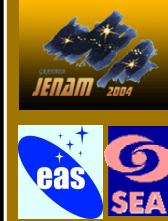




Chromospheric activity variations in late-type stars members of young stellar kinematic groups

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Abstract

During the last years (1999 - 2004), our group has been studying the spectroscopic properties of a large sample of stars members of the young stellar kinematic groups Local Association (20-150 Myrs), IC 2391 supercluster (35 Myrs), Ursa Major group (Sirius supercluster, 300 Myrs), Hyades supercluster (600 Myrs) and Castor moving group (200 Myrs).

The high resolution spectroscopic observations used in this study allow us to better determine radial velocity, chromospheric activity and lithium abundance of each object.

The chromospheric activity level of these stars has been analysed using the information provided by several optical spectroscopic features (from the Ca II H & K to the infrared triplet lines).

We present here our results on chromospheric activity variability of several of these active stars. We analyse the possible rotational modulation, long term variability, as well as flare-like events.

Magnetic activity variations

Some late-type active stars show variations in their magnetic activity with periods of several years, similar to the well-known 22-years magnetic period of the Sun. In addition, they use to show variations of some days due to the stellar rotation and the change in the configuration of active regions, such as flare and microflare events.

One of the most powerful tools in the determination of the magnetic activity is the high-resolution spectroscopic observation of all the chromospheric lines in the optical range, from Ca II H & K to the infrared triplet (IRT), including the Balmer lines H α , H β , H γ , H δ and H ϵ , the Na I doublet D $_1$ & D $_2$, and the He I D $_3$ line. Their study during several days and in different epochs show differences in the structure of the active regions of these stars.

Here we present some results on magnetic variation of several active stars from our spectroscopic survey of young active late-type stars members of young stellar kinematic groups (Montes et al. 2001a), showing some kind of variability in their activity in different epochs, as well as during the same observing run.

Chromospheric variability

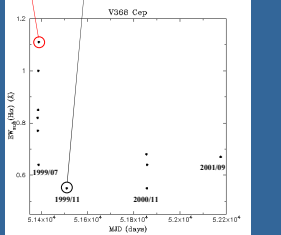
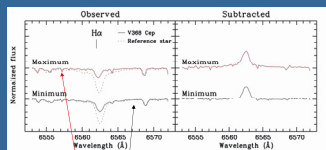


Fig. 1: a) Spectra of V368 Cep in a maximum and a minimum of emission; b) Variation in EW(H α) during different epochs (1999-2001).

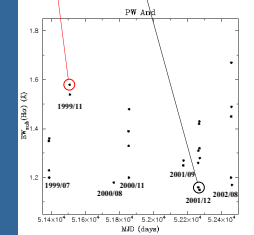
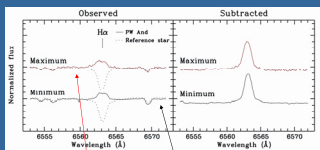


Fig. 2: a) Spectra of PW And in a maximum and a minimum of emission; b) Variation in EW(H α) during different epochs (1999, 2002).

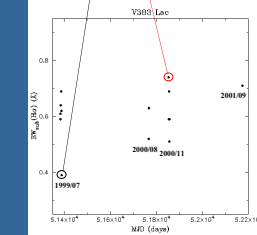
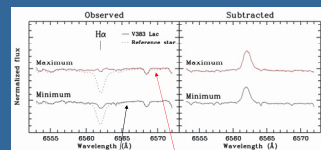
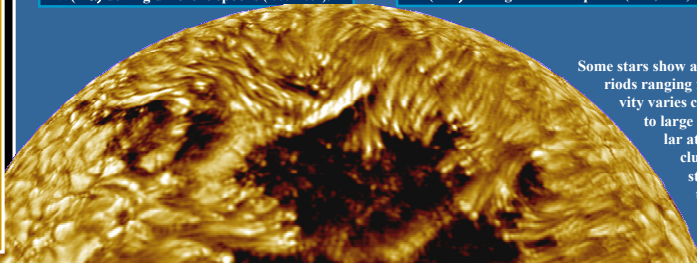


Fig. 3: a) Spectra of V383 Lac in a maximum and a minimum of emission; b) Variation in EW(H α) during different epochs (1999-2001).



Some stars show active cycles similar to the observed in the Sun with periods ranging from several to dozens of years. In addition, their activity varies continuously during the cycle. These variations are due to large active regions appearing and disappearing in the stellar atmosphere. The study of these phenomena can give the clue for understanding the magnetic activity in solar-like stars. In this section we show some results obtained with stars selected from our spectroscopic survey of late-type stars members of young stellar moving groups.

Flare events

Several K dwarfs of our spectroscopic survey show flare events similar to those observed in UV Cet type stars (Montes et al. 2004). During the flare maximum, a broad component appears in H α while the Na I D $_1$ & D $_2$ lines are shown filled-in. In addition, the He I D $_3$ line become visible in emission. The centre position of the broad component varies during the different phases of the event, until it disappears (see Figs. 5 and 7).

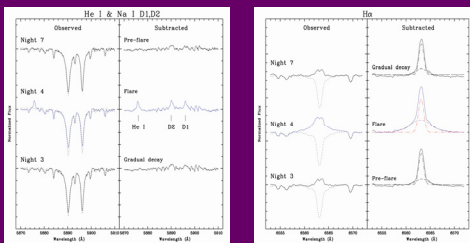


Fig. 4 & 5: Na I D $_1$ & D $_2$, He I D $_3$ and H α during a flare event in PW And.

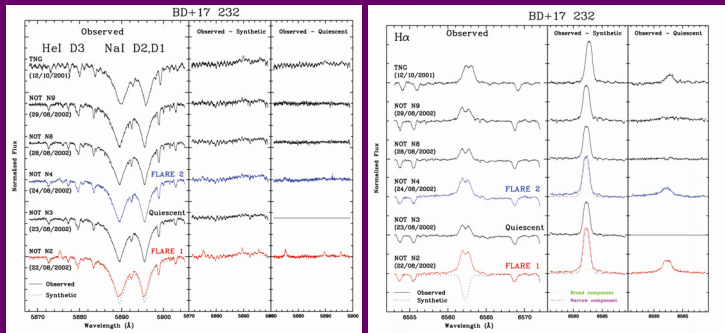


Fig. 6 & 7: Same as Fig. 4 & 5 for BD+17 232. Two consecutive flare events were observed during this run.

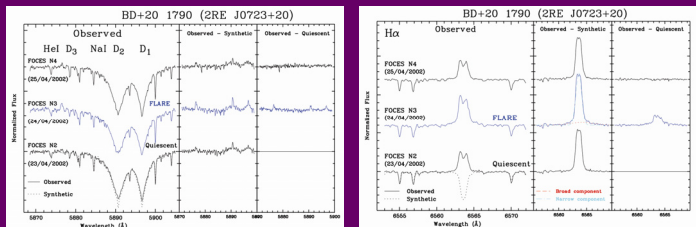


Fig. 8 & 9: Na I D $_1$ & D $_2$, He I D $_3$ and H α during a flare event in BD+20 1790.

Rotational modulation

Figure 10: Rotational modulation of the bisector of the cross-correlation function (CCF) of the K2-dwarf PW And with a radial velocity standard star, due to the presence of cool dark spots moving across the stellar disk. Two colours are used for two different epochs (Blue: July 1999; Orange: December 2001). The rotational period determined is 1.755 days. The similarity between both epochs suggest the presence of active longitudes in which active regions are appearing and disappearing continuously (López-Santiago et al. 2003). The CCF technique is one of the best methods to determine variations due to the presence of asymmetries in the line profiles of stars with rotational periods ranging from 10 to 30 km s $^{-1}$.

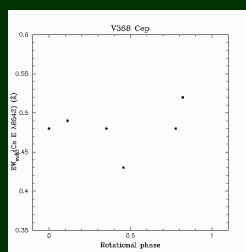
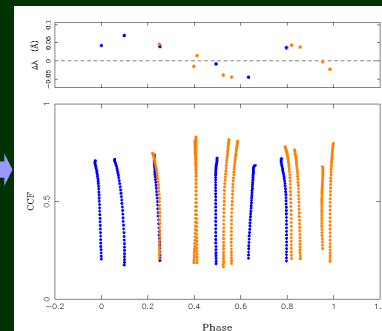


Fig. 11: Modulation of the H α line of the active late-type star RE J1507+76. Each one of the peaks of the auto-absorption profile of the H α line is enhanced alternatively with a period of two days. These effect may be due to the presence of some extended material moving across the stellar disk.

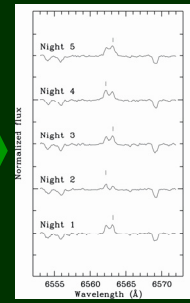


Fig. 12: Variation of the equivalent width (EW) of the Ca II infrared triplet line λ 8542 Å of the dK1 star V368 Cep during one observing run. Variation in the emission of the Ca II lines is related to the presence of plage-like material in the stellar chromosphere (Montes et al. 2001b).

Conclusions

Several stars of our spectroscopic survey of late-type stars members of young stellar kinematic groups show magnetic activity variations in different epochs. In addition, some of them show rotational modulation due to the presence of cool dark spots moving across the stellar disk, and even flare events.

References

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