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The Spatial Structure of the Galactic outer disk with LAMOST DR3 K giant stars

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Abstract. The spatial structure of the Milky Way outer disk is characterized with $\sim$ 70000 LAMOST DR3 K giants after carefully correction of their selection effects. By slicing the data into various Galactocentric radius bins, we are able to fit the vertical stellar density profile with a models composed of two isothermal-sheet disks and an oblate power-law halo. We find that although the thin disk is significantly flared, the radial surface density profile can extend to as far as 19 kpc. Beyond 12 kpc, only one thicker disk, rather than two disk components, are found in the samples. Moreover, the residual of the density profiles after subtracting the best fit models show different oscillation patterns in almost all range of detecting radius.

Keywords. Galaxy: structure, Galaxy: disk, Galaxy: evolution

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1. Introduction

Milky Way plays critical role in the research of the galactic formation and evolution, because we can study in details from large samples of individual stars with the help of large sky surveys. The outskirt of a disk galaxy can tell us how the disk secularly evolves, and there might be multiple formation mechanisms for the outer stellar disk (Rix & Bovy. 2013). The outer disks of galaxies also present a unique laboratory for studying the process of disk formation and it can provide us with a direct view of disk assembly in progress (Roškar *et al.* 2008). The LAMOST DR3 catalogue have provided more than 5 millions spectra, which can renew our understanding of our home galaxy (Deng *et al.* 2012).

2. Data and Method

Distances are determined by using a Bayesian method developed by Carlin *et al.* (2015). Stellar density profiles along different observation fields are derived by considering the post-observation selection effect (Liu *et al.* 2017). We combine these density profiles along the LAMOST observation fields and map them into Galactocentric cylindrical R-Z plane given that the stellar density profile are approximately axisymmetric. Then, we slice the data into different R bins from 8 to more than 20 kpc. At each R bin, the vertical stellar density profile is fitted with two isothermal-sheet disks and an oblate halo. Beyond R=12 kpc, the two-disk model does not fit the data any more, we then turn to use a single disk model for the data with R > 12 kpc.

3. Results

First, even at R=19 kpc, the vertical density profile can still be well fitted using a disk model with scale height of about 1.3 kpc. This implies that the disk can extend

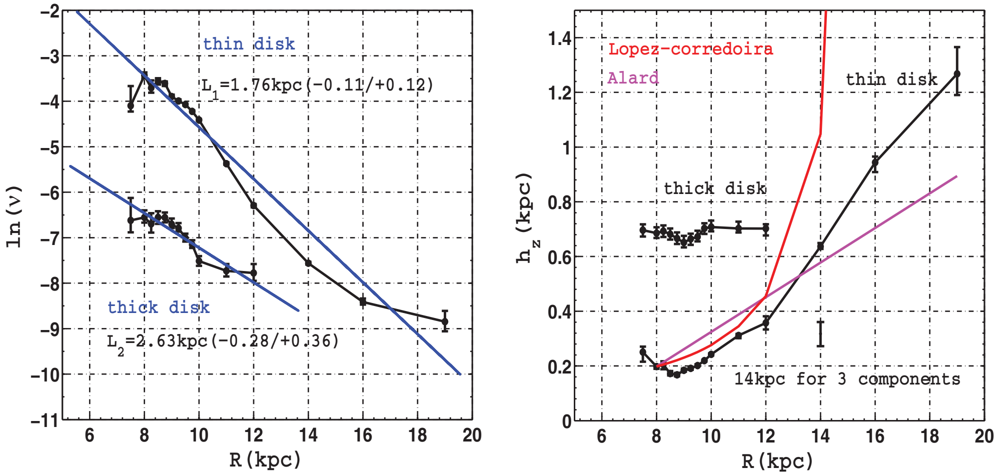

Figure 1. The left panel shows the derived stellar density at Z=0 for the thin disk (black dots located at larger $\ln(\nu)$) and for the thick disk (black dots located at smaller $\ln(\nu)$). The right panel displays the scale heights for the thin and thick disks. The upper and below lines without dots indicate the flared scale heights from López-Corredoira *et al.* (2002) and Alard (2000).

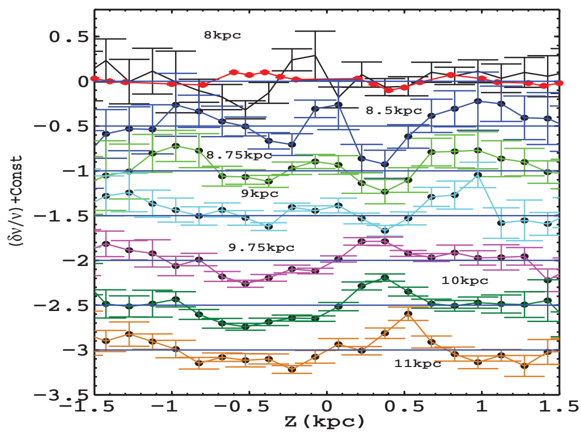

Figure 2. The relative residuals $\delta\nu/\nu \equiv$ (data − model) /model from R=8 to 11 kpc. The red line indicates the result from Widrow *et al.* (2012)

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to R=20 kpc, completely in agreement with Liu *et al.* (2017, also see Liu *et al.* in this volume). Second, the thick disk component truncates at R=12 kpc, beyond that radius, the disk can only be fitted with a single but "thicker" disk. The thin disk component shows increasing scale height changing from about 0.2 kpc at R=8 kpc to 2.3 kpc at R=19 kpc. This indicates that the disk is significantly flared in outer disk. However, compared to previous work, the flaring derived in this work is quantitatively different. It increases faster than a linear model (Alard 2000), but much slower than an exponentially increasing model (López-Corredoira *et al.* 2002). See Figure 1.

Figure 2. shows the relative residuals of the vertical density profiles by subtracting the model at various R bins from R=8 to 11 kpc. The red dots overlapped with the residual at R=8 kpc is from Widrow *et al.* (2012). It is clear that substantial oscillations are found in almost all radius bins. At $R < 9$ kpc, a peak occurs at $Z < 0$ and a dip occurs at $Z > 0$. However, at $9 < R < 11$ kpc, the pattern of oscillation changes, the peak appears

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in north disk and the dip appears in south. The latter oscillation is consistent with the north near substructure in Xu *et al.* (2015).

References

Alard, C. 2000, preprint[astro-ph/0007013]
Carlin, J. L., Liu, C.,Newberg, H., *et al.* 2015, *AJ*, 150, 4
Deng, L. C., Newberg, H., *et al.* 2012, *Research in Astronomy and Astrophysics*, 12, 735
Liu, C., *et al.* 2017, *Research in Astronomy and Astrophysics*, 17, 96
López-Corredoira, M., Cabrera-Savers, A., Carzón,F., *et al.* 2002, *A&A*, 394, 883
Roškar, R., Debattista,V. P., Stinson, G. S.,Quinn, T. R., & Wadsley, J., 2008, *APJ*, 675: L65-L68
Rix, H.- W. & Bovy, J. 2013, *A&ARv*, 21, 61
Widrow, L. M., Gardner, S., Yanny, B., Dodelson, S., & Chen, H.-Y. 2012, *ApJL*, 750, L41
Xu,Y., Newberg, H. J.,Carlin, J. L., *et al.* 2015, *APJ*, 801, 105

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