Cool stars: spectral library of high-resolution echelle spectra and database of stellar parameters

D. Montes[1], et al.[2]

[1]Departamento de Astrofísica, Universidad Complutense de Madrid (UCM), Spain;
[2] M.J., Fernández-Figueroa, E. De Castro, M. Cornide, J. López-Santiago, M.C. Gálvez, I. Crespo-Chacón, R.M. Martínez-Arnáiz, J. Maldonado, H. M. Tabernero, J.I. González Hernández, A. Klutsch, J.A. Caballero, F.J. Alonso-Floriano, J. Ramos Medina.

Abstract

During the last years our group have undertake several high resolution spectroscopic surveys of nearby **FGKM stars** with different spectrographs (FOCES, SARG, SOFIE, FIES, HERMES). A large number of stars have been already observed and we have already determined **spectral types**, rotational velocities (***v*sin*i***) as well as radial velocities (V_r), **Lithium** abundance and several chromospheric activity indicators. We are working now in a homogeneous determination of the fundamental stellar parameters (T_{eff}, log*g*, ξ and [Fe/H]) and chemical **abundance** analysis of all these stars. Some fully reduced spectra in FITS format have been available via ftp and in the World Wide Web by Montes et al. (1997; 1998; and 1999) and some particular spectral regions of the echelle spectra are available at *VizieR* by López-Santiago et al. (2010). We are now working in made accessible all the **spectra** of our different surveys in a Virtual Observatory (**VO**) compliant **library** and database accessible using a common web interface following the standards of the International Virtual Observatory Alliance (IVOA). The spectral library includes F, G, K and M field stars, from dwarfs to giants. The spectral coverage is from 3800 to 10000 Å, with spectral resolution ranging from 40000 to 80000. The database will provide in addition the **stellar parameters** determined for these spectra.

Surveys of nearby FGK stars

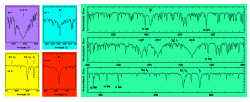
High resolution *echelle* spectra, R= 85000 – 22000 (0.08-0.3 Å)

WHT-**UES**, 2.2m-**FOCES**, NOT-**SOFIN**, INT-**MUSICOS**, TNG-**SARG**, HET-**HRS**, NOT-**FIES**, Mercator-**HERMES**

★ Libraries of high resolution spectra of cool stars

1997- 1999 - 329 FGKM stars

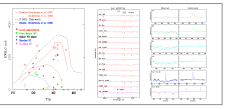
Montes et al. 1997, A&ASS, 123, 473;
Montes & Martín 1998, A&ASS, 128, 485;
Montes, Ramsey & Welty 1999, ApJS, 123, 283



★ Survey late-type stars in Moving Groups (MGs)

1999- 2002 - 144 FGKM stars

Montes et al. 2001 A&A, 379, 976;
López-Santiago et al. 2005, PhD Thesis UCM;
2006 ApJ, 643, 1160; 2009 A&A, 499, 129; 2010 A&A, 514, A97

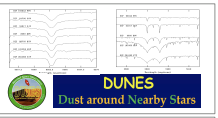


★ Survey of FGK stars in the solar neighborhood

(d < 25 pc), including the DUNES sample

2005- 2009 – 450 FGKM stars

Martínez-Arnáiz et al. 2010, A&A, 520, A79; **2011**, MNRAS, 414, 2629; **2011**, PhD Thesis UCM;
Maldonado et al. 2010, A&A, 521, A12

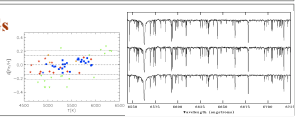


★ Survey for Chemical Tagging of FGK stars in MGs

Hyades and Ursa Major moving groups

2010- 201 – 61 Hya + 34 UMa F6-K4 stars

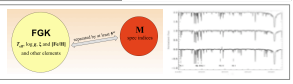
Tabernero, Montes, González Hernández 2010, CS16, **2012**, CS17;
Tabernero, Montes, González Hernández, 2012, A&A, in press, arXiv: 1205.4879



★ Survey of wide binaries FGK + M companions

2012 - 50 F6-K4 primary stars

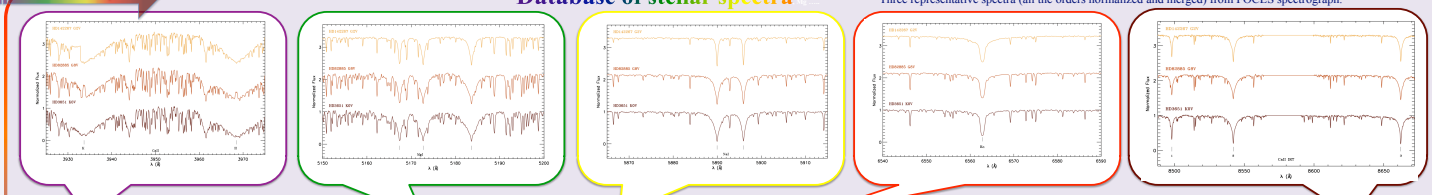
Montes, et al. 2012, CS17;

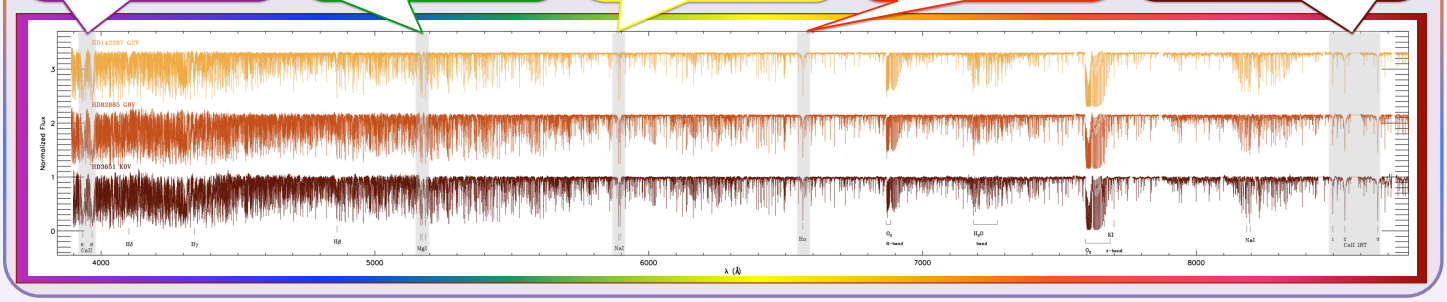


Reduced Spectra

Database of stellar spectra

Three representative spectra (all the orders normalized and merged) from FOCES spectrograph.





Stellar parameters

Stellar atmospheric parameters (T_{eff}, log*g*, ξ and [Fe/H])

StePar (Tabernero Montes, González Hernández, **2012**, A&A, in press, arXiv: 1205.4879):
→ **see Poster 36**

- 2002 version of the MOOG code (Sneden 1973).
- a grid of Kurucz ATLAS9 plane-parallel model atmospheres (Kurucz 1993).

- The EW determination of the Fe lines with the ARES code (Sousa et al. 2007).
- 263 Fe I and 36 Fe II lines (Sousa et al. 2008).

The code iterates until obtain:
- **excitation equilibrium**:
  the slopes of χ *vs* log(ϵ(Fe I))
  and log(EW/λ) *vs* log(ϵ(Fe I)) where zero
- **ionization equilibrium**:
  log(ϵ(Fe I)) = log(ϵ(Fe II)).

- 2-σ rejection of Fe I and Fe II lines after a first determination of the parameters
- **Limitations**: spectral types F6 to K4, slow rotators, no veiling.

Chemical abundances

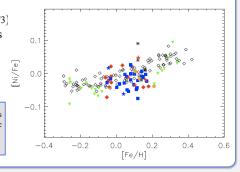
Fe, the α-elements (Mg, Si, Ca, and Ti),
Fe-peak elements (Cr, Mn, Co, and Ni),
odd-Z elements (Na, Al, Sc, and V)
s-process elements (Cu, Zn, Y, Zr, Ba, Ce and Nd)

- **EW** method in a line-by-line basis with *ARES* code (Sousa et al. 2007).

- Line lists and atomic parameters from (Neves et al. 2009; González Hernández et al. 2010).

- Abundance analysis with *MOOG* (Sneden 1973) using our determined atmospheric parameters and a solar spectrum taken with the same instrumental configuration.

[Ni/Fe] vs [Fe/H] for our sample of stars in the Hyades Supercluster (coloured symbols) compared with the thin disc data (González Hernández et al. 2010, open diamonds). See Tabernero et al. (2012).



Spectroscopic Observations

For the spectra included in the three libraries see the references (Montes et al. 1997, 1998, 1999). For the new spectra taken from 1999 - 2012 we have used the following telescope/instrument configuration:

Telescope - spectrograph:	Wavelength range:	Spectral resolution:
• **2.2m-FOCES** Fibre Optics Cassegrain Echelle Spectrograph CAHA, (Almería Spain)	3910 – 9075 Å	0.09 – 0.26 Å
• **INT-MUSICOS** 2.5 m Isaac Newton Telescope, ESA-MUSICOS spectrograph	4430 – 10225 Å	0.16 – 0.30 Å
• **INT-IDS** Intermediate Dispersion Spectrograph (La Palma, Spain)	3554 – 5176 Å	0.48 Å
• **NOT-SOFIN** 2.56 m Nordic Optical Telescope, Soviet Finnish High Resolution Echelle Spectrograph (La Palma, Spain)	3525 – 10425 Å	0.14 – 0.32 Å
• **NOT-FIES** (FIber fed Echelle Spectrograph)	3620 – 7380 Å	0.08 – 0.15 Å
• **TNG-SARG** 3.5 m Telescopio Nazionale Galileo, Spectrografo di Alta Resoluzione Galileo (La Palma, Spain)	4960 – 10110 Å	0.08 – 0.17 Å
• **HET-HRS** 9.2 m Hobby-Eberly Telescope High Resolution Spectrograph (McDonald Observatory in Texas, USA)	5040 – 8775 Å	0.15 – 0.28 Å
• **2.2m ESO- FEROS** Fiber-fed Extended Range Optical Spectrograph (ESO, La Silla, Chile)	3500 – 9000 Å	0.14 Å
• **Mercator-HERMES** High Efficiency and Resolution Mercator Echelle Spectrograph (La Palma, Spain)	3800 – 8750 Å	0.08 Å

Derived Data

Database of stellar parameters

All the spectra and the stellar parameters determined for these spectra will be available in a database constructed using the Astronomical Database Generator ***Saada***.

Name	S_{Tp}	T_{eff} (K)	log *g*	ξ (km/s)	[Fe/H]	[X/H]	Li	*v*sini (km/s)	V_r (km/s)	*UVW* (km/s)	Activity Hα,CaII…
HD 142267	G2V	5768 ±35	4.42 ±0.08	1.00 ±0.05	-0.38 ±0.03	…	…	…	…	…	…
HD 82885	G8V	5536 ±37	4.43 ±0.09	1.32 ±0.06	0.27 ±0.03	…	…	…	…	…	…
HD 3651	K0V	5282 ±45	4.35 ±0.10	1.16 ±0.08	0.11 ±0.03	…	…	…	…	…	…

WWW

All the spectra and derived parameters will be available in the VO

Libraries of spectra of cool stars available in the WWW → http://www.ucm.es/info/Astrof/invest/actividad/spectra.html

Acknowledgments: This work was supported by the Universidad Complutense de Madrid (UCM), the Spanish Ministerio de Economía y Competitividad, (MINECO) under grant **AYA2011-30147-C03-02/-03**, and the Comunidad de Madrid under PRICIT project **S2009/ESP-1496** (AstroMadrid).