

# High resolution spectroscopic analysis of cool stars

## possible members of the AB Doradus moving group.



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D. Montes<sup>1</sup>, J. López-Santiago<sup>1,2</sup>, I. Crespo-Chacón<sup>1</sup>,  
R.M. Martínez-Arnáiz<sup>1</sup>, J. Maldonado<sup>1,3</sup>

<sup>1</sup>Universidad Complutense de Madrid, Dpt. de Astrofísica, Facultad C.C. Físicas, Madrid, Spain, dmg@astrax.fis.ucm.es,

<sup>2</sup>INAF - Osservatorio Astronomico di Palermo, OAPA, Palermo, Italy,

<sup>3</sup>Universidad Autónoma de Madrid, Departamento de Física Teórica C-XI, Facultad de Ciencias, Spain.



### Abstract

In this contribution we present a detailed spectroscopic analysis of several late-type stars possible members of the nearby young moving group AB Doradus. We have used high resolution echelle spectroscopic observations taken with the FEROS spectrograph at the 2.2 m telescope from ESO. We have determined precise radial and rotational velocities, the chromospheric activity level using the information provided for several optical spectroscopic features (from the Ca II H & K to Ca II IRT lines), and the Li I 6707.8 Å line equivalent width (EW). With all this information we have added new constraints to the membership of these stars by applying kinematic criteria (position of the stars in the velocity space (U, V, W), deviation of the proper motion of the star from the convergent point and comparison between the observed and calculated radial velocities), as well as age-dating methods, such as the chromospheric activity level and the comparison of the EW of the lithium line with that obtained for well-known clusters. An additional estimation of the age has been obtained from isochrone fitting on the color-magnitude diagrams.

### Observations

The spectroscopic observations (high resolution echelle spectra) of these stars were obtained during one observing run from 18 to 22 February 2005 using the 2.2 m telescope at the European Southern Observatory, ESO (La Silla, Chile). We have used the FEROS (Fiber-fed Extended Range Optical Spectrograph) linked to the Cassegrain focus of the 2.2m telescope, in unique fiber modus, with CCD (2048x4096, 0.15 μm/pixel). This configuration give a resolution of 48000 and a spectral range from 3500 to 9000 Å, from Ca II H & K (3933, 3968 Å) to Ca II IRT (8498, 8542, 8662 Å) lines, in a total of 39 orders.

Spectra of possible member of the AB Dor moving group has been taken during the 5 nights of observations. Reference stars of similar spectral type and radial velocity standard stars have also been observed with the same configuration.

### AB Doradus Moving Group

In recent years, a series of young stellar kinematic groups of late-type stars with similar space motion and ages ranging from 8 to 50 Myr (see Zuckerman & Song 2004 and references therein) has been discovered in our neighborhood: the TW Hya, β Pic, AB Dor, eta Cha, e Cha, Tucana, and Horologium associations. In Galactic velocity space, they are situated inside the boundaries of the Local Association (see Fig. 1), a mixture of young stellar complexes—OB and T-associations—and clusters with different ages (Eggen 1975, 1983a, 1983b; Montes et al. 2001).

Very recently, Zuckerman et al. (2004) have identified a large group of stars with the same space motion as the well-known young K-dwarf AB Dor (d 15 pc), a quadruple system (Close et al. 2005; Guirado et al. 2006) made up of three late-type stars—AB Dor A (HD 36705), AB Dor Ba, and AB Dor Bb—and a very low mass companion that has recently been object of discussion because of the discrepancy between its dynamical mass and that predicted by evolutionary models (Close et al. 2005). All the stars listed in Table 1 of Zuckerman et al. (2004) are situated inside the Local Association (see Fig. 1) near the boundaries of the young disk stellar population (Eggen 1984), and each has at least one indicator of youth. Taking the intensity of the H $\alpha$  emission line of these stars and the position in a V - Ks diagram of three M-type members of the MG into account, they estimate an age of 50 ± 10 Myr for the AB Dor MG. Very recently, Luhman et al. (2005) and Luhman & Potter (2006) have shown that the components of AB Dor should have an age of 75–150 Myr based on a comparison of both their position in the MK versus V - Ks diagram with respect to the Pleiades and IC 2391 clusters and the EW(Li I) of AB Dor A with that of rapidly rotating K dwarfs in the Pleiades. Moreover, with an age of 100 Myr the discrepancy between observations and models for the very low mass companion (AB Dor C) would disappear (e.g., Close et al. 2005). Taking this into account, they propose an age range of 75–150 Myr for all the MG.

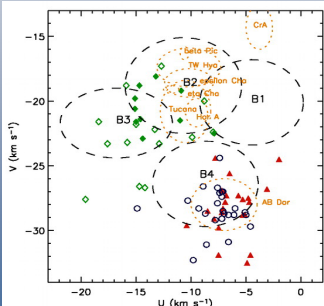


Fig. 1: Position in the (U, V)-plane of the stars analysed by López Santiago et al. (2006) and young stellar associations. Filled diamonds show Hercules-Lyra members, open diamonds show nonmembers of Hercules-Lyra or stars with doubtful classification, triangles show AB Dor MG, and circles show other Local Association members (members of subgroup B4).

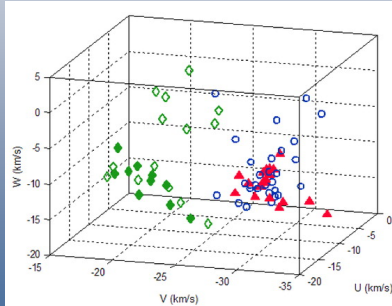


Fig. 2: Position in three-dimensional velocity space of the stars in Fig. 1. Candidates of Hercules-Lyra with values of W different from those of the rest of the group are clearly distinguishable.

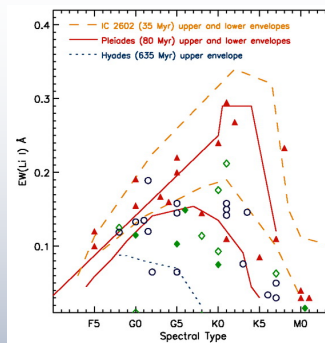


Fig. 3: Equivalent width of the Li I line at 6707.8 Å as a function of spectral type for the stars in Table 1, compared with the envelopes of well-known stellar clusters. Symbols are as in Fig. 1.

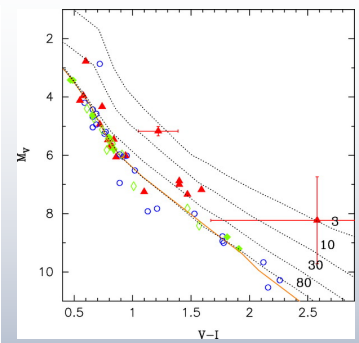


Fig. 4: Plot of MV vs. V - I for the stars of the Hercules-Lyra Association, AB Dor MG, and Local Association subgroup B4. Symbols are as in Fig. 1. The member of AB Dor MG situated under the ZAMS is LO Peg, the photometry of which is probably affected by dark-spot-type features. Isochrones of 3, 10, 30, and 80 Myr from Sess et al. (2000) are plotted, as well as the ZAMS (solid line).

We have added 13 stars to the initial sample of Zuckerman et al. (2004), (see López-Santiago et al. 2006) from our catalog of late-type members of young stellar kinematic groups (Montes et al. 2001). From our detailed analysis of this moving group (López-Santiago et al. 2006) we have concluded that the members of AB Dor MG are situated at a mean distance of 30 pc and show lithium abundances typical of stars with 30–50 Myr (Fig. 3), which is in agreement with their position in the MV versus V - I diagram (Fig. 4); finally, a set of stars with EW(Li I) and positions in the CMD compatible with an age of 80–120 Myr are mixed with Hercules-Lyra and AB Dor MG, and have been classified as other members of the Local Association B4 subgroup.

Here we present the results from new high resolution spectroscopic observations (see Figs. 5, 6, 7) of some of the possible members.

### References:

See López-Santiago J., Montes D., Crespo-Chacón I., Fernández-Figueroa M.J. 2006, ApJ, 643, 1160, and references therein

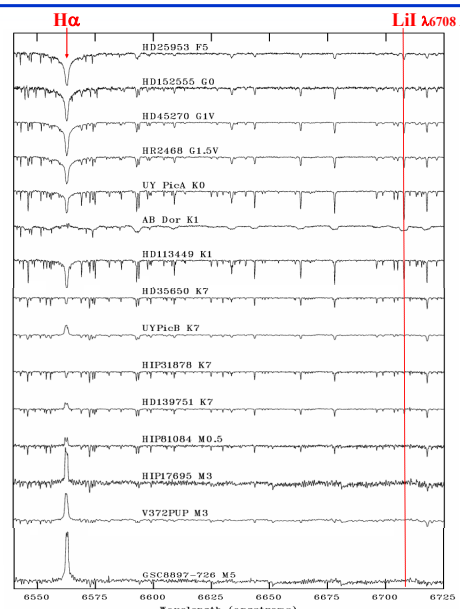


Fig. 5: High resolution spectra of possible members of the AB Doradus moving group in the H $\alpha$  and Li I 6708 Å line region. Note the intense H $\alpha$  emission of some of the stars (some of them also have the other Balmer lines in emission).

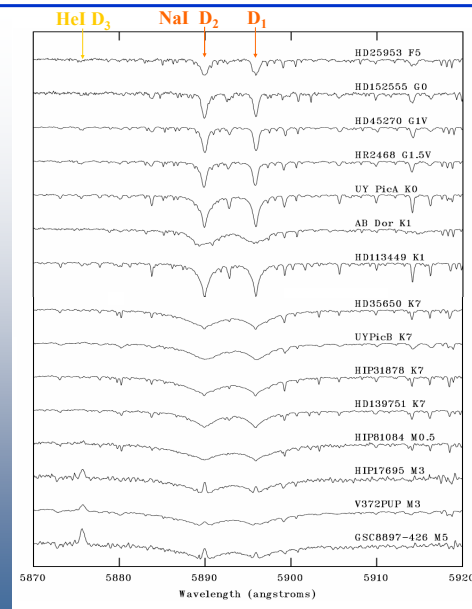


Fig. 6: High resolution spectra of possible members of the AB Doradus moving group in the NaI D<sub>2</sub>, D<sub>1</sub>, and HeI D<sub>3</sub> line region. Note the emission in the HeI D<sub>3</sub> line in the more active stars.

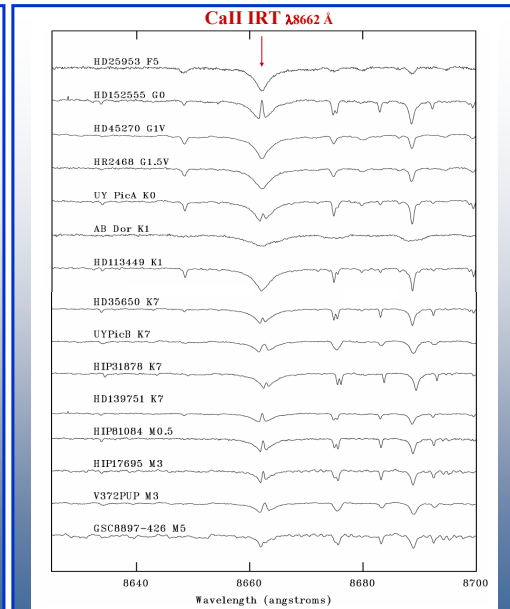


Fig. 7: High resolution spectra of possible members of the AB Doradus moving group in the CaII IRT 8662 Å line region. Note the emission reversal in the more active stars.