CHROMOSPHERIC EMISSION AND ROTATION OF MAIN SEQUENCE STARS

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Here we present a quatitative approach to the problem of the chromospheric emission and rotation in main sequence stars based on a consistent analysis of recent published data of stars from F8 to K5. This analysis has been performed using the following physical parameters:

a) total power emission in the CaII K line, L_K;
b) stellar rotation period, P_{rot}, from chromospheric emission variability;
c) stellar ages from lithium abundance.

The obtained results are summarized as follows.

- The K line luminosity, L_K, follows an exponential law with the rotation period (see the Figure), not dependent on the spectral type,

$$\log L_K = 29.02 - P_{rot}/27.02 \qquad (1)$$

- The K line luminosity, L_K of one solar mass stars, follows an exponential decay with the square root of the age

$$\log L_K = -1.485\text{x}10^{-5}\, t^{\frac{1}{2}} + 29.28 \qquad (2)$$

The combiantion of relations (1) and (2) leads to

$$V_{rot} = 1.27\text{x}10^{5}\, t^{-\frac{1}{2}} \qquad (3a)$$

for stars of about one solar mass and age larger than $2.6\text{x}10^{8}$ years. This result compares fairly well with the Soderblom's observed relation (Soderblom 1981)

$$V\sin i = 1.26\text{x}10^{5}\, t^{-\frac{1}{2}} \qquad (3b)$$

- The K line luminosity for stars of the same age follows a power law

P. B. Byrne and M. Rodonò (eds.), Activity in Red-Dwarf Stars, 71–73.

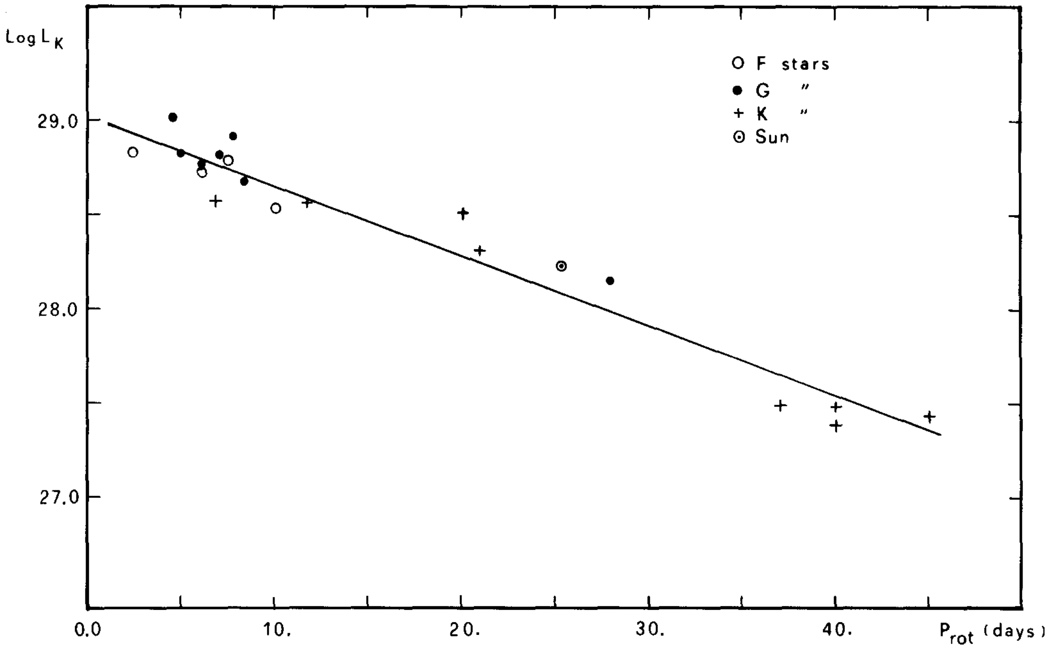

Figure 1. Log L_K versus P_{rot} plot for F-K main sequence stars. The solid line represents a linear fitting for all the stars in our sample, including the Sun.

with the stellar mass

$$\log L_K = 4.97 \log (M/M_\odot) + 28.87 \text{ (Hyades)} \quad (4a)$$

and

$$\log L_K = 5.17 \log (M/M_\odot) + 29.48 \text{ (Pleiades)} \quad (4b)$$

The combiantion of the observed relations (2) and (4) leads to a simple relation for the chromospheric emission of main sequence stars

$$L_K\ (M/M_\odot, t) = L_K\ (1,0)\ (M/M_\odot)^\alpha\ e^{-\beta t^{\frac{1}{2}}} \quad (5)$$

where α and β are real positive coefficients. Further observations are needed to establish if

$$\alpha = \alpha(t) \quad (6a)$$

and

$$\beta = \beta(M/M_\odot) \quad (6b)$$

If α and β are constant, then, relations (1) and (5) lead to

$$P_{rot} = -\alpha' \log(M/M_\odot) + \beta'\ t^{\frac{1}{2}} + \text{const} \quad (7)$$

https://doi.org/10.1017/S0252921100095956 Published online by Cambridge University Press

So the rotation period of main sequence stars would be determined only by their masses and ages. On the other hand this result would have strong implications for rotation at

$t = 0$ (initial angular momentum)

and

$t = t_o$ (angular momentum at the Zero Age Main Sequence)

REFERENCE

Soderblom, D.R.: 1981, Astrophys. J.

https://doi.org/10.1017/S0252921100095956 Published online by Cambridge University Press