Kinematics and spectroscopic properties in stars with/without debris discs and planets

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An important fraction of stars in our neighbourhood are known to host planets and/or show ir-excesses due to dusty debris discs. Several works have studied and analysed the properties of stars with planets and those without them. However, there are relatively few works comparing the properties of stars with and without debris discs (and planets) in spite of the clear connection between debris disks and planets. Using high-resolution echelle spectra, we present a first comparison of the kinematics (radial and spatial-galactic velocities, moving group membership) and spectroscopic properties (lithium abundance, metallicity) between stars with planets and stars with debris discs. This work will be extended in a near future to other stellar properties.

Stellar sample, observations and data

Our basic stellar sample consits of main-sequence (luminosity classes V(IV-V) FGK stars located at distances less than 25 pc. High-resolution spectra have been obtained beteween 2005 and 2009 by using the FOCES spectrograph at the 2.2 m telescope of the Calar Alto Observatory, the SARG spectrograph at the Telescopio Nazionale Galileo (3.56m) in La Palma Observatory and the FIES spectrograph at the Nordic Optical Telescope (2.56m) also in La Palma Observatory. Additional spectra of other stars have been obtained in public archives and libraries like S4N (Allende Prieto et al., 2004). A detailed description of the parameters derived from these spectra can be found in Maldonado et al. (2010) and Martínez-Arnáiz et al. (2010).

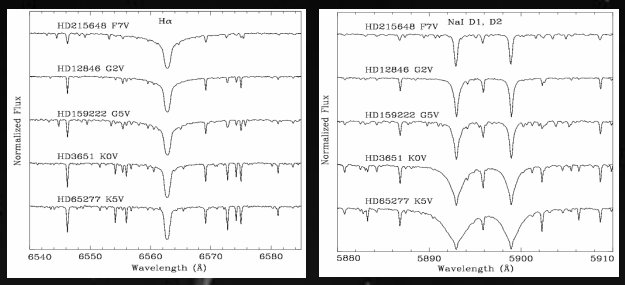


Fig. 1. Example of observed spectra for some stars. Left panel: Hα line region; Right panel: NaI D_1 D_2 lines region.

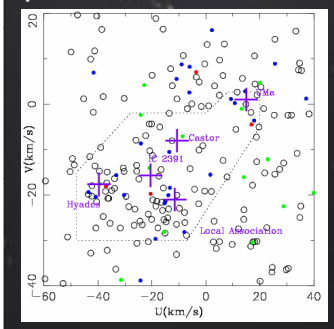
The total number of observed stars amounts to 500. Three subsamples were constructed from the whole sample. A "comparison stars sample", which includes all the stars with no known planets or ir-excess. Knwon spectroscopic binaries (SB9 or Simbad) were also excluded. A "planets – host stars sample", which includes all stars with knwon planets (from the extrasolar planets encyclopaedia) and a "debris disc sample", which contains all stars with knwon ir-excess. The final number of stars are 234, 26 and 40 for the comparison, planets-host and debris disc stars subsamples, respectively.

Kinematics, membership to SKGs

Debris disc systems with high infrarred luminosity are more intimately linked to young Stellar Kinematic Groups (SKGs) than normal stars (e. g. Moór et al. 2006). Is it the same for stars with planets?

To identify members of MGs we proceeded in two steeps:

- Identification of kinematics candidates: Stars are selected as "kinematic candidates" on basis of their Galactic-spatial velocity components (U,V,W).
- Confirmation of kinematic candidates: Candidates are selected as "probable members" if their age-related properties (lithium, chromospheric and coronal activity, rotation) agree and also do with the position of the star in the (U,V) plane.



25% of the stars in the comparison sample are "kinematic candidates" to MGs. The number increases to 45% for the debris disc sample. Percentages of "probable members" are 10% and 60% for the comparison and debris disc sample, respectively.

Nine MGs kinematics candidates have planets. However, when consider age-properties, most of them are doubtufl or probable non-mebers of the corresponding MG. Only HIP71395 hosts a planet and is a bona fide member of of the Ursa Major MG.

Fig. 2. (U,V) plane. Green: stars with planets; Blue: stars with debris discs; Red: stars with both planets and discs; Open circles: comparison stars. Large crosses represent the convergence point of different MGs. The dotted line represents the boundary of the young disc population (Eggen 1984, 1989)

Lithium abundance

Whether stars with planets show higher depletion of lithium when compared with normal stars or not, is nowdays the subject of an intense discussion. For example, González et al. (2010), Gonzálezl (2008), Castro et al. (2008), Israelian et al. (2009), Baumann et al. (2010), Ryan (2002), Luck & Heiter (2006)

Lithium abundances were obtained from the EWs given in Maldonado et al. (2010) and transformed to abundances by using the curves of growth given by Pavlenko & Magazzù (1996)

Even stars in a given cluster show a large spread in lithium content due to dierences in Temperature, metallicity or rotation. Following González et al. (2008) we calculate an index Δ which measures the proximity of two stars in the Teff, logg, [Fe/H], Mv and vsini space.

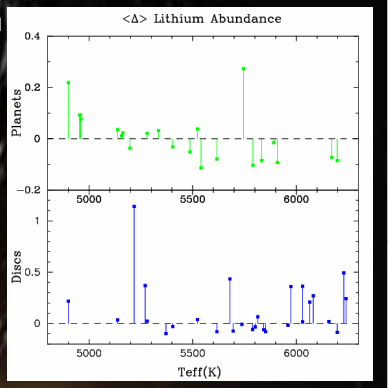


Fig. 3. Lithium abundance for the stars with planets (green, upper pannel) and stars with debris discs (blue, lower pannel) minus its correspondent "comparison abundance" .

A mean "comparison abundance" can be obtained by using all comparison stars but weighting each of them by the quantity $1/\Delta^2$. Results are shown in Figure 3, in where we plot "Star with planet/disc abundance minus comparison abundance" versus the temperature.

$$\Delta = 30\left|\log T_{eff}^{comp} - \log T_{eff}\right| + \left|[Fe/H]^{comp} - [Fe/H]\right| + 0.5\left|logg^{comp} - logg\right| + \left|M_v^{comp} - M_v\right| + \left|\log vsini^{comp} - \log vsini\right|$$

Definition of Δ

As can be seen in Figure 3, the differences between stars with planets and "normal" stars are compatible with zero. The same can be said for stars with debris discs. The debris disc star with the largest lithium overabundance is HIP13402 a young star member of the Local Association.

Metallicity in stars with debris discs

Stars with planetary systems are known to be metal-rich when compared with normal stars (e.g. Fischer & Valenti 2005). Is it the same true for stars with debris discs?. Figure 4 shows the distribution of metallicity for stars with debris discs (fillled grey boxes) compared with the distribution for normal stars (open white boxes). Both distributions have been fitted to a guassian function (continuos red line for normal stars, continuum blue line for stars with debris discs). Mean values of both distributions are shown in dotted lines. We noticed that the mean value for the stars with debris disc subsample is between the mean values of the normal stars and the planet-host star distributions.

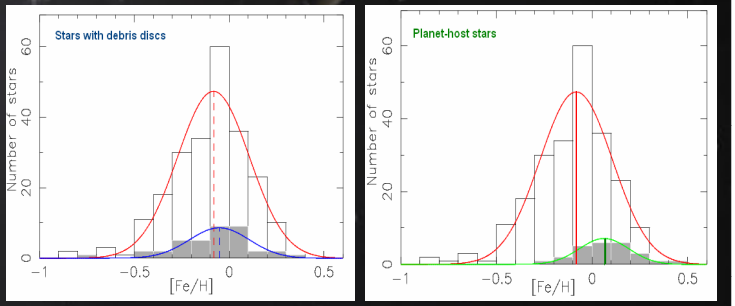


Fig. 4. Left: Metallicity distribution for stars with debris discs (filled grey boxes) against the comparison sample (open white boxes). Right: The same but for the sample of stars with planets.

Background images. Lower pannel: The planetary system of HD 69830 (Credits: ESO) ; Upper pannel: Artist's impression of a debris belt. (Credits: T. Pyle/SSC/NASA/JPL-Caltech)