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PHOTOMETRIC STUDY TO UNDERSTAND THE AMBIGUITY BETWEEN ACCRETION AND CHROMOSPHERIC ACTIVITY PRESENT IN LOW-MASS STARS

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RESUMEN

Realizamos un estudio fotométrico de una muestra de estrellas de la pre-secuencia principal y T Tauri en el intervalo espectral G-K y algunas M tempranas, de masas desde 0.5 hasta 3 masas solares, en asociaciones cercanas al Sol (20–200 pc). Medimos el exceso presente en el ultravioleta y vemos que para estrellas de tipo espectral M temprano y K tardías, éste aumenta notablemente. Se presentan dos posibles escenarios para dicho aumento: (1) Actividad cromosférica, debido a que las estrellas presentan núcleo radiativo y convectivo dando lugar a la actividad magnética lo que genera este exceso presente en el continuo y (2) a los procesos de acreción presentes en las estrellas que poseen alrededor de ellas un disco de gas y polvo que es acrecido hacia ellas por medio de las líneas de campo magnético. Debido a la ambigüedad presente en los dos efectos, ya que estos afectan las mismas líneas de emisión, es difícil distinguir cuál de estos procesos está dominando. Nosotros proponemos una cota mínima de 0.22 magnitudes de exceso en la banda U para nuestra muestra y así podemos distinguir cuando se están dando los dos procesos o cuando sólo el de actividad cromosférica, ya que el de acreción tiene sus finales en edades muy tempranas, $\sim$10 millones de años.

ABSTRACT

We conducted a photometric study of a sample of pre-main sequence and TTauri stars in a spectral range between G-K and some early M of masses from 0.5 to 3 $M_{\odot}$, in associations near the Sun (20–200 pc). We measured the excess of the UV band and found that for stars of spectral type early M and late K, the UV band increases considerably. There are two possible scenarios for such an increase: (1) Chromospheric activity, because the stars have radiative and convective cores, giving rise to magnetic activity which generates this excess present in the continuum and (2) the processes of accretion present in stars that have a disk of gas and dust, which they accrete to them by means of the magnetic lines field. Because of the ambiguity in the two effects (since they affect the same emission lines) it is difficult to distinguish which dominates. We propose that an excess of 0.2 magnitudes in the U band for our sample allows us to determine if both processes are at work, or if chromospheric activity dominates, since accretion stops at a very early age, 10 million years.

Key Words: accretion, accretion disks — stars: activity — stars: chromospheres — stars: low-mass — stars: pre-main sequence

The sample of low-mass stars is made up of:

- Lower Centaurus Crux (LCC; 11–12 Myr) & Upper Centaurus Lupus (UCL; 14–15 Myr) subgroups of the OB association Sco-Cen OB (85–215 pc)
- X-ray candidate stars (ROSAT)
- G-M stars of LCC & UCL with $v \sin i$ reported by Mamajek et al. (2002) and some with $v \sin i$ unreported. For comparison we have nearby associations as TW Hya (TWA; 8 Myr), Beta Pictoris Moving Group (BPMG; 11 Myr) Tucana and Horologium (TH; 30 Myr).

We developed a diagram of color indices $(U-V)$ vs. $(B-V)$ for the sample of stars, which was compared to main sequence stars (Figure 1). We observed a color index $(U-V)$ greater than expected, indicating the presence of an excess in the U band. This excess is associated with two processes: accretion and chromospheric activity. To determine which of the two processes (or if both) are dominating in every phase of stellar evolution towards the main sequence, we used two methods that account for the indicators of these processes: (1) Measurements of the equivalent width (EW) of the Hα line (the equivalent widths were taken from Scholz et al. 2007), plotted versus color index $(B-V)$ (Figure 2). (2) The excess in the U band measured from the photometry (Figure 3).

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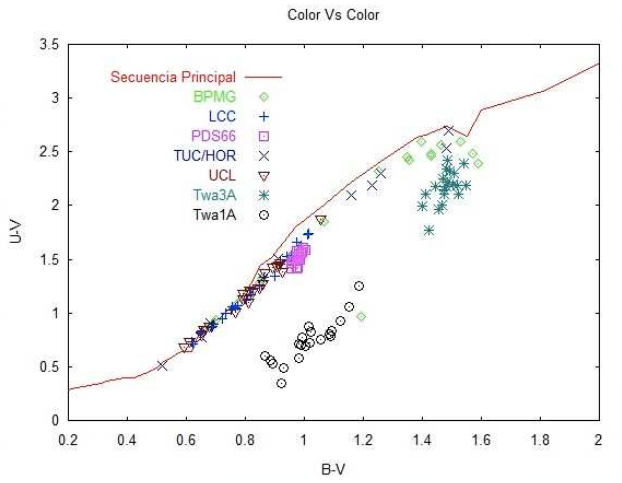

Fig. 1. Diagram of color indices $(U-V)$ vs. $(B-V)$. Photometry is reported in the project SACY(I) (Torres et al. 2006) taken with the high-speed photometer FOTRAP covering a field-of-view of $12'$ at the 0.6 m telescope. More details in Jablonski et al. (1994).

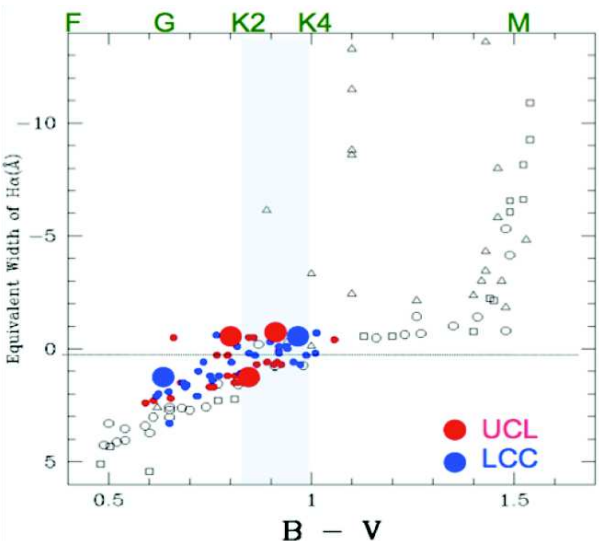

Fig. 2. EW (Hα) vs. color index $(B-V)$. The values above the horizontal line represent the EW (Hα) of measured emission lines.

In Figure 2, we see that the stars located above the horizontal line close to zero, exhibit Hα emission, chromospheric activity and indications of accretion, but as the color index $(B-V)$ increases, the increase in EW is much more noticeable, giving us an idea that these stars are either more chromospherically

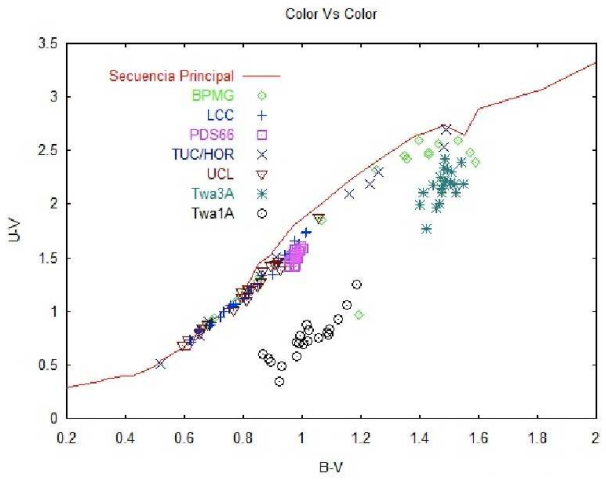

Fig. 3. Diagram of the excesses measured in the band U vs $(B-V)$. The stars with more than 0.2 magnitudes of excess, present the two processes (accretion and chromospheric activity) which are indicators that these are TTauri stars. The rest are stars in the post-TTauri stage.

active or in addition to the chromospheric activity they show signs of accretion of material from a surrounding disk. To distinguish these effects we plot the excess in the U band vs color index $(B-V)$, noting that stars with a large excess in the U band are stars that are accreting material from a surrounding disk, consistent with findings from the EW. This allows us to conclude that stars that have less than 0.2 magnitudes of excess in the U band are stars that have left the T Tauri phase (<10 Myr), are in the post-TTauri stage (>10 Myr) and show only chromospheric activity.

For future work and research, we intend to measure the excess in the U band by using spectrometry and to relate it to the veiling present in the spectra and thus see if hypothesis is validated.

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