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INDICATORS OF SOLAR AND STELLAR ACTIVITY

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Studies of the variations of solar activity levels have received renewed attention in the last years, due to the influence they may have on terrestrial climate. However, direct observations of solar irradiance are only available for the last two cycles. One way to assess how large these variations can be over larger periods, is to study activity in different solar type stars. In this paper we discuss the solar-stellar connection, and present observations done at CASLEO. We discuss which spectral indicators can be used to study activity levels, and compare them with the solar case.

The most extensive database of stellar activity is the one given by the observations at Mount Wilson Observatory, which covers the spectral range with color index $(B-V)$ between 0.4 and 1.4 (Duncan et al. 1991). From this observations, an $S_{\rm MW}$ index is built, defined as the chromospheric H and K Ca II fluxes relative to the photospheric fluxes in two continuum passbands. This index is supposed to be a proxy of the surface magnetism, as in the solar case. These studies have been limited so far to stars covering the spectral range from F to early K, since they are the brightest, and most similar to the Sun. However, the colder K and M stars are of particular interest for two reasons: the most active of these stars present frequent and very large flares and the coolest of them are completely convective.

Our observations were made with a REOSC spectrograph located at the 2.15 m telescope of the Complejo Astronómico El Leoncito (CASLEO), in San Juan, Argentina, in two observing runs in August 2000 and March 2001.The star sample includes 18 calibration stars observed at Mount Wilson, 36 solar type stars and 9 later spectral type stars, classified as flare stars, covering a spectral range between F6V and M5.5V, with color index $(B-V)$ from 0.47 to 1.97. Each of the indexes presented here was calculated as the ratio between the normalized flux at the line center to the average flux in two 20 Å continuum passbands.

First we calibrated our observations with the existing ones. We calculated an $S_{\rm C}$ index from the Ca II lines, and we fit it against $S_{\rm MW}$ for the 18 stars present in both samples, all of them with $(B-V) < 1.15$. We found that $S_{\rm C} \approx 0.25$ is a threshold between the moderately active stars which present the Ca II line cores in emission from the inactive stars which have them in absorption. A similar behavior has been found in the solar case by LaBonte (1986) who found that a value of 0.22 separates the active and quiet regions in the Sun.

However, the indexes based on the Ca II lines are not very useful for the faintest and bluest stars. We constructed an activity index, A, for Hα, more adequate for these stars due to its spectral location, in a similar way to S. We fit it against $S_{\rm C}$ for the solar-like stars with $(B-V) < 1.15$ and for the whole sample, finding that both fits are practically identical, and therefore the same relation between fluxes can be used for the whole sample.

We also studied the Na I D doublet. In the Sun, these are radiation dominated lines, and since the dominant radiation field at this wavelength is photospheric, they are not very sensitive to activity. However, there are solar photometric observations that present a brightening in Na I D_2 images in regions of higher magnetic field. We found that the stars with $(B-V) < 1.15$ show only a weak anticorrelation between this N index and $S_{\rm C}$, while the stars with $(B-V) > 1.15$ have both indexes correlated. This is associated with the fact that, for the most active stars, the D lines become collisionally dominated, and show the central peaks in emission as the Ca lines do for the least active stars. For the least active stars there is a good correlation between N and color, much stronger than with activity. This correlation is lost for the most active stars.

Finally, we calculated a C index from the Ca I 4227 Å line, finding a behavior very similar to the Na lines.

REFERENCES

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