

# The GALAH survey

## Update on spectroscopic analysis pipeline

WG4 - Sven Buder, contributions by Anish Amarsi, Jane Lin, Karin Lind, Thomas Nordlander

September 29, 2018

### 1 Important changes after GALAH DR2

#### 1.1 Spectroscopic synthesis pipeline available for members

The spectroscopic synthesis pipeline is now open for all GALAH members to use via

<https://galah-survey.org/wiki/galah-spectrum-synthesis-pipeline>

#### 1.2 Documents in preparation of GALAH DR3 available on github

Initial documents for the preparation of GALAH DR3 have been uploaded on a private (hidden) repository on

[https://github.com/svenbuder/GALAH\\_DR3](https://github.com/svenbuder/GALAH_DR3)

If you want to access to these documents, please email Sven to be added as a collaborator (you need a github account for this).

#### 1.3 Updates regarding SME

- Pipeline finally and successfully converted to the recent SME version 536 (if interested, ask WG4 regarding the major changes). Thanks to Thomas Nordlander!
- Improved continuum selection and normalisation with SME. Thanks to Karin Lind!
- Non-LTE now also for H (in addition to Li, O, Na, Mg, Al, Si, and Fe). Thanks to Anish Amarsi!

#### 1.4 Updates regarding use of *Gaia* DR2 and asteroseismic data

- Parallaxes now available for almost all stars observed by GALAH and a vast majority of them are very good, see Figure 1
- The asteroseismic information provided by Sanjib Sharma and others have been used to run a pipeline version which constrains  $\log g$  as a function of  $T_{\text{eff}}$  and  $\nu_{\text{max}}$ , which consists of up to 3175 stars (including bad S/N, bad  $\nu_{\text{extmax}}$  values, and bad reductions).

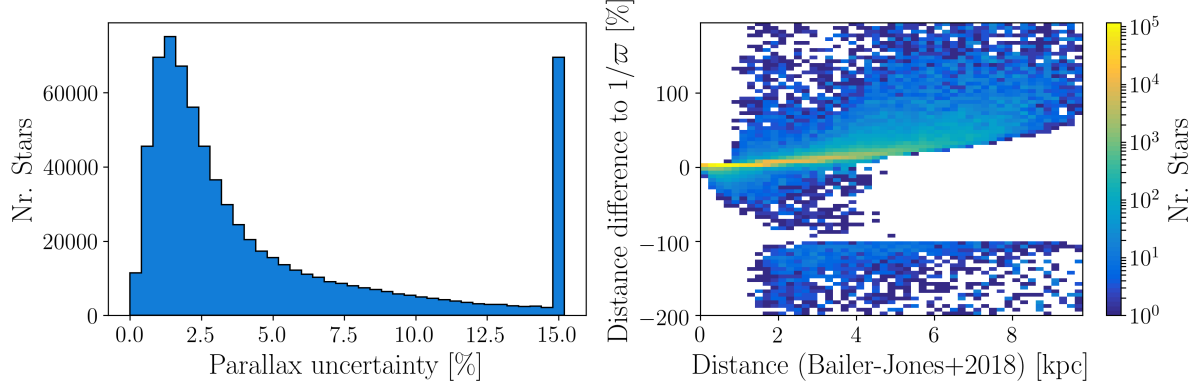


Figure 1: Overview of parallaxes/distances of the stars observed by GALAH.

- For the interim mass and age estimation, we have switched to the use of Parsec isochrones, which include core helium burning stars (in contrary to Dartmouth isochrones) and alpha-enhancement (in contrary to MIST). Thanks to Jane Lin!

## 2 Performances

### 2.1 *Gaia* FGK benchmark stars

We do not see any significant biases for  $T_{\text{eff}}$  and  $\log g$ , but had to correct and  $[\text{Fe}/\text{H}]$  bias of -0.1 (underestimated  $[\text{Fe}/\text{H}]$ ), see Figure 2. Underestimated temperatures for the hottest stars are still likely, but more testing is needed as the continuum normalisation has been improved and hydrogen has been implemented in non-LTE now.

### 2.2 Stars with asteroseismic information

The overlap of the stars with asteroseismic parameters and parallaxes show that the bolometric pipeline (middle panels) performs significantly better than the pipeline without additional non-spectroscopic information (left panels). Especially the Red Clump stars show an outstanding agreement with the pipeline results which also used  $\nu_{\text{max}}$  values, see Figure 3.

The scatter in the differences between asteroseismic and bolometric pipeline for  $\log g$  is mainly driven by the red clump stars, which have to be further investigated, but are significantly better than for GALAH DR2, see the right hand plot in ??.

The biases between asteroseismic and bolometric pipelines for the stellar parameters are not significant but show a trend of lower  $T_{\text{eff}}$  (-21K), lower  $\log g$  (-0.03dex), and lower  $[\text{Fe}/\text{H}]$  (-0.03dex) than the values from the pipeline using asteroseismic values/relations for  $\log g$ .

### 2.3 Stars in clusters

Based on the cluster membership analysis by Janez Kos, we have calculated the stellar parameters for all open and globular cluster members, for which an overview in forms of CMD, Kiel diagram, and distribution of  $[\text{Fe}/\text{H}]$  and interim ages (only maximum likelihood isochrone interpolation) can be found in Figure 4.

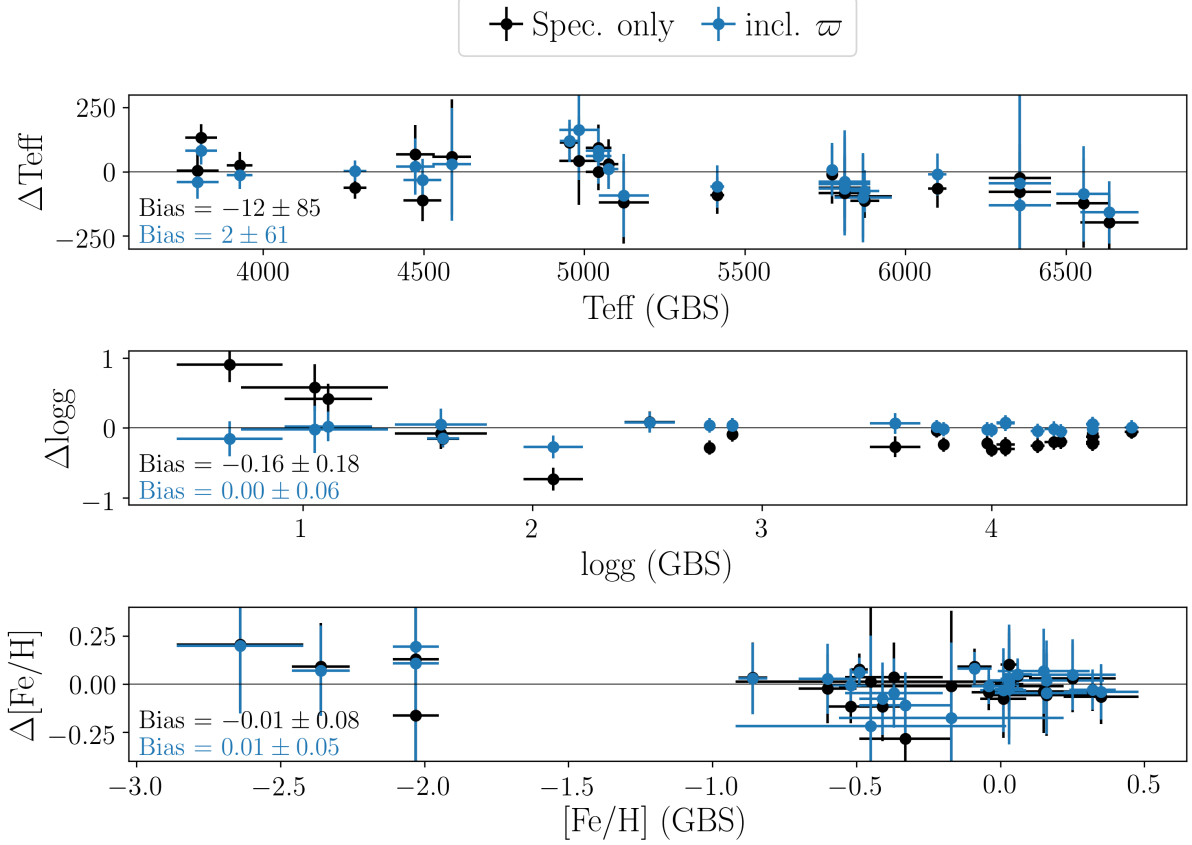


Figure 2: Performance of GALAH synthesis pipeline without (black) and with (blue) bolometric information.

### 3 Additional information: Dynamics

Sven Buder has calculated velocities and actions for all observed GALAH stars based on the *Gaia* DR2 5D information and the radial velocities from WG3 (GUESS).

The python script is added to the github repository and based on the following definitions:

- Uses Galpy 1.4 and its MWPotential2014
- Position of the sun:  $R_{GC,\odot} = 8.2$  kpc,  $z_{GC,\odot} = 25$  pc (Bland-Hawthorn & Gerhard 2016)
- $V_{LSR} = (-11, 10, 7.25)$  km/s (Schoenrich+2012)
- Errors are MC sampled with 10000 draws, distance is sampled with 2-sided Gaussian sampling the distance estimates from Bailer-Jones+2018
- Calculated parameters:  $X/Y/Z$ ,  $U/V/W$ ,  $R/\phi/z$ ,  $J_R/L_Z/J_Z$ ,  $e/z_{\text{max}}/R_{\text{peri}}/R_{\text{ap}}$  with means and standard deviations from MC sampling
- Use the estimated values  $e/z_{\text{max}}/R_{\text{peri}}/R_{\text{ap}}$  with caution! More testing and confirmation is needed!

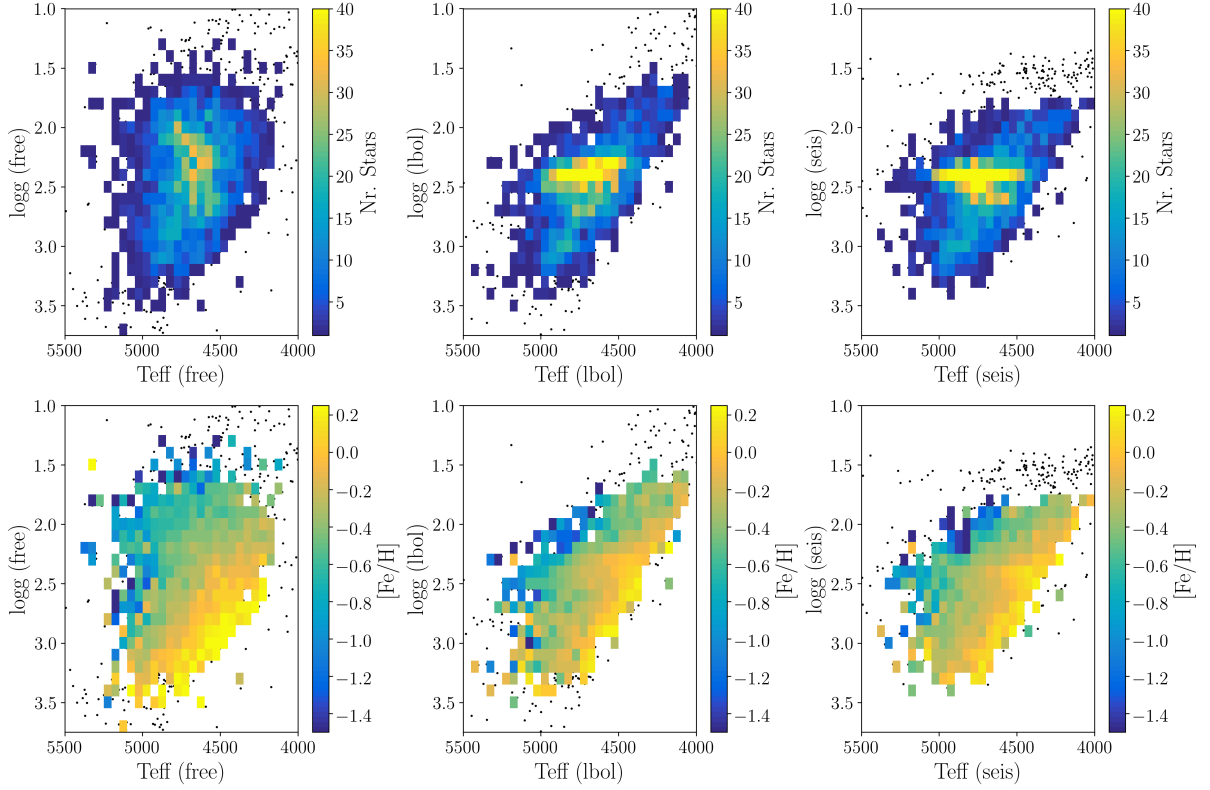


Figure 3: Kiel diagrams showing the performances of the three GALAH synthesis pipelines for the stars with asteroseismic information ( $\log g = f(T_{\text{eff}}, \nu_{\text{max}})$ ) and bolometric information ( $\log g = f(M, T_{\text{eff}}, \varpi, BC, K_S, A_{K_S})$ ), with top plots for density and bottom plots colored by mean  $[\text{Fe}/\text{H}]$ . Left panels show the results without additional non-spectroscopic information, middle panels when using bolometric information and right panels when using asteroseismic information.

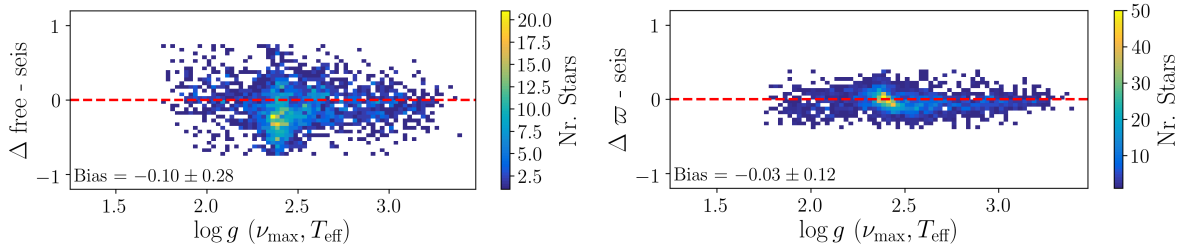


Figure 4: Difference of  $\log g$  for stars with asteroseismic sample. Left:  $\log g$  (free - seis). Right:  $\log g$  (lbol - seis)

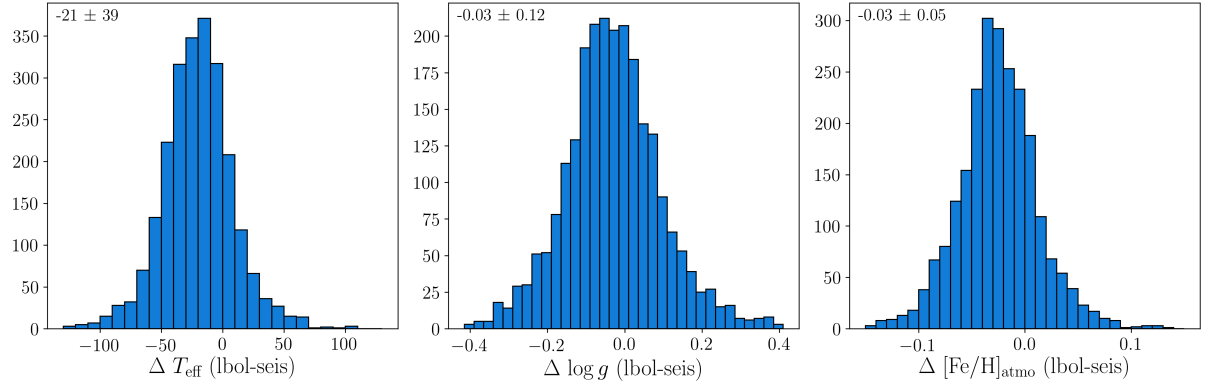


Figure 5: Differences (lbol - seis setups) of stellar parameters (left  $T_{\text{eff}}$ , middle  $\log g$ , right  $[\text{Fe}/\text{H}]$ ) for the stars with asteroseismic information.

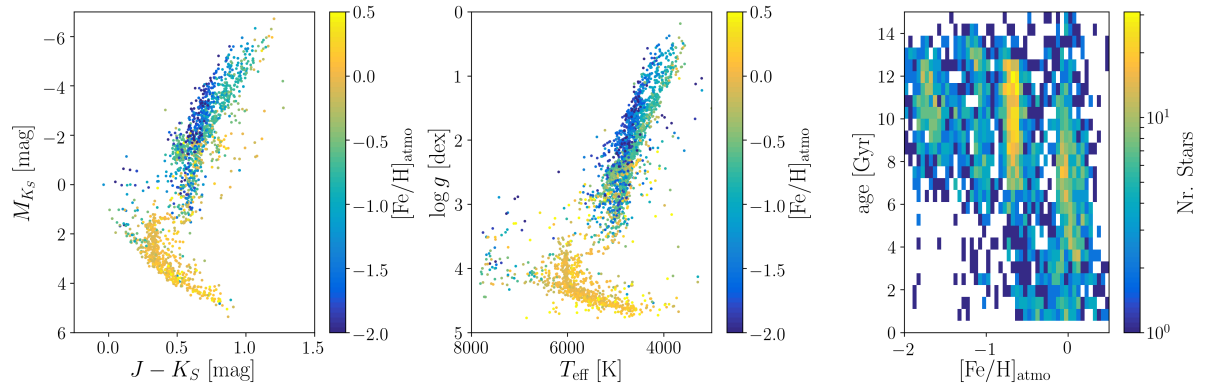


Figure 6: Overview of cluster stars observed by GALAH.

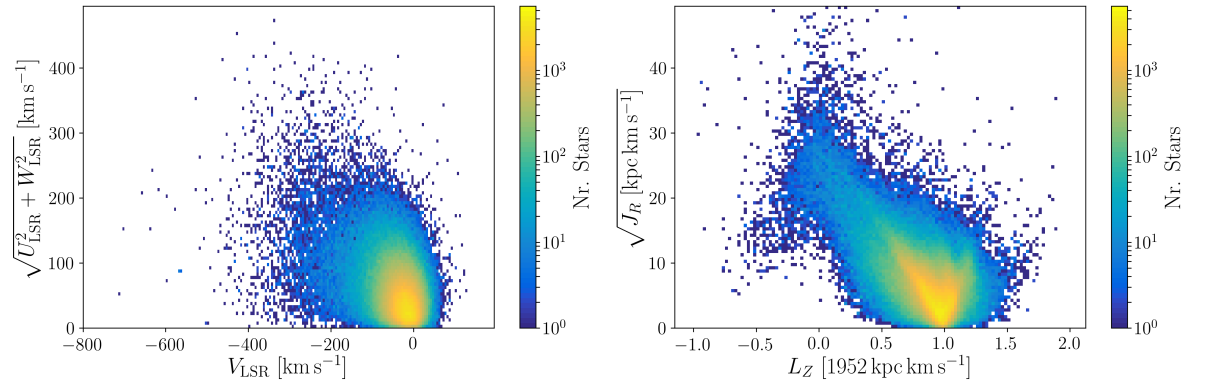


Figure 7: Overview of dynamics of stars observed by GALAH.

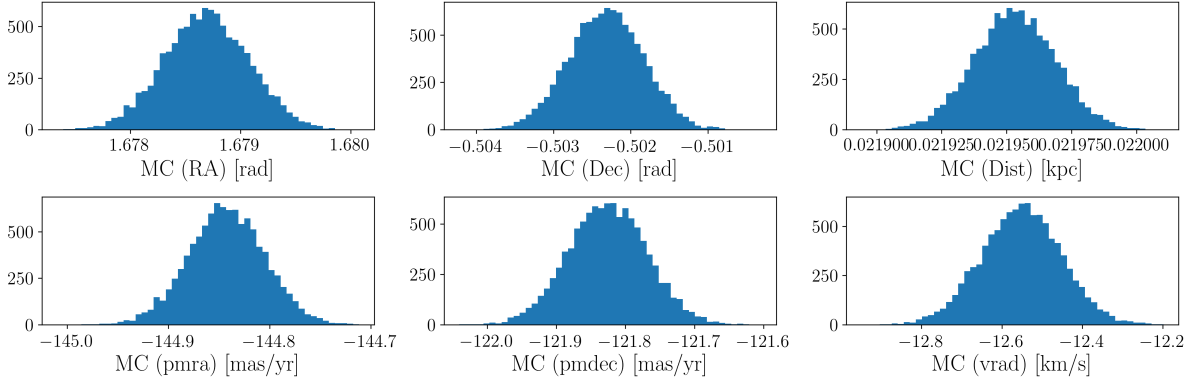


Figure 8: Diagnostic plots of dynamic output from a subset of the GALAH sample.

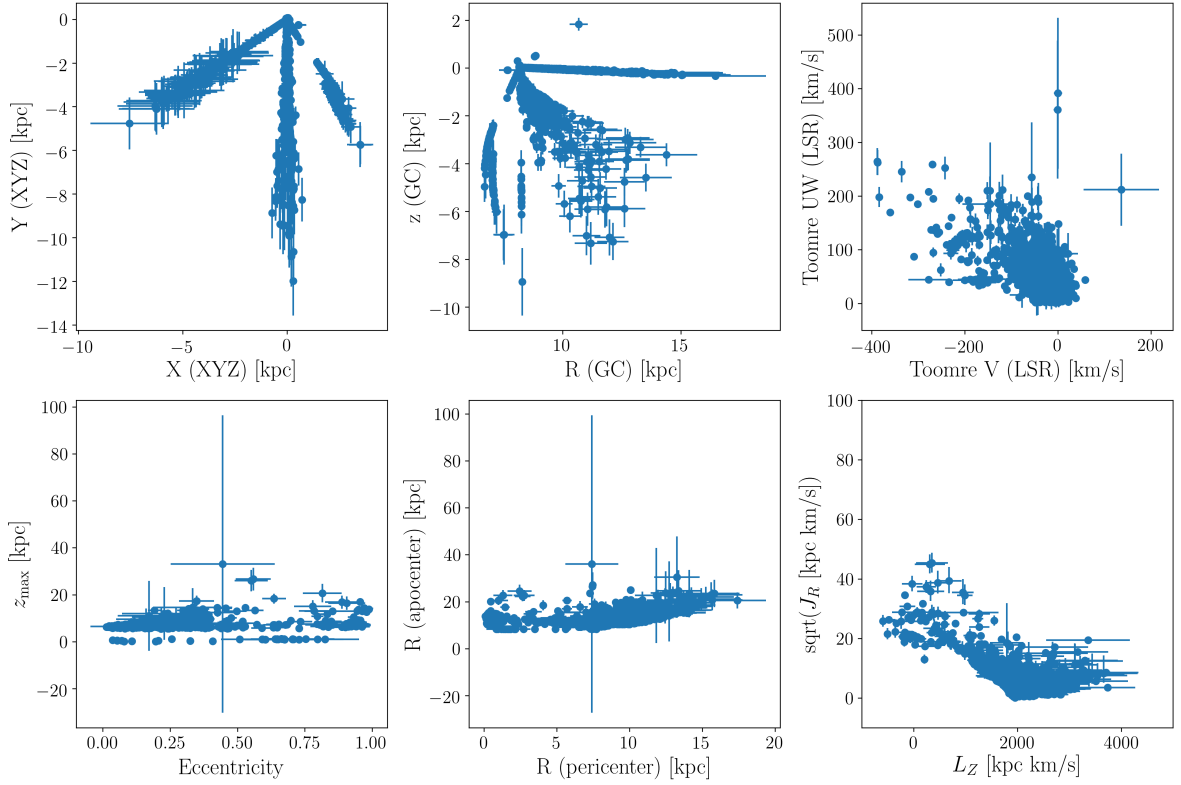


Figure 9: Diagnostic plots of dynamic output from a subset of the GALAH sample.