CoRoT-GES

The joint action of Asteroseismology and Spectroscopy in the Field of Galactic Archeology

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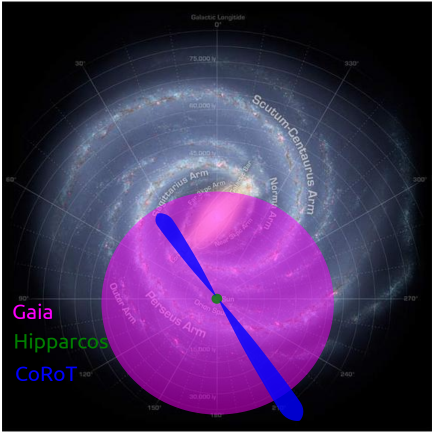
June 4, 2015

Galactic Archaeology

Some of the most important ingredients for investigating our Galaxy are:

1. Accurate element abundances
2. Accurate ages
3. Accurate distances
4. Large number of stars



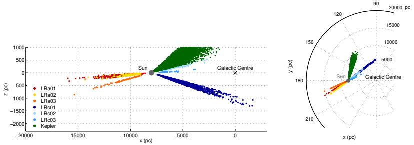
What we can use, while we are waiting for GAIA?

SOLAR LIKE OSCILLATING GIANTS!

Some of the most important ingredients for investigating our Galaxy are:

1. Accurate element abundances → ASTEROSEISMOLOGY
2. Accurate ages → ASTEROSEISMOLOGY
3. Accurate distances → ASTEROSEISMOLOGY
4. Large number of stars → 5000 RG targets in CoRoT and Kepler fields

Nowadays asteroseismology is among the most promising projects in different surveys: GES, APOGEE, GALAH, RAVE, 4MOST



SOLAR LIKE OSCILLATING GIANTS - SCALING RELATIONS

Thanks to two simple scaling equations, seismic observables $\nu_{\rm max}$ and $\Delta\nu$, we have a DIRECT estimate of the Mass and Radius of the star (Kallinger et al.2010):

$$\frac{M}{M_\odot} \simeq \left(\frac{\nu_{\rm max}}{\nu_{\rm max,\odot}}\right)^3 \left(\frac{\Delta\nu}{\Delta\nu_\odot}\right)^{-4} \left(\frac{T_{\rm eff}}{T_{\rm eff,\odot}}\right)^{3/2} \quad (1)$$

$$\frac{R}{R_\odot} \simeq \left(\frac{\nu_{\rm max}}{\nu_{\rm max,\odot}}\right) \left(\frac{\Delta\nu}{\Delta\nu_\odot}\right)^{-2} \left(\frac{T_{\rm eff}}{T_{\rm eff,\odot}}\right)^{1/2}. \quad (2)$$

- Uncertainty on M $\sim$ 10%
- Uncertainty on R $\sim$ 3%
- Tests ongoing: interferometry (Huber et al. 2012); Hipparcos parallaxes (Silva Aguirre et al. 2012); OC NGC6791 (i.e. Miglio et al. 2012 and Sandquist et al.2013), eclipsing binaries, etc

Spectroscopic follow-up

Last proposal submitted to ESO (2013) ...

European Organisation for Astronomical Research in the Southern Hemisphere

[illegible]

APPLICATION FOR OBSERVING TIME PERIOD: **91A**

Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations, should observing time be granted.

1. Title Category: B–3

Galactic archaeology: mapping and dating stellar populations by combining CoRoT photometry of red giants with spectroscopy

2. Abstract / Total Time Requested

Total Amount of Time: 0 nights VM, 22 hours SM

Our understanding of how the Galaxy was formed and evolves is severely hampered by the lack of precise constraints on basic stellar properties such as distances, masses, and ages. Solar-like pulsating red giants represent a well-populated class of accurate distance indicators, spanning a large age range, which can be used

The Gaia-ESO Survey

GES is a public spectroscopic survey of $\sim$ 100,000 stars.

Support of the ESA Gaia astrometric satellite, but will have numerous other uses.

- co-PIs: G. Gilmore (Cambridge) and S. Randich (Arcetri)
- $\sim$ 400 Co-Is from $\sim$ 90 Institutes across all ESO
- 19 WGs
- Stars are observed using the FLAMES spectrograph on the ESO VLT, UVES (3 setups) and GIRAFFE (8 setups) in parallel, at Paranal in Chile. UVES: 5,000 field stars and 2000 OC members. Accurate radial velocities and atmospheric parameters, plus detailed abundances of V, Cr, Mn, Fe, Co and α elements (Si, Ca, Ti). GIRAFFE: accurate radial velocities and atmospheric parameters. [Fe/H] and $[\alpha/Fe]$ + some element (i.e. Ca, Li)

Gaia-ESO Survey Aims

- Delivery of homegeneus atmospheric parameters, results of the effort and synchronization of more that 90 different nodes;
- Creation of a benchmark catalogue of stars (Jofre et al.2014) suitable for Gaia;
- Investigation of the major properties of the MW disks: matallicity gradients, etc (i.e. Recio Blanco et al 2013, Bergemann et al 2014);
- Integration of Asteroseismology in the calibration process.

The CoRoT-GES collaboration

The aims of the collaboration:

- Spectroscopic follow-up of the CoRoT RG.

What the CoRoT-RG group provide to GES:

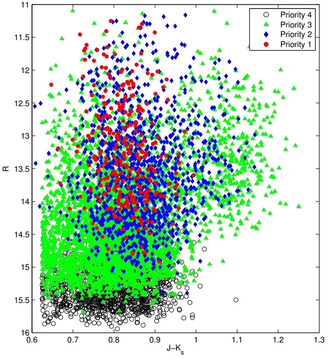
- Use of the seismic gravities for calibrating pipelines log(g)
- Refined atmospheric parameters for CoRoT-RG.

The Imput Catalog

CoRoT RG group provided to GES a list of 6846 targets (Mosser, 2010) in LRc01:

- Priority 1: 283 (evolutionary status from sismology)
- Priority 2: 1196 (sismo available)
- Priority 3: 3985 (possible sismo from new LC)
- Priority 4: 1381 (phot. selected RG - no sismo)

UVES: U580
GIRAFFE: HR21, HR15, HR10



Requirements

Setups:

- UVES: U580
- GIRAFFE: HR10+HR21, HR15

SNR requirements:

- UVES: SNR > 100
- GIRAFFE: SNR > 50

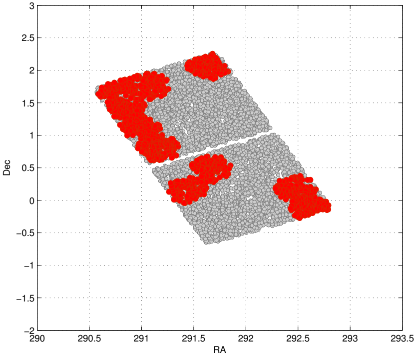
Element abundances

- GIRAFFE : Fe, Ti, Ca, Si, Mg, Mn, Co, Cr, Ni, V, Y, Zr, Li.
- UVES: alpha elements (O, Mg, Si, Ca, Ti), s-elements (Ba and Y), iron peak elements (Fe, Ni, Mn, Cr), and also Na, Al and Li. C CH C2 Swan (0,1) band head (very high SNR).

Observations

LRc01 field is 1 x 2.5 deg, FLAMES instrumental FOV is 25 arcmin (more than 30 fields required).
In iDR3 there are 1115 stars from the imput list - 13 fields.

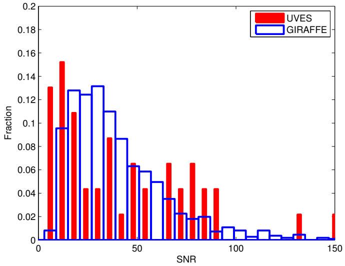
- 38 observed with UVES
- 1077 observed with GIRAFFE



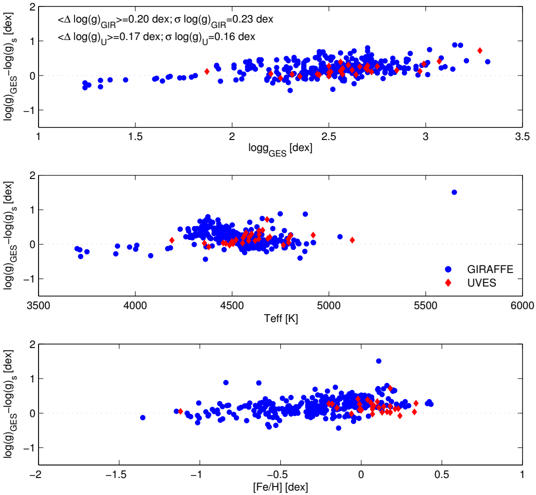
Observations

In iDR3 there are 1115 stars from the CoRoT-GES imput list.

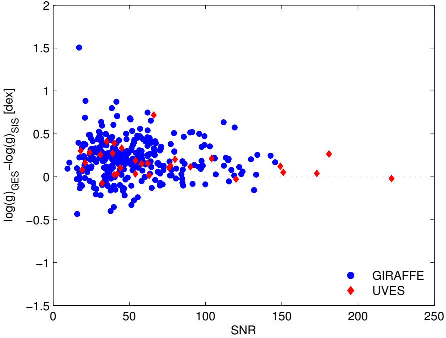
- 67 List 1
  (26 UVES, 41 GIRAFFE)
- 337 List 2
  (6 UVES, 331 GIRAFFE)
- 651 List 3
  (6 UVES, 645 GIRAFFE)
- 56 List 4
  (GIRAFFE)



The CoRoT-GES collaboration: Atm. Parameters

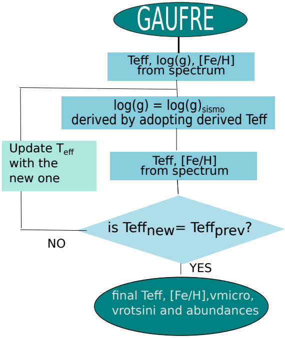


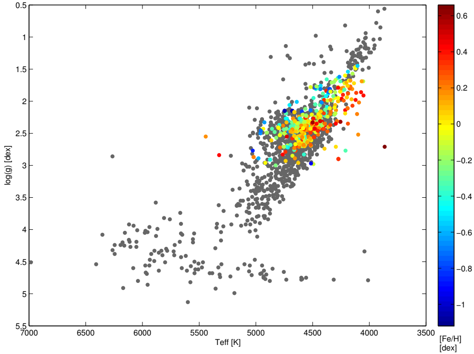
The CoRoT-GES collaboration: Atm. Parameters



The CoRoT-GES collaboration: Atm. Parameters

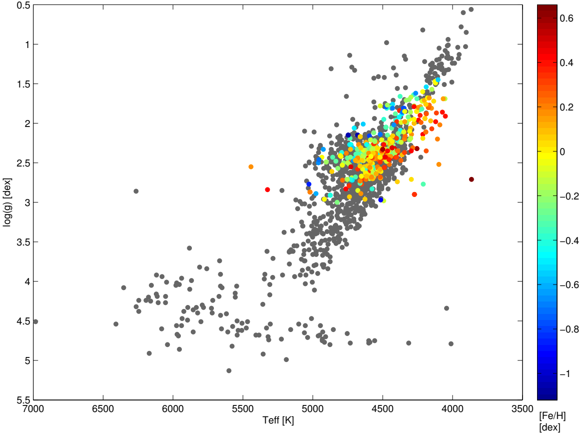
GAUFRE (Valentini et al., 2013) is a spectroscopic pipeline designed for deriving atmospheric parameters of RG fixing log(g) to $\log(g)_{seismo}$. EW of Fe lines, GES linelist,MARCS model atm.





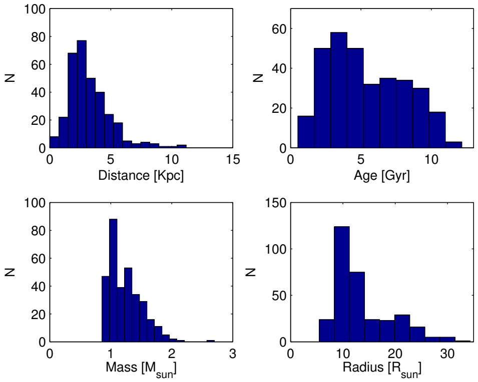
The CoRoT-GES collaboration: Atm. Parameters

GES-CoRoT targets DR3 parameters



R, M, Av, Age, Distances

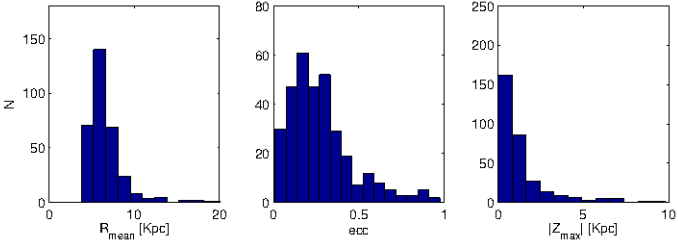
For each star we run PARAM (Da Silva, 2006; Rodriguez et al. 2014) using $\nu_{\rm max}$, $\Delta\nu$ and refined Teff and [Fe/H].
$\rightarrow$ 505 stars



The iDR3Sample

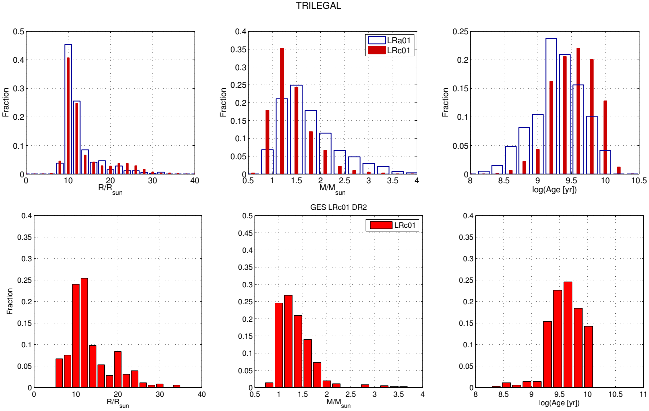
Proper motions from UCAC4, errors on orbital parameters via montecarlo simulation

→ 336 stars:



The iDR3 Sample

Comparison TRILEGAL (Miglio, Chiappini, Morel et al. 2013) and GES (using PARAM)



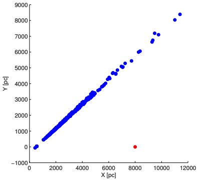
The iDR3 Sample

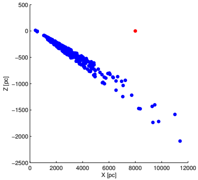
505 stars with Asteroseismology and refined parameters
336 with orbital parameters (Valentini et al., in prep)

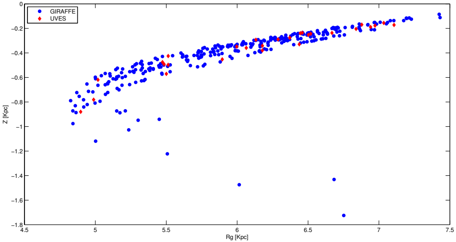
	BEFORE	WITH ASTEROSEISMOLOGY
GIRAFFE Teff [K]	100	65
UVES Teff [K]	70	55
GIRAFFE log(g) [dex]	0.20	0.03
UVES log(g) [dex]	0.12	0.03
GIRAFFE [Fe/H] [dex]	0.10	0.08
UVES Teff [Fe/H] [dex]	0.09	0.05
GIRAFFE [elem.] [dex]	0.20	0.08
UVES [elem.] [dex]	0.08	0.05
Mass	-	10%
Radius	-	5%
Age	>80%	<20%
Dist.	-	<5%

The iDR3 Sample

Spatial distribution:







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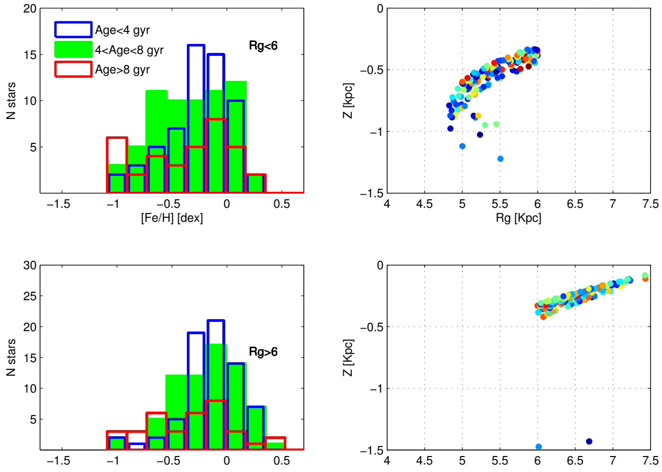

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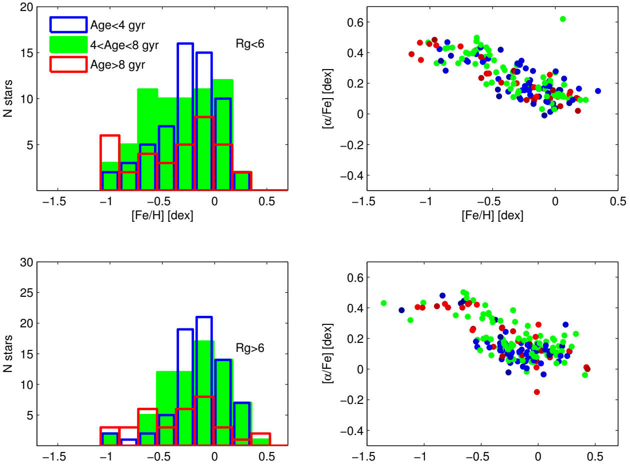

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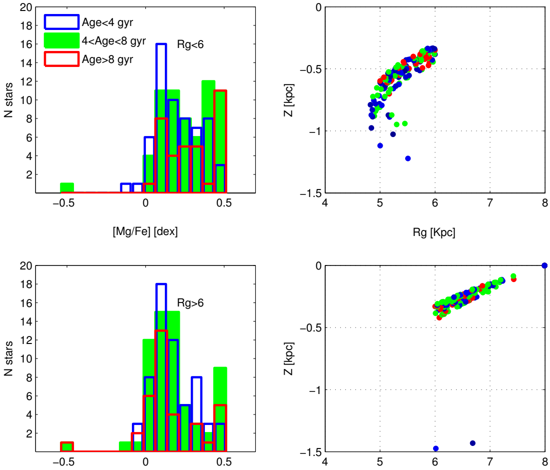
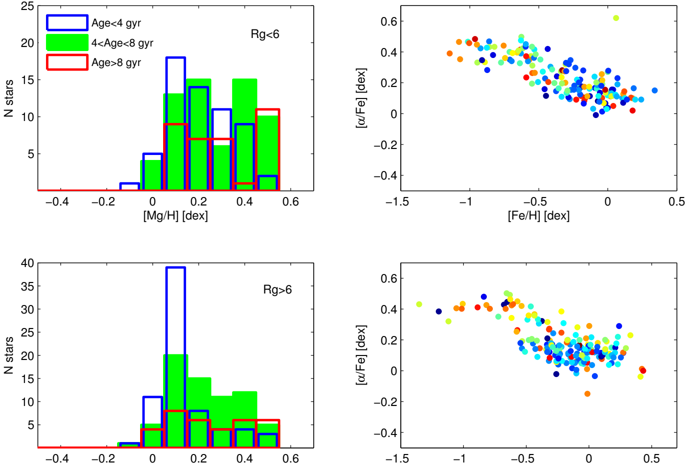
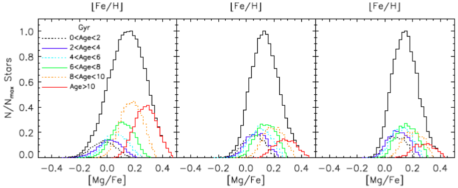


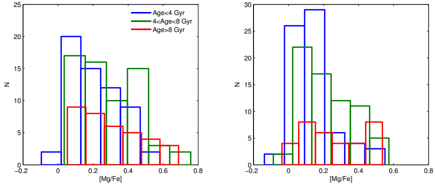
The iDR3 Sample



The iDR3 Sample

Minchev, Chiappini and Martig (2014) (3<r<5kpc,5<r<7 kpc and 7<r<9 kpc)

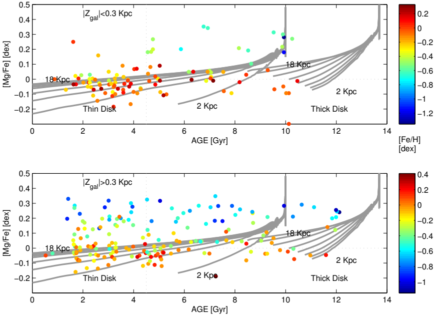




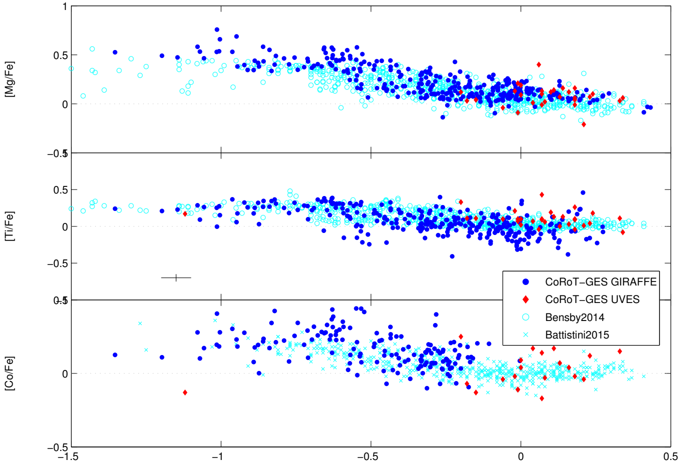
In the inner regions young and old groups of stars should separate better in $[\alpha/Fe]$.

Young Alpha-rich Stars

New young α-enhanced stars (Chiappini et al. 2015,Martig et al. 2015)



Abundances


[Mg/Fe]
[Ti/Fe]
[Co/Fe]
1
0.5
0
−0.5
−1.5
−1
0
0.5
CoRoT−GES GIRAFFE
CoRoT−GES UVES
Bensby2014
Battistini2015

Conclusions

CoRoT-GES sample of 436 stars:

- Wide radius in the inner disk (4.5-7.5 Kpc)
- Accurate atmospheric parameters, abundances,ages and distances thanks to seismology

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UVES Teff [K]	70	55
GIRAFFE log(g) [dex]	0.20	0.03
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Mass	-	10%
Radius	-	5%
Age	$>$80%	$<$20%
Dist.	-	$<$5%

Conclusions

- Characterization of the stellar population in LRc01.
- New young α-enhanced stars (Chiappini et al. 2015,Martig et al. 2015)
- Future: DR4 (1718 CoRoT-RG observed, 979 with seismology), outer disk (see F. Anders talk), K2, Plato and 4MOST.