THE CHROMOSPHERES AND CORONAE OF LATE-TYPE MAIN SEQUENCE STARS

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Summary

Low resolution observations of late-type main sequence stars have allowed the measurement of fluxes in a variety of chromospheric and transition region emission lines. The methods of analysing such fluxes in terms of an emission measure (\( \int N_e^2 \, dh \)) distribution with \( T_e \) have been described by Jordan and Brown (1981), extending earlier solar work.

If the electron density can be measured from suitable line ratios then models of the variation of electron temperature and density with height can also be made.

The terms of the energy equation giving radiation losses and net conductive flux can then be calculated and the energy input requirements found. If the line profiles can be measured from high resolution spectra it is possible to compare the energy input required with the non-thermal energy density as a function of height and thus investigate specific heating processes.

So far this full analysis has been made only for Procyon (F5 IV-V), (Brown and Jordan 1981), but data are now becoming available for \( \alpha \) Cen A (G2 V) and \( \alpha \) Cen B (K1 V) (Ayres and Linsky 1980, Ayres et al 1981, 1982) and for \( \zeta \) Boo A (Jordan, Ayres and Brown, in preparation, Hartman et al 1979).

The ultraviolet lines in these stars lead to emission measure distributions which are similar in shape, although ranging over an order of magnitude in absolute value. In the region up to \( \sim 10^8 \) K thermal conduction is negligible and one can conclude that the heating process which balances radiation losses has the same dependence on \( T_e \) in these stars, in this part of the atmosphere.

The X-ray emission observed with rockets and satellites (e.g. Golub et al 1982, Linsky et al 1982) shows a larger spread of flux.

Examination of the density sensitive line ratios shows that the X-ray flux correlates with the transition region pressure. (As yet little is known concerning the precise coronal temperatures).

The general scaling law proposed by Jordan (1980) relates coronal temperature and emission measure, to the transition region pressure and emission measure, but also includes the stellar gravity. Thus \( \alpha \) Cen A, which has a lower pressure and lower gravity than \( \alpha \) Cen B, is predicted to have a lower coronal temperature and X-ray flux, consistent with recent observations with the Einstein satellite. The coronal properties cannot be predicted on the basis of the radiative properties of the chromospheric lines, such as Mg II, alone.

The quantitative results for these stars will be discussed in forthcoming papers.