Spectroscopy follow up of planet-bearing stars

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Summary. We present here the beginning of our high resolution echelle spectroscopic observations of several late-type stars recently discovered to be extra-solar planetary host stars. These multiwavelength optical observations will allow us to determine fundamental parameters of the stars ($T_{\rm eff}$, $\log g$, [Fe/H]), age (Li I 6707.8 Å abundance), radial velocity and kinematics (membership to moving groups), rotational velocities ($v \sin i$), as well as study in detail the chromosphere using the information provided for several optical spectroscopic features (from the Ca II H&K to Ca II IRT lines). With all this information we will have a testing method of analysis the possible dependence of the orbital parameters and planet properties on the stellar parameters as well as the possible influence of the planets in the host stars.

1 Observations

The spectroscopic observations of these stars were obtained during several runs from 2001 to 2004, mainly in July 2004, all using the 9m Hobby-Eberly Telescope (HET) at McDonald Observatory in Texas (USA), with the High Resolution Spectrograph (HRS). The wavelength range covers from 4200 to 7880 Å in 70 orders. The spectral resolution is R = 120000. The data reduction was performed using standard IRAF subroutines for echelle spectra where the wavelength calibration was obtained by taking spectra of Th-Ar lamp and afterward the spectra have been normalized by a polynomial fit to the observed continuum. The measurements of equivalent width (EW) and abundances have been made using splot routine in IRAF, MIDAS integration routines, and three synthesis programs MOOG (Sneden 1973), ATLAS9 code (Kurucz 1993) and STARMOD (Barden 1983). With these programs, a synthesized stellar spectrum is constructed and can be compared with or subtracted from the original image. The rotational velocity ($v \sin i$) measures are obtained by us based on the Queloz el at. (1998) technique, revised by Montes et al., that is adequate for low rotating stars.

2 Objectives and Work Description

The main goal of the study we have began to develop is to add a new sample of candidates, among young and active stars, to measure radial velocity variations, determine the nature of these radial velocity variations and obtain the contribution to this variations due to low mass companions, mainly planetary companions.

For this purpose, we have started a global study of the spectroscopic characteristics and behavior of stars bearing planets and the nature and influence of sources of radial velocity variation (stellar spots, surface inhomogeneities from convection, etc). Although several studies of this kind have been carried on in the last years, we want to improve the spectra resolution of the survey, R=120000 (before searches have resolutions around R= 60000-70000), and make an homogeneous reduction and synthesis of all the sample. In addition we are measuring the metallicities using both MOOG and ATLAS9 synthesis programs to compare the resulst between them and with previous studies. We follow the previous studies from Saar et al. (1997, 1998), Paulson et al. (2003, 2004, 2006), Fischer & valenti (2005), etc and we pretend to apply the results in the study of the activity caused by interaction of the host stars with its planets companions and its influence in orbit parameters. The results will be taken into account to look for a new list of young active stars candidates to host planets and include them in radial velocity observing runs with new instruments as ET (the Exoplanet Tracker) and high resolution spectrographs in big telescopes. ET is a dispersed fixed-delay interferometer consists of a wide angle Michelson interferometer followed by a medium resolution spectrograph (see Ge 2002).

We present here a first view of 22 planet bearing stars from a spectroscopic survey carried on during several observing runs taken from 2001 to 2004 that we are actually analyzing.

3 Chromospheric activity indicators and abundances

In Table 1, we give the abundance for the Li I 6707.8 Å absorption line, metallicity measures based on several Fe I and II lines and a measure of activity level based on Ca II H & K emission lines from previous studies. For our study we are determining the equivalent width (EW) of Li I line and Fe I lines and we will measure in the same way the, Ca II H & K, Hα, Hβ, Hδ, Hγ and Ca II IRT (λ8498, λ8542, λ8662) lines to measure the activity level, and determine different Na I, Si I, Mg I, Ca I, Ti I and Zn I EWs lines for measure their abundances. The chromospheric contribution in the different optical chromospheric activity indicators has been determined using the spectral subtraction technique Montes et al. (1995; 1997; 1998). The synthesized spectrum was constructed using the program STARMOD developed at Penn State (Barden 1985). Abundances are being measured with both synthesis programs MOOG

Table 1. Planet Bearing Stars Data

Name (HD)	other	Spt Type	V mag	M ($M_\odot$)	distance (pc)	C. [1]	[Fe/H] [2]	A(Li I [3])	R'_{HK} [4]
3651		K0 V	5.80	0.79	11	1	0.05	-	-4.98
9826	Ups And	F8 V	4.09	1.3	13.47	3	0.09	2.47	-4.99
16141		G5 IV	6.78	1	35.9	1	0.22	1.11	-5.09
19994		F8 V	5.07	1.35	22.38	1	0.23	2.01	-
22049		K2 V	3.73	0.8	3.2	2	-0.1	<0.3	-
38529		G4 IV	5.94	1.39	42.43	2	0.313	<0.61	-
75732	55 Cnc	G8 V	5.95	1.03	13.4	1	0.29	<0.02	-5.00
89744		F7 V	5.74	1.4	40	1	0.18	2.07	-5.11
95128	47 UMa	G0 V	5.10	1.03	13.3	2	-0.08	1.8	-5.02
120136	Tau Boo	F7 V	4.50	1.3	15	1	0.28	-	-4.78
143761	Rho CrB	G0V or G2V	5.40	0.95	16.7	1	-0.19	1.38	-5.03
145675		K0 V	6.67	1	18.1	2	0.35	<-0.02	-5.09
168443		G5	6.92	1.01	33	2	0.1	<0.76	-5.0/-5.02
177830		K0	7.17	1.17	59	1	0	<-0.050	-5.35
178911 B		G5	7.98	0.87	46.73	1	0.28	<0.39	-4.98
186408	16 CygB	G2.5 V	6.20	1.01	21.4	1	0.09	-	-5.09
190228		G5 IV	7.30	1.3	66.11	1	-0.24	1.23	-5.18
190360	GL 777 A	G6 IV+	5.71	0.96	15.89	2	-	<0.34	5.07
192263		K2 V	7.79	0.79	19.9	1	-0.2	<-0.035	-4.44
195019		G3 IV-V	6.91	1.02	20	1	0	1.46	-4.99
209458		G0 V	7.65	1.01	47	1	0.04	2.70	-4.95
217014	51 Peg	G2 IV	5.49	-	14.7	1	0.16	1.30	-5.05

[1] C.: Number of substellar companion found.
[2] Data of Li abundances taken from Extrasolar Planets Encyclopedia: http://exoplanet.eu.
[3] Data taken from Israelian G. et al. 2004.
[4] Active: Activity level based on $<\log R'_{HK}>$ measures in Saffe et al. 2006.

and ATLAS9. As an example, the profiles of the Hα and Li I lines are plotted in Fig. 1 in left and right panel respectively and in Fig. 2, we plot an example of ATLAS9 results for HD 145675, that is, the synthetic spectra superimposed to the observed spectra.

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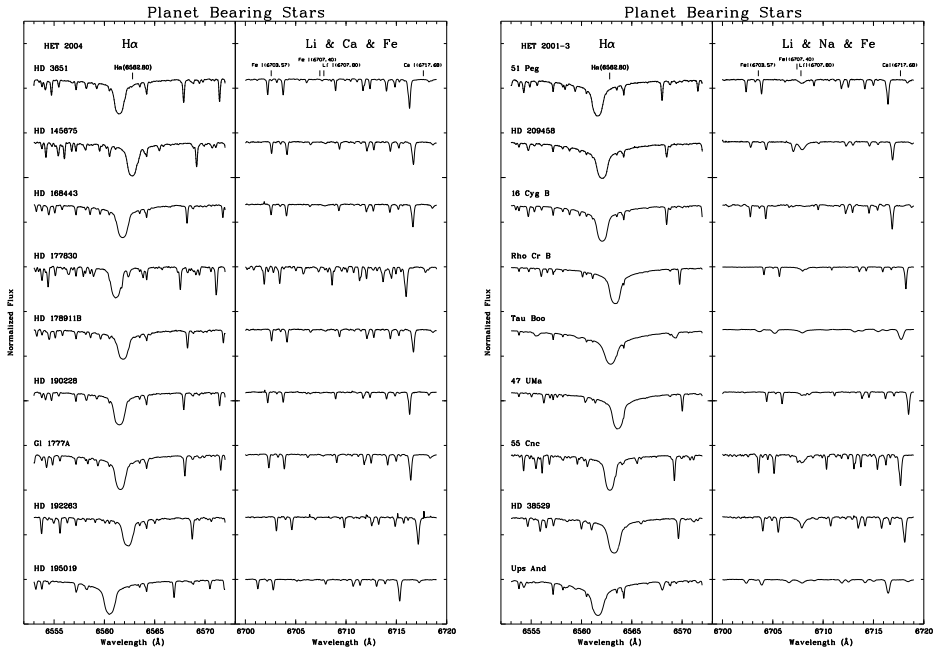

Fig. 1. We plot an example spectra of the spectra of 18 of the 22 stars in two different spectral regions, one centred in Hα line (left side of every figure) and other that contains Lithium I (6707.8 Å), Ca I (6717.78 Å) and Fe I (6707.4 Å) (right side of every figure) lines.

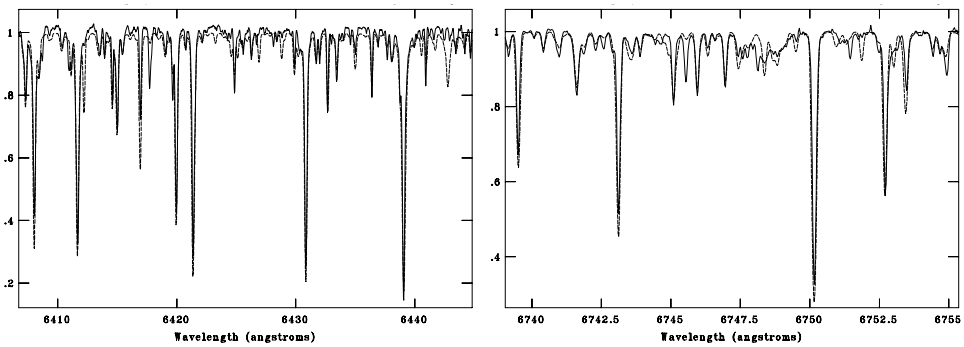

Fig. 2. We plot an example spectra of HD 145675 in two different spectral regions. The observed spectra is plotted in solid line and the synthesized spectrum obtained by ATLAS9 code is superimposed in dashed-line.