CHROMOSPHERIC ACTIVITY IN F- AND G-STARS

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Summary. Chromospheric activity, as seen by the presence of a central K_2 emission in the Ca II K λ 393.4 nm line, is studied in F- and G-stars of all luminosity classes. K_2 equivalent widths have been measured and corresponding absolute K_2 fluxes (power per unit area at the stellar surface) calculated. Large K_2 equivalent widths and thus easily detectable chromospheres occur only for stars later than about F8 but the absolute level of K_2 flux does not significantly change between F0 and K0; *there is no break in chromospheric activity between F- and G-stars.* The apparent break, cited in the past (e.g. Wilson, 1973) is illusory and due to the observational threshold being different for different spectral classes.

90 stars have been observed, covering spectral types F0 to K0. Coudé spectra at dispersions 0.3 or 1.2 nm mm^{-1} were obtained with the plates heavily exposed to show details in the K-line core. To reduce photographic grain noise, the spectra are well widened, typically to 1 mm. Through digital microphotometry, followed by spatial frequency filtering, the plate densities have been converted to intensity profiles using the detailed shape of the characteristic curve of the emulsion. The resulting grain noise even at the lower dispersion typically corresponds to a K_2 emission equivalent width $\simeq 0.05$ pm (1 pm = 10 mÅ) which is less than the solar K_2. On highly widened high-dispersion spectra, the grain noise is again only a fraction of this. The main source of uncertainty in assessing the K_2 emission is now the lack of knowledge of the exact shape of the undisturbed absorption line.

The K_2 equivalent widths were obtained by extrapolating the absorption line profile to the line center and then measuring the emission component as the difference to the observed profile. Conservative estimates were aimed at and only rarely was the absorption line extended below the lowest observed intensity point and then only in cases with an obvious central emission peak. Thus the values below are probably on the low side and will not take into account such possible emission that contributes to a symmetrical and smooth infilling of the K-line. The apparent local 'continuum' was defined as the point of highest intensity between the Ca II H and K lines.

In Figure 1 the K_2 equivalent width is given as a function of spectral class. Late G-giants have the largest equivalent widths and easily the most prominent emission profiles while all stars earlier than F8 have emission <6 pm. A given equivalent width is in addition more difficult to see in earlier-type stars since the background K-line is narrower in wavelength and the emission components are frequently seen only as undulations in the line wings rather than isolated emission peaks in the line bottom. Figure 1 thus shows the apparent cessation of K-line emission as seen on moderate resolution spectrograms for spectral types earlier than about F8. However this gives a misleading impression of the level of chromospheric activity since the equivalent

* Work based on observations made at European Southern Observatory, La Silla, Chile.

Bumba and Kleczek (eds.), Basic Mechanisms of Solar Activity, 469–471.

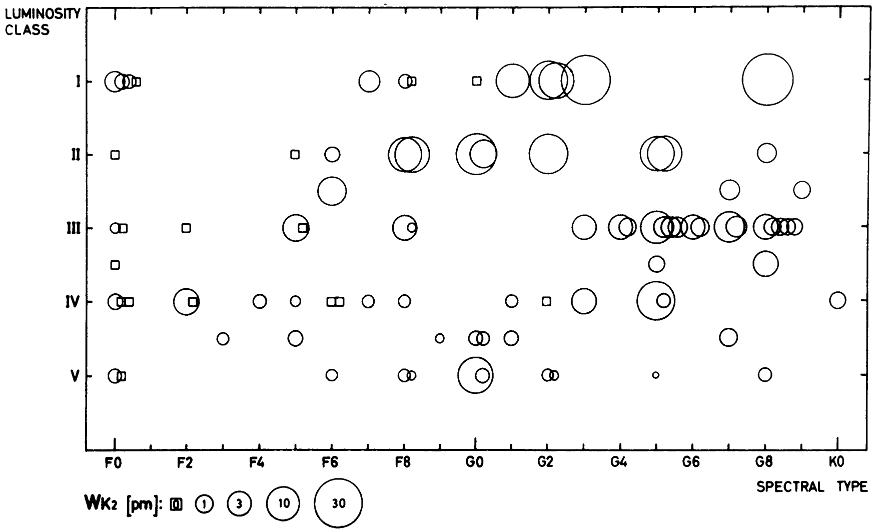

Fig. 1. Ca II K_2 emission equivalent width as function of spectral class. The diameter of a circle is proportional to the cube root of the equivalent width. 1 pm = 10 mÅ.

widths are measured relative to a local continuum whose absolute level is greatly different in different spectral types.

Absolute fluxes were therefore calculated, using standard fluxes given by Lamla (1959) for the smeared-out spectra of different types of stars. The intensity averaged over a 2 nm wavelength interval between the Ca II H and K lines was taken as the value for the local smeared-out spectrum and the absolute K_2 flux then obtained from its equivalent width and knowing the absolute flux per wavelength interval for that spectral type; Figure 2.

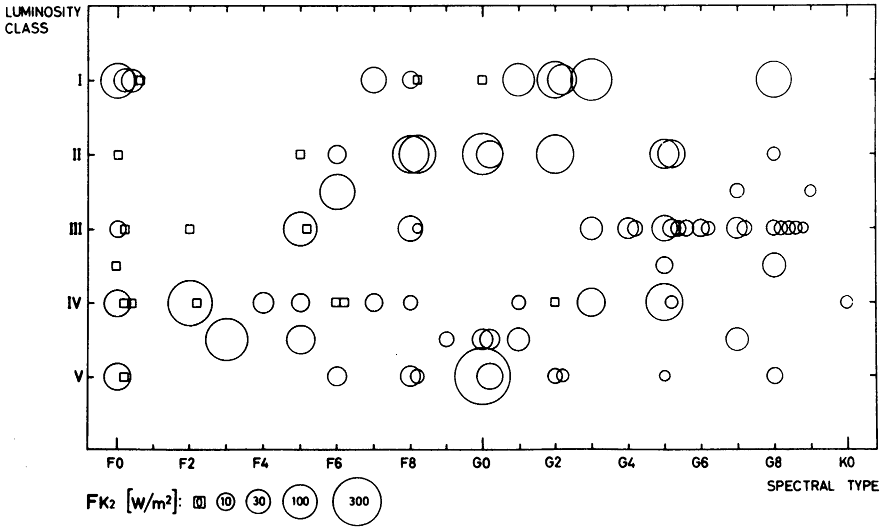

Fig. 2. Ca II K_2 emission flux in absolute units (W m^{-2}) at the stellar surface as function of spectral class.

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Now there are no special differences in the level of K_2 flux to the left and to the right of a vertical line at F8. The previously prominent emission from late G giants dwindles because the absolute surface fluxes of these cool stars are low and the previously modest emission in earlier F-stars becomes more prominent. There is no clear tendency for the K_2 flux to decrease with earlier spectral type and chromospheres should continue beyond F0. It seems that the few F- and A-stars previously reported with K_2 emission mark the rule, not the exception. If one assumes that the amount of K_2 emission is directly connected with the mechanical flux from the convection zone, this is fully consistent with the calculations by de Loore (1970).

References

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