HD 32918, HD 36705, and HD 199178 (Bopp and Rucinski 1981, Bopp 1982, Collier 1982). Also, UZ Lib is counted as a member of this group (see e.g. Bopp et al. 1984), despite the fact that radial velocity variations have been discovered which reveal the presence of a low mass companion. All five stars show signs of strong chromospheric activity at optical wavelengths (CaII and H-alpha emission) and optical light curves somewhat similar to those of RS CVn stars or other stars with surface spots. At ultraviolet wavelengths they all show strong chromospheric and transition region lines (Bopp and Stencel 1981, Bopp et al. 1984, Bianchi et al. 1984,1985, Grewing et al. 1986), and with the exception of HD 199178 they all have been observed to emit soft x-rays.

Here we shall focus the discussion on the ultraviolet spectra of the three stars FK Comae, HD 32918, and UZ Lib. The observational data,

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which were obtained with the International Ultraviolet Explorer (IUE) satellite, are displayed in Fig.1 and 2., covering the 1200-2000 A and the 2400-3200 A range, respectively.

In Table 1 we have compiled the absolutely calibrated UV line fluxes for the three stars discussed here. These data have been corrected for interstellar extinction when necessary and refer to the emission at the surface of the stars. Also included in the Table are the surface fluxes for β Cet (Engvold et al. 1984), a K 1 III star which shows no sign of rapid rotation.

Table 1

Chromospheric and TZ line fluxes
for three FK Comae stars and β Cet

	FK Comae G2 III	HD 32918 K1 III	UZ Lib K0 III	β Cet K1 III
N V 1240	2.8(30)	2.8(30)	0.2(30)	-
O I 1304	9.2(')	2.7(')	0.8(')	16.1(28)
C II 1335	3.2(')	1.8(')	1.2(')	1.3(')
SiIV 1393	2.5(')	1.6(')	1.1(')	1.1(')
C IV 1548/50	8.1(')	5.6(')	3.0(')	1.0(')
HeII 1640	2.6(')	3.3(')	3.2(')	1.1(')
SiII 1808/17	4.7(')	3.2(')	1.3(')	8.5(')
MgII 2800	125.9(')	69.4(')	44.9(')	-

Note: the fluxes are given in units of ergs/ s.

Table 1 shows that the UV line intensities of the FK Comae stars are similar to each other and differ significantly from those of a normal giant : their absolute intensities are higher by typically a factor of 100, and the transition zone lines are relatively more intense than the chromospheric lines. This clearly demonstrates the fact that their atmospheres are much more active - very likely due to their fast rotation.

The absolute emission line fluxes as given in Table 1 can be used to derive the emission measure distribution by assuming a spherically symmetric atmosphere, an effectively optically thin collisionally excited plasma. Furthermore, by assuming also hydrostatic equilibrium, a temperature-height-relation can be obtained. Results for HD 32918 are given by e.g. Grewing et al. 1986.

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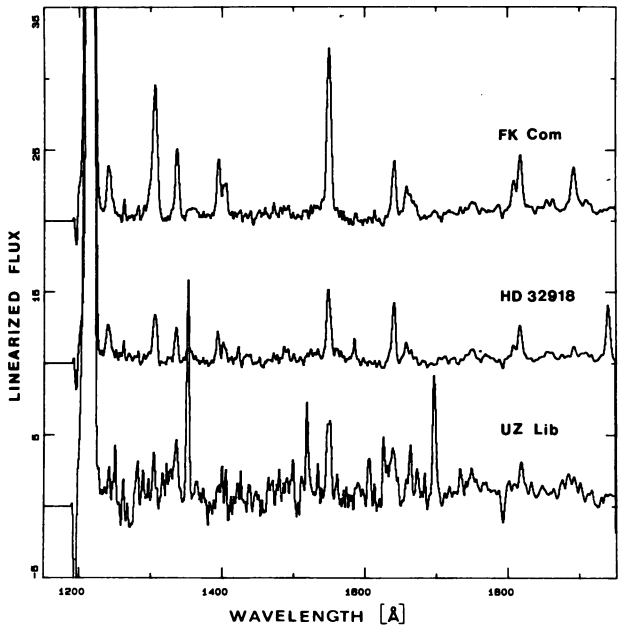

Figure 1:
The short-wavelengths IUE-spectra of three FK Comae stars showing strong chromospheric and transition zone lines.

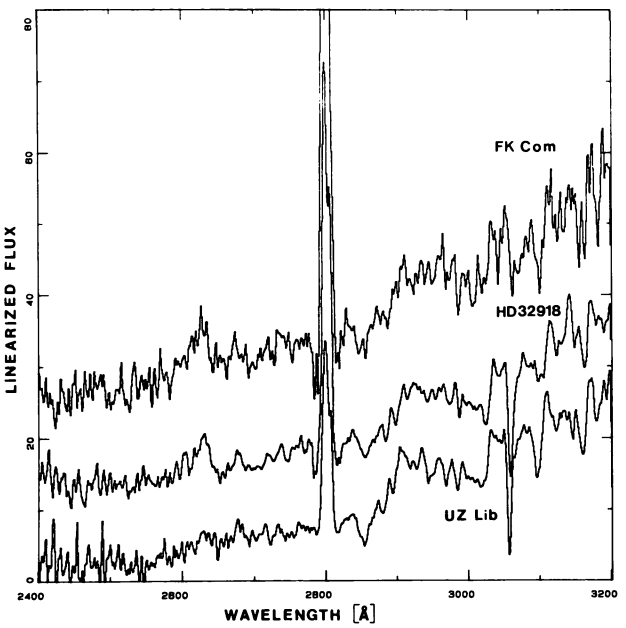

Figure 2:
The long-wavelengths IUE-spectra of the same three FK Comae stars. Note the strong MgII-emission which is found to vary over a timescale of months.

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