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Chemo-Kinematic Properties of the Galactic Disk with SEGUE G and K Dwarfs: Constraints on Formation

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Abstract. We present the derived kinematic characteristics of low-α thin-disk and high-α thick-disk stars in the Milky Way, investigated with a sample of about 32,000 G- and K-type dwarfs from the Sloan Extension for Galactic Understanding and Exploration (SEGUE). Based on the level of α-element enhancement as a function of [Fe/H], we separate our sample into thin- and thick-disk stars and then derive mean velocities, velocity dispersions, and velocity gradients for the U, V, and W velocity components, respectively, as well as the orbital eccentricity distribution. There are notable gradients in the V velocity over [Fe/H] in both populations: -23 km s^{-1} dex^{-1} for the thin disk and $+44$ km s^{-1} dex^{-1} for the thick disk. The velocity dispersion of the thick disk decreases with increasing [Fe/H], while the velocity dispersion gradient over [Fe/H] for the thin disk is almost flat for all velocity components, except for the W velocity dispersion of the metal-poor thin-disk stars. The eccentricity distribution exhibits a peak at a higher value, and is more symmetric as [α/Fe] increases, implying that complex formation mechanisms may be involved. Our results can be used to constrain several proposed disk-formation scenarios of the Milky Way and other large spirals.

Keywords. Methods: data analysis, Galaxy: disk, stars: α-abundances

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We have investigated the kinematic properties of the chemically-separated Galactic disks. As shown in the left panel of Figure 1, we separated disk stars into low-α thin-disk (lower dashed line) and high-α thick-disk (upper dashed line) populations.

As seen in the right panel of Figure 1, we found significant slopes in the V velocity over [Fe/H] for the thin and thick disk, with opposite signs: -22.8 ± 2.2 km s^{-1} dex^{-1} for the thin and 43.9 ± 2.8 km s^{-1} dex^{-1} for the thick disk, respectively, which agree well with previous studies (Adibekyan *et al.* 2013; Recio-Blanco *et al.* 2014). The chemically-selected thick-disk stars have higher velocity dispersion than the thin-disk counterparts in all velocity components: mean velocity dispersion $\sigma(U,V,W)=(48,30,28)$ km s^{-1} for the thin disk and $\sigma(U,V,W)=(62,40,37)$ km s^{-1} for the thick disk. These are slightly larger than those reported by Wojno *et al.* (2016).

Figure 2 shows the eccentricity (e) distribution in a given range of [α/Fe] for the both disks. We note that the shape of eccentricity distribution changes with increasing [α/Fe] for the thick disk, becoming more symmetric as [α/Fe] increases. Even though this behavior can be explained by *blurring* or formation from very turbulent gas, the extended tail to high eccentricity may be the result of a gas-rich merger, which implies a complex formation history of the Galactic thick disk.

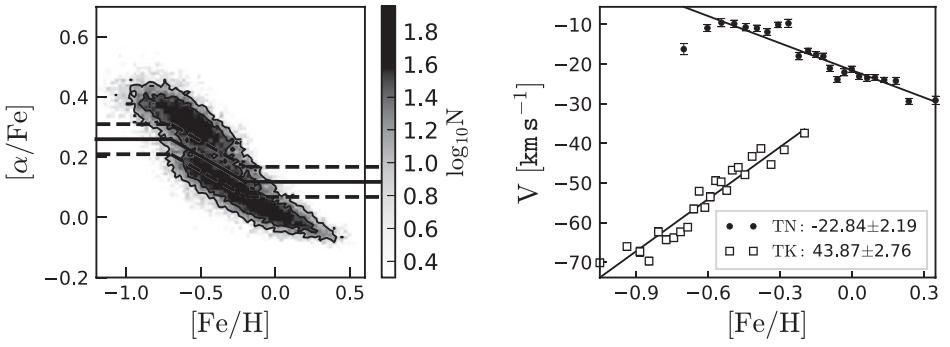

Figure 1. *Left*: Logarithmic number density of stars in the [α/Fe]-[Fe/H] plane. A solid line summarizes our criterion to separate the thin and thick disk. *Right*: The slopes of rotation velocity for the thin- and thick-disk populations over [Fe/H]. The open squares represent the thick disk, while the filled circles are for the thin disk.

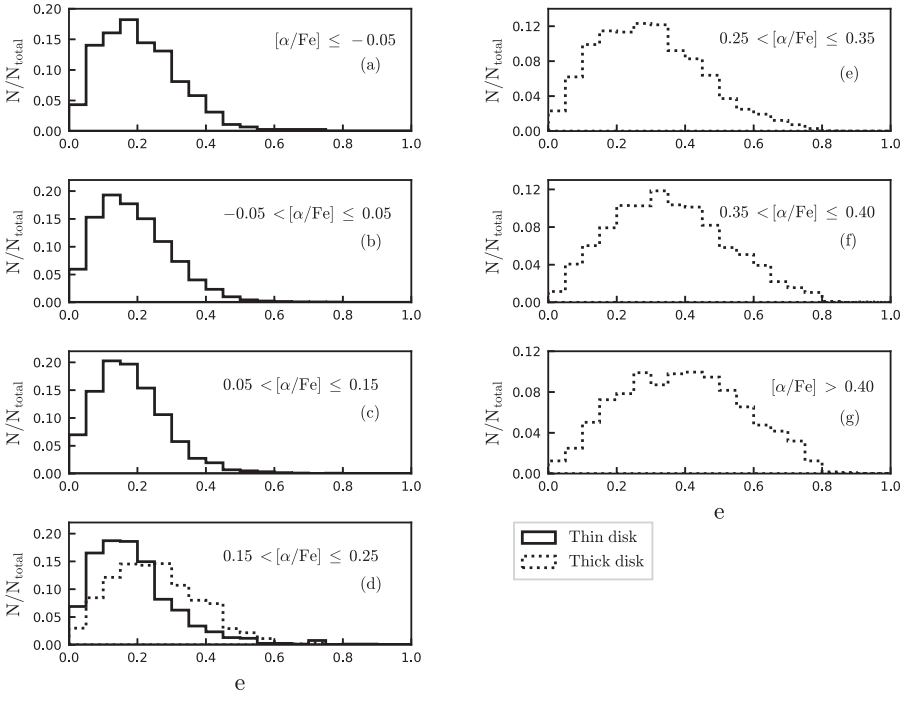

Figure 2. Histogram of eccentricities for the thin disk (solid line) and the thick disk (dotted line) with the various [α/Fe] bins. The [α/Fe] range increases from panel (a) to (g).

References

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