Galactic Disk Structure and Metallicity of Mono-age Stellar Populations from LAMOST

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Outline

• Motivation
• The LAMOST Galactic surveys
• Stellar metallicity of mono-age populations
• Disk structures of mono-age populations
• Summary
The Milky Way’s disk

When did the disk start to form? and how?  
What’s the star formation history of the disk?  
How did the structure/metallicity of the disk evolve with time?

Gilmore & Reid 1983

Thin disk: $h_z = 300$ pc
Thick disk: $h_z = 1450$ pc

Disk structures & metallicity of mono-age stellar populations!
The LAMOST Galactic Spectroscopic Surveys

First five-year survey: 2012/10-2017/6
6.5 million stellar spectra by June, 2016
R~1800; magnitude range: 9 - 17.8 in r-band

Robust stellar parameters with LSP3: \( V_r(5\text{km/s}), T_{\text{eff}}(100\text{K}), \log g (0.1\text{dex}), [\text{Fe/H}](0.1\text{dex}), [\alpha/\text{Fe}] (0.05\text{dex}) [\text{C/H}]&[\text{N/H}](0.1\text{dex}), E_{B-V} (0.04\text{mag}), M_V(0.3\text{mag}), \text{Distance}(15\%), \text{age} \)

+ Proper motions from Gaia: >12 dimensions

The LAMOST MSTO star sample

One million stars defined in the $T_{\text{eff}} - M_V$ diagram

$T_{\text{eff}} < 10000 \text{ K}$, $[\text{Fe/H}] > -1 \text{ dex}$, $M_V$ cut
SNR > 20 (SNR > 50 for 60 per cent stars)

Stellar age and mass are estimated from $T_{\text{eff}}$, $M_V$, $[\text{Fe/H}]$, $[\alpha/\text{Fe}]$ with isochrones in Bayesian scheme

Uncertainties: 20-30% in age; <10% in mass

Xiang et al., submitted
Validations of age & mass estimates

- Gaia TGAS, Asteroseismology, Open clusters, Mock stars, duplicate observations

![Graphs showing comparisons of ages and masses estimated from various methods.](image)
[Fe/H]-poor, [α/Fe]-rich stars are old
Sharp demarcation between intermediate-age and young stars
Decreasing trend of “thin disk” stars
Young, α-rich stars: binaries, BSS, HB, bad spectrum

Double sequence of age—[α/Fe]
Double sequence of age—[Fe/H]

Xiang et al., submitted
[Fe/H] — [α/Fe] of Mono-age populations

The “thick disk” sequence disappear when age < 8Gyr
The “thin disk” sequence occur at 8-10 Gyr ago
Mono-abundance populations, especially for those with intermediate values of $\alpha/\text{Fe}$, exhibit wide distribution of stellar ages.

Mono-abundance bin size: $0.1 \times 0.05$ dex
[Fe/H]/[α/Fe] gradients of Mono-age populations

Significant temporal evolution of radial metallicity gradients

Maximal gradients at ~8Gyr

See Wang Chun’s poster (c7) for spatial variations of metallicity distribution function and [α/Fe] gradients of mono-age populations

Xiang et al. (2015), RAA, 15, 1209
Summary

• LAMOST Galactic surveys collected 7 million stellar spectra, simple target selection function; Accurate stellar parameters have been derived

• Robust ages and masses of a million disk stars

• Clear patterns among age -[Fe/H] -[α/Fe] correlations; The age-[Fe/H] relations show double negative sequences

• Temporal evolution of [Fe/H] & [α/Fe] gradients; Stars of ~8Gyr exhibit maximal radial gradients

• The “thin” disk sequence in the [Fe/H]-[α/Fe] plane arise from 8-10Gyr; the “thick” disk sequence becomes very weak below 8Gyr

• The stellar mass density distribution exhibits plenty of spatial and temporal features
Accurate ages have already come!

A combination of the LAMOST data with Gaia DR2+ will be certainly powerful resource to further characterize the Milky Way

Thanks for your attention