Optical follow-up of the stellar content of the XBSS

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Motivation

Since the decrease in stellar X-ray emission occurs mainly during the main sequence phase after the Zero Age Main Sequence phase, flux-limited X-ray surveys detect young stars up to larger distances than old ones. As a result, young stars dominate shallow surveys while old stars are dominant in deep, high-latitude surveys due to the lower scale height of young stars. We use this property of shallow surveys to detect young stars in the solar neighbourhood. In a previous work (López-Santiago et al. 2007) we studied general X-ray properties of the XMM-Newton Bright Serendipitous (XBSS) an detected a population of coronal sources with characteristics of pre-main sequence stars. Then, we conducted a high resolution spectroscopic survey to confirm the young nature of those stars. We also investigated their spatial distribution with the aim of looking for any preference in their location in the sky. In particular, we searched for any correlation of these stars with well-known young stellar associations.

Results

We determined new spectral types, luminosity classes, equivalent width of lithium and several chromospheric lines, and binarity for the stars in our sample. From the study of their spectroscopic properties we found that:

1. Some of the X-ray sources are indeed RS CVn systems. This result is supported by the detection of variation in their radial velocity with time, their luminosity class and levels of chromospheric activity (see Fig. 1). Other binaries are also detected but they show characteristics of young stars (BY Dra type systems).
2. The sample contains some very young stars. Their young nature was confirmed through the lithium line (λ6708 Å) strength and the presence of chromospheric emission lines in their spectrum (see Figs. 3 and 4).
3. Of the nine stars with lithium abundance higher than or similar to the Pleiades members (see Fig. 3), at least three are isolated T Tauri stars and other two are very young M stars. The remainder are located inside or close to the boundaries of well-known young stellar associations (see Fig. 2).

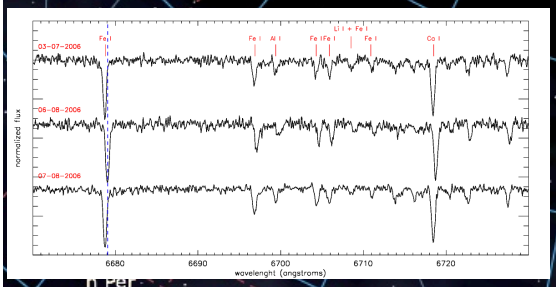

Fig. 1. High-resolution optical spectra of the source XBS J005822.9-274016, an RS CVn system with spectral type K0/1 and luminosity class IV. Shifts in the position of the spectral lines for different days are clearly detected (see dashed blue line). Some strong absorption lines are plotted. The observations were done with FEROS at the ESO/2.2m telescope of La Silla (Chile).

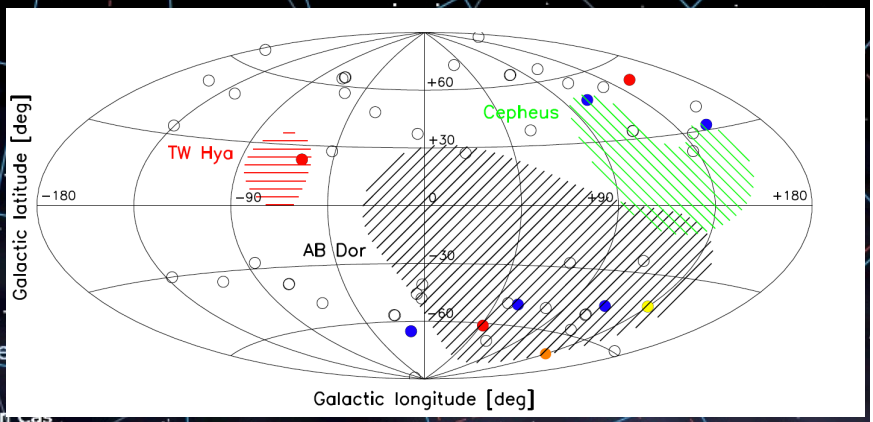

Fig. 2. Galactic distribution of the stars in the XBSS. Dots are stars with large EW(Li I) (higher than the Pleiades members). Striped areas mark the regions in which the young associations and moving groups AB Dor, Cepheus and TW Hya are located. Dots are colour coded depending on their spectral type: blue for F stars, yellow for G stars, orange for K stars and red for M stars.

Conclusions

The results of the optical follow-up of the XBSS suggest that young stars in the observations are related to the presence of the young stellar associations and moving groups in the solar vicinity. Many of the young stellar associations are related to the pass of the Scorpius-Centaurus-Lupus molecular complex close to the solar neighbourhood and are located at the Southern Hemisphere. The young stars in our sample have ages ranging from approximately 8 to 100 Myr and are spread all over the sky, but inside the boundaries of young moving groups (Fig. 2).

Our results confirm that shallow X-ray surveys are a powerful tool to detect young stars, including pre-main sequence stars, in the solar vicinity.

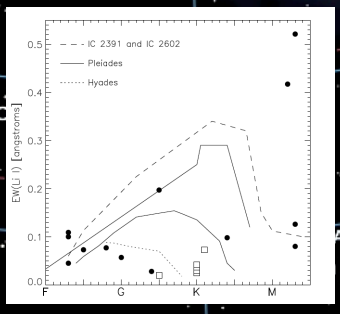

Fig. 3. Measured equivalent widths in the Li I λ6707.8 Å line. Squares are stars with luminosity class IV or III. Dots are dwarfs.

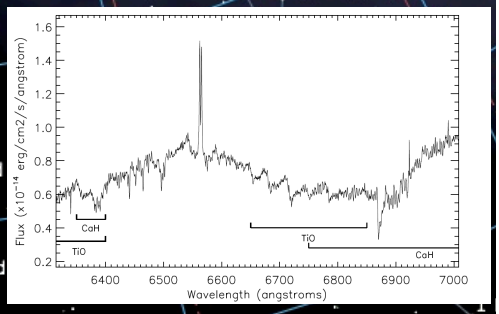

Fig. 4. Part of the optical spectrum of the source XBS J021830.0-045514, an M1/2 dwarf, binary system with Hα in emission for both companions. This observation was performed with DOLORES at the TNG (La Palma, Spain). TiO and CaH bands in the spectral region are indicated. The double peak emission line is Hα.