High-resolution spectroscopy of **FGK**-type stars **pre-** and **post-Gaia**

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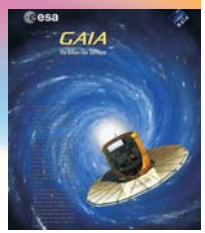
RED DE INFRAESTRUCTURAS DE ASTRONOMIA

RIA Workshop:

La contribución de las ICTS españolas a la misión Gaia de ESA

21 de marzo 2012, CDTI, Madrid

gaia



Collaborators

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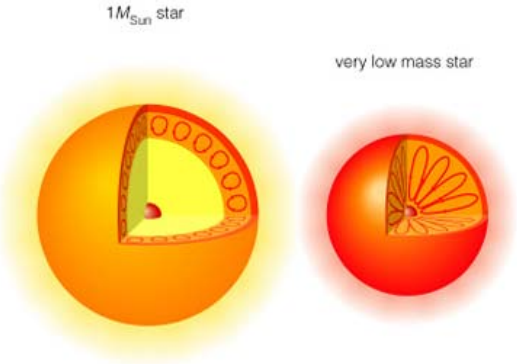
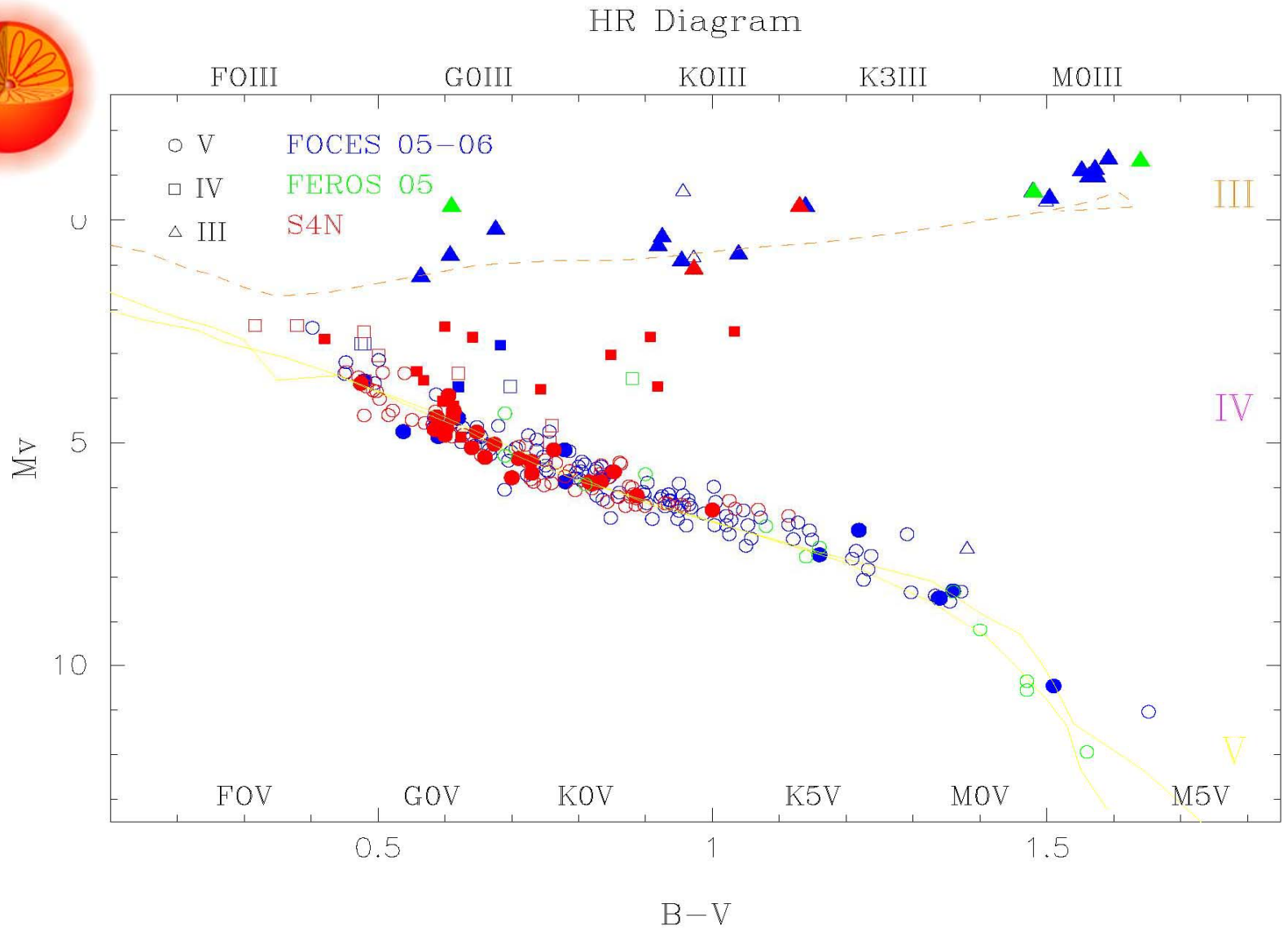
	CAB (Centro de Astrobiologia) Madrid	**José Antonio Caballero.**
	IAC (Instituto de Astrofísica de Canarias)	**Jonay I. González Hernández.**
UAM UNIVERSIDAD AUTONOMA DE MADRID DUNES	***Universidad Autónoma de Madrid, UAM*** ***CAB (Centro de Astrobiologia) Madrid***	**Carlos Eiroa,** **Jesús Maldonado.** **Benjamín Montesinos,** **and DUNES team.**
UNIVERSITÉ DE STRASBOURG Observatoire astronomique de Strasbourg INAF	**Observatoire Astronomique,** **Université de Strasbourg** **Osservatorio Astrofisico di Catania**	**Patrick Guillout,** **Rubens Freire Ferrero,** **F.-X. Pineau,** **N. Grosso,** **Antonio Frasca,** **Ettore Marilli.**

Cool Stars – FGKM–type stars





High-Res **pre-Gaia**

Spectroscopic surveys of FGKs dedicated to:

- Detailed analysis of the chromospheric activity – 1990-
- Libraries of high resolution spectra of cool stars – 1997 - 1999
- Survey of late-type (F-M) stars in MGs – 1999 - 2002
- Survey of FGK in the solar neighbourhood (DUNES) – 2005 - 2009
- Confirming members of MGs by Chemical Tagging – 2010 -
- *RasTyc* Survey (young stars, ROSAT All-Sky X-ray sources) – 2000 - 2008
- Survey of co-moving young stars in Cepheus – 2009 -
- Searching “isolated” very young star – 2011-

High resolution échelle spectra

R= 85000 – 22000 (0.08-0.3 Å) – Different échelle spectrographs

Observations:

WHT-**UES**,
INT-**MUSICOS**,

2.2m-**FOCES**,

NOT-**SOFIN**,
NOT-**FIES**,

TNG-**SARG**,

HET-**HRS**,

2.2m ESO- **FEROS**,

Mercator-**HERMES.**

From archives:

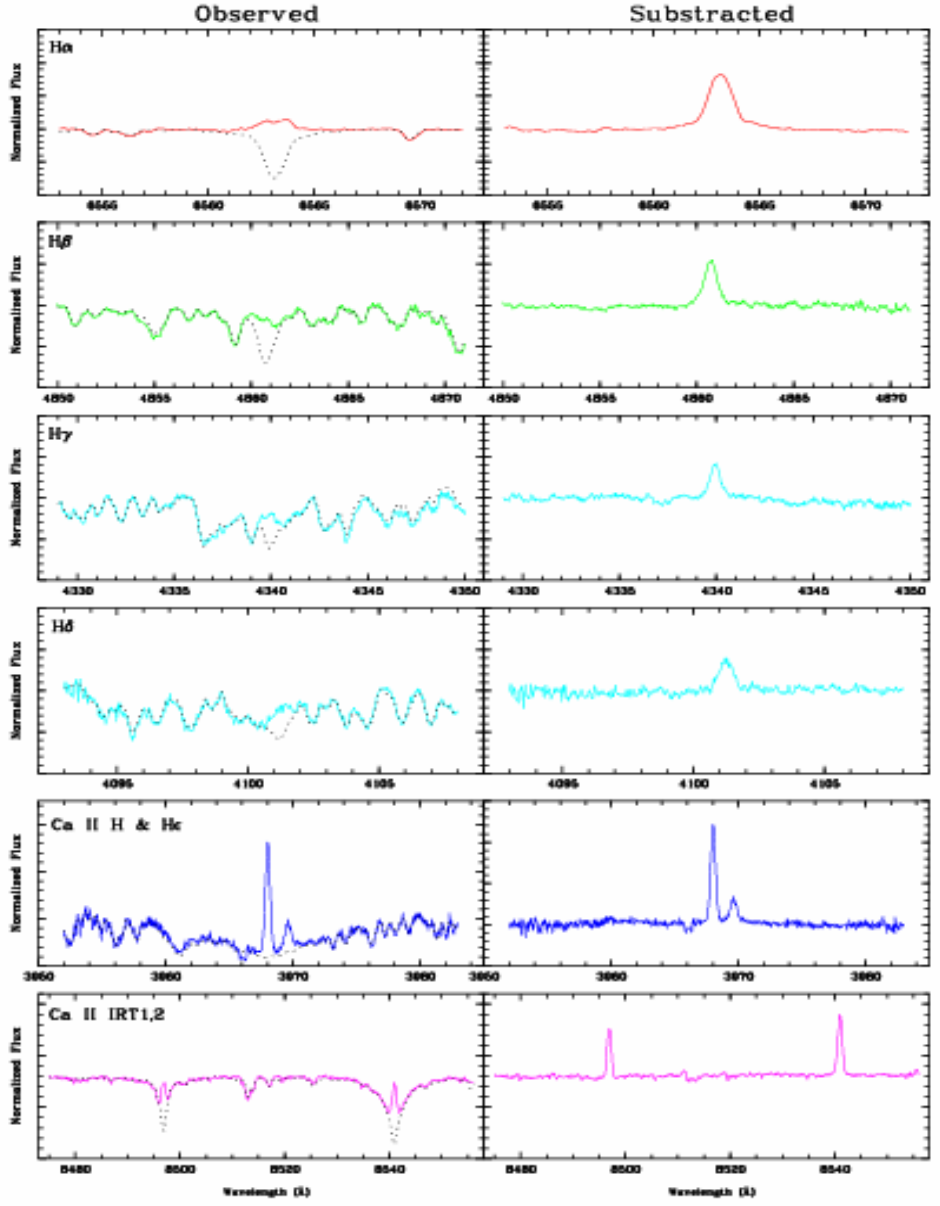
3.5m ESO-**HARPS**,
VLT ESO-**UVES**,

OHP - **ELODIE**,
OHP - **T193/Sophie**

MacDonald - **2dcoudé** (S4N),
2.2m ESO- **FEROS** (S4N).

Spectroscopic Analysis

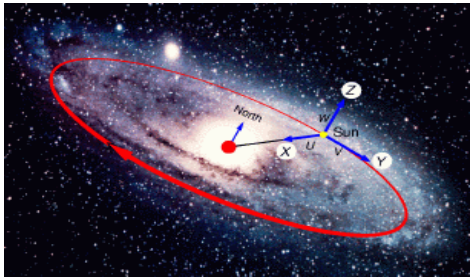
- **Kinematics (U, V, W).**
  - Radial velocity (Vr)
- **Age** (LiI 6707.8Å).
- **Chromospheric activity**
  - CaII H&K to CaII IRT
- **Rotation** (*vseni*).
  - Activity – rotación relation
- **Stellar parameters**.
  - T_{eff}, log g, ξ and **[Fe/H]**
- **Absolute and differential abudances**.
  - Chemical tagging



Stellar Kinematics Groups

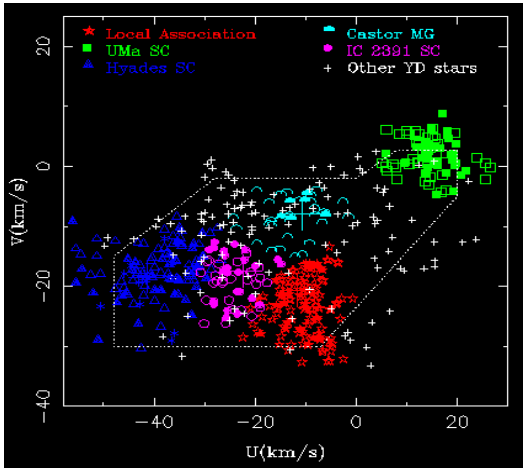
- **Moving group (Supercluster)** Eggen (1994)

Group of stars gravitationally unbound that share the same kinematics and may occupy extended regions in the Galaxy



Origin:

- the evaporation of an open cluster
- the remnants of a star formation region,
- a juxtaposition of several little star formation bursts

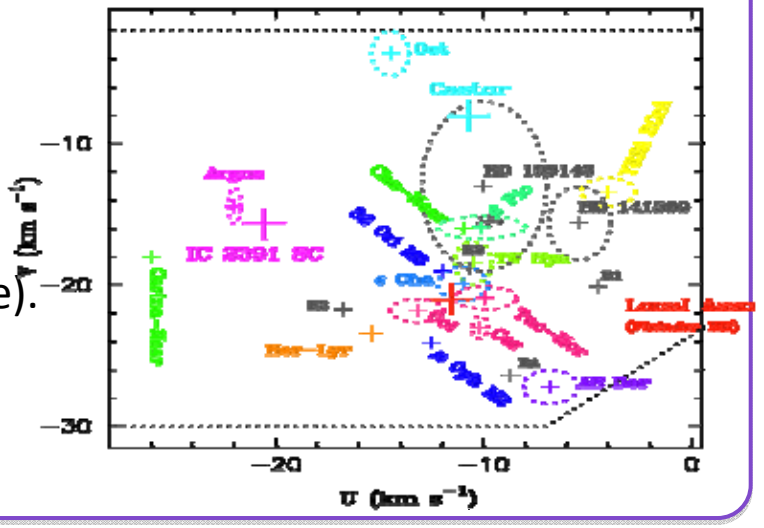


- **Boettlinger diagram:**
  - (U, V) & (U, W)

Factors against the persistence of MG:

- the **Galactic differential rotation** (tends to spread the stars)
- the **disc heating** (velocity dispersion of disc stars)

- High resolution spectra is needed for discerning between:



- **field-like stars**

(associated with dynamical resonances (bar) or spiral structure).

- **young coeval stars**

(debris of star-forming aggregates in the disk).

Libraries FGK stars

Montes et al.

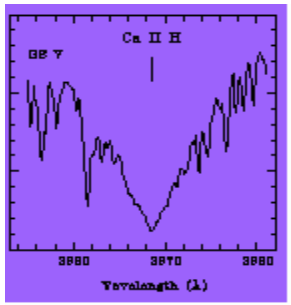
Libraries of high resolution spectra of cool stars (chromospheric activity)

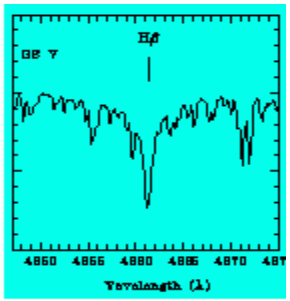
1997- 1999 - 329 FGKM stars

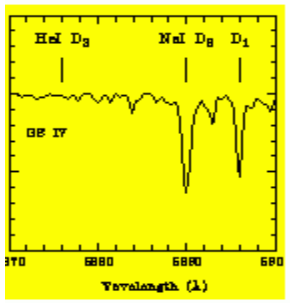
1) Montes et al. 1997, A&ASS, 123, 473;
Intermediate-resolution (0.2-3 Å) CaII H&K, H β , NaI D_1, D_2 & HeI D_3, H α 170 spectra, 116 stars (V, IV, III)

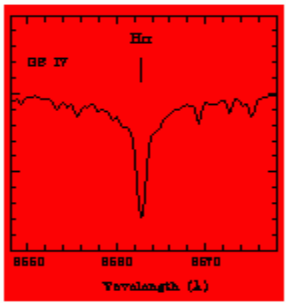
2) Montes & Martín 1998, A&ASS, 128, 485;
High-resolution (0.09-0.19 Å) *echelle* (4800 – 10600 Å) 105 spectra, 83 stars (V)

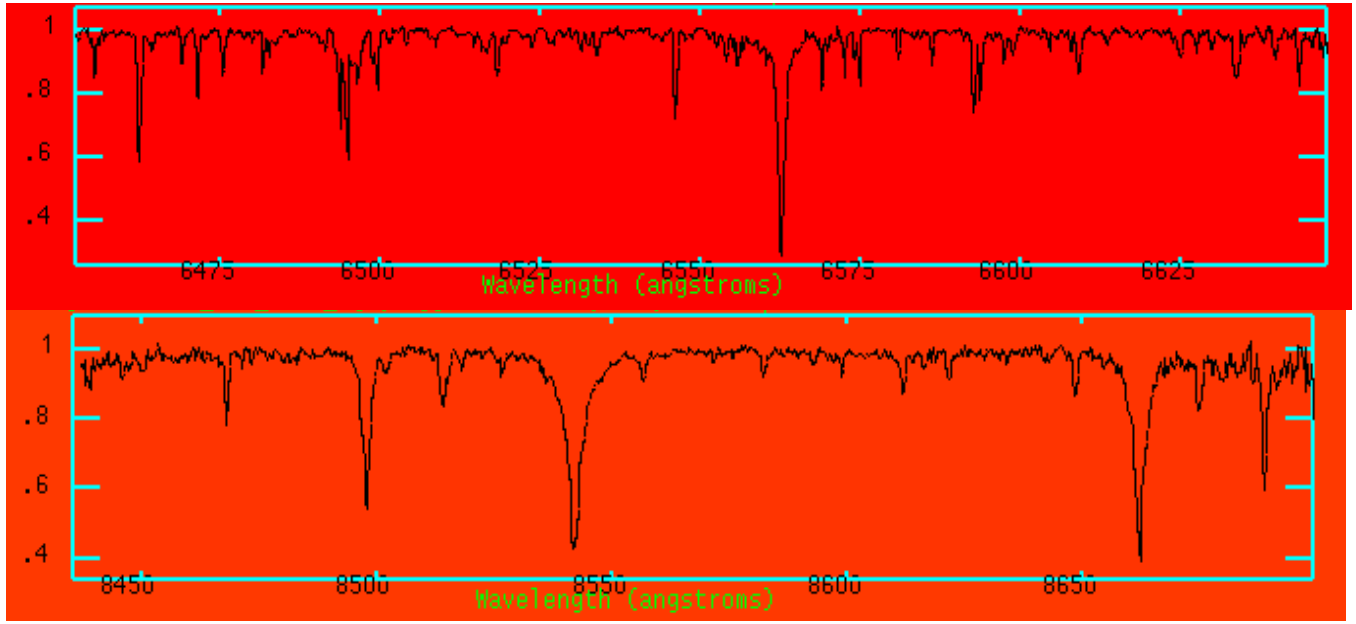
3) Montes, Ramsey & Welty 1999, ApJS, 123, 283;
intermediate resolution (0.5 Å) *echelle* (3900 – 9000 Å) 345 spectra, 130 stars (V, IV, III, II, I)











http://www.ucm.es/info/Astrof/invest/actividad/spectra.html

Survey of FGK stars in MGs

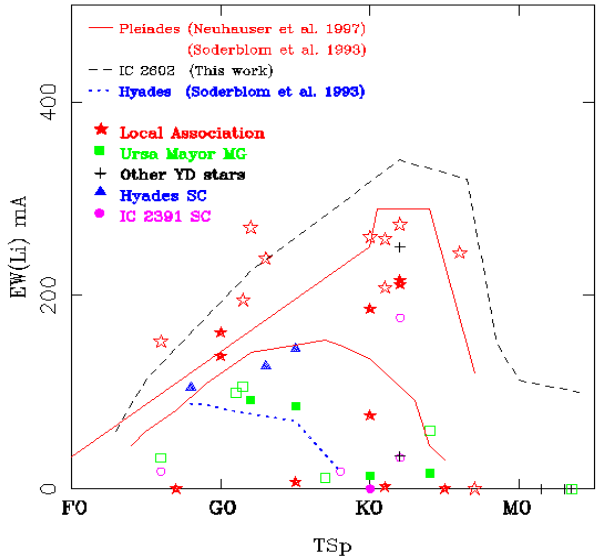
★ Survey late-type stars in Moving Groups (MGs)

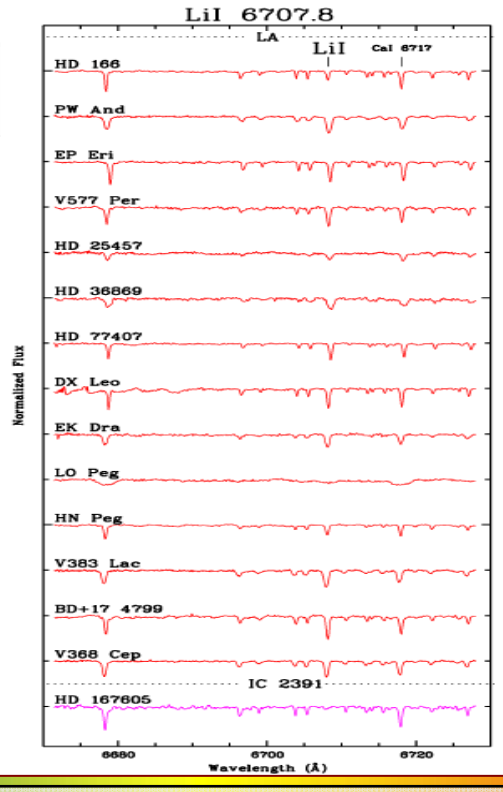
1999- 2002 - 144 FGKM stars

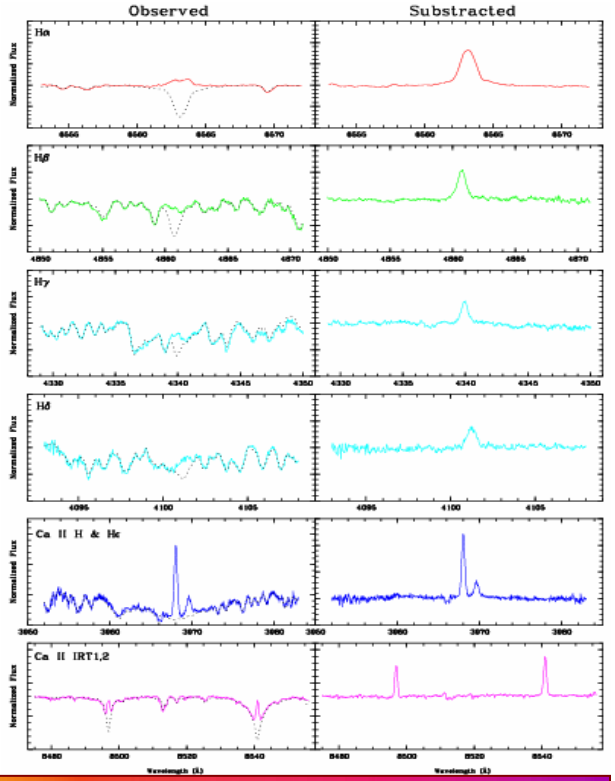
- **Montes et al.** 2001, A&A, 379, 976;
- **López-Santiago et al.** 2005, PhD Thesis UCM;
2006, ApJ, 643, 1160; 2009, A&A, 499, 129; 2010, A&A, 514, A97

A high-resolution spectroscopic survey of late-type stars: chromospheric activity, rotation, kinematics, and age★,★★

J. López-Santiago[1], D. Montes[1], M. C. Gálvez-Ortiz[2], I. Crespo-Chacón[1], R. M. Martínez-Arnáiz[1], M. J. Fernández-Figueroa[1], E. de Castro[1], and M. Cornide[1]







http://www.ucm.es/info/Astrof/invest/actividad/skg/skg_SS.html

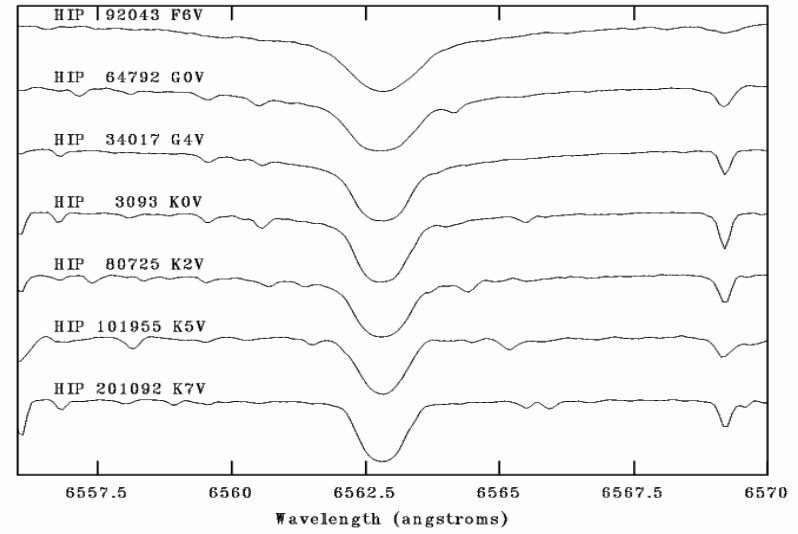
Survey Nearby FGK stars

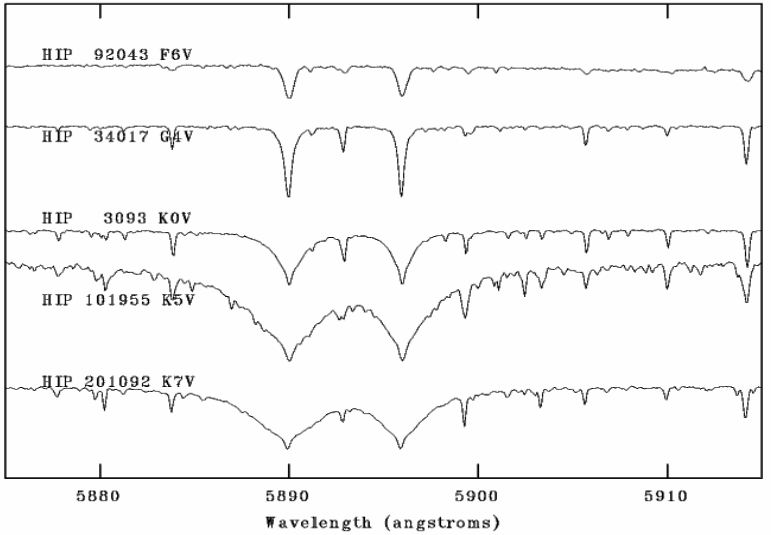
★ Survey of FGK stars in the solar neighbourhood

(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





FGK stars in the solar neighbourhood (d < 25 pc) which include the DUNES sample, an approved Herschel OTKP with the aim of detecting cool faint dusty disks (Eiroa et al. 2010).

DUNES
Dust around Nearby Stars

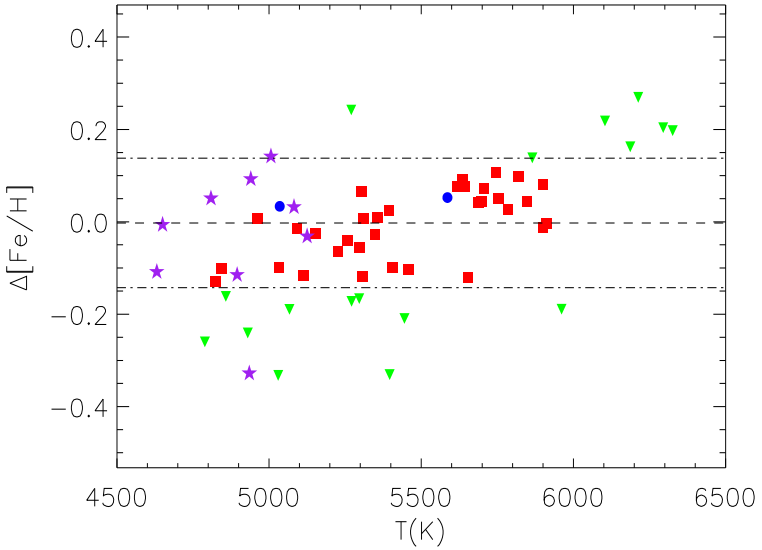
Chemical Tagging FGK stars

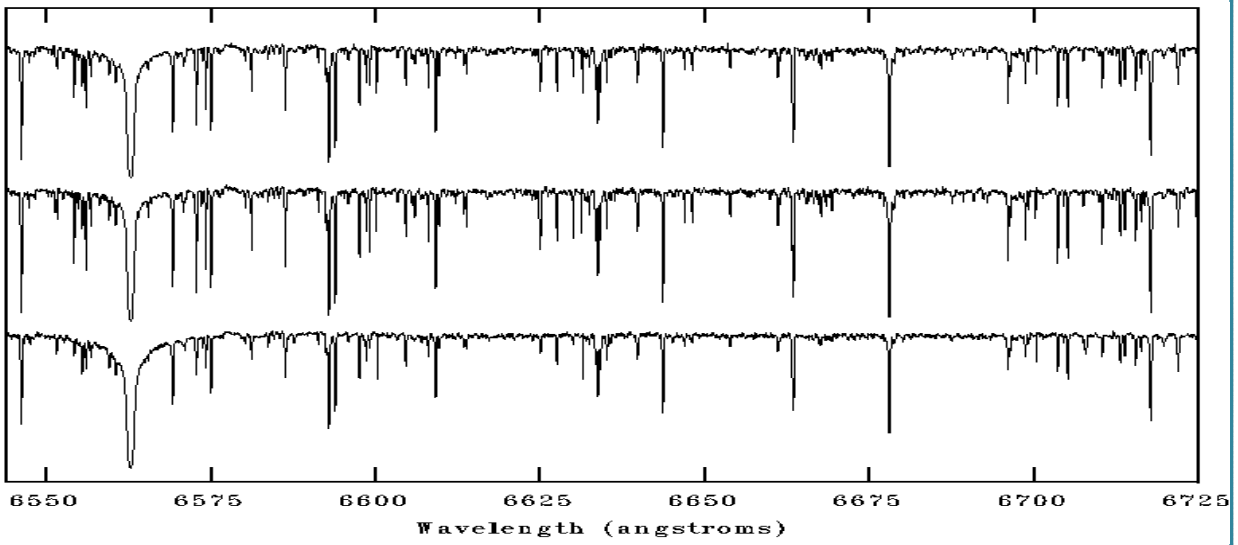
★ Survey for Chemical Tagging of FGK stars in MGs

Hyades and Ursa Major MGs

2010- 2011 – 61 F6-K4 stars

- **Tabernero, Montes, González Hernández** 2011, CS16;
- **Tabernero, Montes, González Hernández** 2012, A&A, in press





Chemically tagging the Hyades Supercluster.

A homogeneous sample of F6-K4 kinematically-selected northern stars⋆

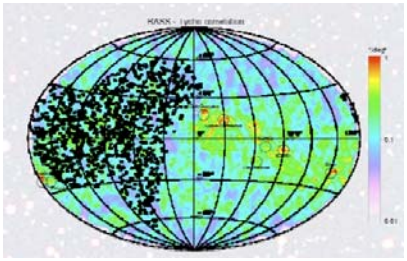
H.M. Tabernero,[1] D. Montes[1] and J.I. González Hernández[1,2]

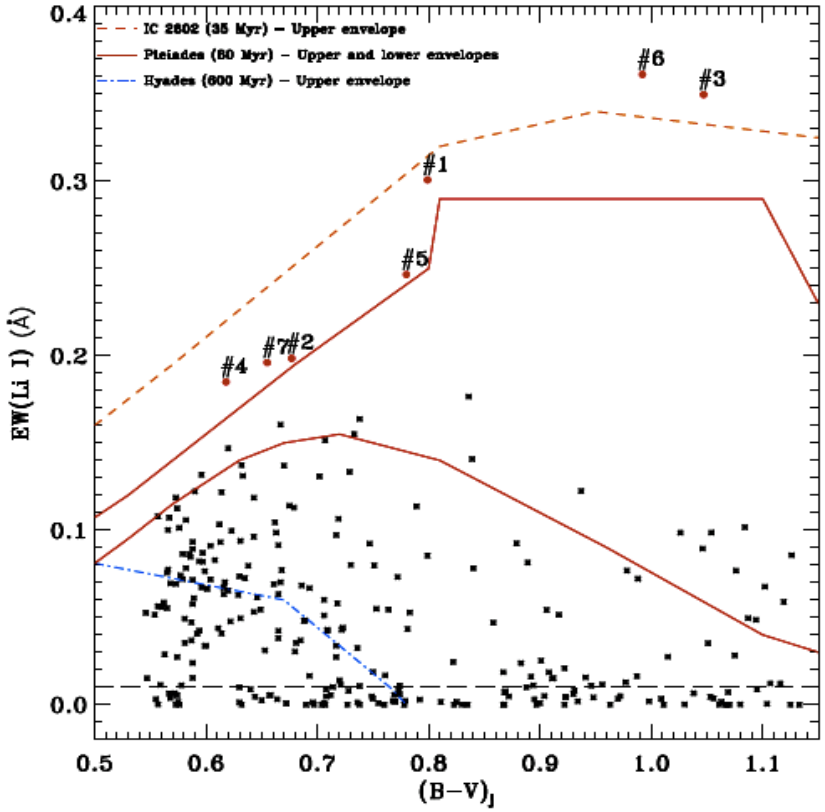
RasTyc Survey

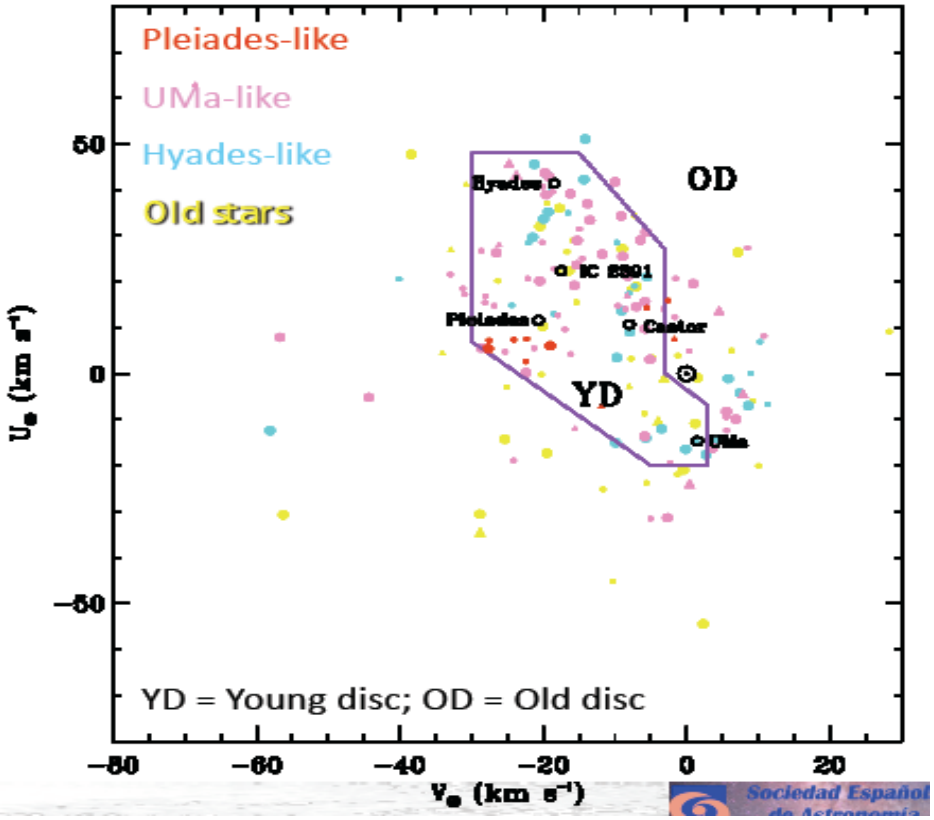
A spectroscopic survey of the youngest field stars in the solar neighbourhood

I. The optically bright sample[⋆,⋆⋆]

P. Guillout[1], A. Klutsch[1], A. Frasca[2], R. Freire Ferrero[1], E. Marilli[2], G. Mignemi[3,1], K. Biazzo[2], J. Bouvier[4], R. Monier[5], C. Motch[1], and M. Sterzik[6]

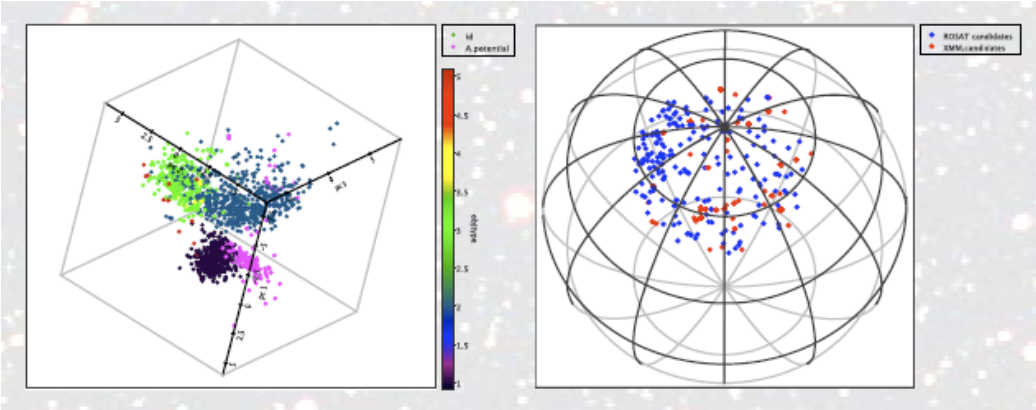


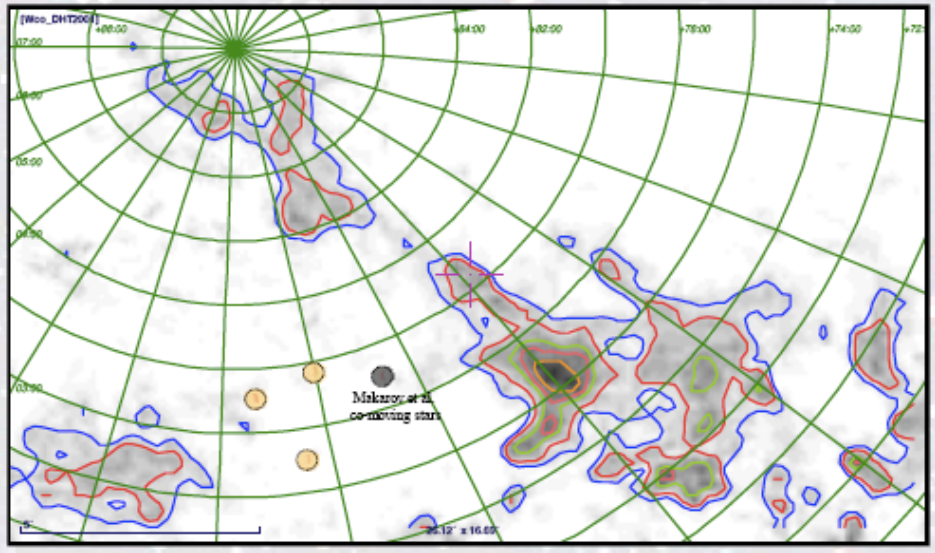




The spectroscopic survey of the youngest field stars in the solar neighbourhood selected from the RasTyc sample (cross-correlation of the ROSAT All-Sky Survey (RASS) with the TYCHO catalogue, Guillout et al. 2009, A&A, 504, 829) indentified new late-type stars MG members and new MG.

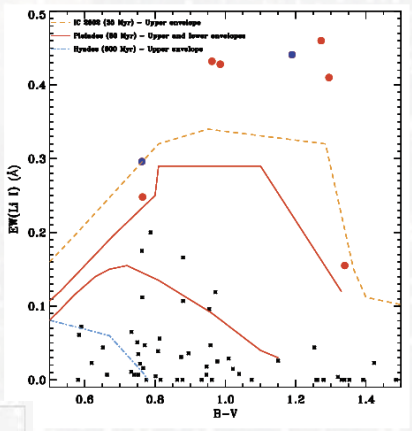
Survey of co-moving young stars in Cepheus

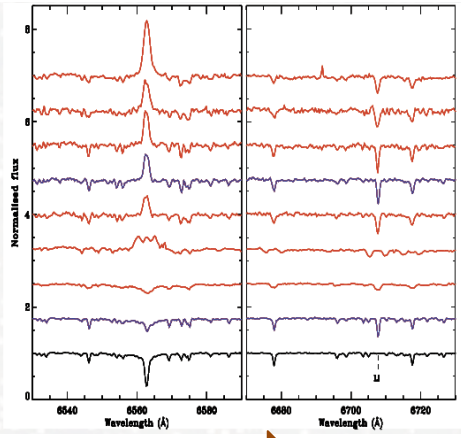




We looked for **optical counterparts of RASS X-ray sources** cross-identified with late-type stars using **multivariate analysis methods** to disentangle the stellar population from the extragalactic component (galaxies and quasars) also emitting in X-ray (Pineau et al. 2011).

Intermediate- and high-resolution optical spectra for 142 candidates, using spectrographs:
INT/IDS (La Palma),
2.2m/FOCES (CAHA),





Young stars towards the CO Cepheus void

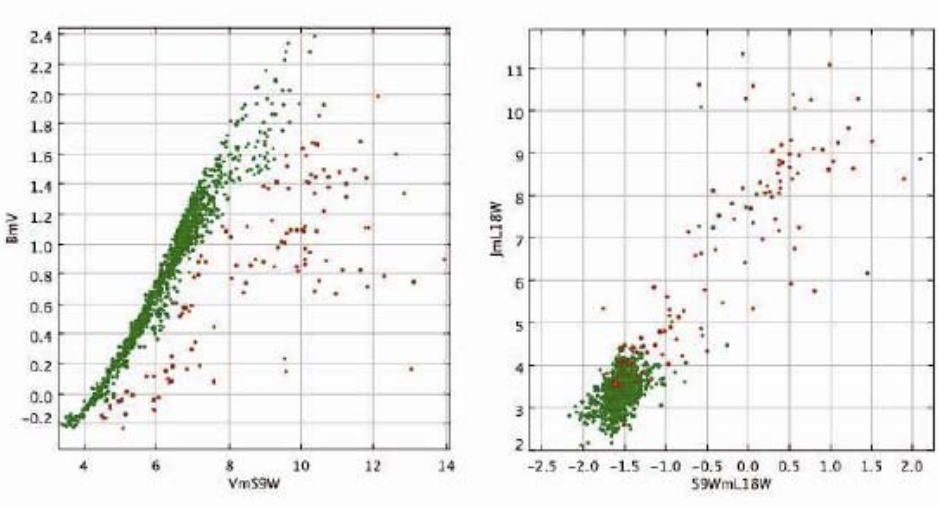
A. Klutsch[1], D. Montes[1], P. Guillout[2], A. Frasca[3], F.-X. Pineau[2], N. Grosso[2], E. Marilli[3], J. López-Santiago[1]

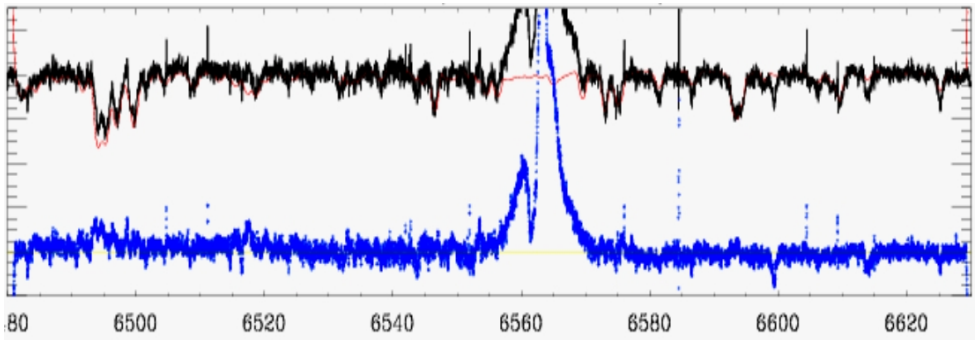
First young loose association in the northern hemisphere?

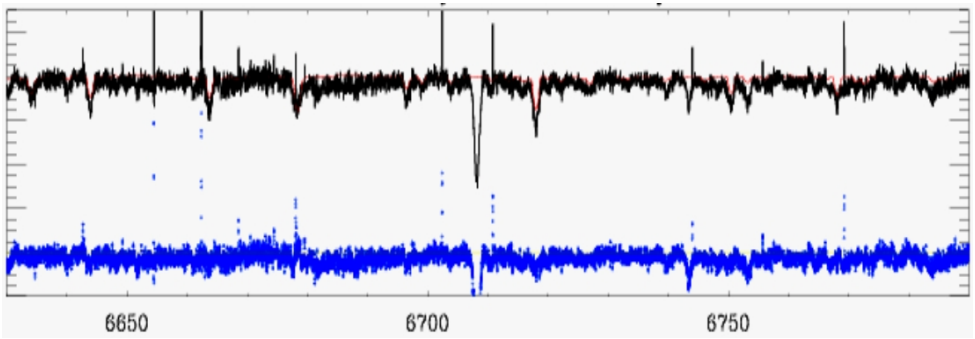
Gaia distances are needed

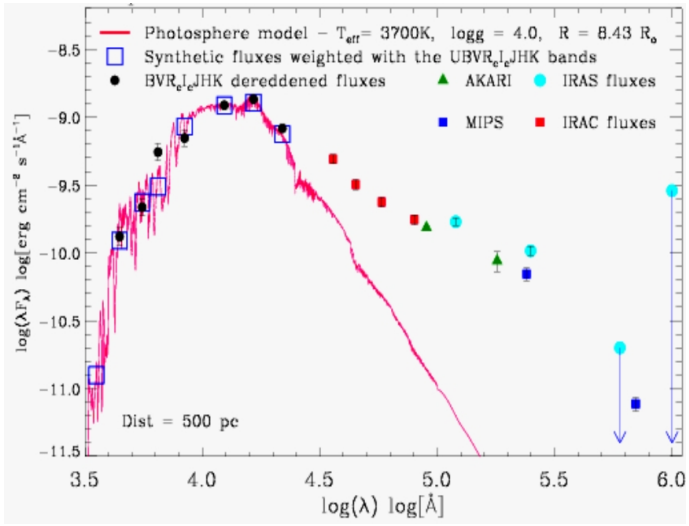
Searching “isolated” very young star

We used color-color diagrams to select, a priori, young stellar objects from the cross-correlation of the **RSC** (RASS-Stars catalogue) and **AKARI** catalogues. In the B-V vs. V-S9W diagram (*Fig.1, left panel*), stars showing IR excess are clearly visible on the right side of the major sequence. They are also outsiders in the right upper region of the J-L18W vs. S9W-L18W diagram (*Fig.1, right panel*).









Gaia distances are needed

Characterization of the CARMENES sample

carmenes

Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs

Calar Alto

- **Characterization of late-type M-dwarfs**

(possible new CARMENES targets from Lepine & Gaidos 2011 catalog)

- CAFOS/2.2m (CAHA)

(G100 – R =1500, 4250-8600 Å)

→ Tsp, activity

- 5 nights Spanish time: 11-12 y 14 Nov 2011; 7-8 Dic 2011
- 5 nights guarantied (GTO) German time: Jan; Feb; Mar 2012
- proposal submitted 2012b

- CAFE/2.2m (CAHA)

(R =60000, 3950-8600 Å)

→ *v*sin*i*

- proposal submitted 2012b

High-Res **pre-Gaia**

Gaia ESO Spectroscopic Survey (GES):

- PIs: Sofia Randich (INAF-Arcetri) & Gerry Gilmore (IoA, Cambridge)
- Public large spectroscopic survey with **FLAMES@VLT**
- Limiting mag. (R): 16.5 (**UVES**), 19 (**Giraffe**)
- **300 nights** (30n/semester) over 5 (4+1) years;
  start 1/2012 (P88), end 9/2016 (P97)+; visitor mode
- **GES spectroscopy** complements and completes **Gaia astrometry**
  and viceversa

Gaia ESO Spectroscopic Survey (GES)

Will start to provide large amount of data

For the stars that will be be observed in the Gaia ESO Spectroscopic Survey (**GES**) with VLT-FLAMES, **UVES** and **Giraffe**

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

- Different tests with UVES archive spectra already started.

- **WG1**: Cluster Membership Analysis
- **WG11**: UVES FGK-star Spectrum Analyses
- **WG12**: Pre-Main-Sequence Stars Spectrum Analyses

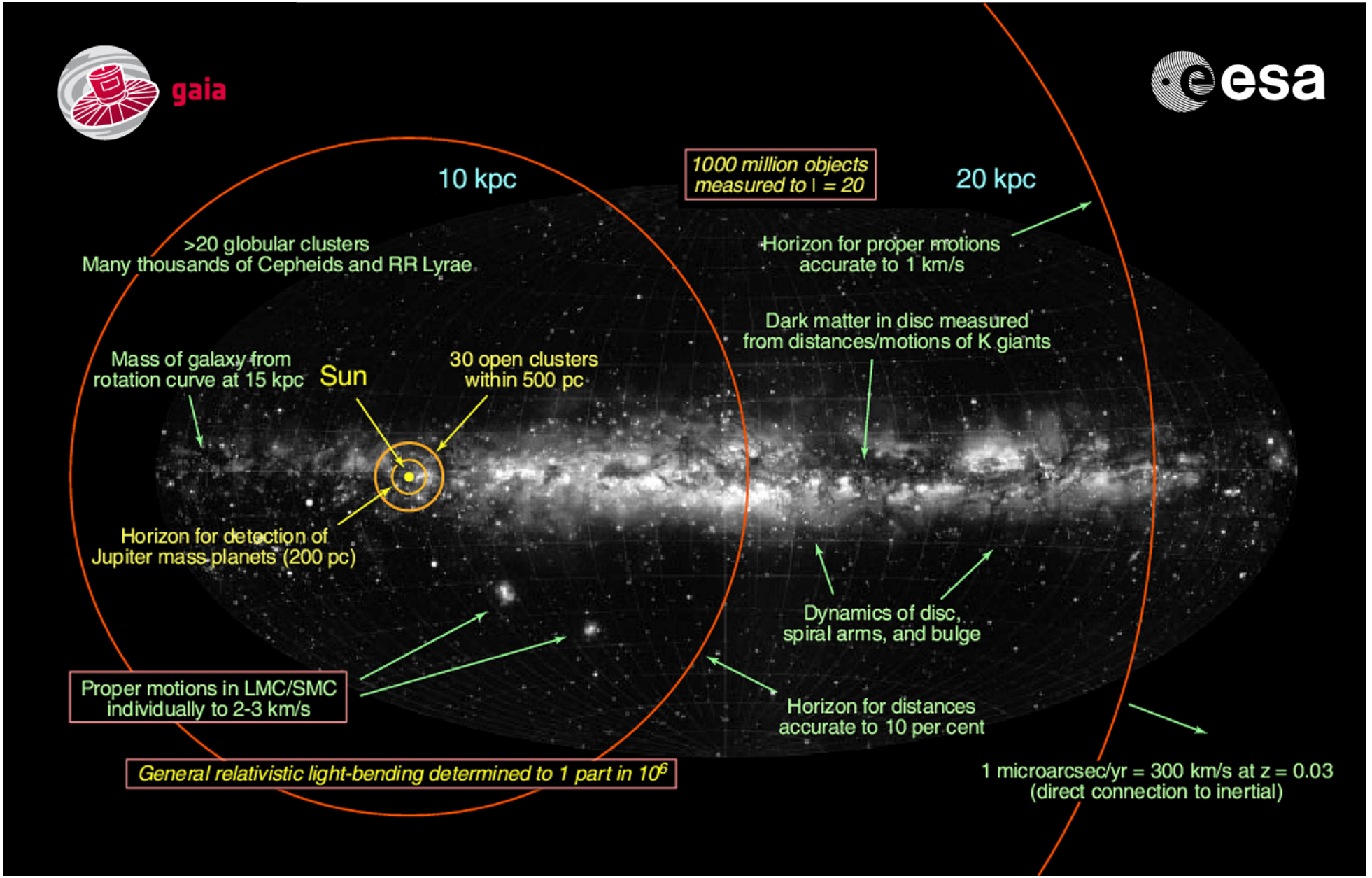
→ Combined Gaia and homogeneous spectroscopic dataset full 6D phase space f(x,y,z,v_x,v_y,v_z), plus stellar parameters, and chemistry for a very large number and variety of stars down to the 19 mag: core science plus legacy science

Gaia ESO Spectroscopic Survey (**GES**)

But additional observations are needed

- Only covers selected targets, selected regions on the sky
- Only the South sky
- Limiting mag. (R): 16.5 (UVES), 19 (Giraffe)
- No follow-up new objects

Future Work: Gaia



Future Work: Gaia

- Precise astrometry (distances) of stars already observed in these surveys

  → confirm or not the results obtained until now.

- Study in detail known and new structures (UVW) in stellar kinematic groups (well-characterized possible members)

  → new follow-up high resolution observations will be needed (determine stellar properties, ages, etc…).

High-Res **post-Gaia**

Spectroscopic surveys of FGKs to complement the deficits of Gaia:

- **RV** of fainter stars G > 17
  (completion of the 6D phase space)

- **Atmosph param** (T_{eff}, log ***g***, ξ and **[Fe/H]**), and ***v*sin*i*** (G > 12)
  (Gaia good T_{eff} limited for log ***g*** and **[Fe/H]**)

- **Chemical tagging,** detailed chemical abundances (G > 11)
  (Gaia only very bright stars)

  (R = 20000, precision 0.1 – 0.15 dex)
  (R > 40000, precision < 0.05 dex)

High-Res **post-Gaia**

Spectroscopic surveys of FGKs dedicated to:

- Obtain additional information (e.g, Li, H α)
- Follow-up of interesting kinematic objects (determine stellar properties, ages, etc…).
- Confirm “isolated” very young star candidates.
- Galactic archaeology (disk population (thin, thick, halo), kinematic structure, etc…)

High-Res **post-Gaia**

More spectroscopic observations of FGKs will be needed:

Large number of stars

Multi-object spectrographs (MOS)
WHT - **WEAVE**
GTC - **MEGARA**
GTC - **MIRADAS**
6 m-CAHA – **HEXA**
But R < 20000

High-Res:

High-Res spectrographs (1.2-2-4m tel)
2.2m – **CAFE**
3.5m - **CARMENES**
NOT-**FIES**
TNG-**HARPS-N**
Mercator-**HERMES**
But only V<10-12

High-Res **post-Gaia**

More spectroscopic observations of FGKs will be needed:

High-Res & faint stars:

High-Res spectrographs (**10m** tel)

GTC-HORUS ?

R = 40 - 80000

Large number of data

Large dedicated program
Queue observing mode
Automatic pipelines

North Spectroscopic survey


The End