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Kinematic trends in young and old stars

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Abstract. Using RAVE DR5, we explore the age, kinematic, and chemical correlations of a sample of 30,000 FGK stars. We separate a sample of turnoff stars into two age groups: young and old. For each of the two age groups, we calculate kinematic trends as a function of Galactocentric radius (R), for different metallicity ([Fe/H]) bins. For both young and old stars, we measure a negative gradient in $\partial\langle V_R\rangle/\partial R$. In addition, for young stars we find a correlation between the magnitude of the slope and metallicity, with the most metal-rich bins having the steepest gradient and the most metal-poor bins having a flatter trend.

Keywords. stars: ages, stars: abundances, stars: kinematics

1. Introduction

The presence of a gradient in Galactocentric radial velocity as a function of R in the solar neighborhood was first shown by Siebert *et al.* (2011) using RAVE (Steinmetz *et al.* 2006) stars, and they suggested that the observed trends could be the result of a combination of non-axisymmetric components (e.g. the bar, spiral arms) of the Galactic potential. Siebert *et al.* (2012) and Faure *et al.* (2014) found the gradient to be consistent with dynamical models that contained spiral arms, while Monari *et al.* (2014) showed that the gradient could be reproduced with a bar. In addition, Monari *et al.* (2016) also explained this gradient with a model that included both a bar and spiral arms. In this proceeding, we characterize the dependence of age and metallicity on $\partial\langle V_R\rangle/\partial R$, in order to explore the contribution of both the bar and spiral arms on the observed gradient.

2. Age validation and sample selection

Ages are determined using a Bayesian isochrone projection pipeline (McMillan *et al.* 2017). We assessed the accuracy of age estimates from this pipeline using a RAVE-like mock catalogue generated with Galaxia (Sharma *et al.* 2011). We find that age estimates from the pipeline are more reliable for turnoff stars, and in particular for both young and old turnoff stars. To conduct our analysis, we select a sample of high-quality (SNR > 40) turnoff stars from RAVE DR5 (Kunder er al. 2017). We separate this RAVE sample into two age groups: young ($0 < \tau < 3$ Gyr) and old ($10 < \tau < 13$ Gyr). For each of the two age groups, we divide the sample into [Fe/H] bins as shown in the left panel of Figure 1.

3. Results: radial velocity gradients as a function of R

In the middle and right panels of Figure 1, we explore trends in Galactocentric radial velocity as a function of R for each age group and metallicity bin. We find negative gradients in $\partial\langle V_R\rangle/\partial R$ for both young and old stars. For young stars, we find a strong correlation between metallicity and the magnitude of the gradient, with the most metal-rich bin ($0.15 \leqslant$ [Fe/H] < 0.45) having a steeper gradient (-24.7 ± 1.0 km s^{-1} kpc^{-1})

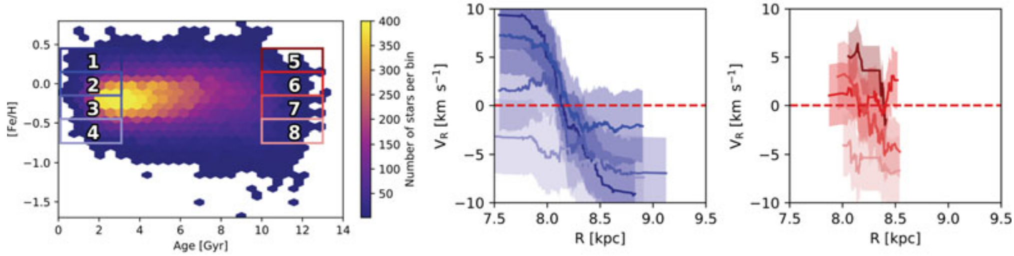

Figure 1. Left: 2D histogram of our turnoff sample in age vs. [Fe/H], with age groups (young in blue, old in red) and metallicity bins overplotted. Middle, right: Mean Galactocentric radial velocity as a function of R for our young (blue, middle) and old (red, right) stars. Colors correspond to the metallicity bins in the leftmost panel.

than the most metal-poor bin ($-0.75 \leqslant$ [Fe/H] < -0.45, -0.7 ± 0.3 km s^{-1} kpc^{-1}). We note that we find a similar correlation for old stars, but the effect is much weaker. Although the gradient we find for young, metal-rich stars is steeper than literature values (e.g. ~ -8 km s^{-1} kpc^{-1}, Siebert *et al.* (2011) and Williams *et al.* (2013)), we attribute this difference to our sample selection.

4. Conclusions and outlook

We find a negative gradient in $\partial\langle V_R\rangle/\partial R$, consistent with previous findings. For young stars, we find a correlation between the magnitude of this gradient and metallicity, such that as metallicity decreases, so does the magnitude of the gradient. In Wojno *et al.* (in prep.), we further investigate the contribution of each non-axisymmetric component by investigating the distribution in $V_{\mathrm{R}} - V_{\phi}$ space of stars in each metallicity bin. We conclude that the both the bar and spiral arms contribute to the gradient, and the magnitude of the contribution of each component varies as a function of metallicity (i.e., metal-poor stars have less of a contribution from the bar) to produce the flattening of the gradient that we see. We also explore trends in mean azimuthal velocity as a function of R and metallicity. Understanding such features of the local velocity field is crucial for developing realistic Milky Way disc models, and now with age estimates of field stars, we add another dimension to help disentangle the chemodynamical history of the Galaxy.

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