Cool stars in the solar neighborhood. Preparatory activities for the Darwin mission

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Summary. We are carrying out a systematic analysis or the spectroscopic properties of nearby ($d < 25$ pc) FGK stars aiming to widen the knowledge of the stellar formation history in the solar neighborhood. The stars already observed are included in the Darwin catalogue (ESA mission to detect and characterize Earth-like exoplanets). In this contribution we present a preliminary analysis of the high resolution echelle spectra obtained in Calar Alto and La Palma observatories. Both the spectroscopic observations and the physical parameters obtained will be deposited in DAMA (DArwin archive MAdrid), a Virtual Observatory tool that is being developed.

1 Scientific Context and Observations

The study of the stellar population in the solar neighborhood possess an unquestionable interest for a wide range of investigations dealing with the overall properties of the Galaxy, but it also has an intrinsic astrophysical value: the precise characterization of the fundamental stellar parameters. Nearby cool stars like the Sun (FGK spectral types) are very useful to understand the structure and evolution of the Galaxy. These stars have intrinsically narrow absorption lines that allow to determine radial velocities with high precision. Combining them with Hipparcos accurate astrometry makes possible to define a volume limited sample and analyze their kinematics. In addition these stars constitute the natural places to look for the presence of extra-solar planets and planetary systems. The knowledge of the physical properties of the stars and of their immediate environment are essential for the success of future space missions, like Darwin. Here we present the results obtained so far of

our ongoing long-term resolution spectroscopic study of the FGK stars in the solar neighborhood.

Spectroscopic observations of 136 stars were obtained during four observing runs form 2005-2006. In two of them we usted the FOCES spectrograph attached to the 2.2 m telescope at the Calar Alto Observatory. The spectral range covers from Ca II H&K (3933, 3968Å) to Ca II IRT (8498, 8542, 8662Å). The spectral resolution in this case varies from 0.08 to 0.35Å. In the other two observing runs the spectrograph SARG was used in the Telescopio Nazionale Galileo (3.56 m) in La Palma Observatory. The spectral range is shorter in this case (4960-10110Å) and the resolution varies from 0.08 to 0.17Å.

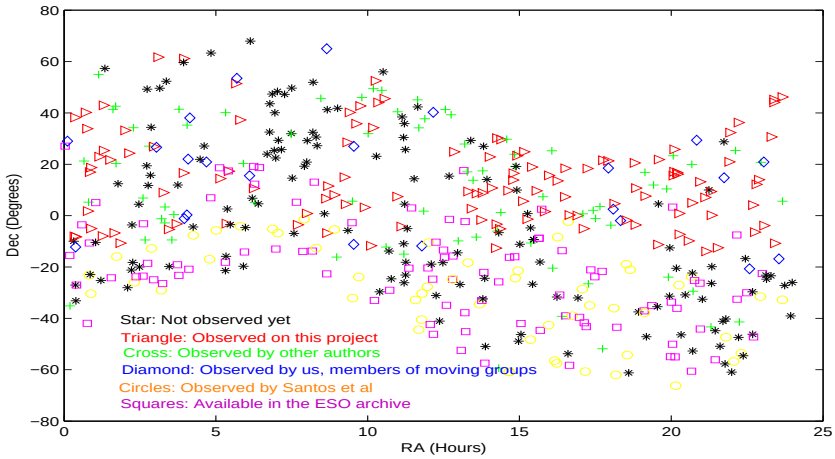

Fig. 1. Spatial distribution in equatorial coordinates of the Darwin stars. Stars observed by us, within the global scope of these project, as well us, stars observed by other groups and stars includes in the ESO archives, are indicated by different symbols

2 Chromospheric Activity, Stellar Clasification & Age

Echelle spectra allow us to study the behaviour of the different optical chromospheric activity indicators from the Ca II H&K to the Ca II IRT lines formed at different atmospheric heights. The chromospheric contribution in these features has been determined using the spectral subtraction technique (see [3, 4, 5])

Although most of our targets have already a spectral type assigned, in many cases, this type is not reliable and must be revised. One of our aims is therefore to establish spectroscopic criteria to classify correctly our sample. In order to achieve this goal, we follow the procedure by Montes et al. (this

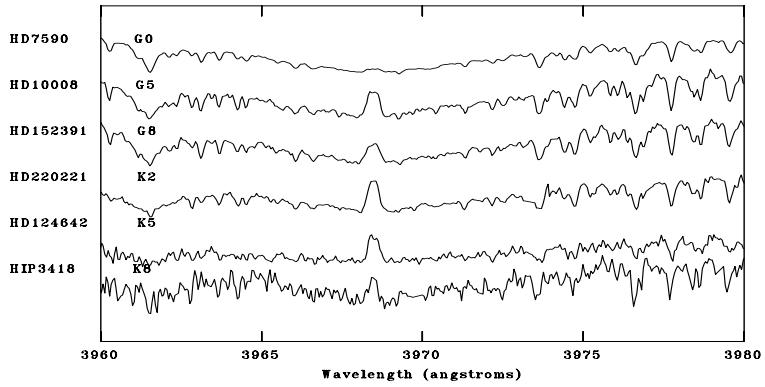

Fig. 2. Evolution of activity with the Spectral Type for the Ca II H line

proceedings): to establish relationships between the equivalent width (EW) of same lines and EW ratios with the temperature (color index). On the other hand, it is well known that the resonance doublet of Li I at 6707.8Å is an important diagnostic of age in late-type stars. At this spectral resolution the observed stars the Li I line is blended with the nearby Fe I 6707.41Å line. We have corrected the total measured EW(Li I+Fe I), by subtracting the EW of Fe I calculated from the empirical relationship with $(B-V)$ given by [10]. In order to obtain an estimate of the ages of our stars we compare their EW(Li I) with those of stars in well known youn open clusters of different age.

3 Rotation ($v \sin i$), and Kinematics

Rotational velocities, can be written as follows (see [7] and references therein): $v \sin i = \mathrm{A}\sqrt{\sigma_{obs}^2 - \sigma_0^2}$ where A is the coupling constat. We calculate A, using eight slowly rotating stars. Each spectra was broadened using the program STARMOD between $v \sin i = 1$ km/s up to 50 km/s and the respective CCF was calculated. A was found by fitting the relation ($v \sin i$) vs σ_{obs}. We obtained the main value $\langle A \rangle = 0.56 \pm 0.04$. It is well known that σ_0 is a function of all the broadening mechanism, except rotation ([2]). Since the broadening mechanisms are a function of the temperature and gravity, we may expect a dependence of σ_0 with the temperature. To determinate this dependence we use synthetic spectra with no rotational velocity computed using the ATLAS9 code by Kurucz ([1]) adapted to work under linux platform by Sbordone ([8], [9]).

Heliocentric radial velocities have been determined by using the cross-correlation technique. The spectra of the program stars were cross-correlated order by order, using the routine FXCOR in IRAF. The orders including chromospheric features and prominent telluric lines have been excluded when determining the mean velocity. Uncertainties in the derived velocities are around

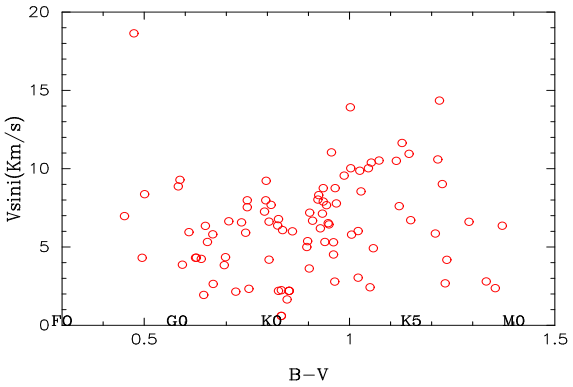

Fig. 3. Relation between the obtained $v \sin i$ and the color index $B - V$ for the observed stars

1-2 km/s. We have used these radial velocities together with precise measurements of proper motions and parallaxes taken form Hipparcos and Thycho-2 Catalogs, to calculate Galactic space-velocity components (U, V, W). The (U, V) and (W, V) planes (Boettlinger Diagram) will be used to analyse the membership of these stars to different moving groups (see [6]).

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