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THE BEHAVIOUR OF CaII LINES OF GIANTS AND SUPERGIANTS IN THE LIGHT OF STELLAR WINDS

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RESUMO. Foram obtidos no Laboratório Nacional de Astrofísica (LNA) espectros fotográficos das linhas de ressonância H e K do CaII, de trinta e cinco gigantes e supergigantes de tipos K - M.

A intensidade de linha K do CaII varia com a temperatura de forma semelhante às linhas da região de transição e da emissão de raios-X da coroa, indicando que o aquecimento magnético exerce uma certa influência no aquecimento das camadas externas de estrelas de tipos tardios.

ABSTRACT. Coudé IIaO plates of thirty-five southern K-M giants and supergiants were obtained in the H and K lines of CaII using the 1.6 m telescope of the Laboratório Nacional de Astrofísica (LNA, Brazil). CaII K line intensity varies with temperature in a similar way as do transition region lines and coronal X-ray emission. This indicates that magnetic heating plays a certain role in the heating of the outer layers of late-type stars.

Key words: STARS-GIANT — STARS-SPECTRUM VARIABILITY — STARS-SUPERGIANT STARS-WINDS

NTRODUCTION

Analysis of data obtained by the Einstein (soft X-ray) and International Ultraviolet xplorer (λλ1150-3200) satellites, indicated that the late-type stars could be separated in he HR diagram, by a nearly vertical boundary line at (V-R)∿ 0.80, dividing these stars into wo groups according to their atmospheric structure. The dwarfs, giants and some supergiants f class G, which have an atmosphere composed by chromospheres (6×10^3 - 2×10^4 K) - ransition regions (2×10^4 - 2×10^5 K) - coronae (∿ 10^6 K), are found in the left half; iants later than K2III and supergiants later than G5Ib, which would have an outer atmosphere ith extenses chromospheres and no evidence of regions with temperature higher than 10^4 K in he other half (Linsky and Haisch, 1979; Ayres et al., 1981).

Later on, ultraviolet spectra of β Aqr (G2Ib), α Aqr(G0Ib) and β TrA(K4II-III) howed evidences of a third group - the hybrid stars, whose atmospheres present characteristics f the other two groups: ultraviolet lines formed in the transition region (but without soft -ray detection) and circunstellar absorption lines indicative of massive, cool winds Hartmann et al. 1980).

The existence of the hybrid stars shows that dividing lines in the HR diagram are ot so sharp, and may have a certain width.

The mechanism responsible for the existence of the boundary lines in the HR diagram ot yet well known, but the strength and geometry of the magnetic field may play an important ole in the changing atmospheric structure of the stars across the HR diagram (Vaiana and osner, 1978). As the resonance lines H and K of CaII are spacially correlated with the agnetic field in the solar surface (Skumanich et al., 1975), we used the CaII K line as a atmospheric structure tracer" to study the behaviour of this line, and consequently of the agnetic energy, for stars near the coronal and transition boundary lines.

RESULTS AND DISCUSSION

We obtained spectra for K-M giants and supergiants using IIaO plates in the coudé spectrograph of the 1.60 m telescope at Laboratório Nacional de Astrofísica (LNA - Brasópolis/ MG). The data were reduced using a PDS microdensitometer at Observatório Nacional (RJ - Brazil) and the Nice Observatory (France) data treatment programs at Centro de Computação Eletrônica da Universidade de São Paulo (CCE-USP).

To transform the chromospheric K emission equivalent widths (EW(K)) into flux units, we used the expression:

$$F_K/F_* = B(T_{ef}) \quad EW(K)/\sigma T_{ef}^4$$

where $B(T_{ef})$ is the Planck function, and F_K, F_* are K emission and bolometric fluxes.

The results are plotted in figure 1, where two trends can be observed:

a) The K emission flux decrease slowly with temperature for the supergiant stars. The same behaviour was also verified by Linsky et al. (1979).

b) For the giants, the K emission flux decreases sharply for stellar types ∿ K0-K1 (0.80 < (V-R) < 1.00); but for stars with (V-R) > 1.00 no definite tendency could be evidenced from our data.

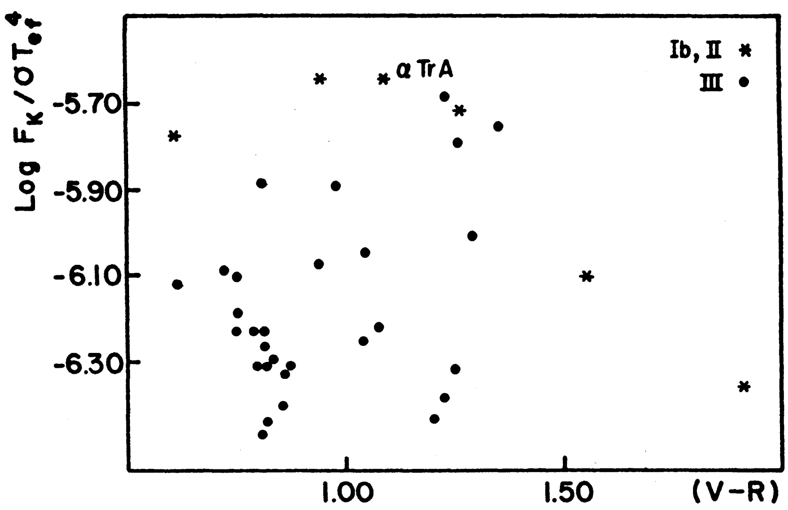

Figure 1 - CaII K emission flux (in units of the bolometric flux) in function of the (V-R) color index.

Consequently, we can say that the net magnetic energy in the stellar surface also decreases with T_{ef} for supergiants and giants with 0.80 > (V-R)> 1.00. On the other hand, for giants later than ∿ K4-K5 the magnetic energy trend is not clear. It suggests two interpretations: a) The magnetic energy plays an important role in the heating of the outer atmosphere (chromosphere - transition region - corona). This would probably imply some kind of process leading to a sharp decrease in the observed F_K for stellar types K0III-K1III; and for giants with (V-R) > 1.00 we may have a magnetic field regenerating process so that the magnetic energy would probably be used to accelerate a stellar wind rather than to heat up the outer atmosphere. Figure 2 shows the ratio between blue (V) and red (R) K emission intensity peaks for some stars in our sample. It can be seen that the transition from V/R > 1 to V/R < 1 occurs about (V-R) ∿ 1.00, indicating also the set up of cool winds in the stellar atmospheres (Stencel, R.E. 1978; Stencel, R.E. and Mullan, D.J. 1980). However, up to now there are no enough data to asses an explanation about these process; or

b) The magnetic energy do not play an important role in atmospheric heating when compared to other types of released stellar energy; however, all intensities decrease with T.

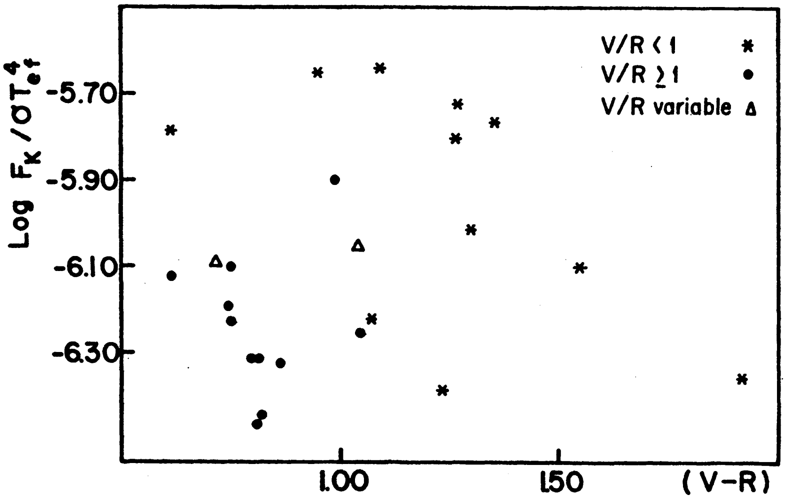

Figure 2 - CaII V/R ratio for some stars of the sample.

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