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The GALAH Survey: Variable star - Cepheids & RR Lyrae

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ABSTRACT

By selecting stars of the GALAH+*Gaia* overlap with high photometric variability, we have identified 2238 stars with photometric variability in *Gaia*'s G band. Selections within color-magnitude diagrams allowed us to identify 91 Cepheid and 384 RR Lyrae candidates. Looking at the coordinates of these stars, 47% of the found Cepheid candidates are located in the loci of the SMC and LMC. Their distances from Bailer-Jones et al. (2018) are ranging from 4 to 17 kpc but have very uncertain parallaxes, which could cause an underestimated distance due to the chosen prior. These Cepheid candidates might hence actually be located in the SMC/LMC. The $BP - RP$ color of the RR Lyrae candidates suggests that their vast majority are RR Lyrae (ab). The non-classified variable stars could include long-periodic variables (e.g. the most luminous variables) and eclipsing binaries. Combining the GALAH survey can help to identify unresolved binaries or confirm their nature via spectroscopy.

1. Introduction

One can select variable stars from the *Gaia*'s photometric variability, i.e.

$$var = \sqrt{\text{N\_OBS\_G\_MAG}} \cdot \text{PHOT\_G\_MEAN\_FLUX\_OVER\_ERROR} \quad (1)$$

$$\sim 0.25 \text{peak to peak variability} \quad (2)$$

2. Data selection

1. Use x-match of GALAH with *Gaia* DR2, WISE, 2MASS, hereafter called "All GALAH stars".
2. Select stars with $4 \cdot variability > 0.32$ (using Equation 1), hereafter called "Variable stars". These are stars with high photometric variability, which in the magnitude range of GALAH stars (see Fig. 1) is likely to be intrinsic.

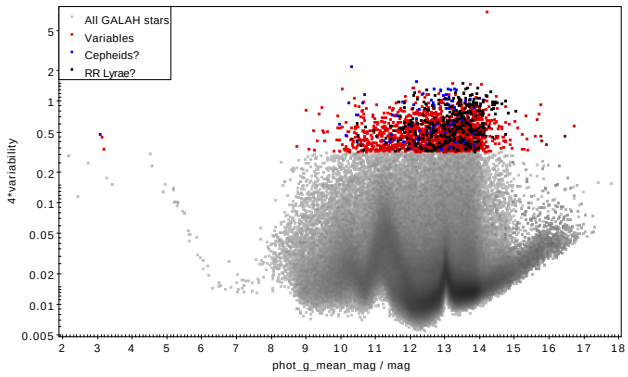

Fig. 1. Photometric variability from Equation 1 as a function of *Gaia* G.

Cepheid selection Select a subset of the latter, hereafter called "Cepheids?", with a cut in M_{K_S} and poorly dereddened 2MASS color

$$\text{KS\_M} - 5 \cdot \log_{10}(\frac{\text{R\_EST}}{10}) < -3, \quad (3)$$

$$\text{J\_M} - \text{KS\_M} - \frac{1}{4} \cdot (\text{PHOT\_RP\_MEAN\_MAG} - \text{KS\_M}) < 0.35 \quad (4)$$

RR Lyrae selection Gaia Collaboration et al. (2018) have shown that RR Lyrae can be identified at a distinct position in the *Gaia* CMD.

Select another subset of the latter, hereafter called "RR Lyrae?", within a bin M_{K_S} and cut in $BP - RP$

$$\text{BP\_RP} < 1, \quad (5)$$

$$-0.25 < \text{PHOT\_RP\_MEAN\_MAG} - 5 \cdot \log_{10}(\frac{\text{R\_EST}}{10}) < 1.75 \quad (6)$$

The distribution of these subsets are plotted in a $T_{\rm eff}$-log g diagram (Fig. 2), color-magnitude diagrams (Fig. 3) and in a sky plot (Fig. 4).

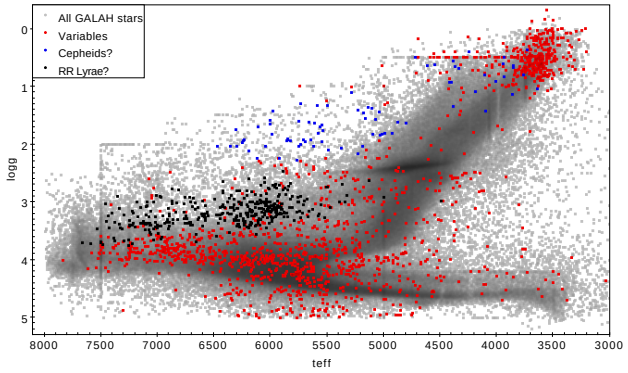

Fig. 2. Spectroscopic log g as a function of $T_{\rm eff}$ from GALAH iDR3.

References

Bailer-Jones, C. A. L., Rybizki, J., Fouesneau, M., Mantelet, G., & Andrae, R. 2018, ArXiv e-prints [arXiv:1804.10121]
Gaia Collaboration, Eyer, L., Rimoldini, L., et al. 2018, arXiv e-prints [arXiv:1804.09382]

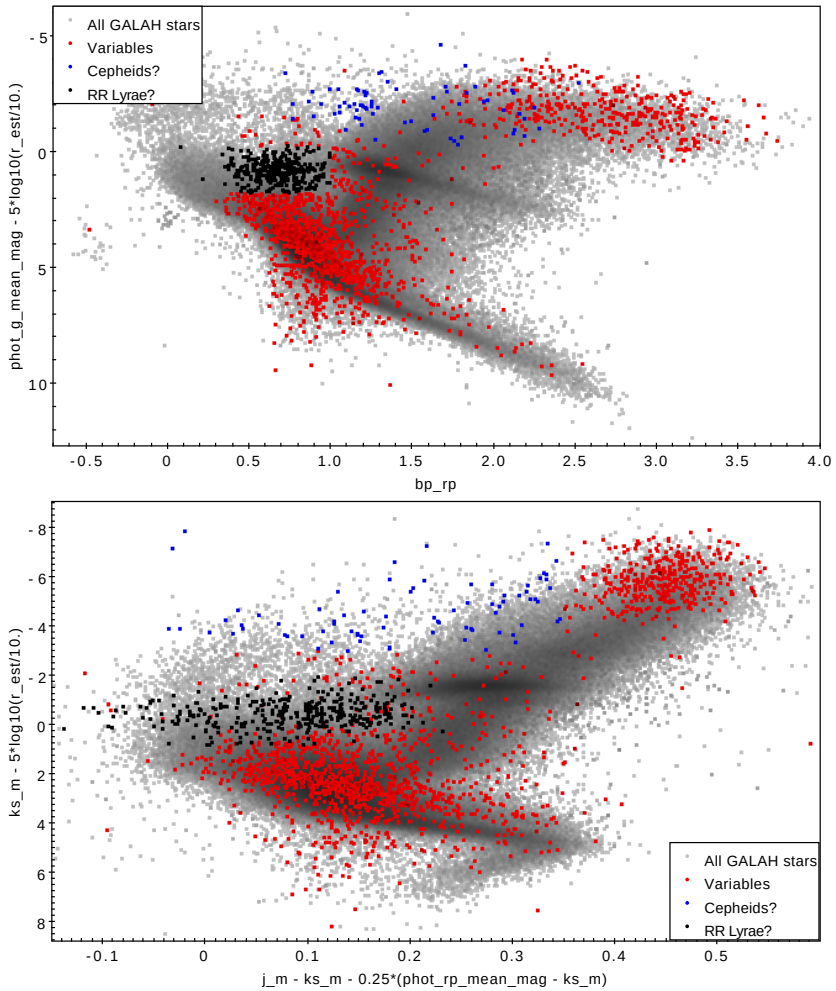

Fig. 3. Color-magnitude-diagrams: M_G as a function of $BP - RP$ (upper panel) and M_{K_S} as a function of poorly dereddened $J - K_S$ color (lower panel).

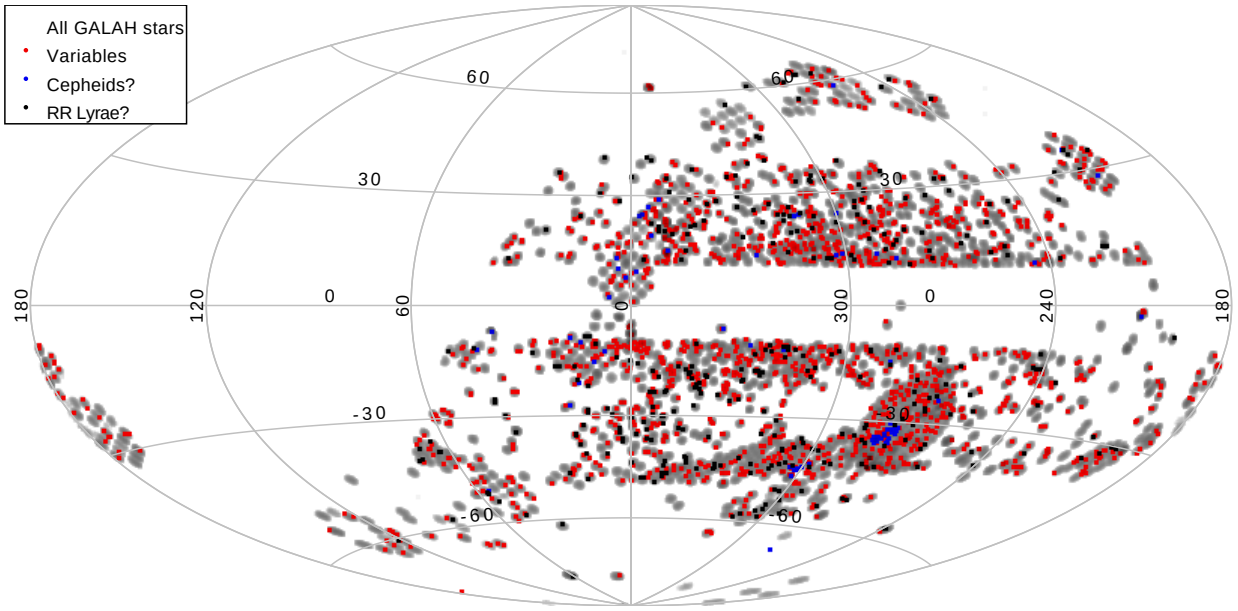

Fig. 4. Sky distribution (l, b) of "Variables", "Cepheids?", and "RR Lyraes?".