Towards the characterization of the Darwin Stars

J. Maldonado[1,2], R.M. Martínez-Arnáiz[2], D. Montes[2], C. Eiroa[1], B. Montesinos[3,4], I. Ribas[5] & E. Solano[4]

[1] Universidad Autónoma de Madrid, Dpt. De Física Teórica C-XI, Facultad de Ciencias, Cantoblanco, Madrid, Spain. E-mail: jesus.maldonado@uam.es
[2] Universidad Complutense de Madrid, Dpt. De Astrofísica, Facultad C.C. Físicas, Madrid, Spain
[3] Instituto de Astrofísica de Andalucía, CSIC, Granada, Spain.
[4] Laboratorio de Astrofísica Espacial y Física Fundamental LAEFF, INTA, Madrid, Spain.
[5] Institut de Ciències de l'Espai, CSIC, Universidad Autónoma de Barcelona, Barcelona, Spain.

4th TPF/Darwin Workshop

Abstract

The ESA mission **Darwin** will search for the presence of Earth-like planets orbiting nearby stars, study the planet atmospheres, carry out comparative planetology, and analyze potential spectroscopic signatures of life. A deep knowledge of the Darwin stars and of their environment is required to achieve these objectives. Existing data in public archives do not allow us to characterize in detail the whole sample of stars to the level required by Darwin scientific objectives. We have started a high resolution spectroscopic observational program aiming to a complete characterization of the Darwin stars. Up to now more than 100 Darwin stars have been observed. In this contribution we present a preliminary analysis of the kinematics and spatial velocities of these stars, as well as their plausible adscription to young, nearby Stellar Kinematics Groups.

Scientific Context: Precursor Science for Darwin

Darwin's success depends on an extremely careful selection of the stellar targets. Since the existing data fulfil Darwin requirements, astrophysical information acquired through an observational roadmap is fundamental to carry out such selection. Preparatory observations should focuss on aspects like:

✓ ***Host stars :***

Fundamental stellar parameters (temperature, luminosity, radius, rotation, age, distance, radial velocity, proper motions ...)

Photometric stellar behaviour and variability.

Chromospheric activity and flares, magnetic fields and stellar winds.

✓ ***Stellar environments :***

Exo-zodiacal disk and Kuiper belts.

Physical membership in stellar associations.

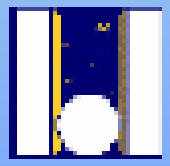
Projected field, angular distance and proper motions.

Observations + Results

We have started a high resolution spectroscopic observational program in order to characterize the Darwin stars. Our main goals are: a) to determine good spectral types and luminosity classes; b) to analyze the stars' kinematics; c) to estimate accurate rotational velocities; d) to quantify the level of chromospheric activity; e) to estimate stellar ages.

Spectroscopic observations (high resolution echelle spectra) of 110 stars were obtained during 4 observing runs in 2005 and 2006. The FOCES spectrograph at the 2.2 m telescope of the Calar Alto Observatory was used in two observing runs.The spectral range covers from Ca II H & K (3933, 3968 Å) to Ca II IRT (8498, 8542, 8662 Å); the spectral resolution ranges from 0.08 to 0.35 Å. In the other two observing runs the SARG spectrograph at the Telescopio Nazionale Galileo (3.56m) in La Palma Observatory was used. The spectral range is shorter in this case (4960-10110 Å) and the resolution varies from 0.08 to 0.17 Å.

- **Calar Alto** 2.2m-FOCES 6 nights (23 - 28 Jul 2005) 76 stars
- **Calar Alto** 2.2m-FOCES 9 nights (8 - 16 Jan 2006) 29 stars



- **La Palma** TNG-SARG 4 nights (11- 14 Nov 2005) 0 stars (Bad wheater)
- **La Palma** TNG-SARG 2 half nights (18 - 19 Feb 2006) 15 stars

Another 6 nights have been awared (Dec 2006) at Calar Alto, and 3 nights at La Palma (Jan 2007) We hope to observe at least more 100 stars.

Up to now, we have obtained spectra of 110 Darwin stars for which, to our knowledge, no previous high resolution spectra are available in public archives. Figure 1 plots the spatial distribution of the observed stars. All spectra have been reduced and data are being analysed to estimate the fundamental parameters of the stars (see also poster at the Cool Stars 14th meeting by Martínez-Arnáiz et al.,). Here we restrict ourselves to present preliminary results concerning the spatial velocities of the observed stars which can be used to estimate stellar ages via the adscription to some young stellar kinematic groups (SKGs).

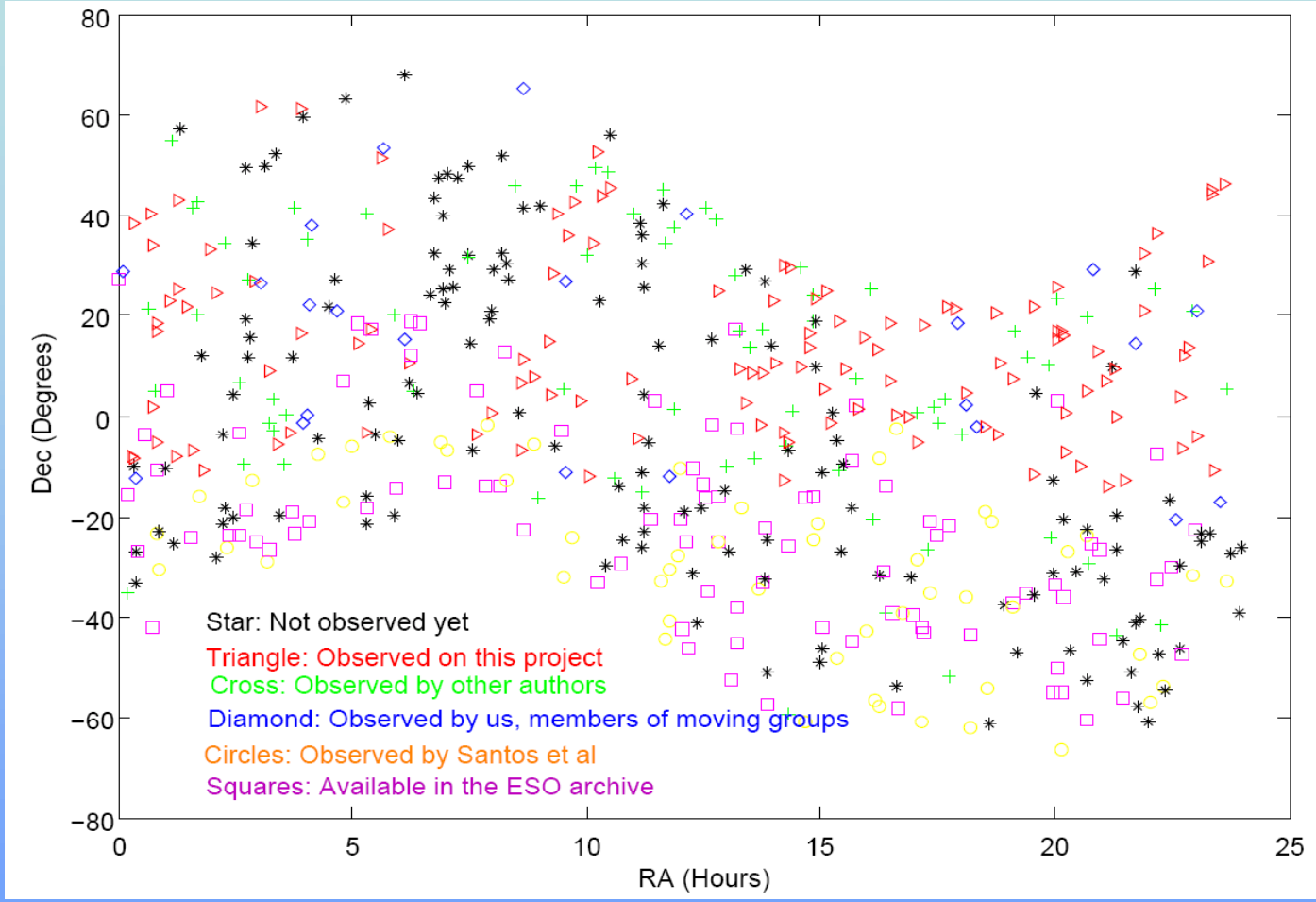


Fig. 1 Spatial distribution (in equatorial coordinates) of the Darwin stars. Stars observed by us as well as stars observed by other groups and stars includes in the ESO archives, are indicated by different symbols.

Spatial Velocities + Age estimates

The age of stars, although not a primary constraint for the presence of Earth-like planets, largely influences their atmospheres and consequently their habitability. The determination of the stellar galactic spatial velocities provide an useful method to estimate stellar ages via the adscription of the stars to different young stellar kinematic groups (SKGs) and to determine the galactic population (thick/thin disk/halo) of the stars (Zuckerman & Song, 2004).

Heliocentric radial velocities have been determined by using the cross-correlation technique. Uncertainties in the derived velocities are around 1-2 km/s. We have used these radial velocities together with precise measurements of proper motions and parallaxes taken from Hipparcos and Tycho-2 catalogues to calculate the galactic space-velocity components (U,V,W) in a right-handed coordinated system (positive in the direction of the Galactic center, Galactic rotation, and the North Galactic Pole, respectively). The (U,V) and (W,V) planes (Boettlinger Diagrams) are used to analyse the membership of stars in different SKGs (Montes et al., 2001). Figure 2 plot the Boettlinger Diagram of the already observed stars. Five stars are new identifications with possible membership to SKGs.

HIP	HD	Kinematic Group	Age of the SKG (Myr)
3979	4915	Local Association	20-150
69526	124642	Hyades Supercluster	600
114886	219538	Hyades Supercluster	600
115331	220182	Hades Supercluster	600
115341	220221	Local Association	20-150

Table 1. New possible members of SKGs identified in this work.

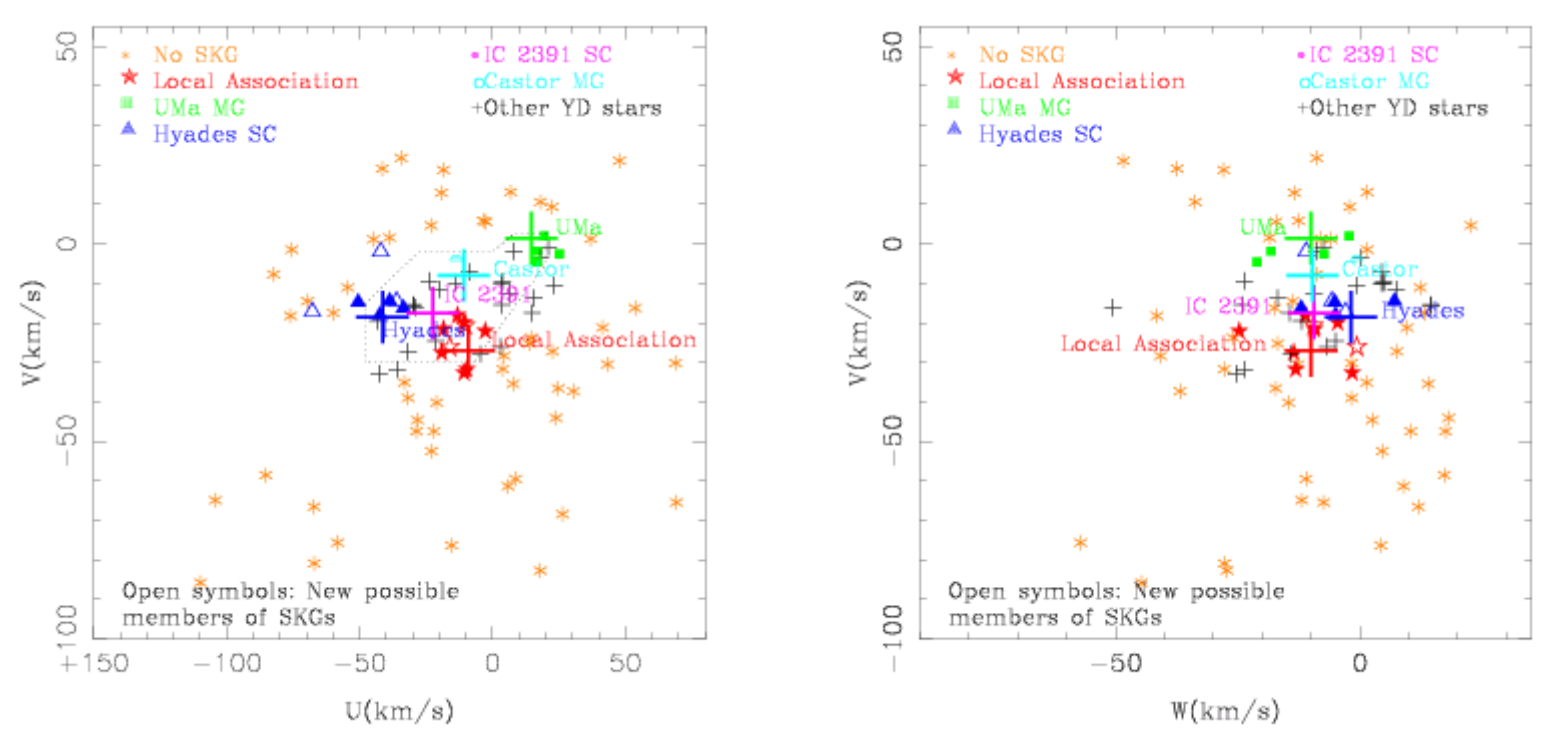


Fig. 2 (U, V) and (V,W) planes of the observed stars. Different colors and symbols indicate membership to different young moving groups, previously identify by Montes et al., (2001). We have identified five new possible members of young SKGs (open symbols), using Eggen's astrometric criteria (see Table 1). Large crosses represent the convergence point of the young SKGs shown in the figure. The dotted line represents the boundaries that determine the young disc population as defined by Eggen (1984, 1989).

References

- ✓ Eggen O. J., 1984, AJ, 89, 1358
- ✓ Eggen O. J., 1989, PASP, 101, 366
- ✓ Martínez-Arnáiz R.M. et al., 2006, 14th Cambridge Workshop on Cool Stars
- ✓ Montes D. et al., 2001, MNRAS, 328, 45
- ✓ Zuckerman, B. & Song, I. 2004, AR&A, 42, 685

Acknowledgments

This work was supported by the Spanish Ministerio de Educación y Ciencia (MEC) under grants AYA2005-00954 and AYA2005-02750, and "The Comunidad de Madrid" projects ASTRID (S-0505/ESP/000361) and ASTROCAM (S-0505/ESP/000237).

MINISTERIO DE EDUCACIÓN Y CIENCIA

astrid

ASTROCAM
Astrofísica Comunidad de Madrid