Spatial and temporal variations of stellar metallicity distribution of the Milky Way disk from the LAMOST survey

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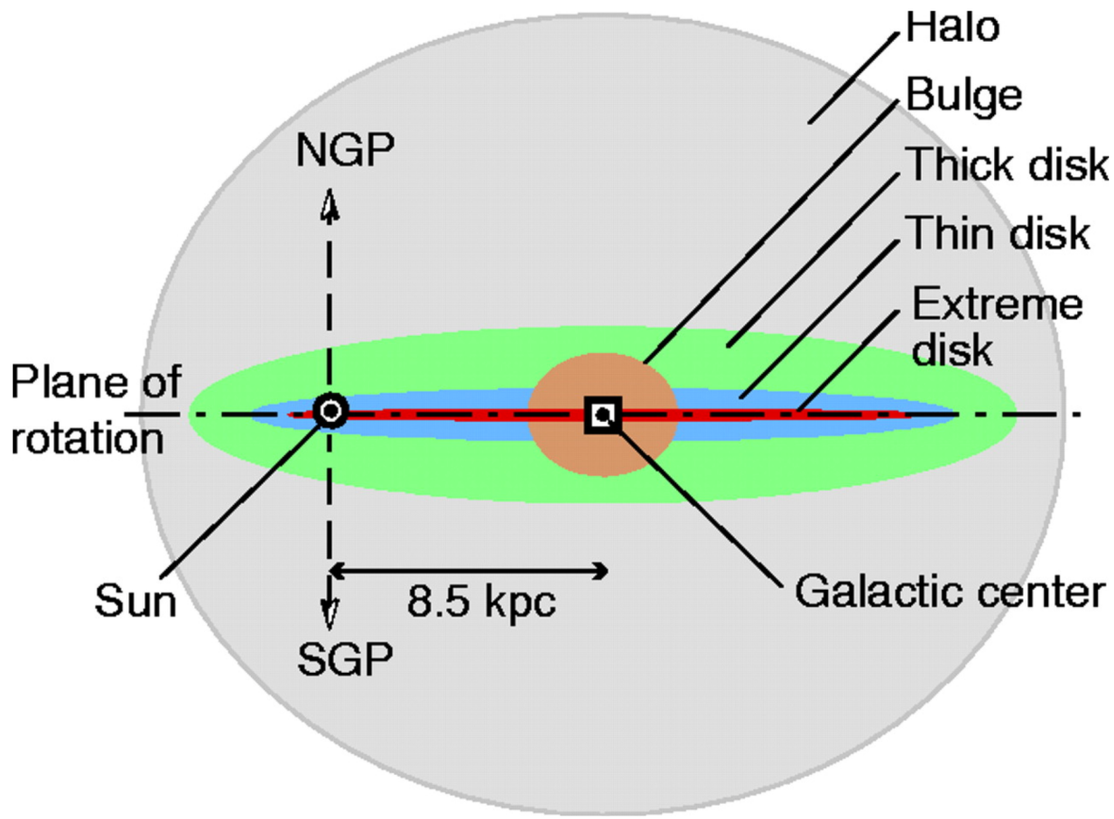
Outline

- Why we study the spatial and temporal variations of metallicity distribution
- LAMOST survey
- Data sample
- Results and Discussion
- Summary

The Milky Way Disk

- Galaxies are the building blocks of the universe
- Milky Way (MW) is the only spiral galaxy of which individual constituent stars can be resolved
- MW structure: bar,disk,halo
- MW disk contains 90% baryonic material and most of angular momentum
- MW disk structure: thin and thick disks, spiral arms
- MW disk formation and evolution: inside-out, radial migration, merger…
- How was MW disk formed?

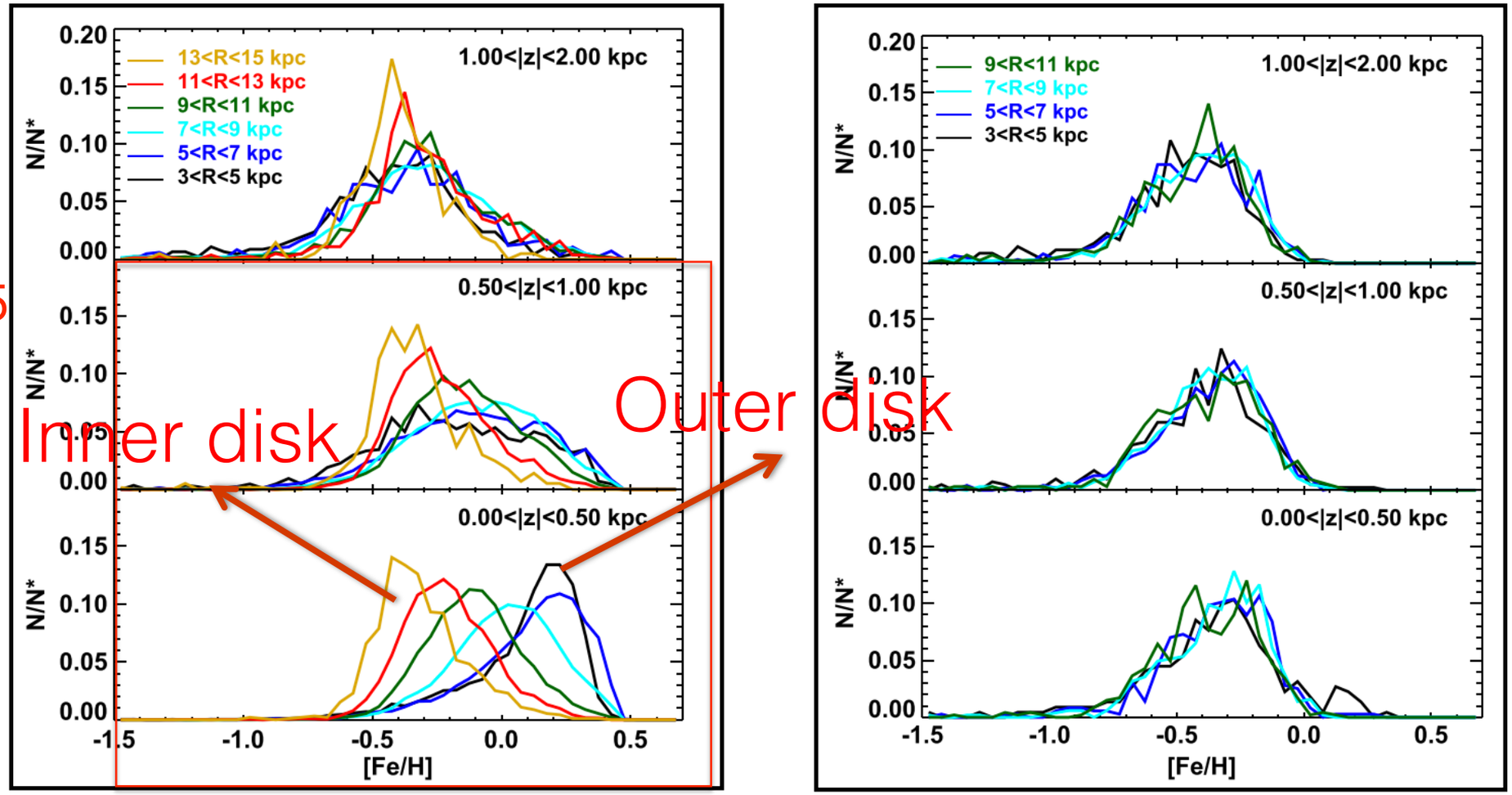


Metallicity distribution function

- Stellar metallicity: fossil record
- Metallicity distribution function, MDF=N([Fe/H],[α/Fe] I R (Rg), Z (Zmax), τ), provides key clues of Galactic formation and evolution
- Radial migration, star formation history …
- Small sample, covering small volume of disk , lack of age information

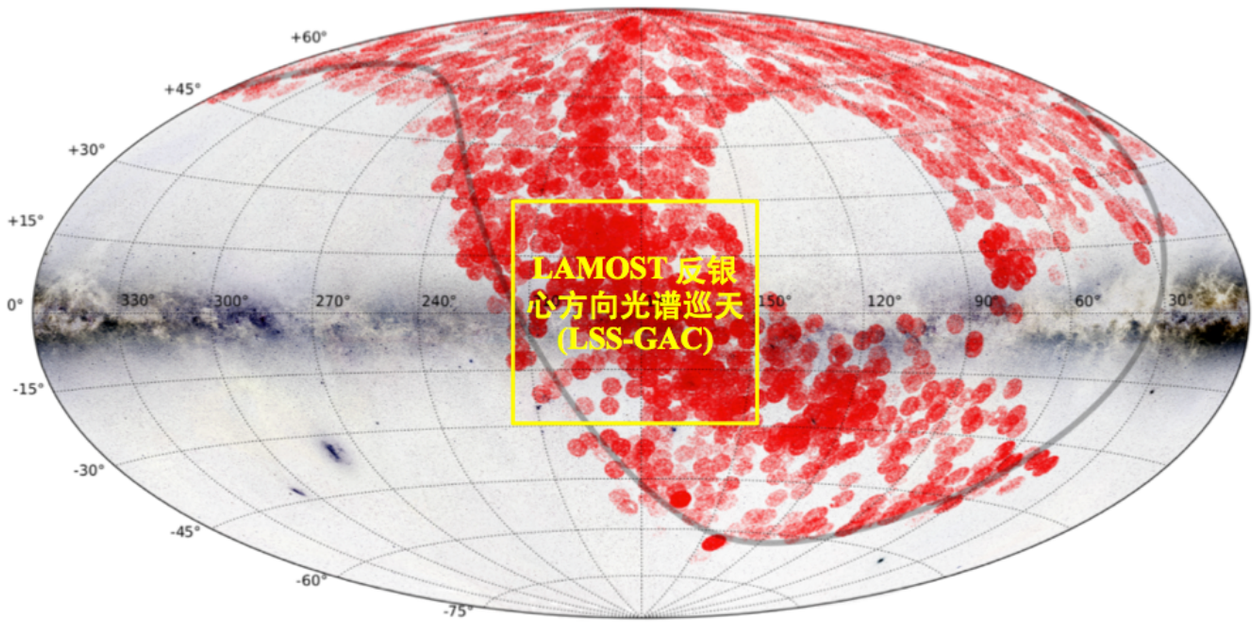
alpha-poor : young alpha-rich: old

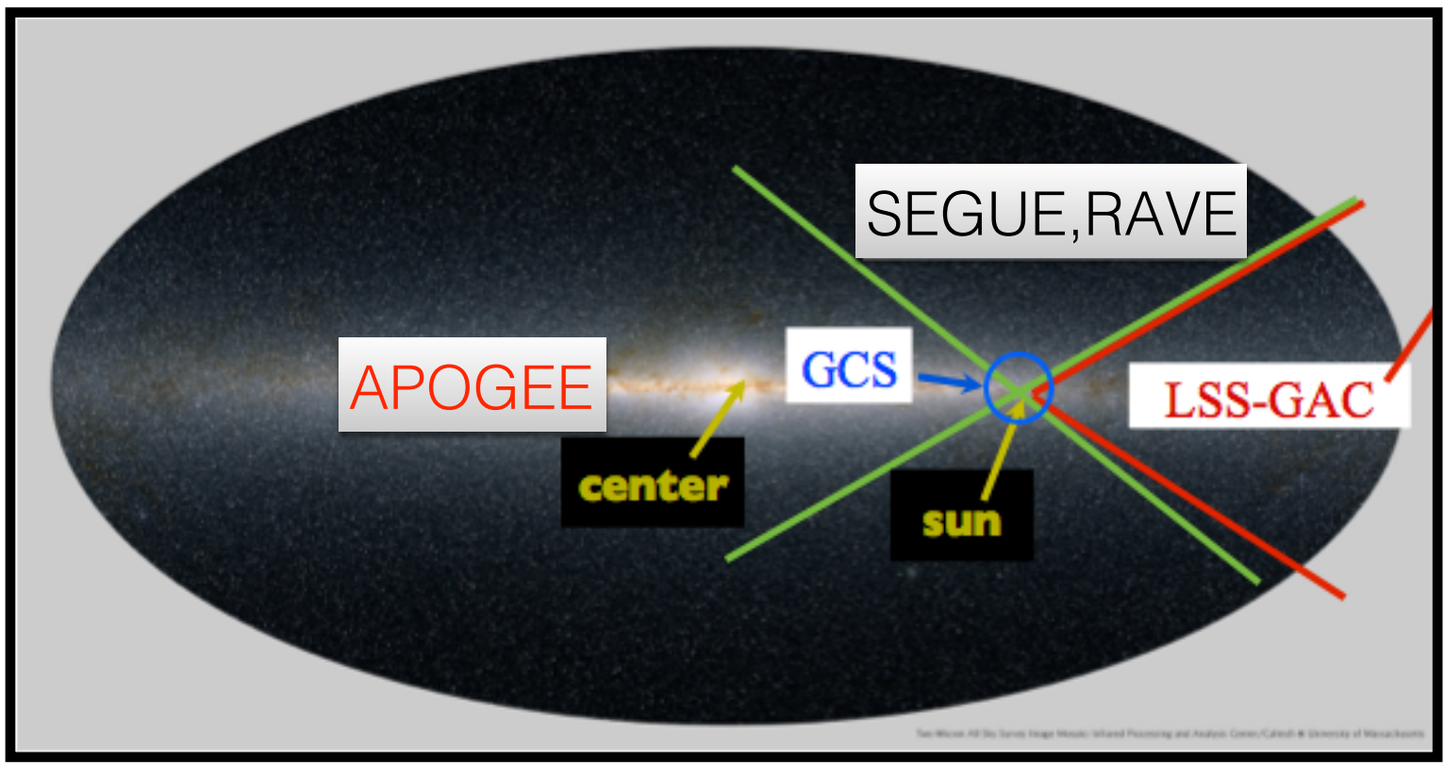
Hayden et al.2015



The LAMOST Galactic survey (2011.10-2017.06)

- A huge stellar sample, small selection bias, containing various types of stars, sampling a large volume of the disk
- By now, ~7 million spectra of S/N > 10 have been obtained
- LAMOST stellar parameter pipeline at PKU (LSP3)(Xiang et al. 2015a, Han et al. 2015, Xiang et al.2017 submitted): Vr~5km/s, Teff~ 150K, logg ~ 0.2 dex, [Fe/H]/ [C/H]/[N/H] ~ 0.15 dex, [alpha/Fe]~0.05dex, dist~15% for dwarfs (Xiang et al.2017 submitted; Yuan et al. 2015)



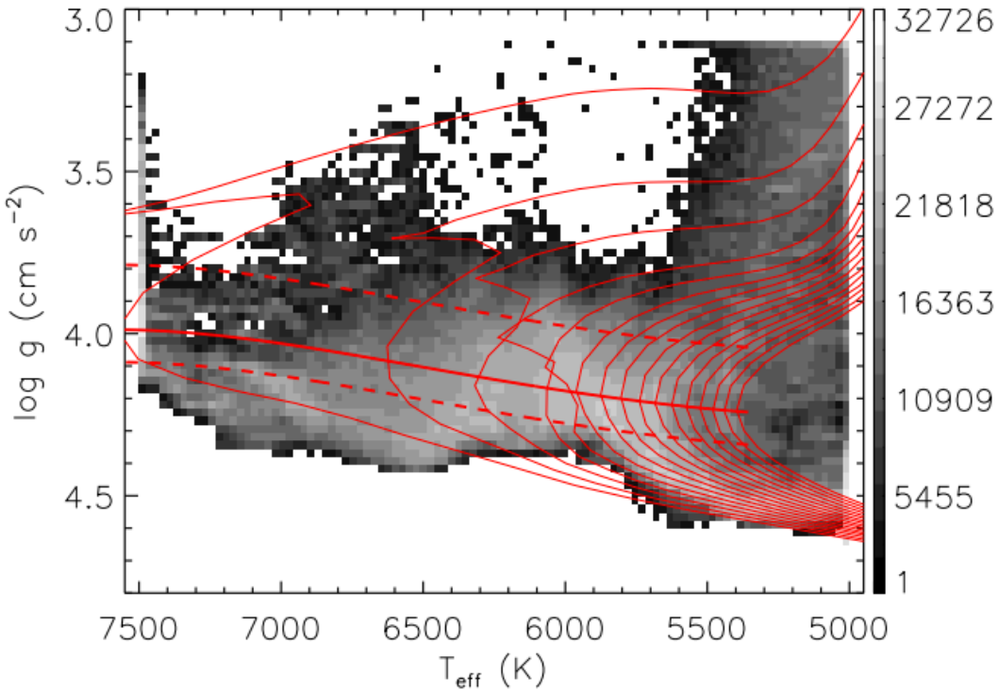


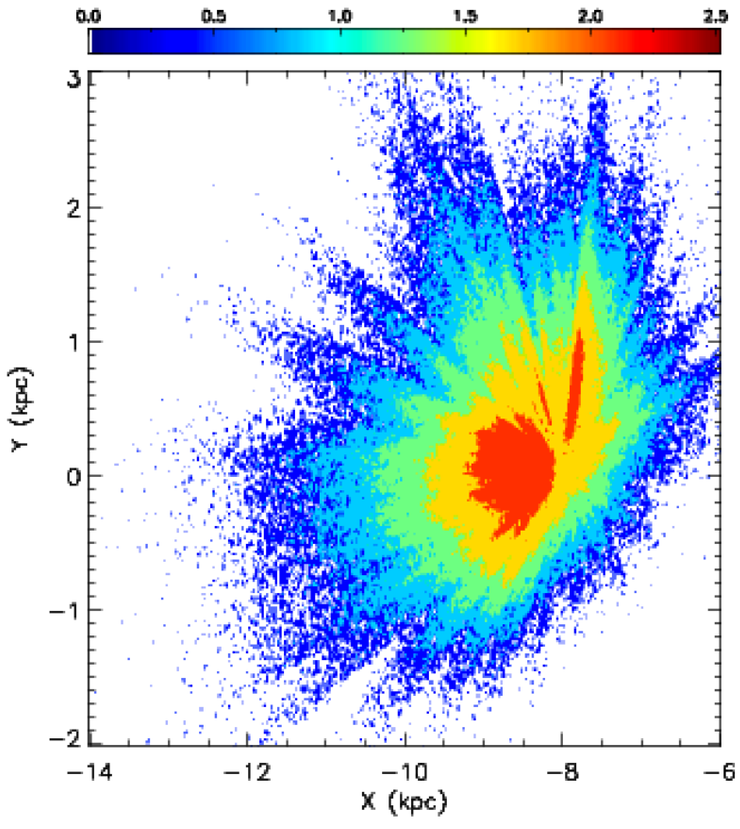
Millions of stellar spectra within continuous sky coverage of the outer Galactic disk

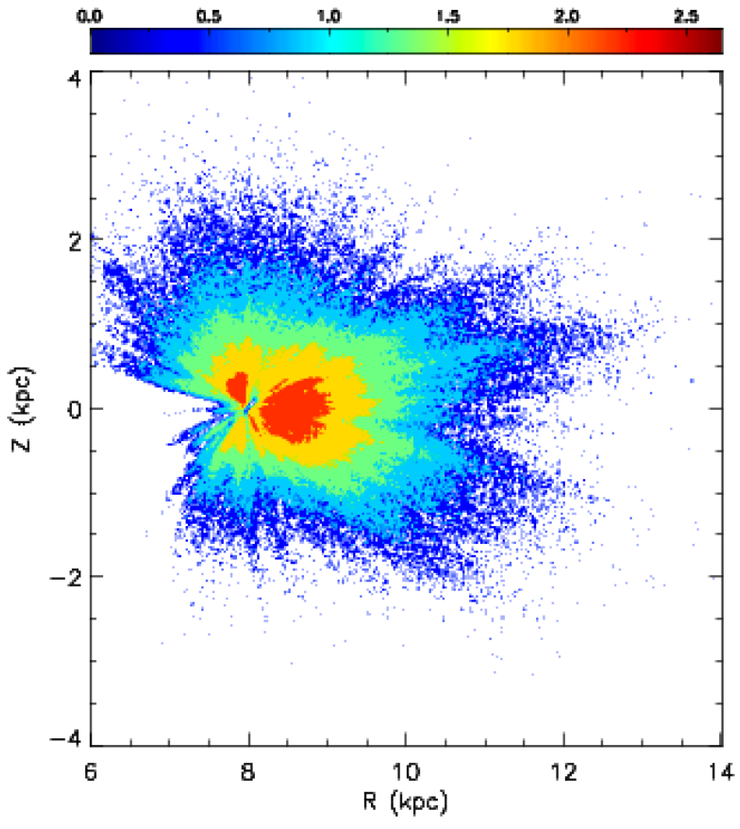
Pilot Survey: 2011.10 — 2012.06
Formal Survey: 2012.09 — 2017.06

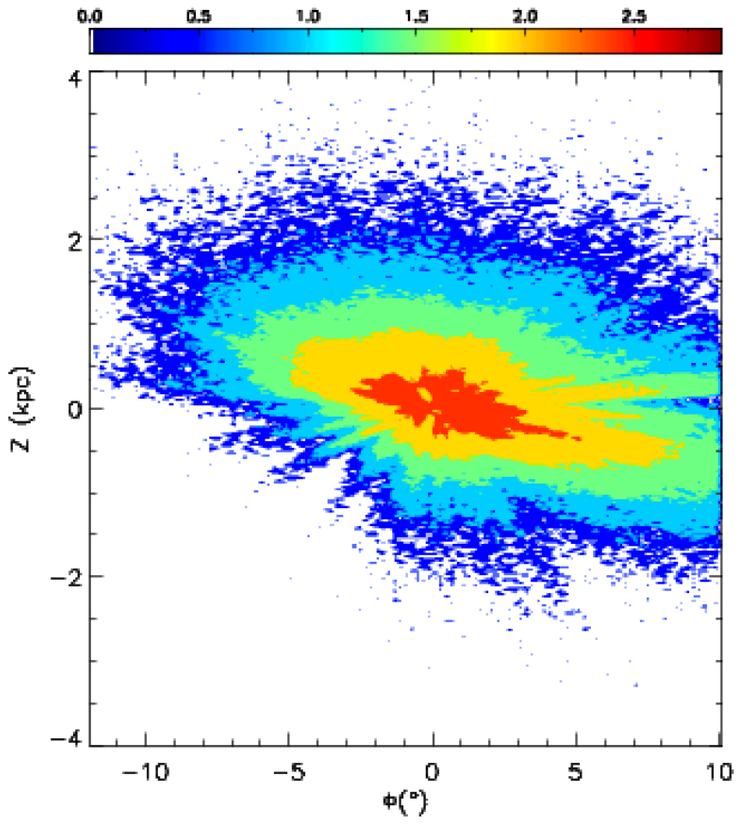
MSTO stellar sample

- A reliable age of main-sequence turn-off (MSTO) stars could be estimated using isochrone fitting method.(Xiang et al. 2015, Xiang et al. to be submitted)
- Comparing the absolute magnitude which also derived through isochrone fitting and observed magnitude, the distance are also derived.
- Typically distance and age errors are 20 % and 30 % for ~ 0.7 million MSTO stars, respectively.
- -2< Z < 2 kpc, 8 < R < 12 kpc, age > 1.2 Gyr









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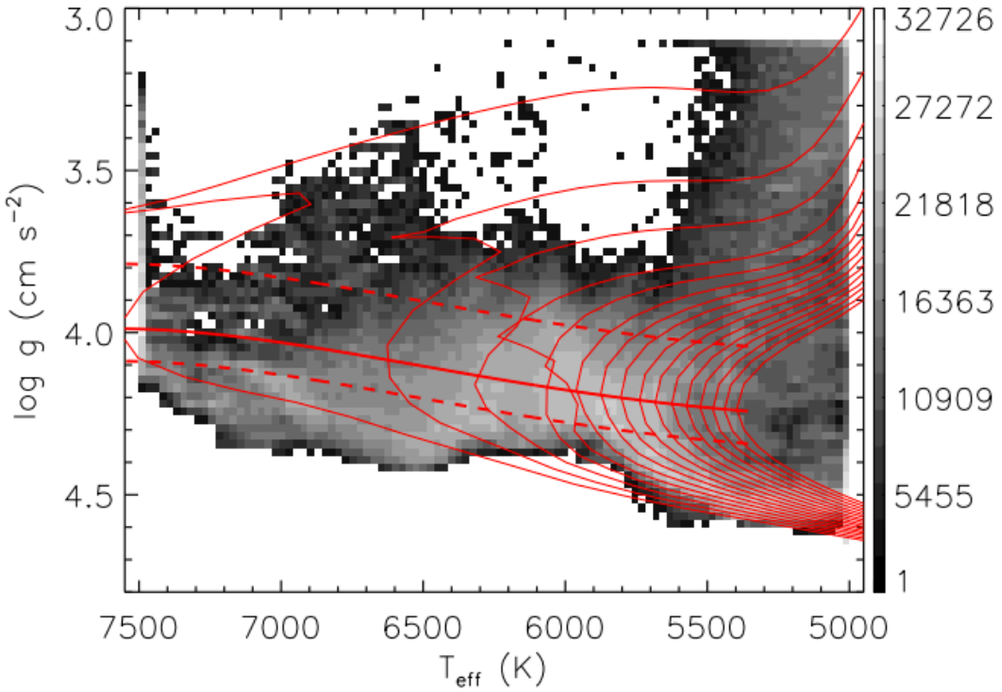
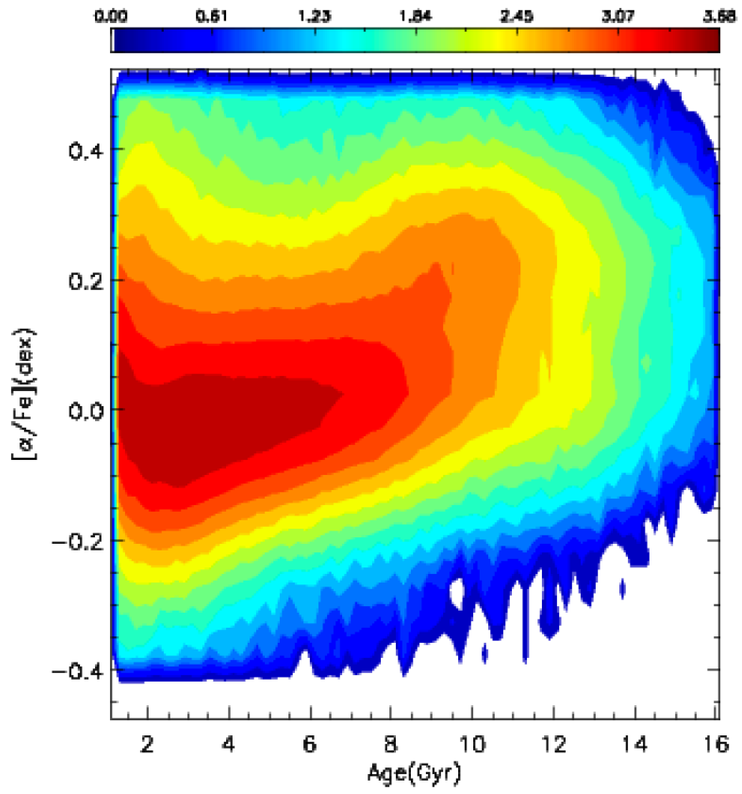
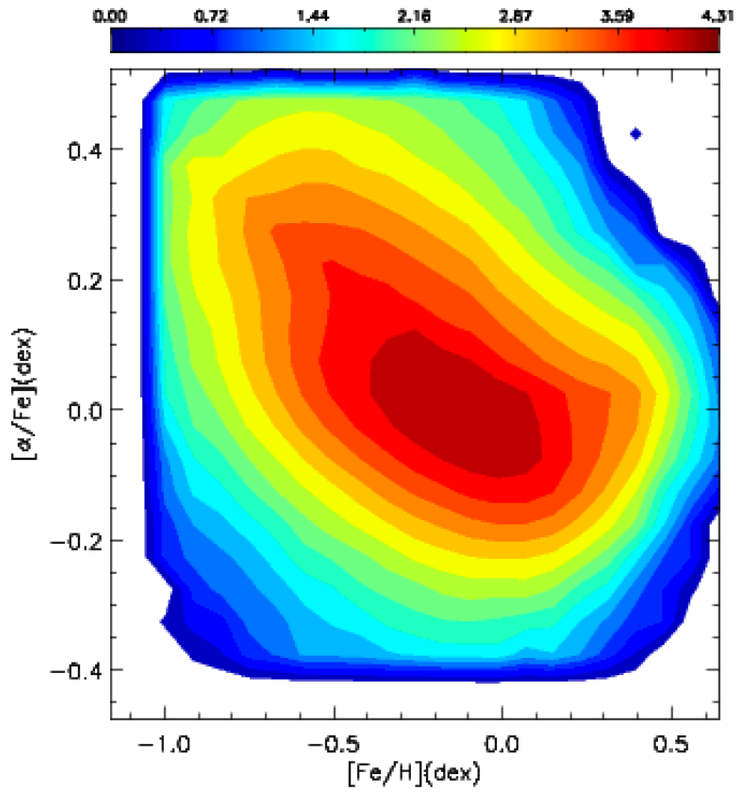
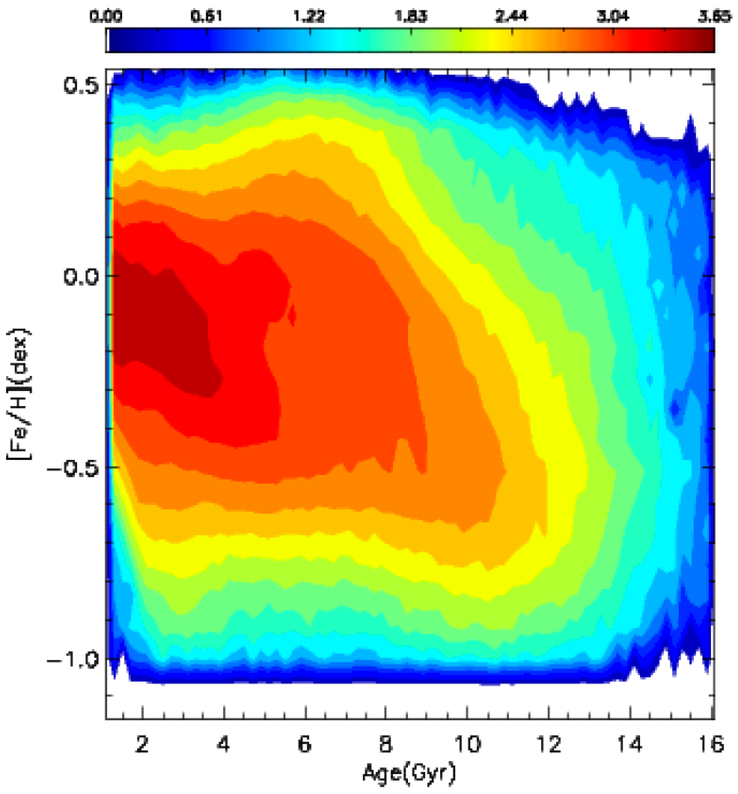
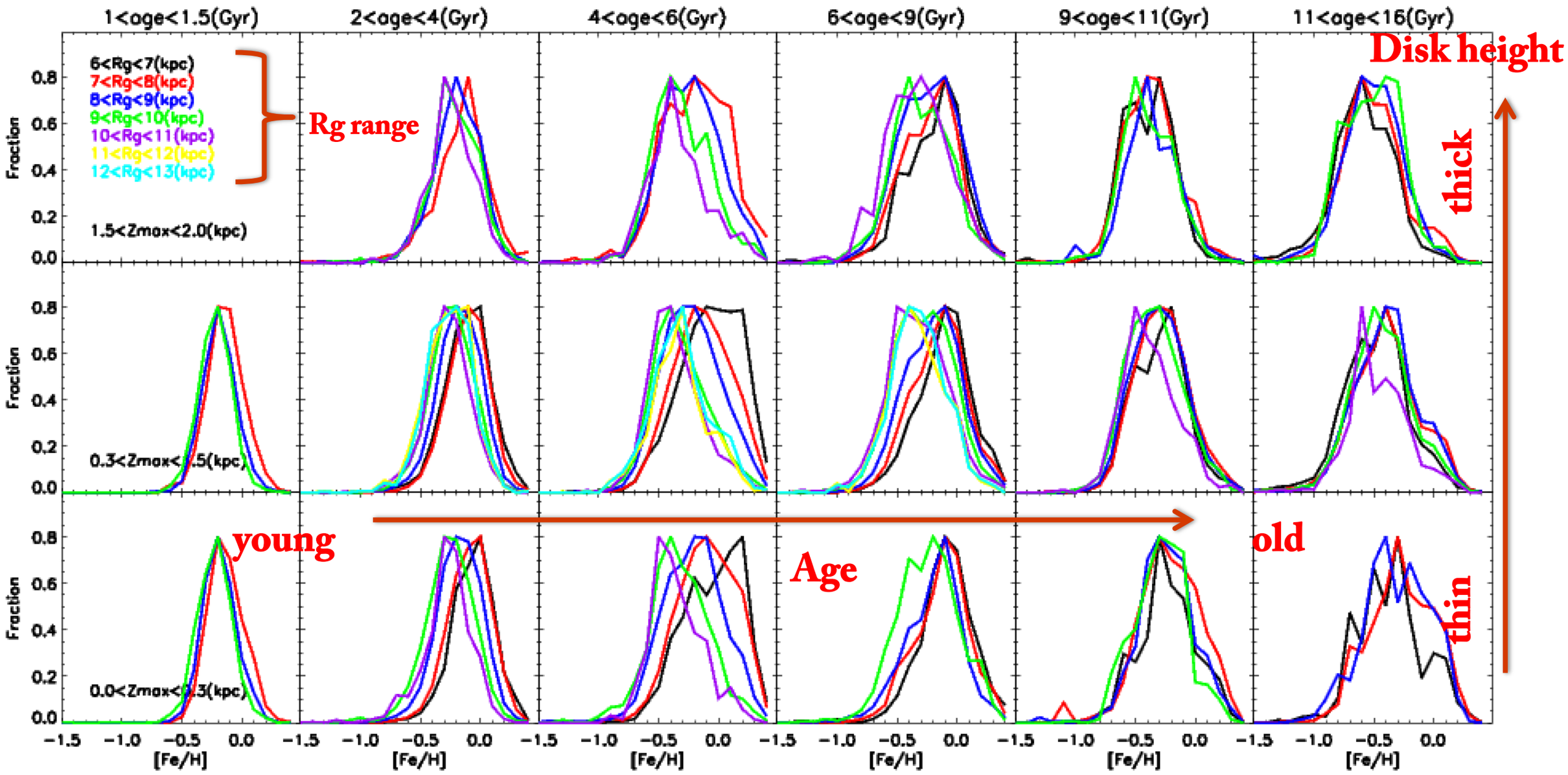








Spatial and temporal variations of [Fe/H] distribution



MDFs show significantly spatial and temporal variations.

MDFs shape are almost gaussian and uniform for youngest and oldest samples.

MDFs shape are almost uniform for median age sample at high |Zmax| region.

MDFs shape vary with R for median age sample at low |Zmax| region .

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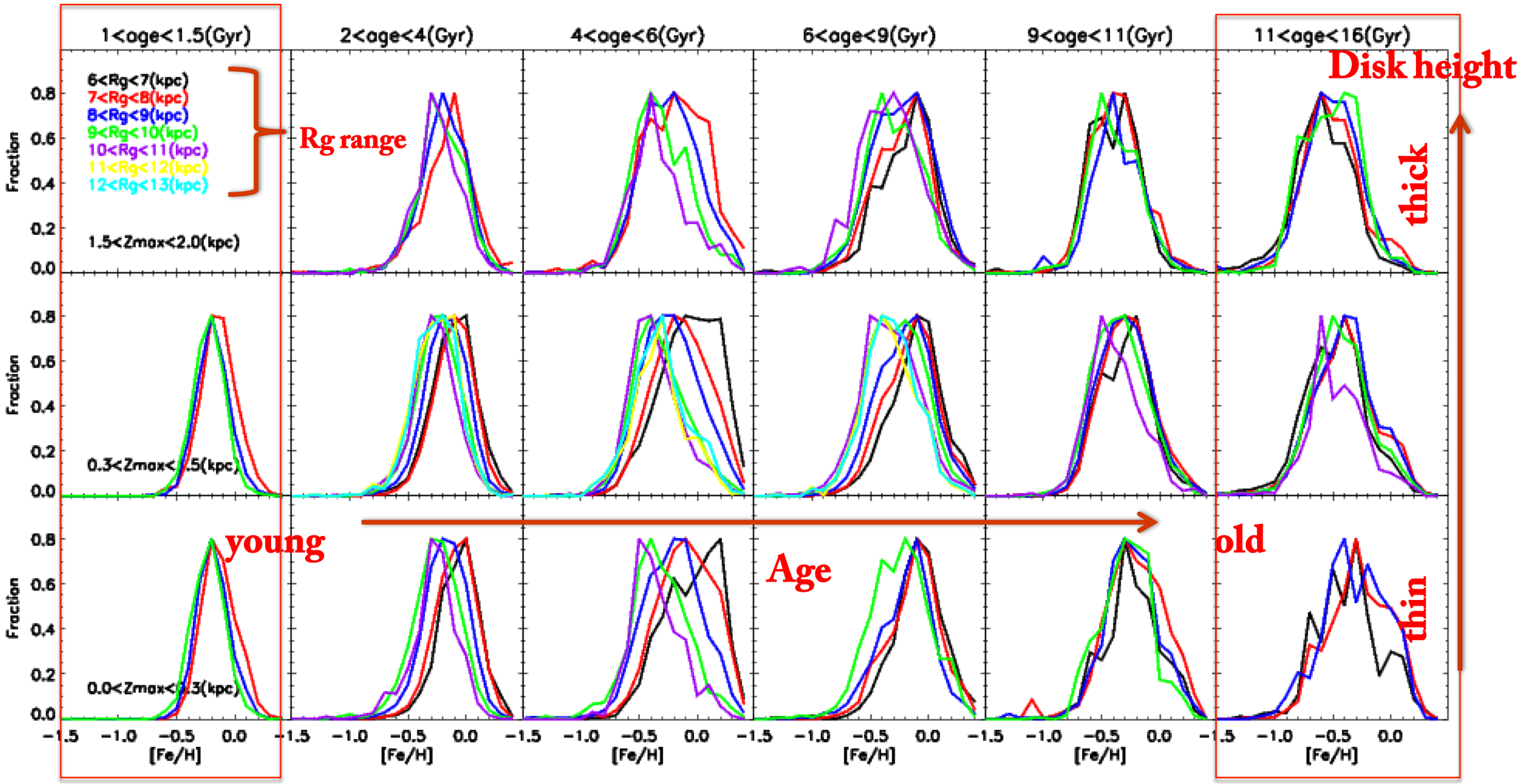

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MDFs shape are almost uniform for median age (2 < age < 8 Gyr) sample at high |Zmax| region.

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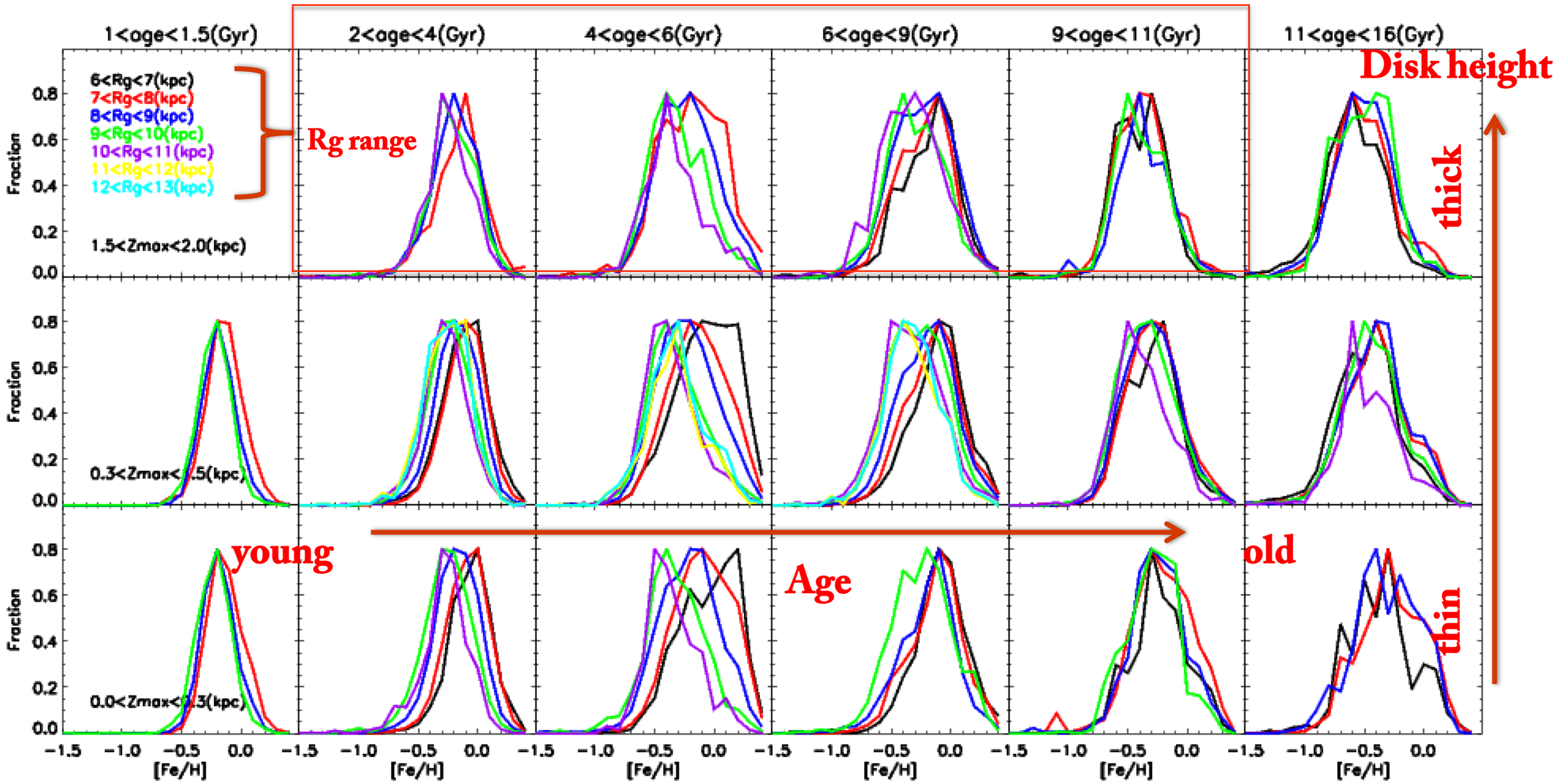

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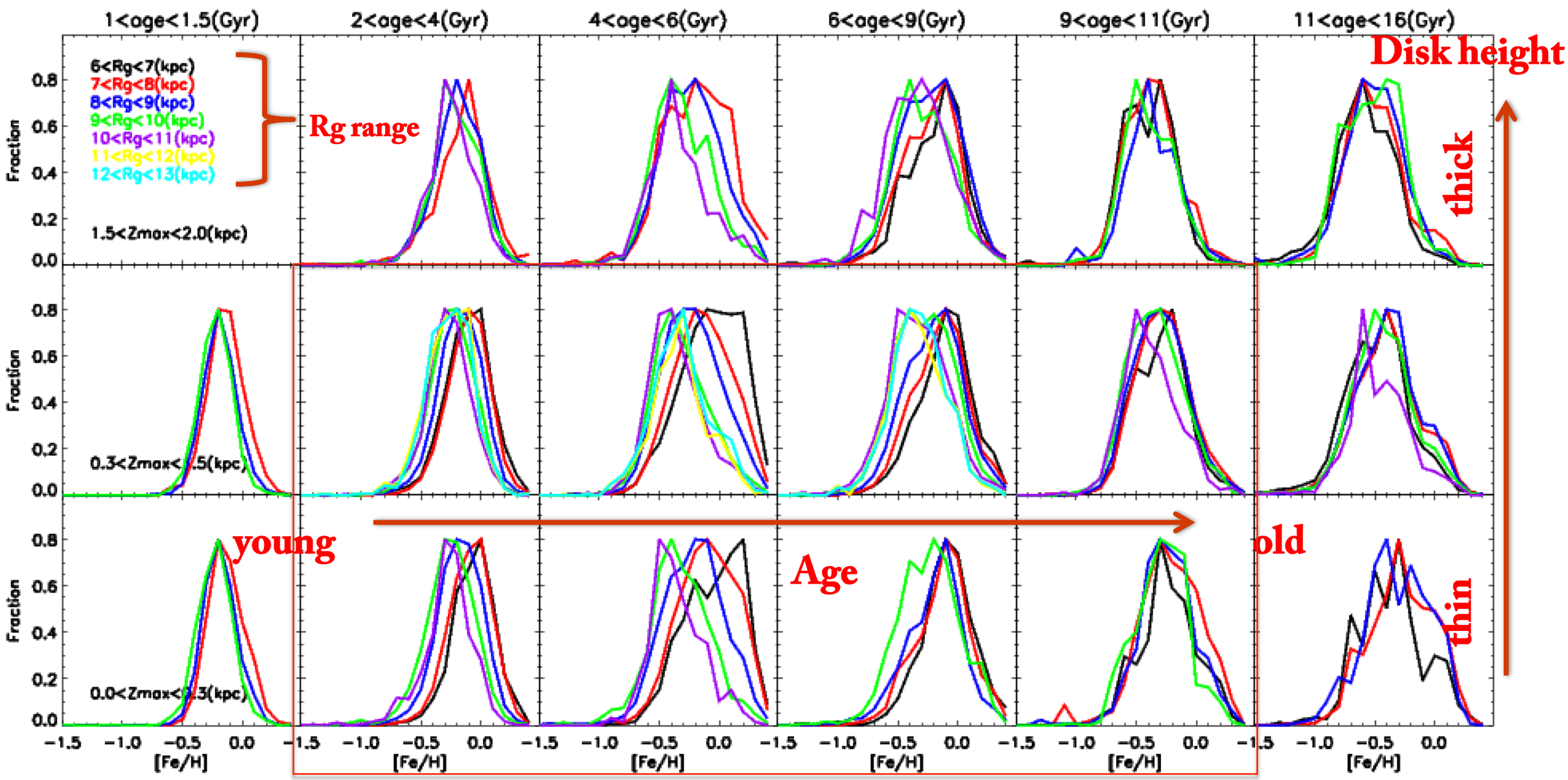

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MDFs shape are almost uniform for median age samples (2< age < 8 Gyr) at high |Zmax| region.

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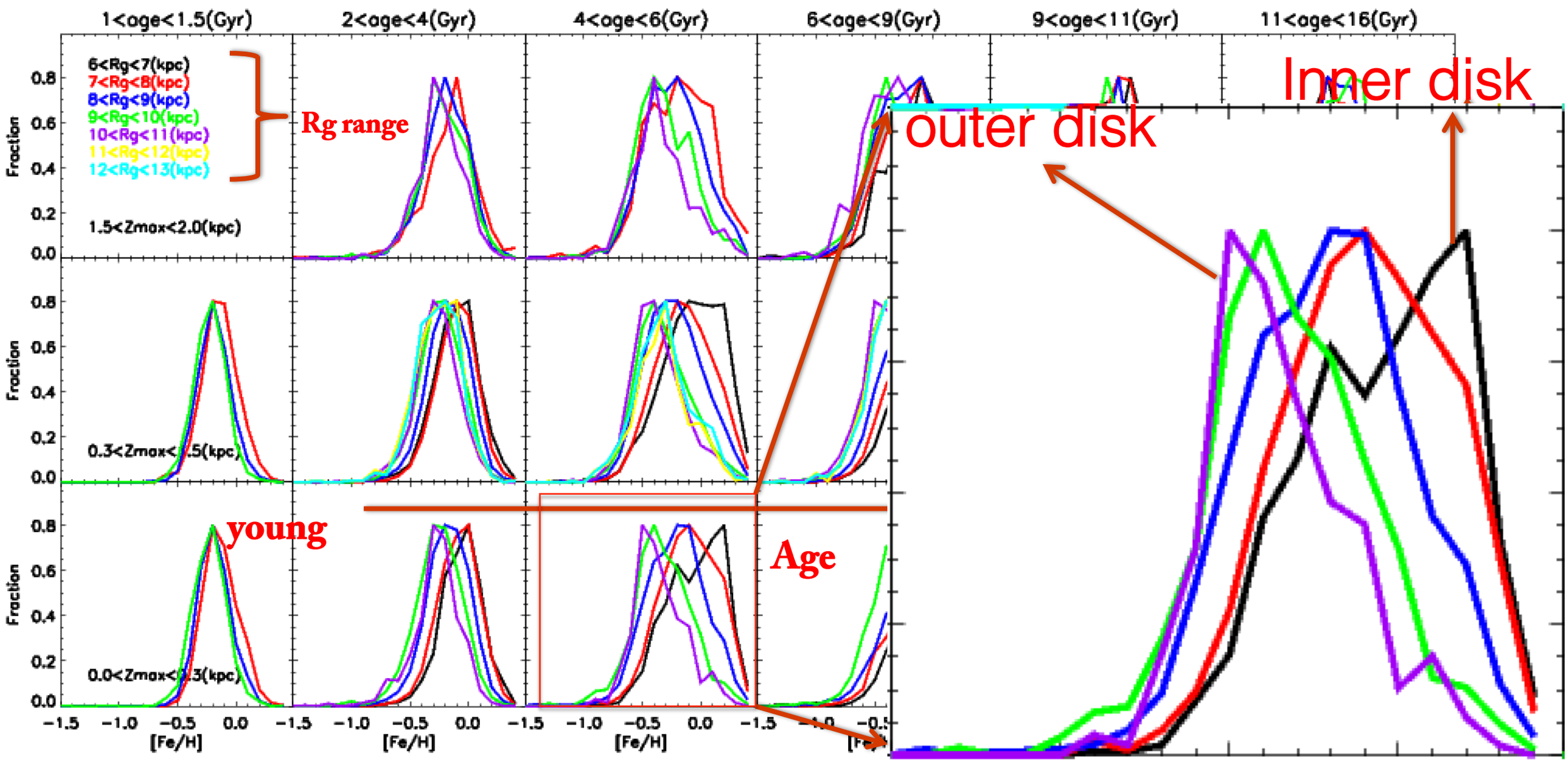
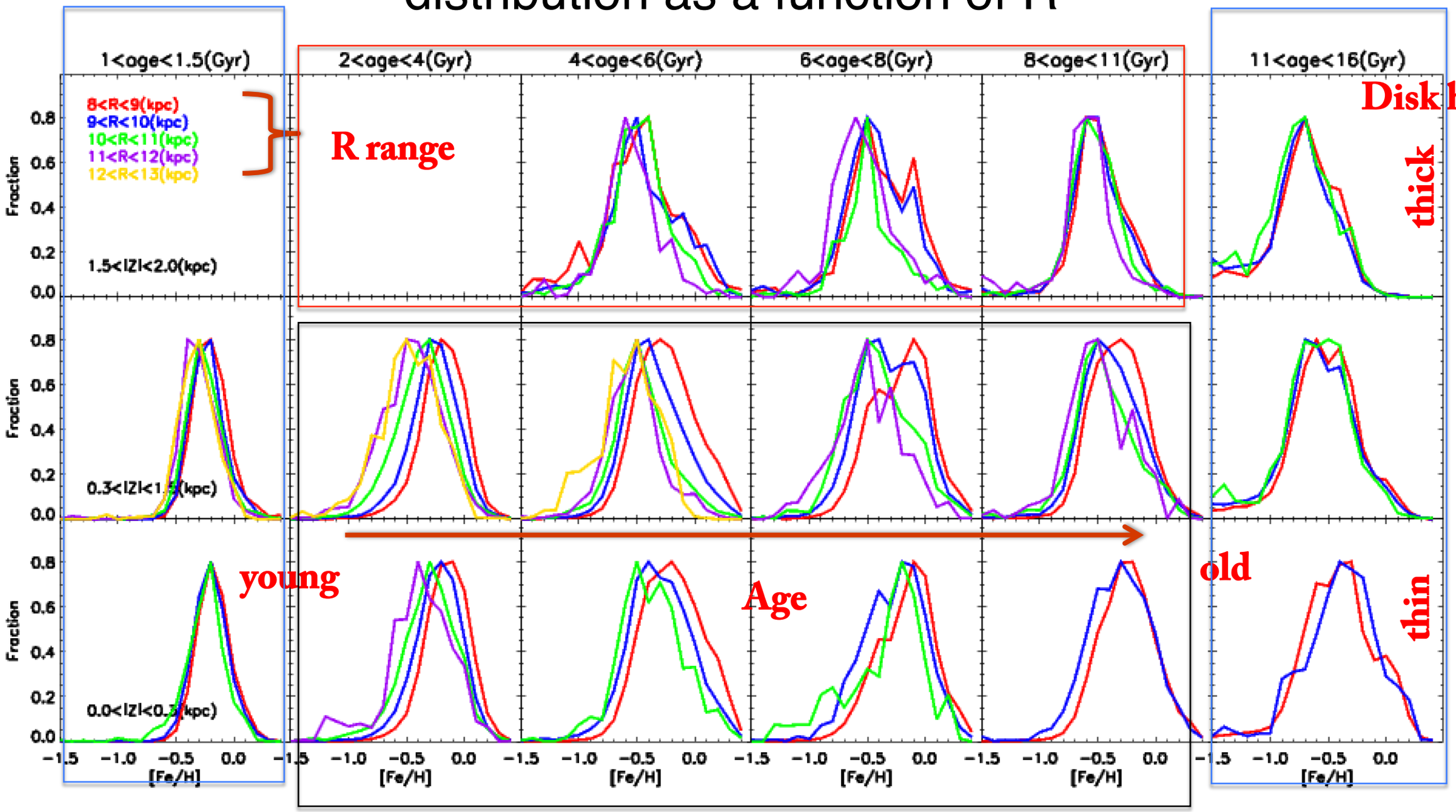


MDFs shape vary with R for median age samples at low |Zmax| region: the inner disk has a relative negtive skewed distribution and outer disk has a erlative positive skewed distribution.

The churning process play an important role on the MW disk formation and evolution.

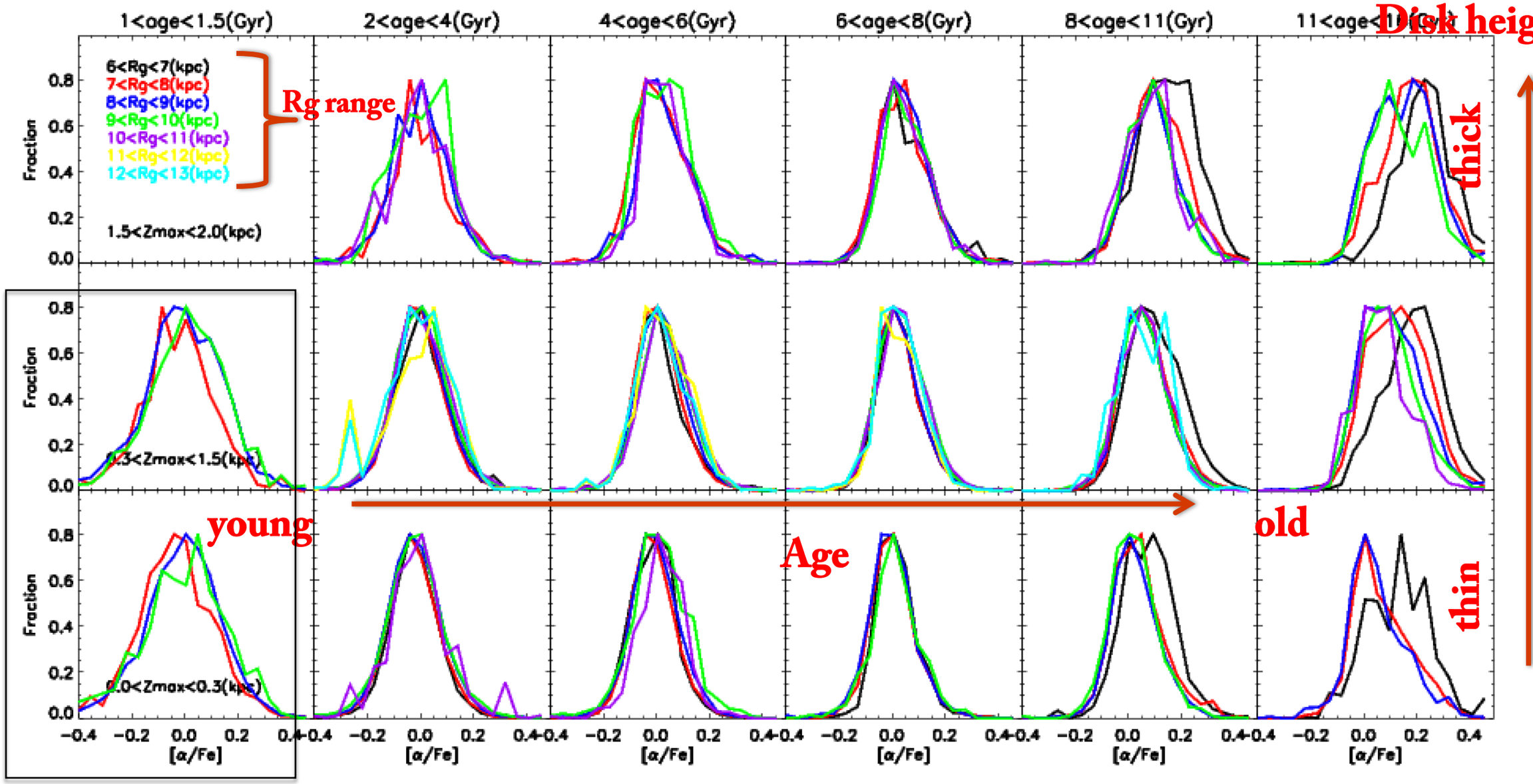
Discussion — Spatial and temporal variations of [Fe/H] distribution as a function of R



MDFs as a function of R and Rg are similar.

The radial migration especially churning process play an important role on the MW disk evolution.

Spatial and temporal variations of [alpha/Fe] distribution



- The distribution shape of [alpha/Fe] are almost uniform with Rg varying at 2 < age < 11 Gyr .
- The distribution shape of [alpha/Fe] vary with Rg at age >8 Gyr.
- The mean value of [alpha/Fe] vary Rg and |Zmax| at age > 8 Gyr.
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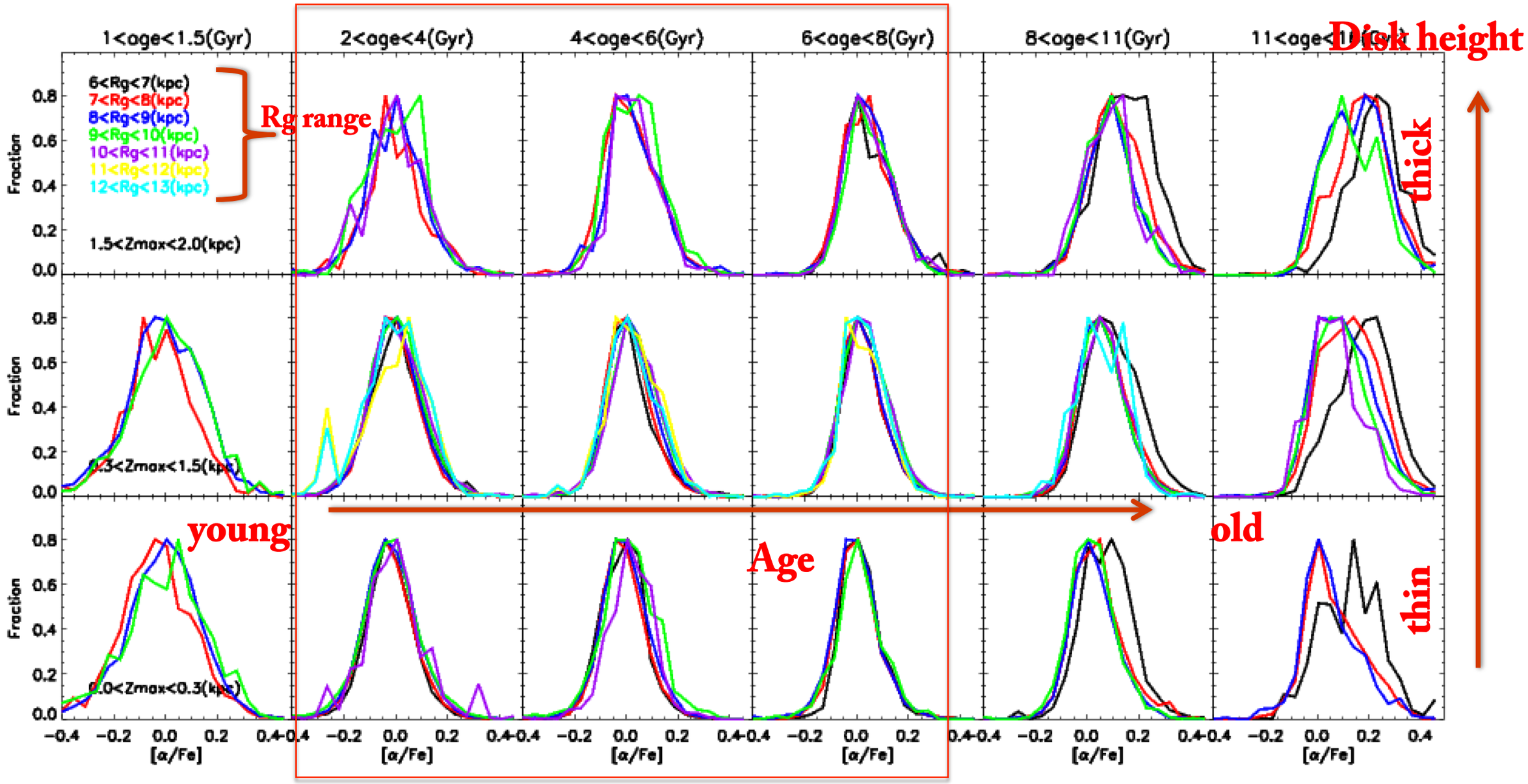

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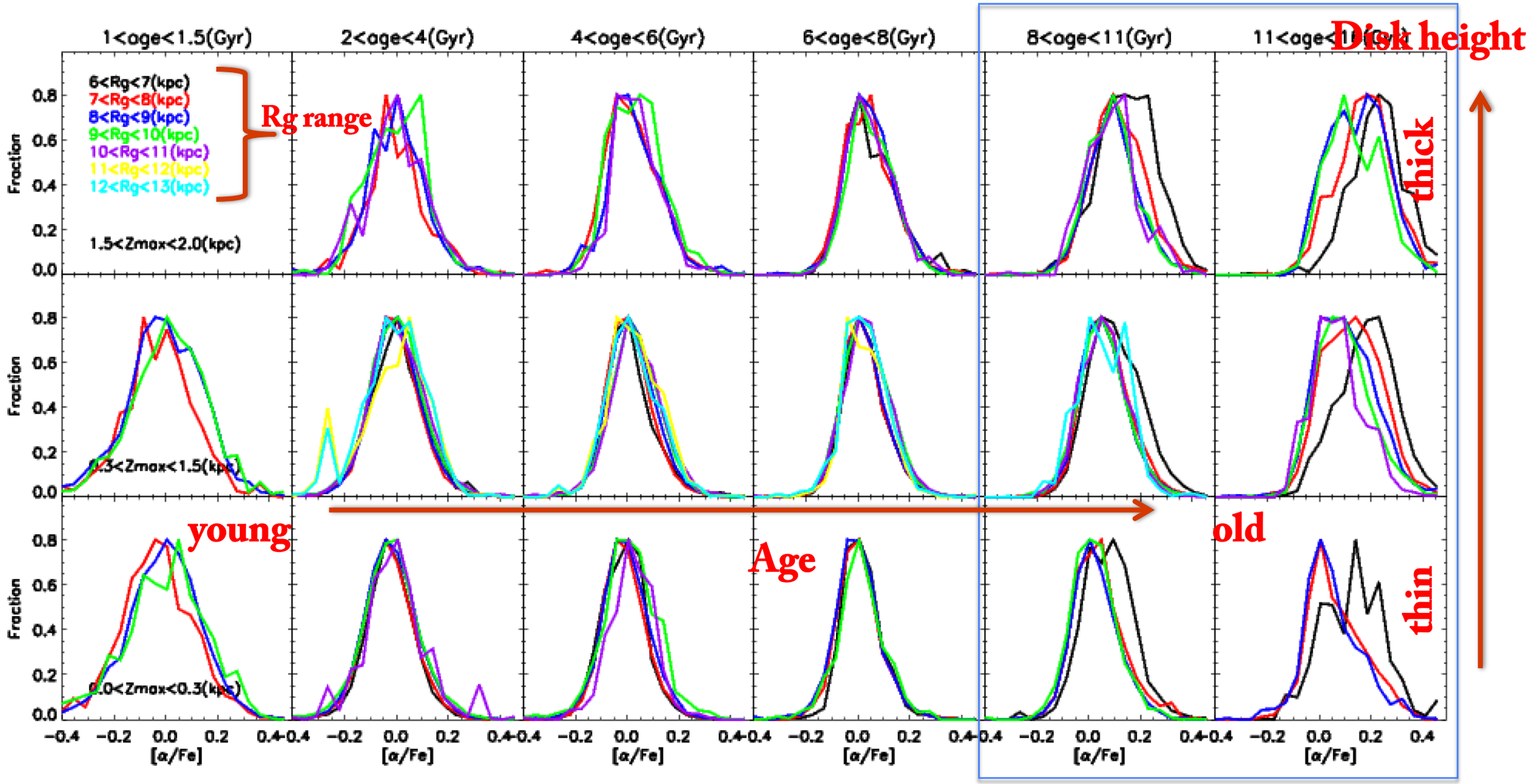

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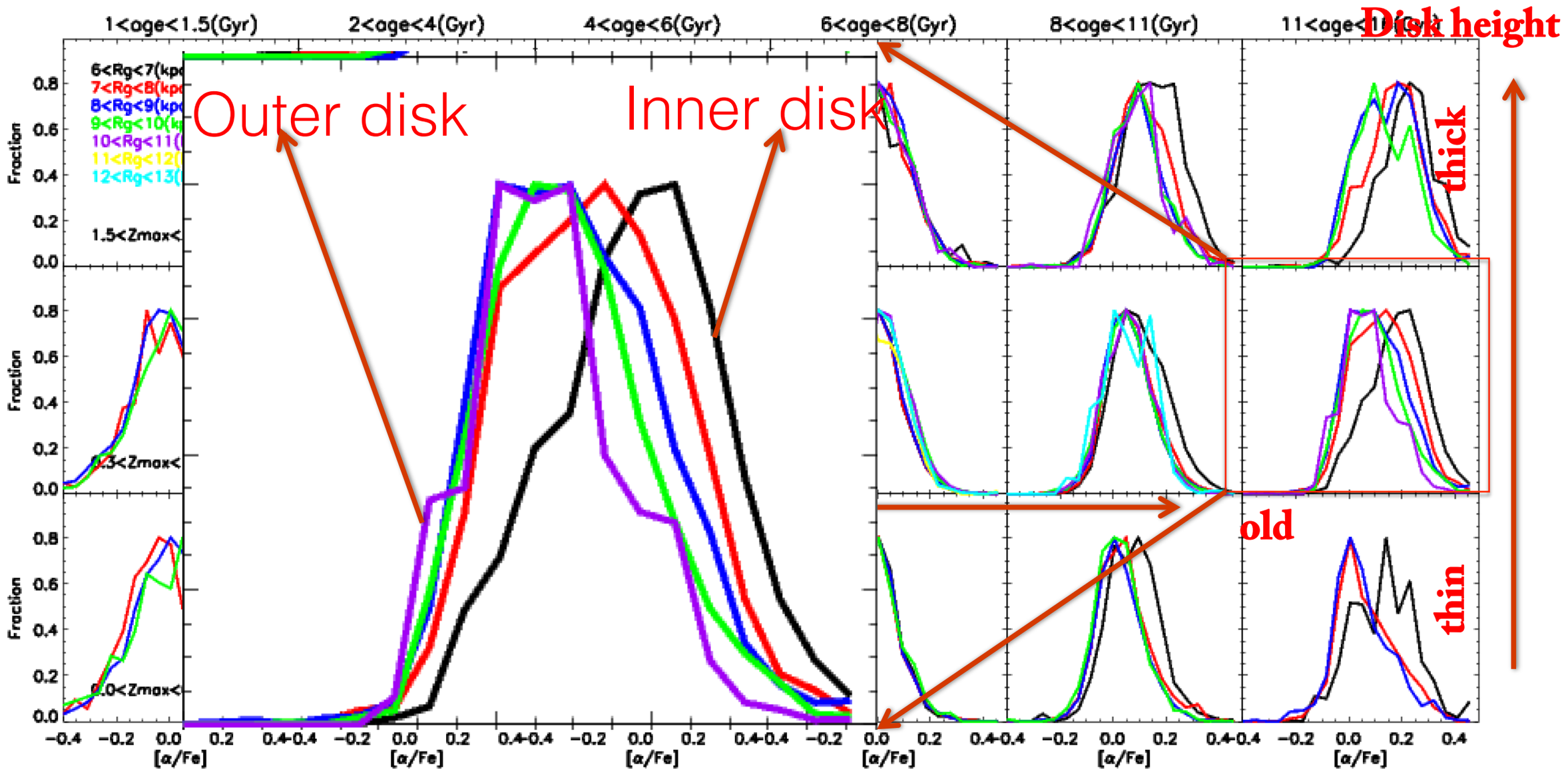

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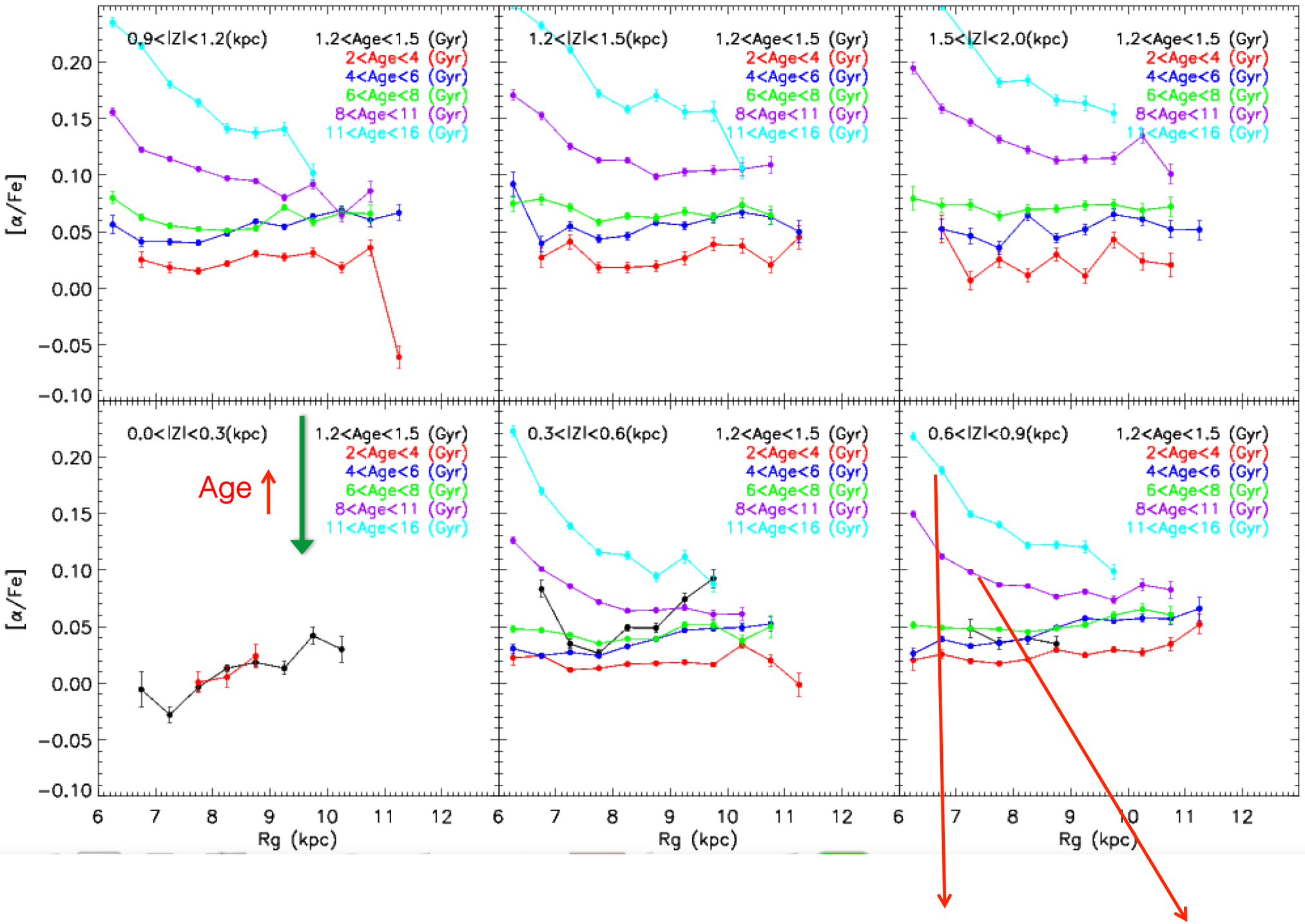

Negative radial gradients (for sample with age > 8Gyr)

Summary

- We mapped out the [Fe/H] and [alpha/Fe] distribution as a function of Rg, |Zmax|, age (R, |Z|, age) using MSTO sample.

- [Fe/H] and [alpha/Fe] distribution show significant spatial and temporal variations.

- [Fe/H] (at low |Z| (|Zmax|)) and [alpha/Fe] (at all |Z| (|Zmax|)) have relative negative skewed distributions in the inner disk, relative positive skewed distributions in the outer disk for median (2 Gyr < Age < 8 Gyr) and old age bins (> 8 Gyr), respectively.

- [Alpha/Fe] of old samples show negative radial gradients.

- The [Fe/H] and [alpha/Fe] distribution are different for samples younger than 8 Gyr and older than 8 Gyr.

- Radial migration especially churning process play an important role on the MW disk formation and evolution.

Thank you!