

The effects of the selection function on metallicity trends in spectroscopic surveys of the Milky Way

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Abstract. We investigate here the effect of the selection function on the metallicity distribution function (MDF) as well as on the vertical metallicity gradient by studying similar lines-of-sight using four different spectroscopic surveys (APOGEE, LAMOST, RAVE and Gaia-ESO) which have different targeting strategies and therefore different selection functions. We create mock fields for each survey using two stellar population synthesis models, GALAXIA and TRILEGAL. The effects of the selection function are studied in detail by applying the selection function to the two models and comparing the MDF as well as vertical metallicity gradients of the selected sources with that of the underlying sample. We find a negligible selection function effect on the MDF as well as on the vertical metallicity gradients for APOGEE, RAVE and LAMOST, and estimate a mean vertical metallicity gradient of -0.241 ± 0.028 dex kpc^{-1} .

Keywords. Galaxy: solar neighbourhood, stellar content, disk, abundances, evolution, general

1. Introduction

Multi-object spectroscopic surveys of the Milky Way differ in spectral resolution, wavelength coverage as well as their selected targets based on their science goals. These unique target selection schemes can lead to biases in which stellar populations are observed, and affect measurements of the observed properties of the Milky Way; these targeting biases are known as the selection function. The target selection schemes limit the coverage of parameter space of T_{eff} , $\log g$ and $[\text{Fe}/\text{H}]$ that could potentially lead to biases while carrying out analyses that measure the gradients and MDFs of certain stellar populations. It is thus important to investigate the effect of selection function on metallicity trends using the derived metallicities from main Milky Way spectroscopic surveys.

2. Method

APOGEE (Majewski *et al.* 2015), RAVE (Kunder *et al.* 2017), GES (Gilmore *et al.* 2012) and LAMOST (Deng *et al.* 2012) are four different spectroscopic surveys of the Milky Way tracing different stellar populations. We have chosen similar lines-of-sight considering common fields between three surveys at a time: APOGEE-LAMOST-RAVE

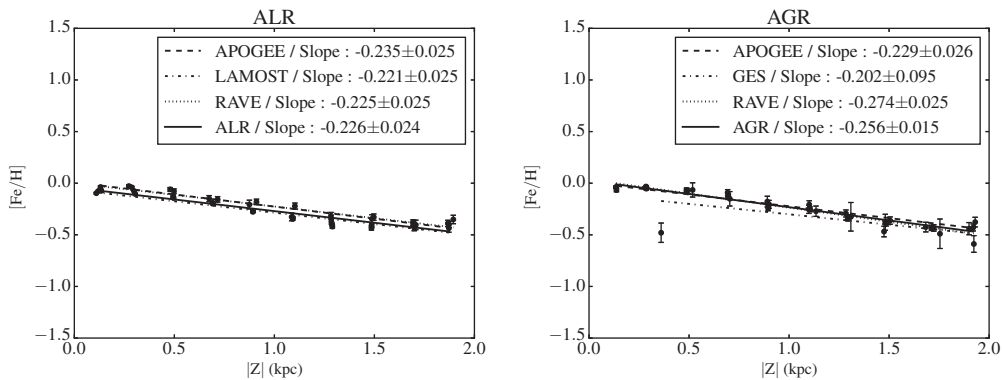


Figure 1. The plot showing the vertical metallicity gradients calculated for all sources in each survey belonging to ALR and AGR. The slope estimated for each survey is also shown in the plots. The gradient for the combined sample of surveys is also shown for ALR and AGR .

(ALR) and APOGEE-GES-RAVE (AGR). We create mock fields for each survey using GALAXIA and TRILEGAL, and apply the selection function in the form of colour and magnitude cuts of the respective survey to the mock fields to replicate the observed source sample.

3. Results

We investigate the effect of the selection function in the MDF by comparing the MDF of the mock observed sources with that of the mock underlying sample using their quartile values (difference in quartiles should be less than 0.1 dex). We find APOGEE, RAVE and LAMOST to have negligible selection effect using both models while GES is suffering too low-number statistics to be conclusive. Similarly, we compare the vertical metallicity gradients between mock observed and mock underlying samples, and we do not find any significant difference using both models for APOGEE, RAVE and LAMOST. In addition, we scale the metallicities in RAVE and LAMOST to that in APOGEE for combined fields for each survey in ALR and AGR, and find the estimated vertical metallicity gradient for each survey to be consistent within 1σ indicating the negligible effect of selection function (see Fig. 1). Finally, we estimate a mean vertical metallicity gradient of -0.241 ± 0.028 dex kpc^{-1} , and conclude that in the era of rising large spectroscopic surveys, in principle common fields of the surveys can be combined once they are put in the same metallicity scale (Nandakumar *et al.* 2017).

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References

- Majewski, S. R., Schiavon, R. P., Frinchaboy, P. M., *et al.* 2015, arXiv:1509.054
 Kunder, A., Kordopatis, G., Steinmetz, M., *et al.* 2017, *AJ*, 153, 75
 Gilmore, G., Randich, S., Asplund, M., *et al.* 2012, *The Messenger*, 147, 25
 Deng, L.-C., Newberg, H. J., Liu, C., *et al.* 2012, *Research in A&A*, 12, 735
 Nandakumar, G., Schultheis, M., Hayden, M., *et al.* 2017, arXiv:1707.09932