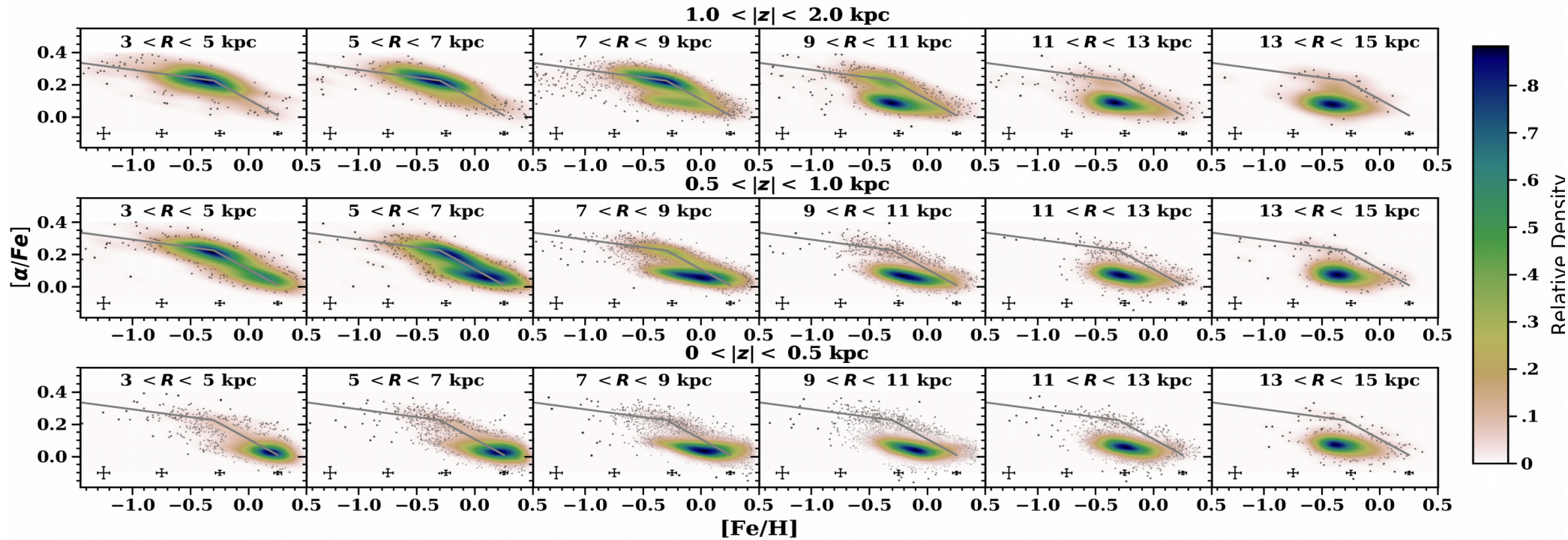


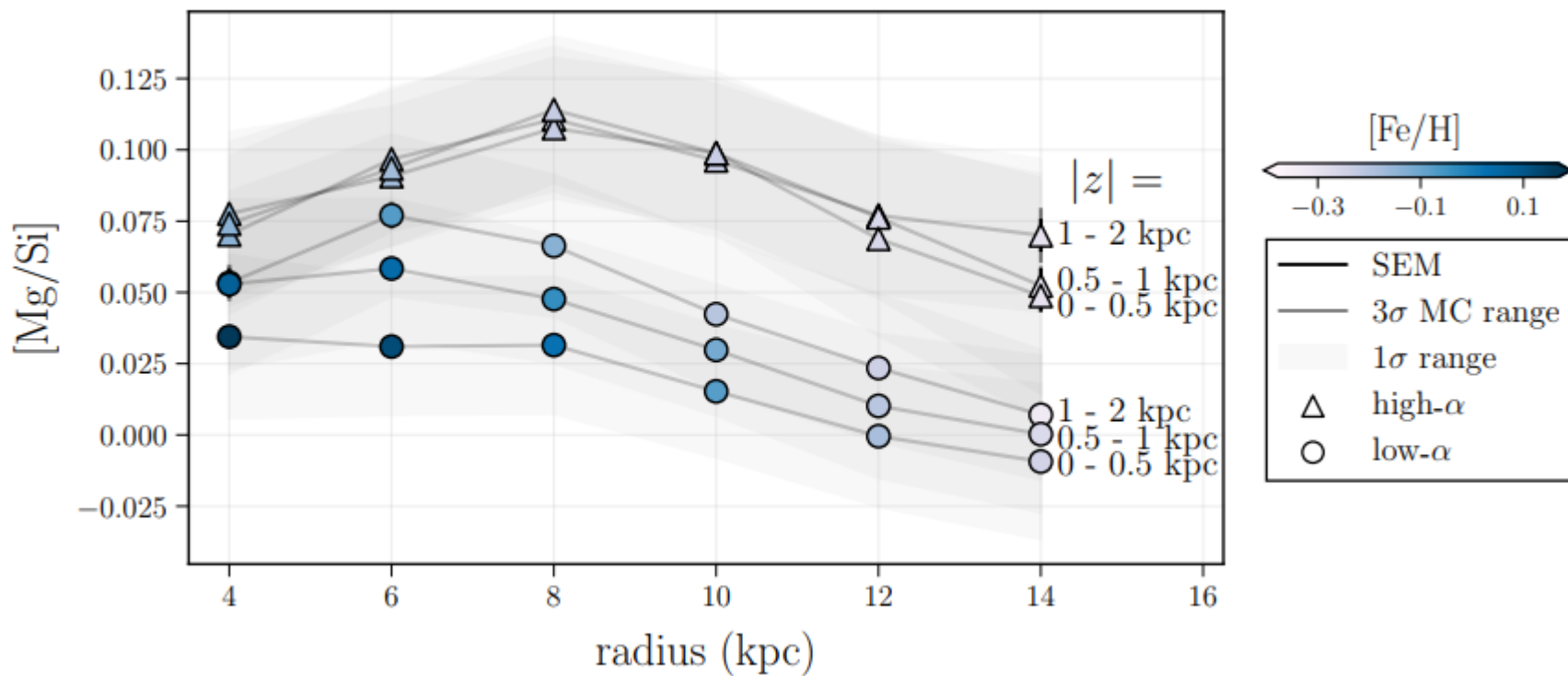
Structure and Formation of the Milky Way Disk

Michael Hayden
University of Sydney

Mapping the Milky Way

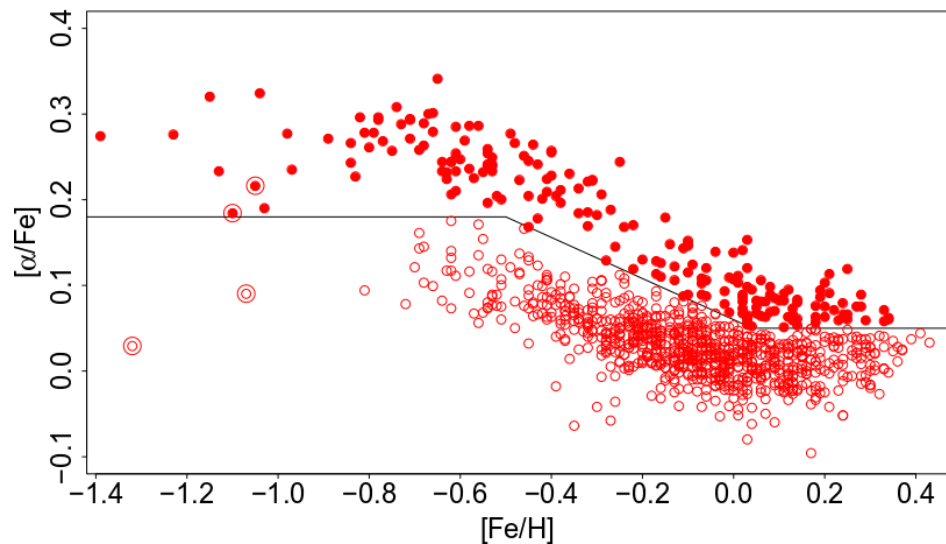


Hayden+ 2015



Blancato+ 2019

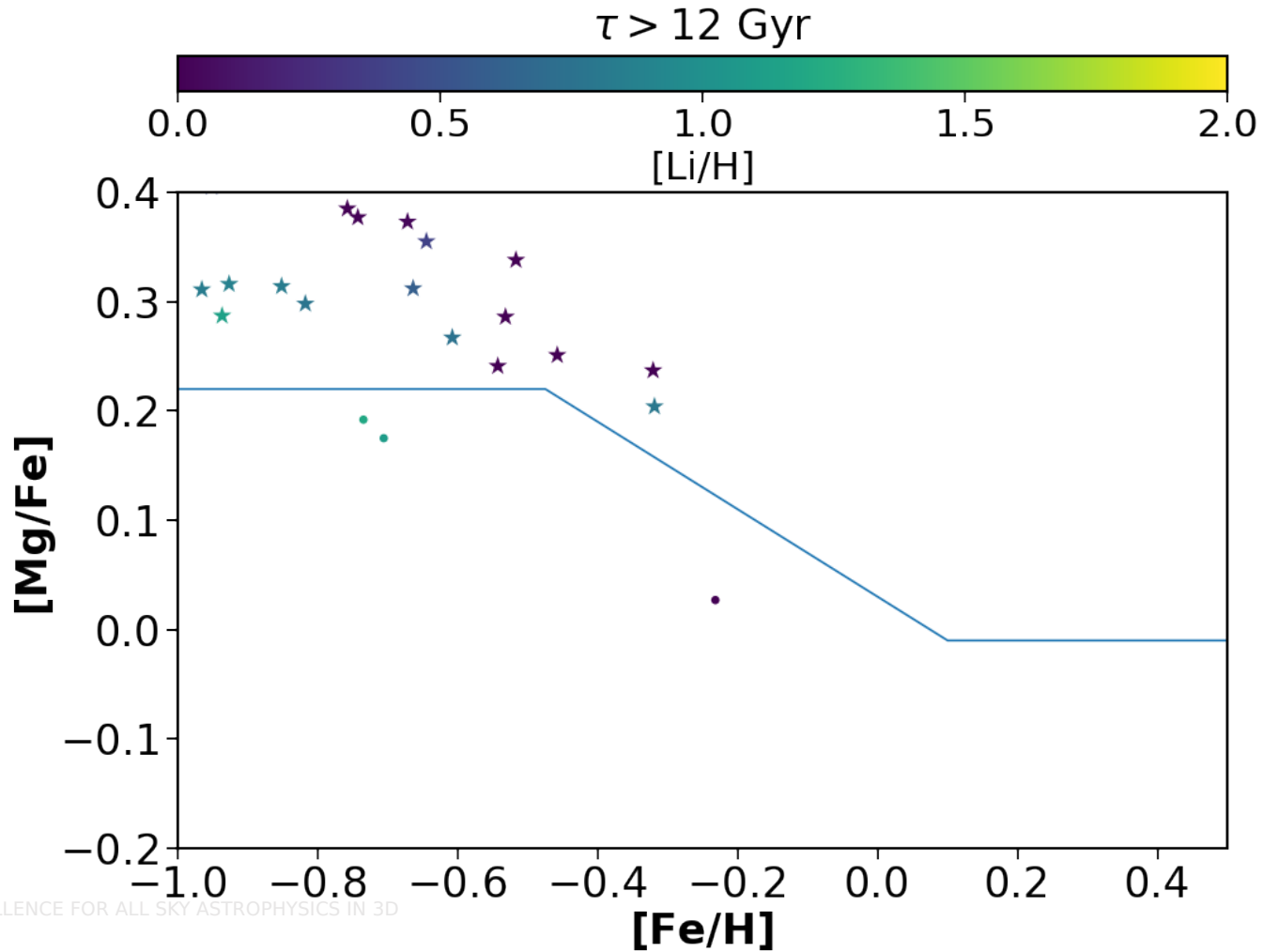
HARPS

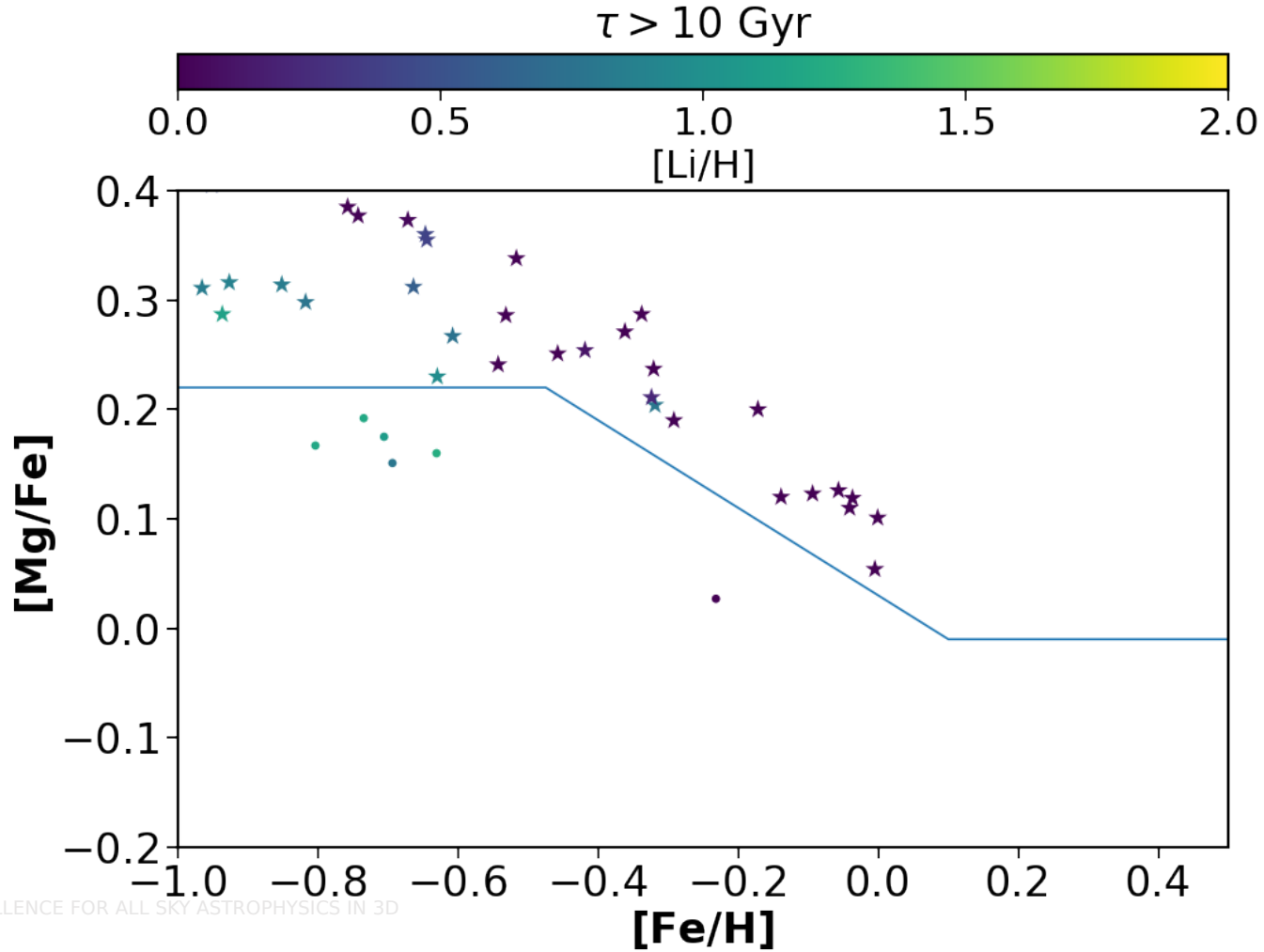


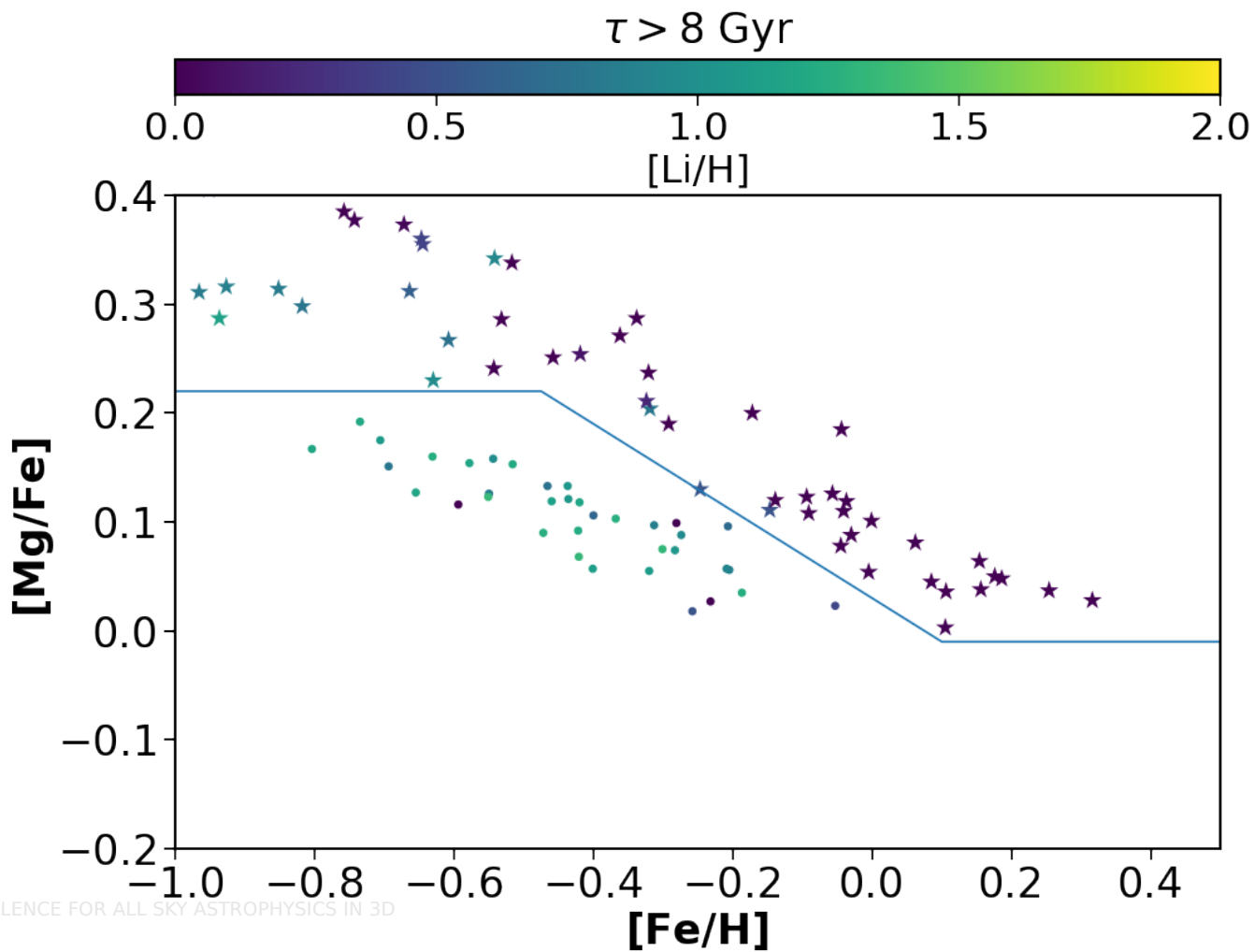
Haywood+201

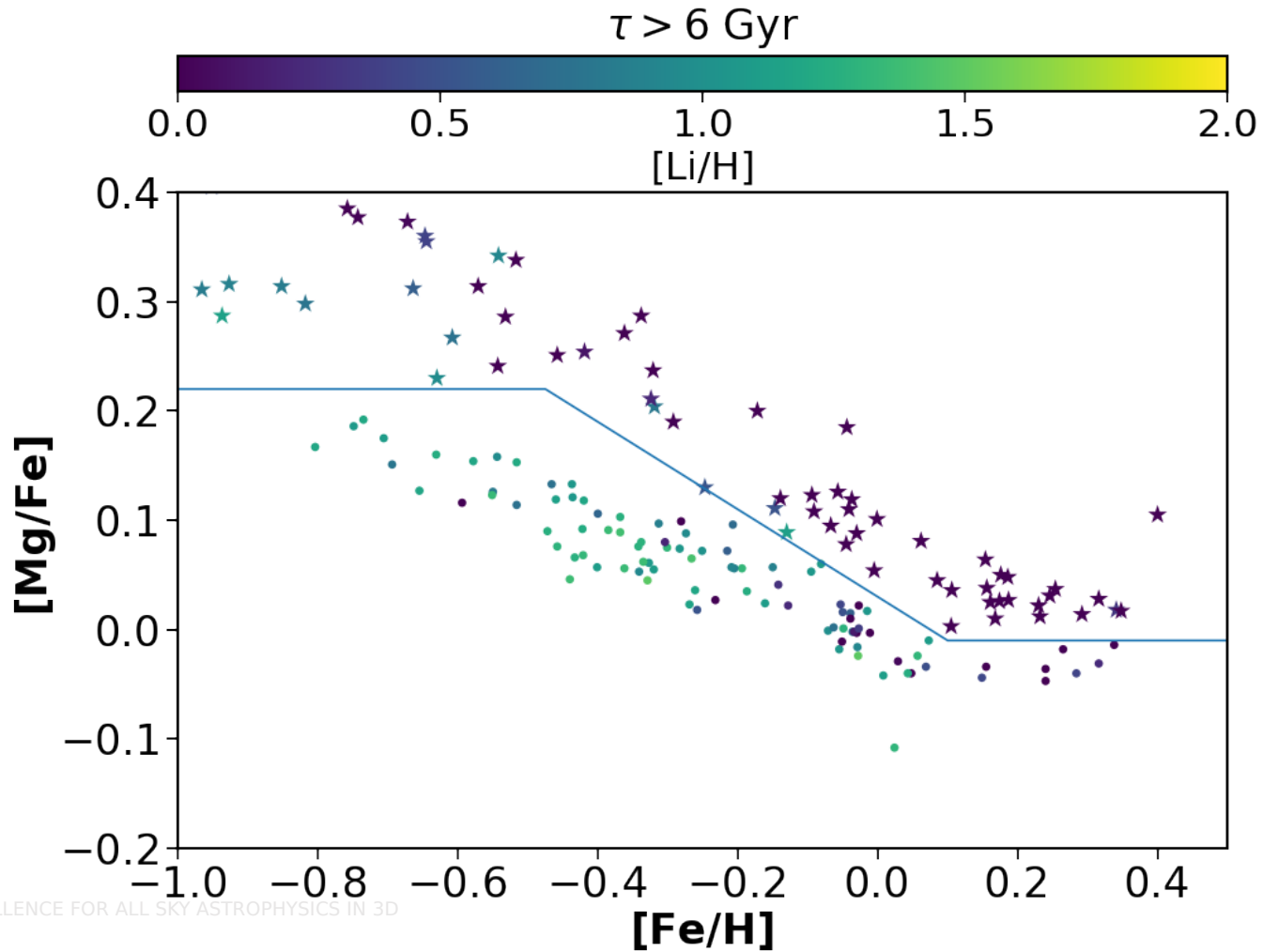
3

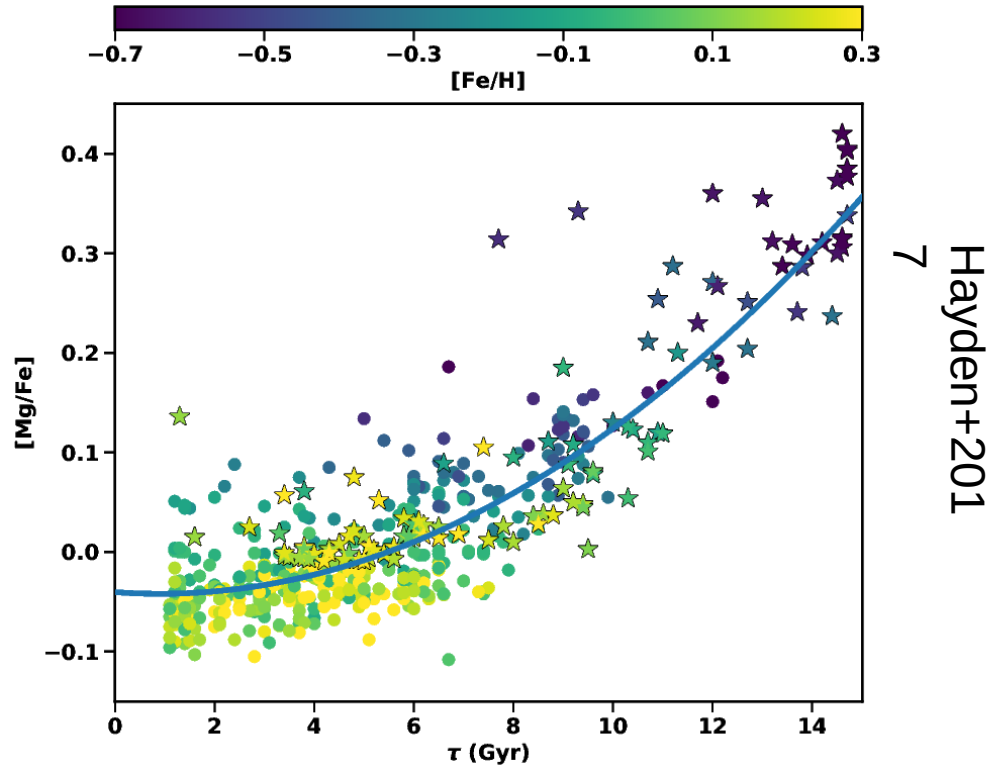
- High-res spectra $R \sim 120\,000$
- RV precision ~ 1 m/s
- Data taken for $\sim 1\,500$ stars within 100 pc of sun
- Accurate abundances for many elements
- ~ 600 turn off stars in sample: can get 10-20% relative ages!





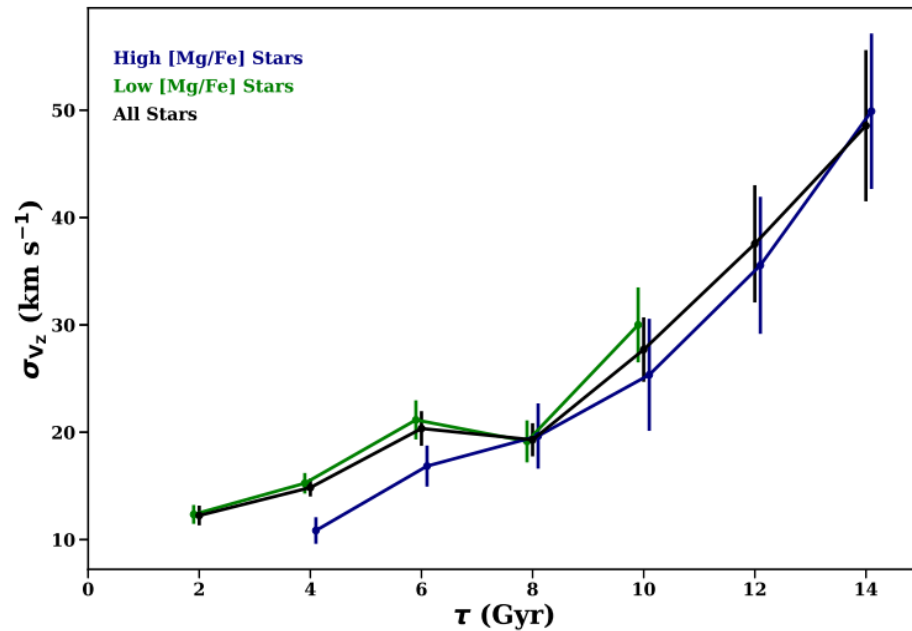
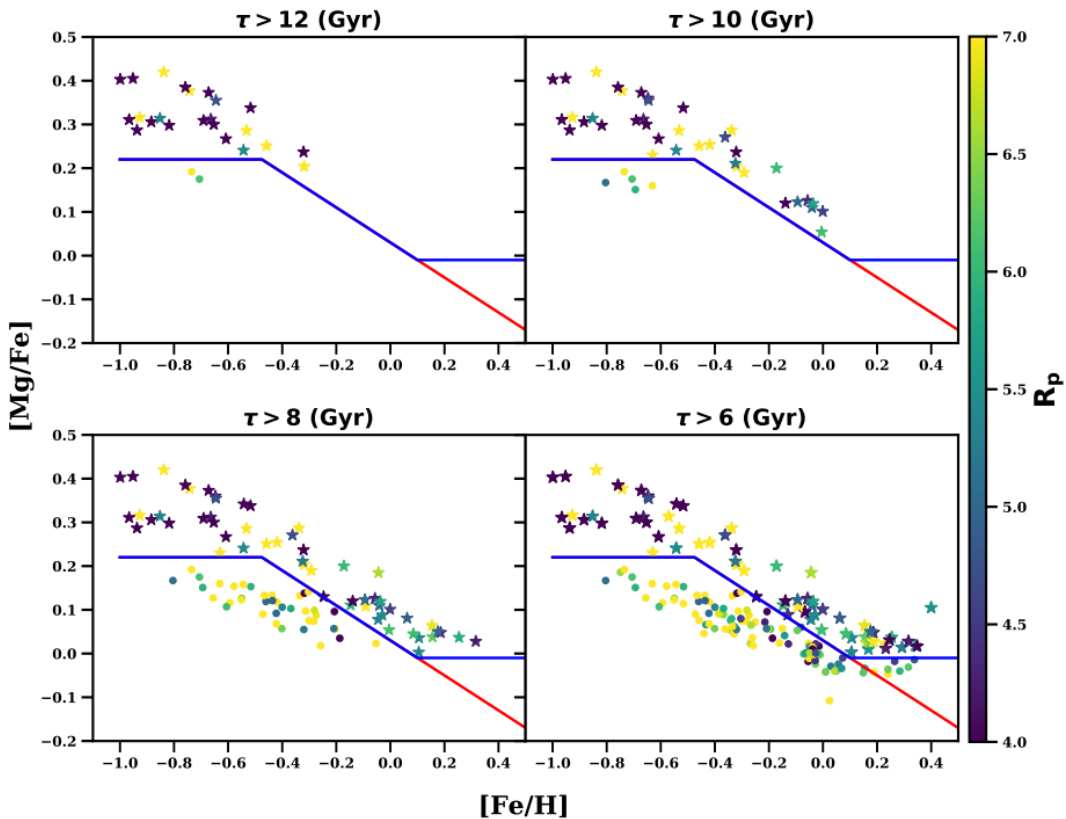






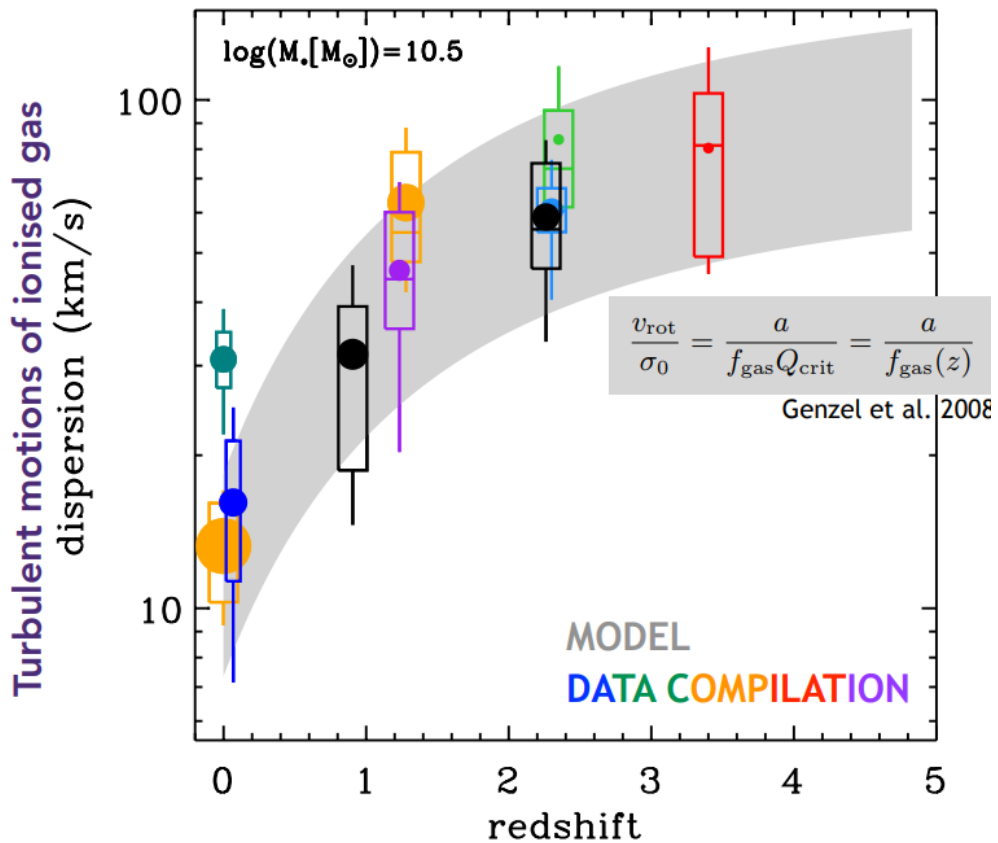
Summary of Chemistry

- High alpha disk is uniform with radius
- “Two” sequences in solar neighborhood are co-eval: difference in metallicity >0.5 dex
- High alpha track in solar neighborhood is identical to inner disk sequence
- Clear age alpha relation for alpha enhanced stars
- For $R > \sim 10$ kpc, the thick disk is made up of solar alpha populations

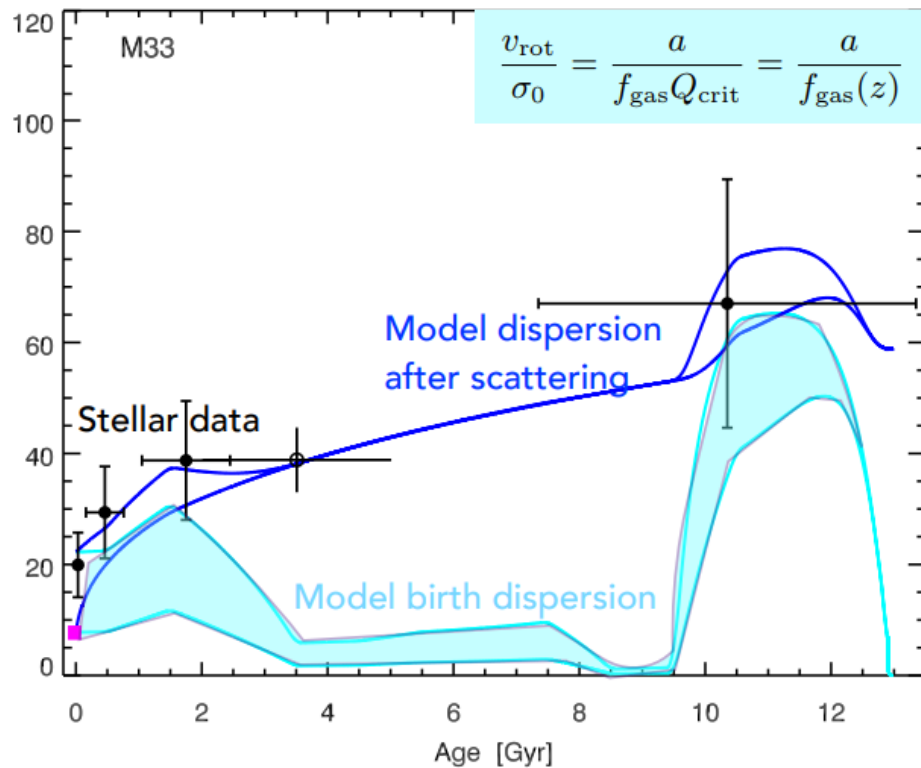


Hayden+201
7

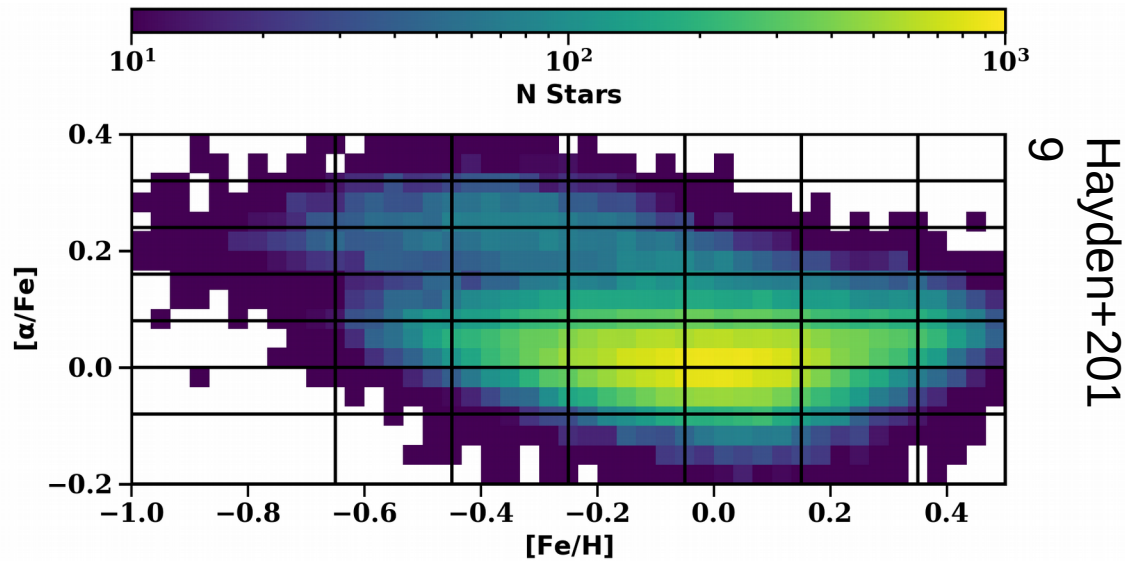
Wisnoiski+ 2015



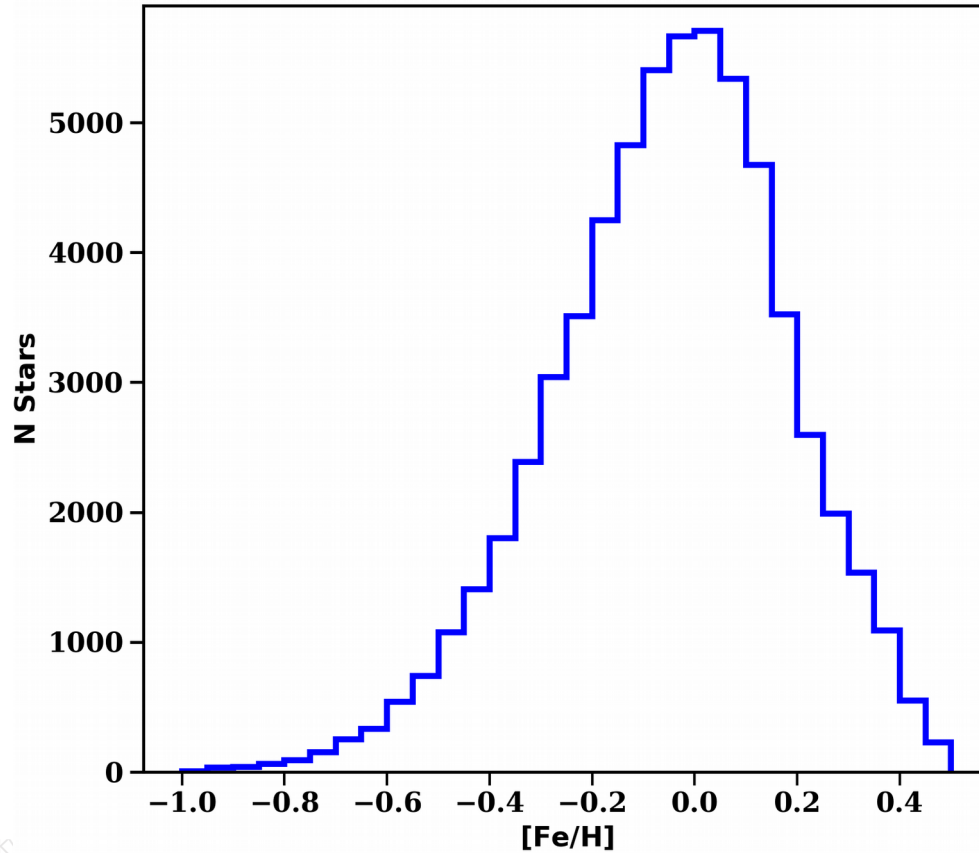
Leaman+ 2017



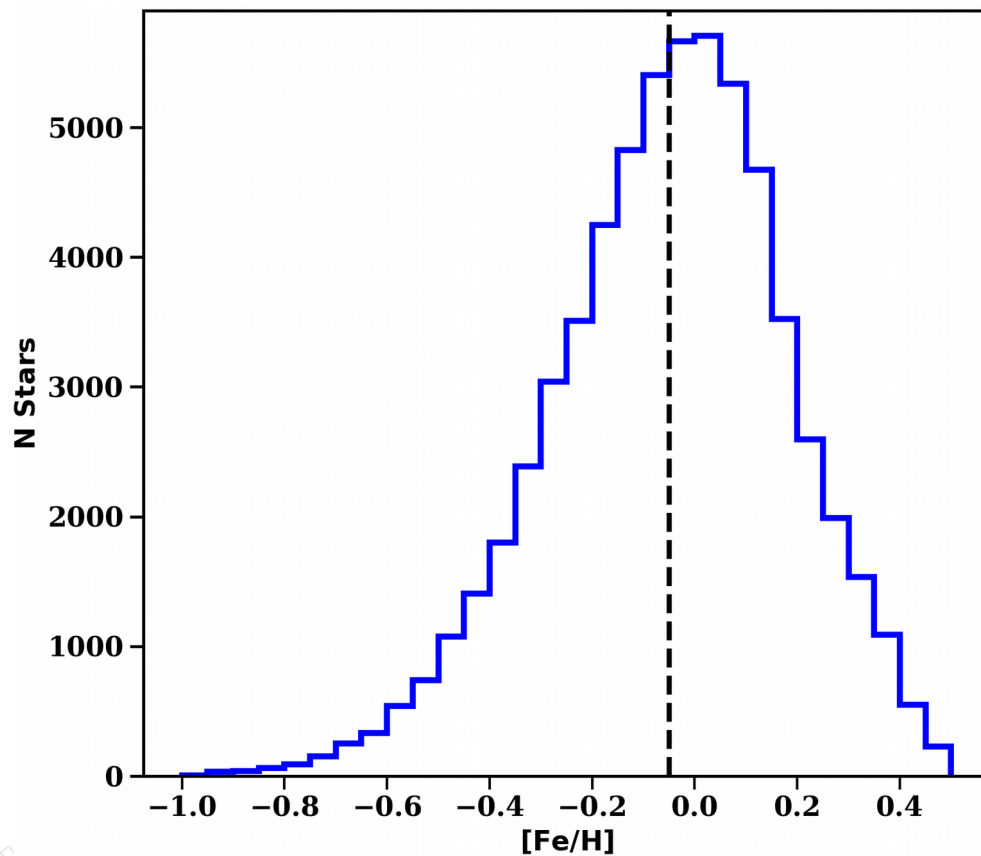
GALAH Solar Neighborhood



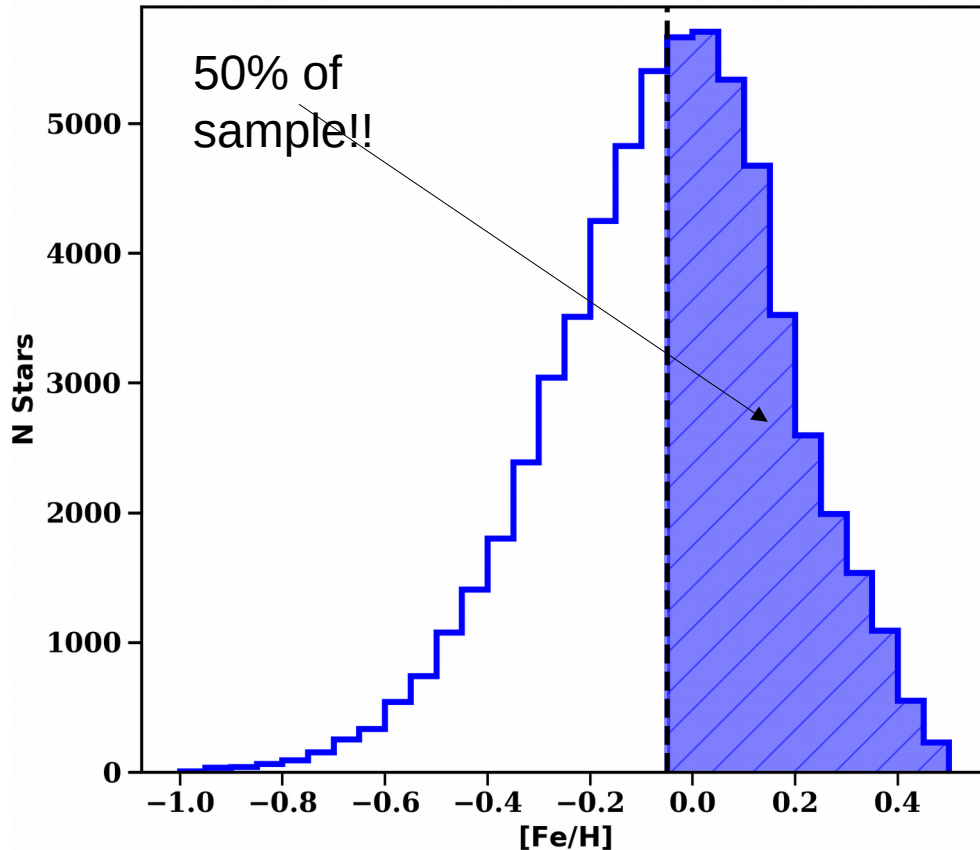
GALAH: Solar Neighborhood



GALAH: Solar Neighborhood

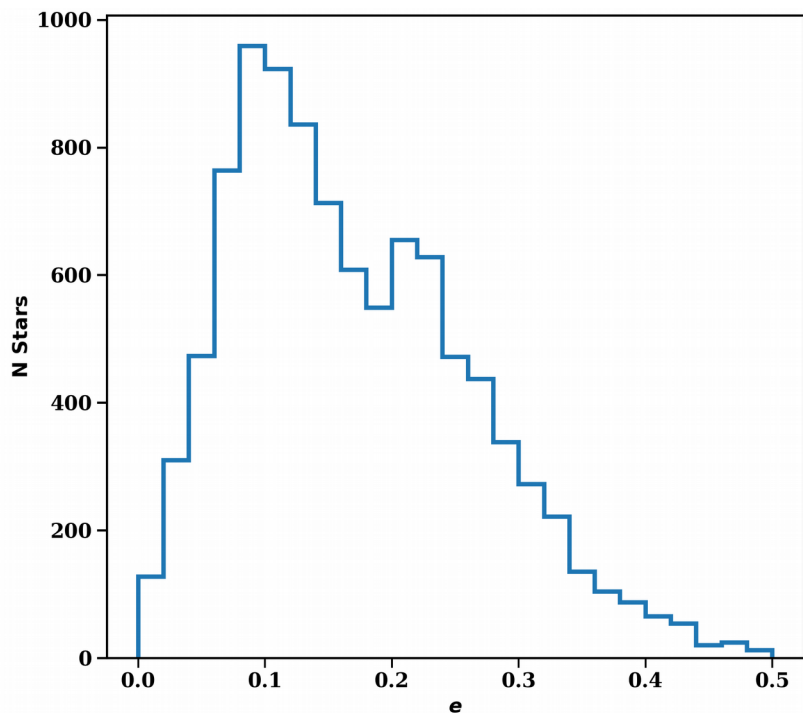


GALAH: Solar Neighborhood



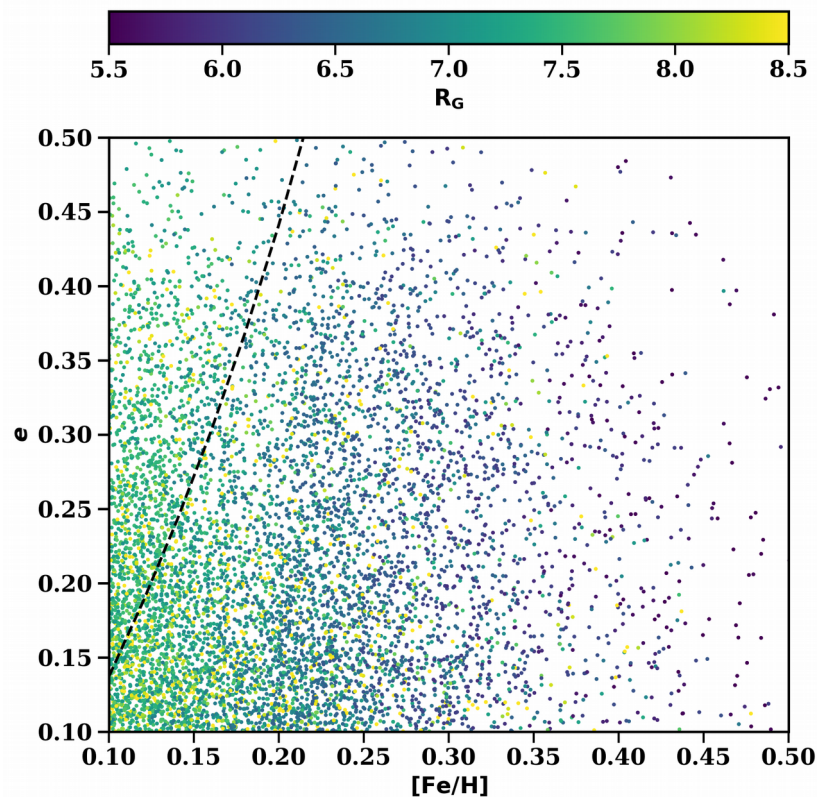
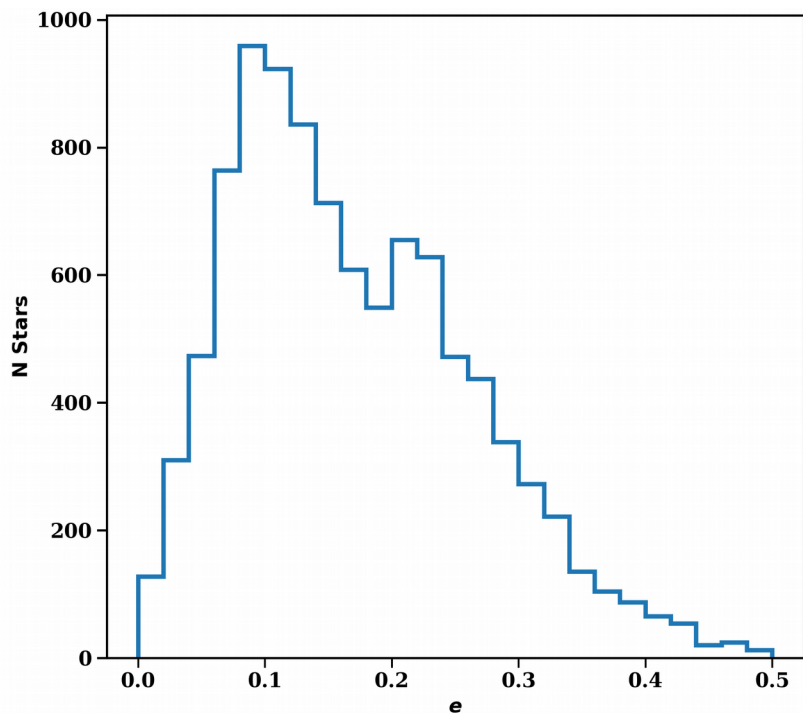
- ISM: Current metallicity near sun $[Fe/H] \sim -0.05$
- **Where do metal rich stars come from?**

Eccentricity, $[\text{Fe}/\text{H}] > 0.1$



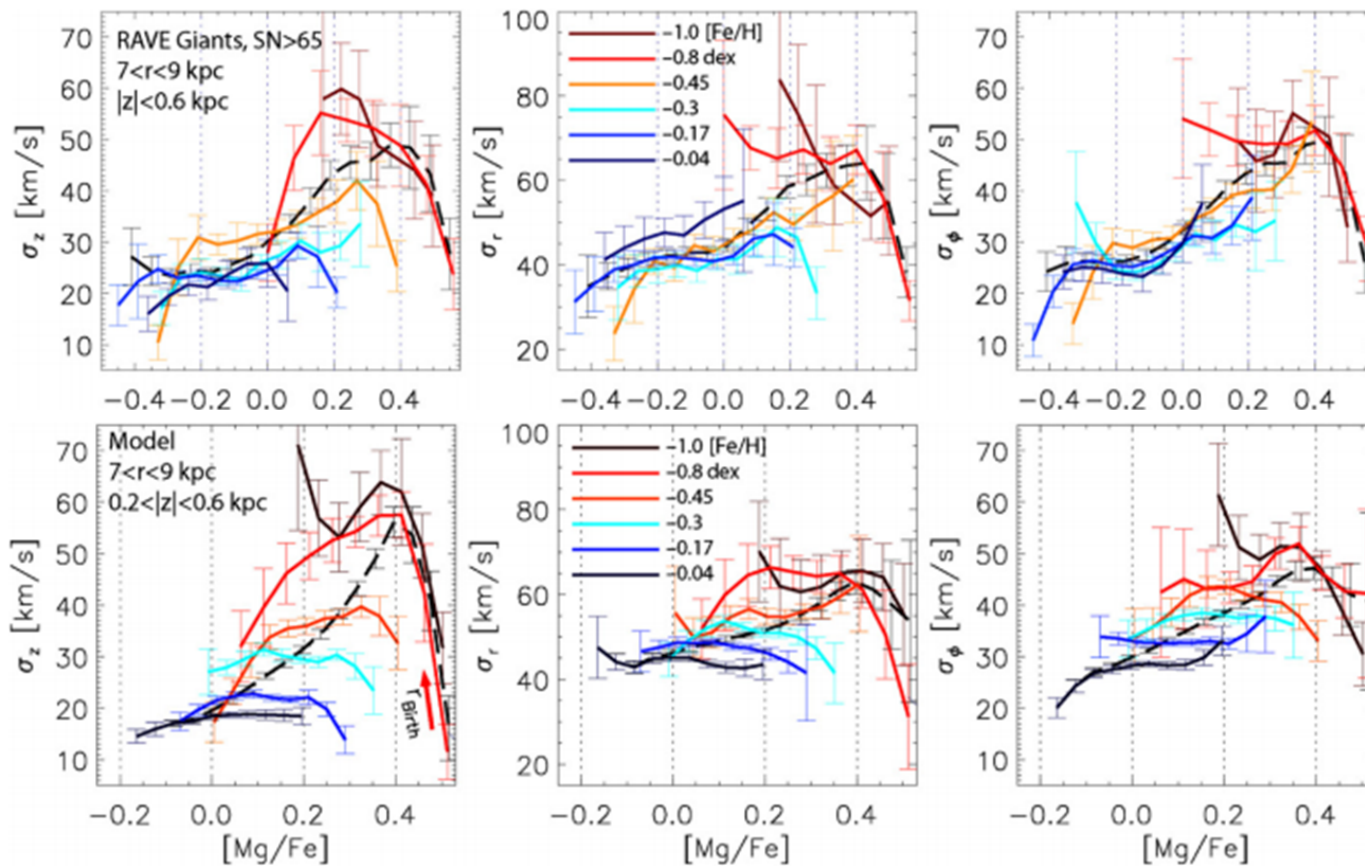
- Eccentricity distribution is bimodal
- **However** both peaks are fairly low eccentricity

Eccentricity, $[\text{Fe}/\text{H}] > 0.1$

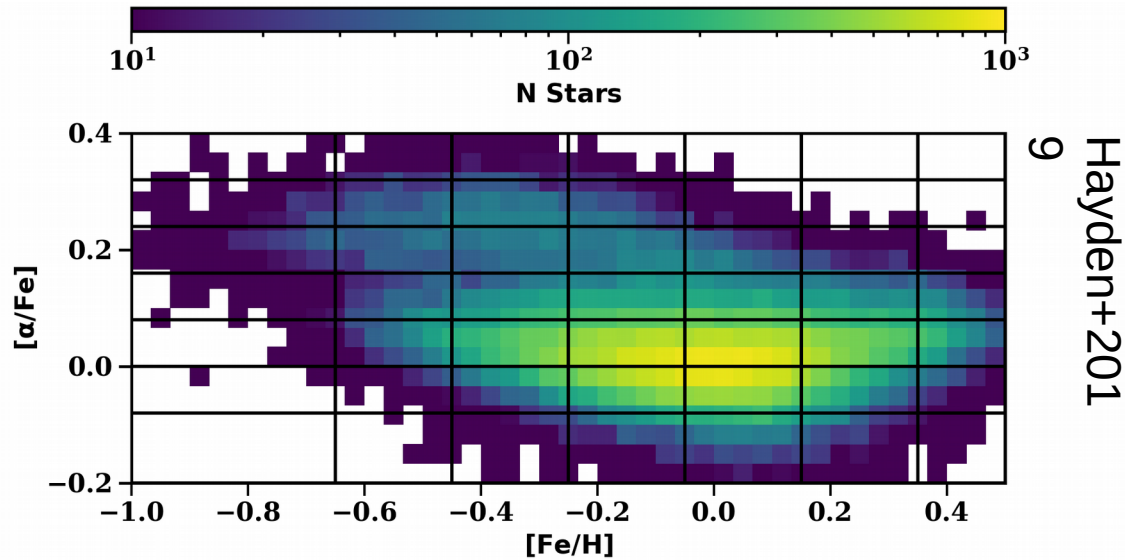


Kinematics+Chemistry: Evidence for Past Mergers?

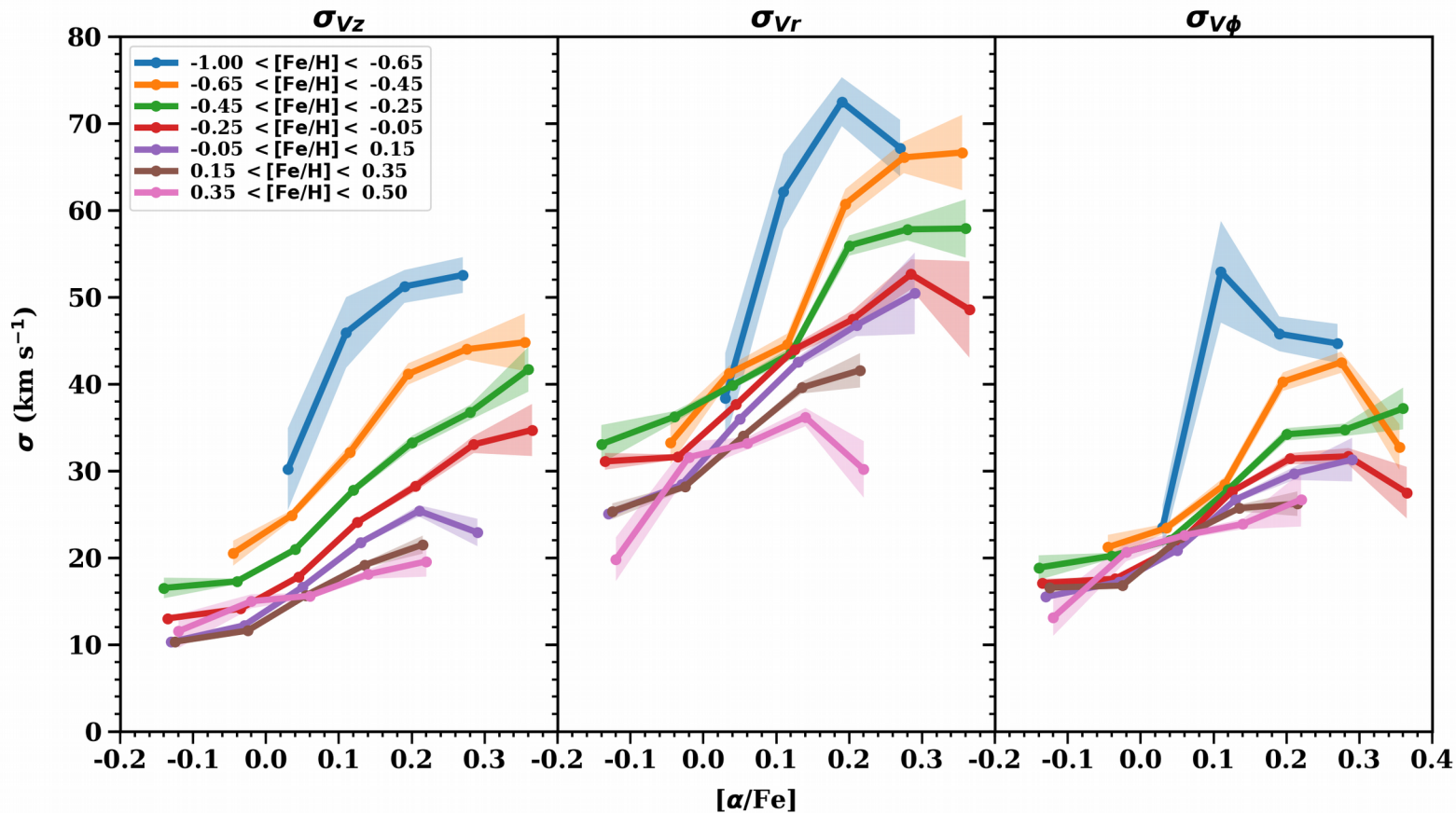
Minchev+2014

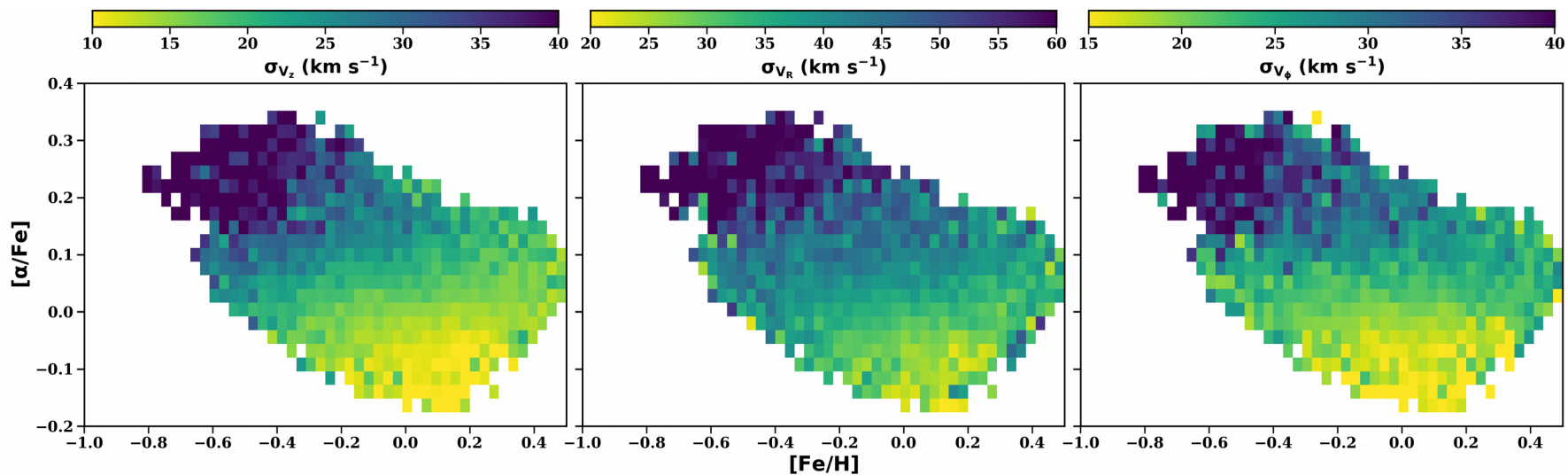


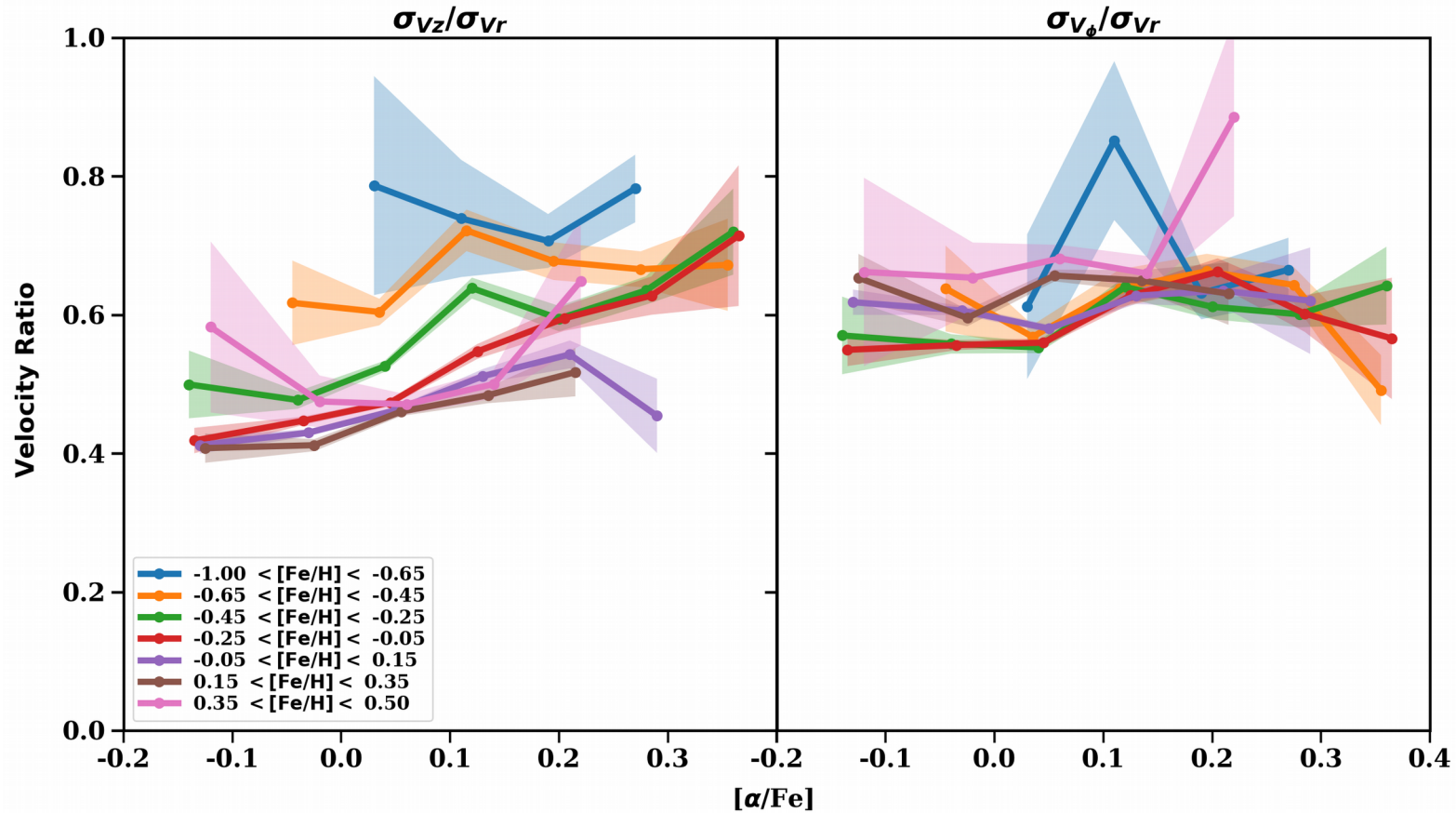
GALAH Solar Neighborhood

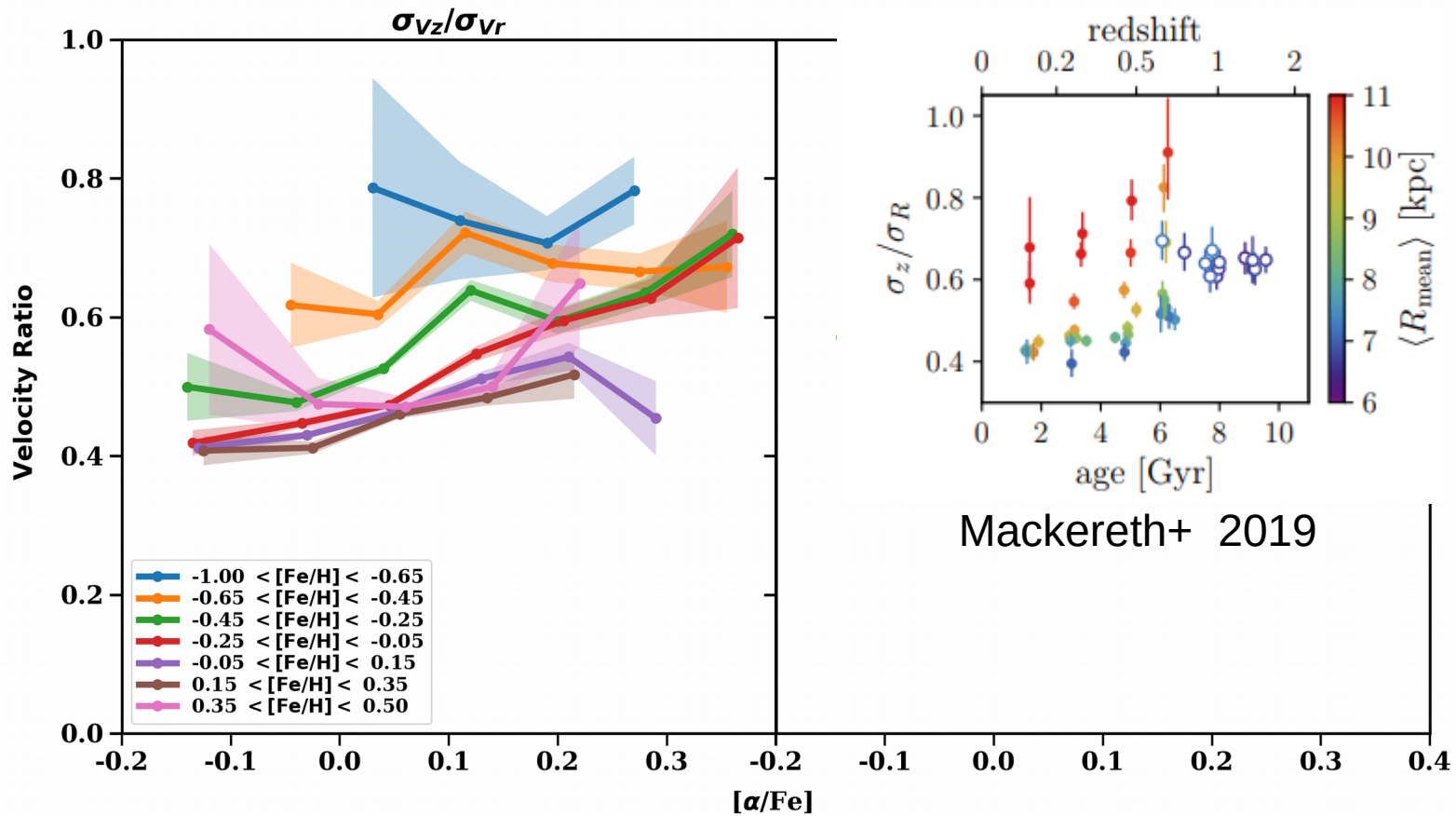


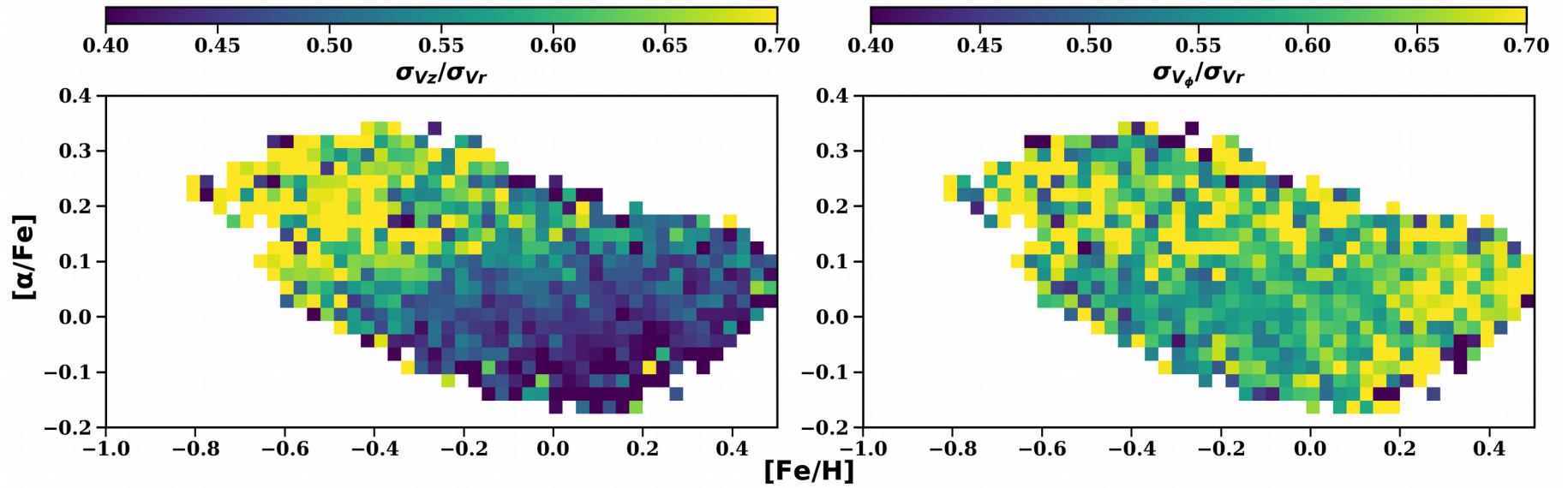
Velocity Dispersion



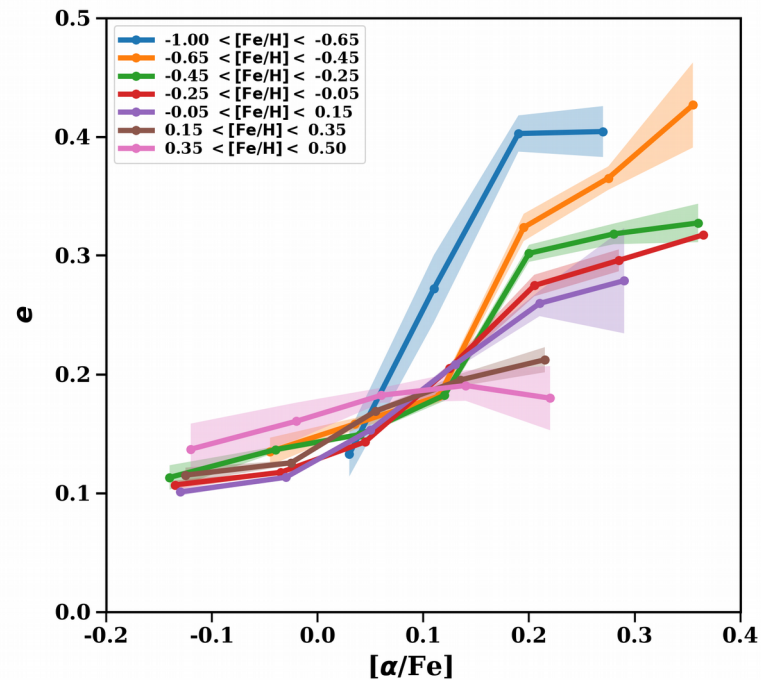
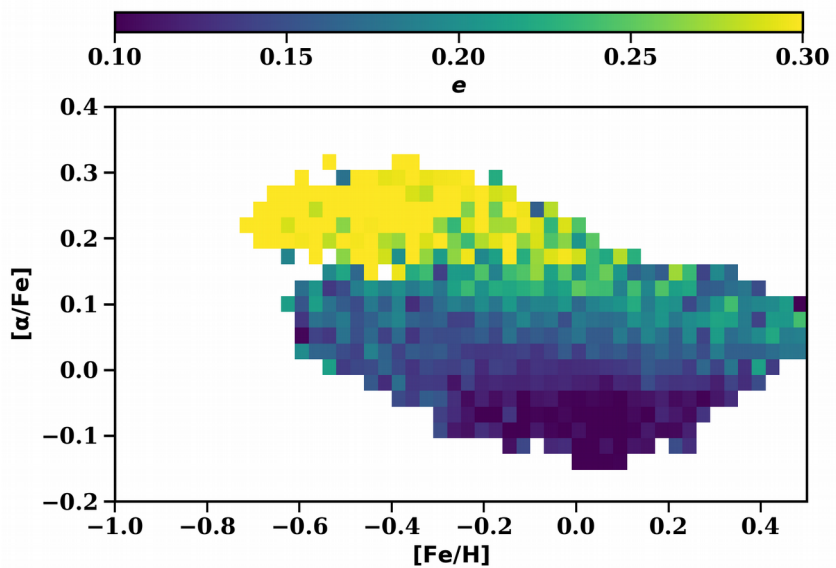




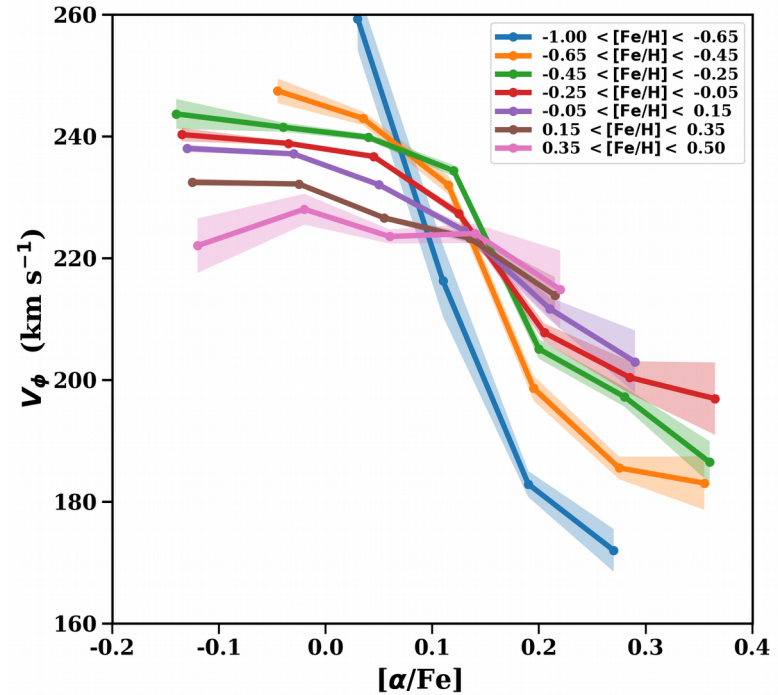
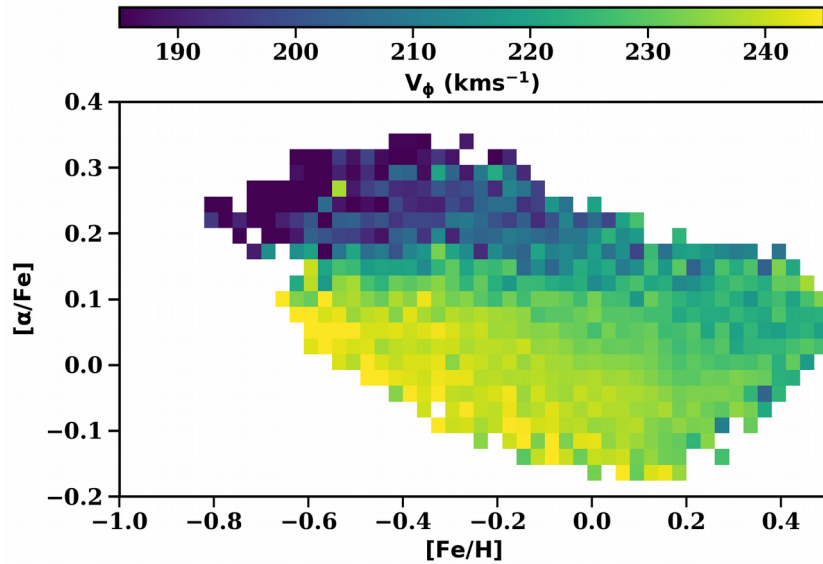


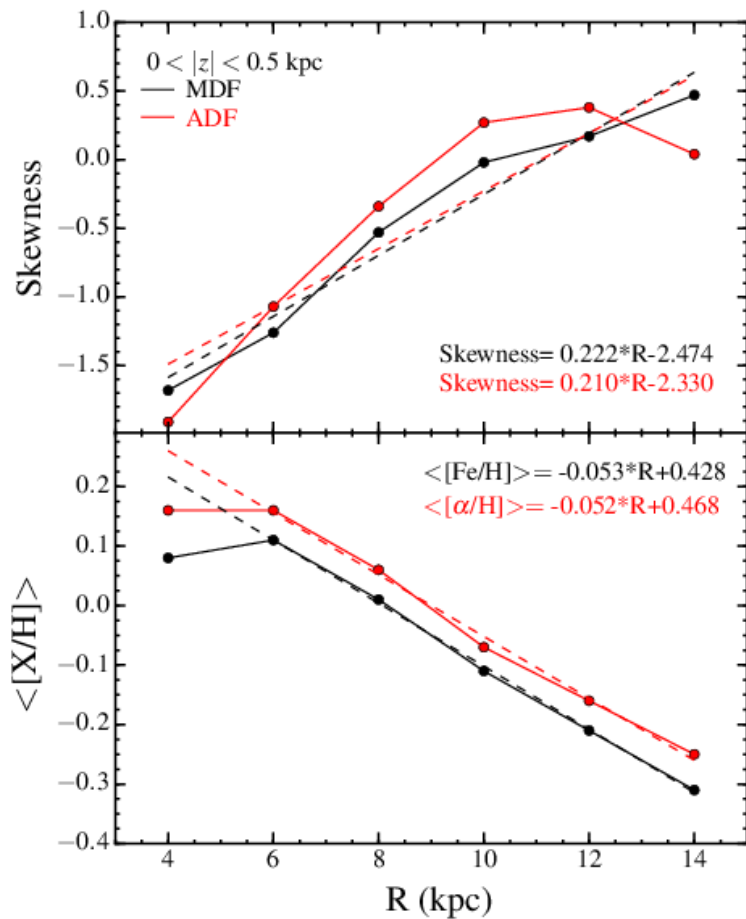
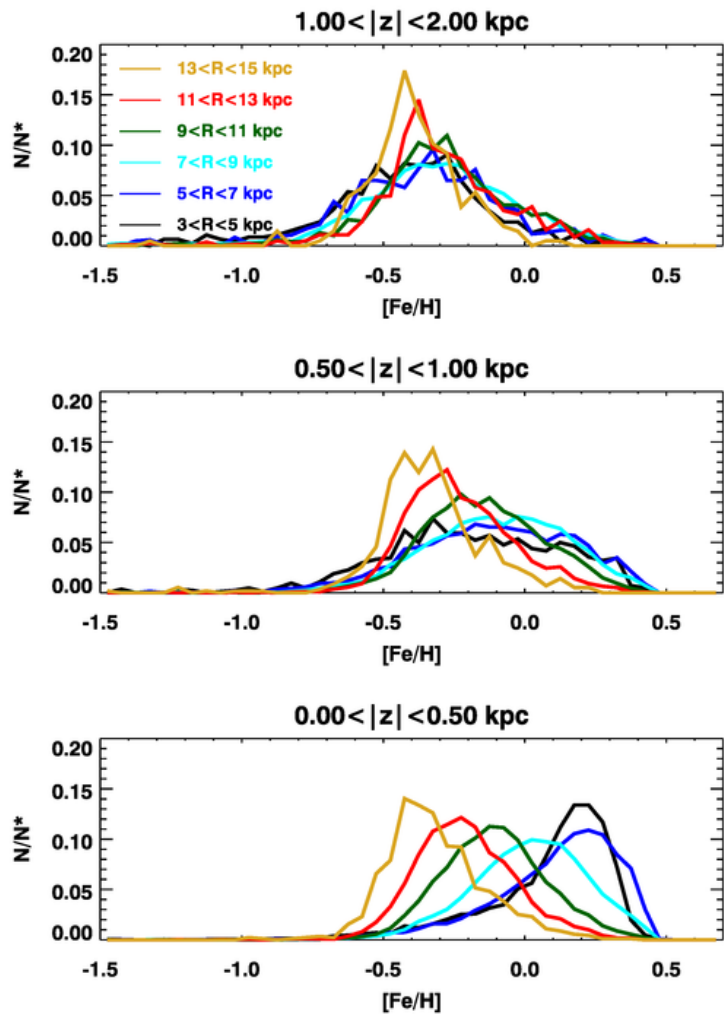


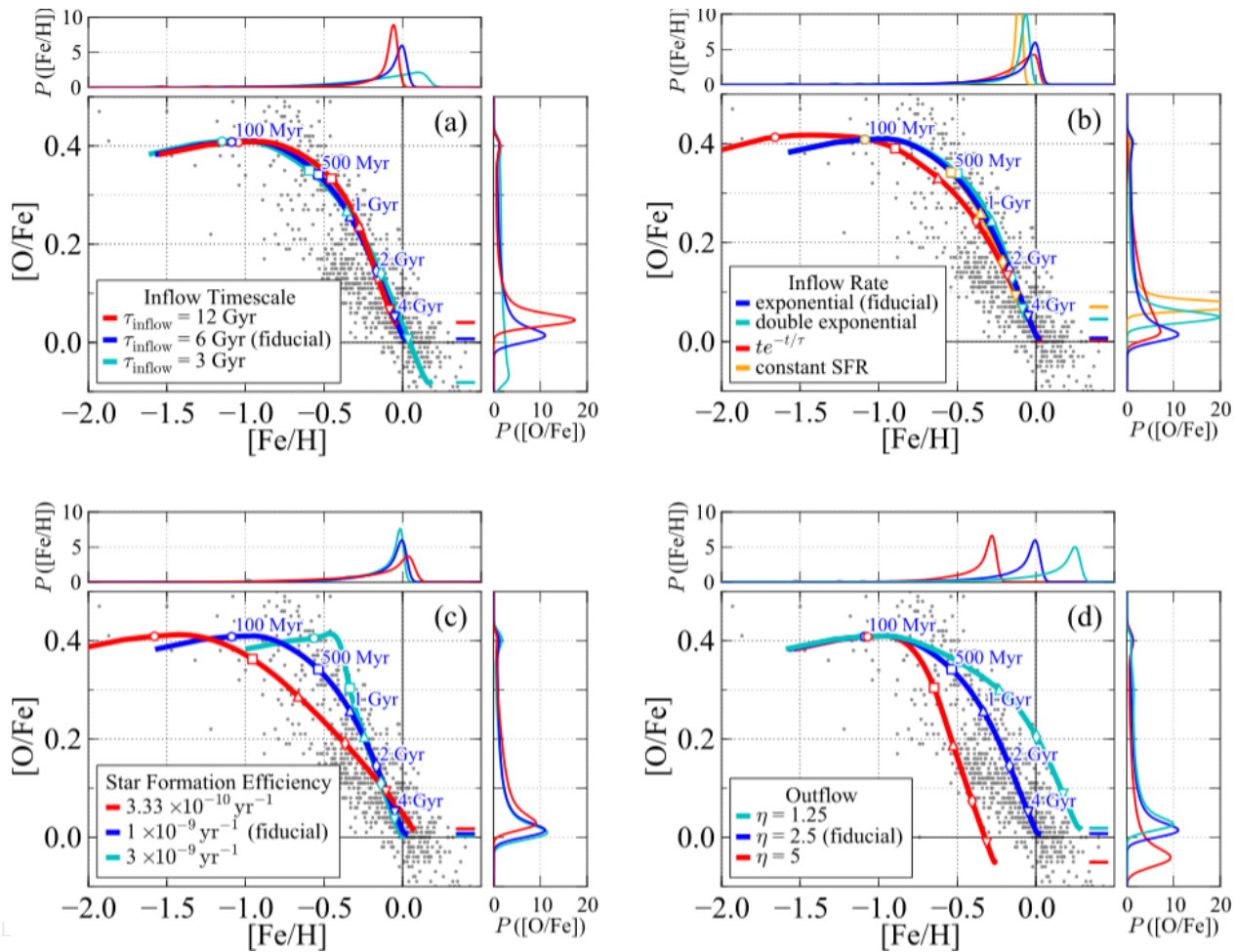
Eccentricity



Rotational Velocity





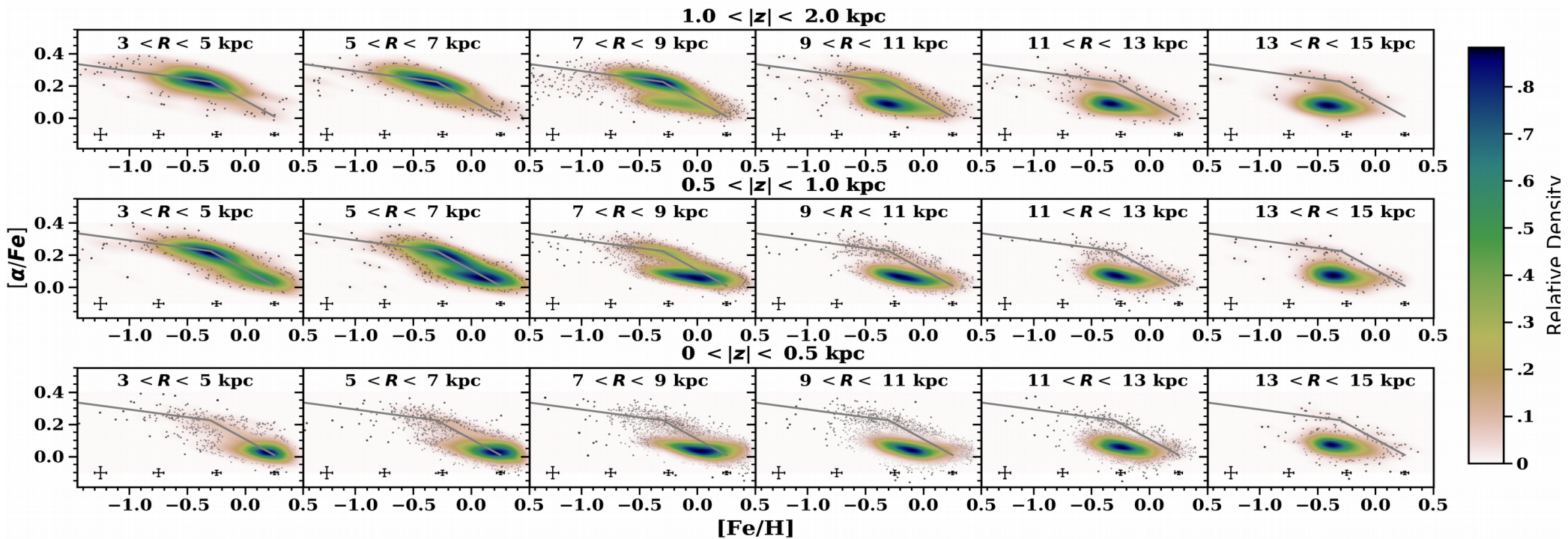


Andrews+2016

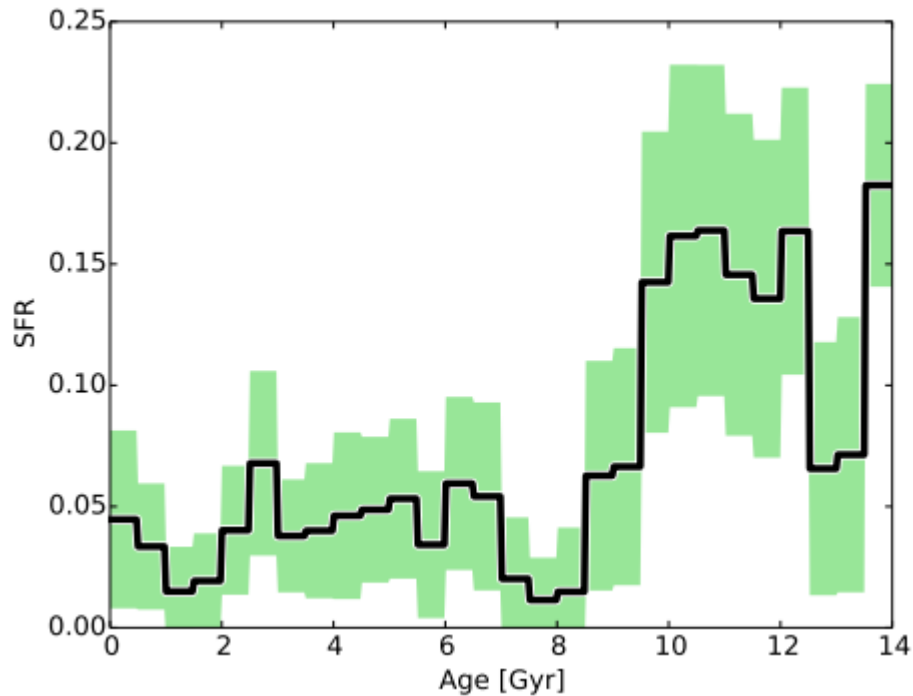
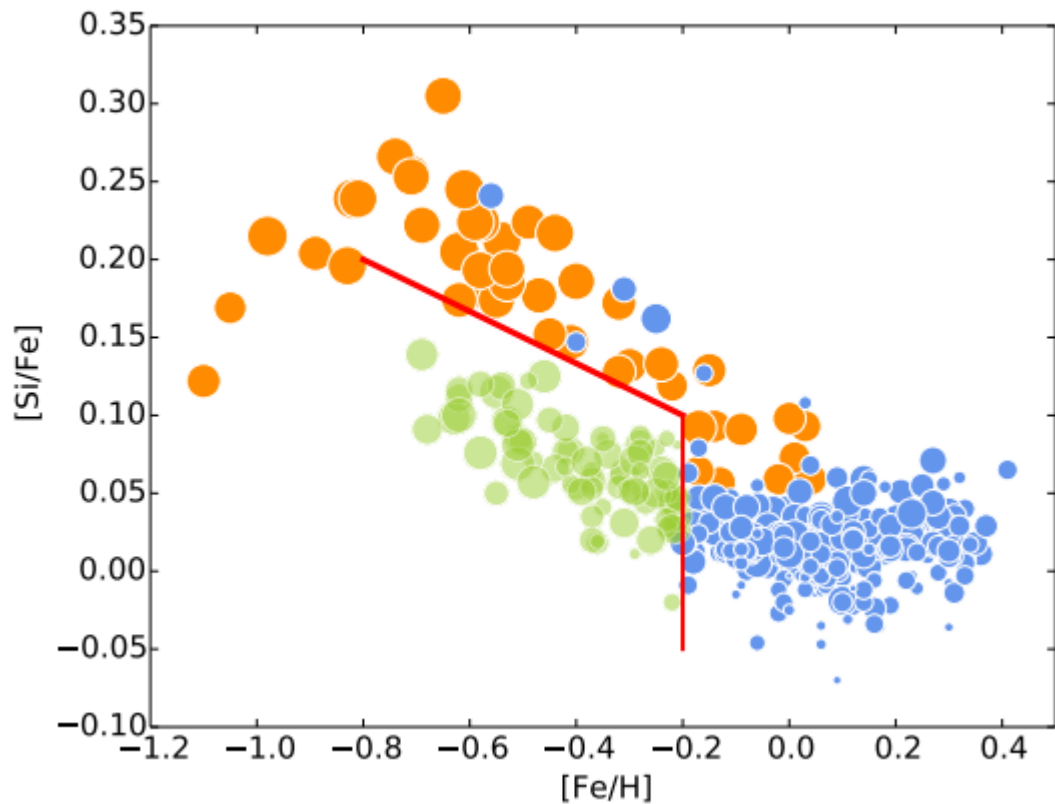
Summary of Chemodynamics

- Metal rich stars in solar neighborhood are likely migrated
- Metal poor “solar” alpha stars are likely from the outer disk
- MDF skewness is a function of radius: signature of migration
- Velocity dispersion tends to vary smoothly with chemistry
- Hints of two phases in vertical velocity dispersion: GMC heating vs. forming hot?

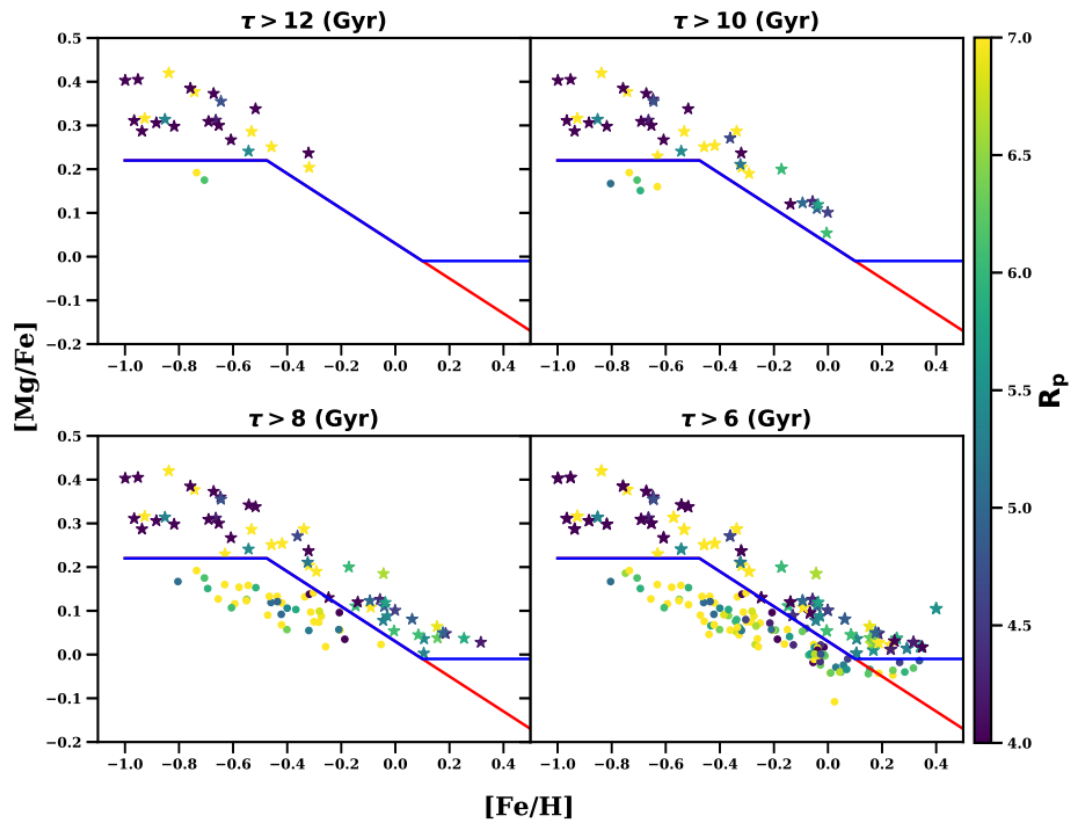
Mapping the Milky Way



Hayden+ 2015

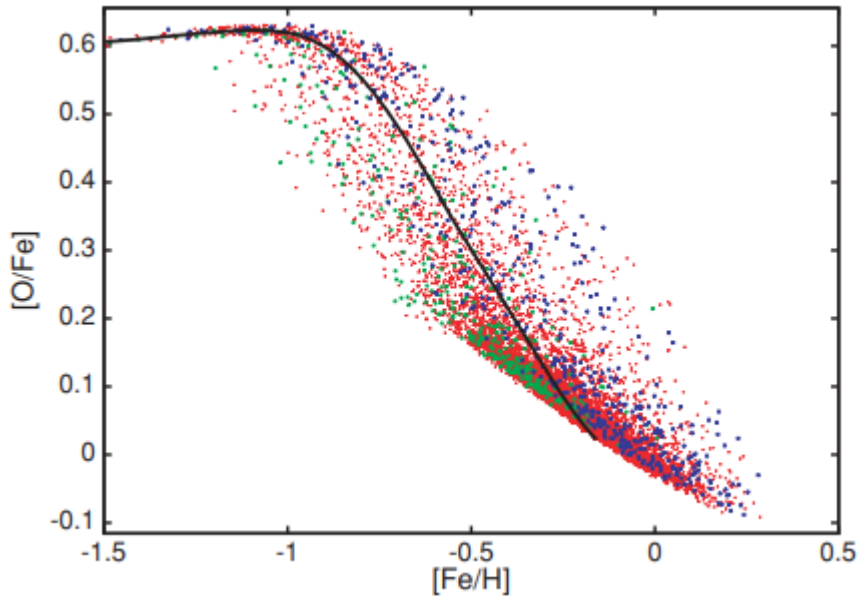
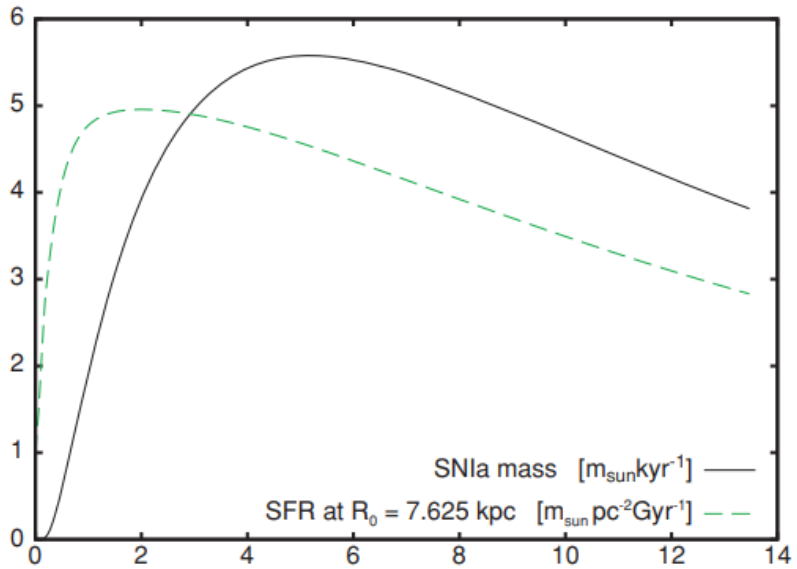


Snaith+ 2015

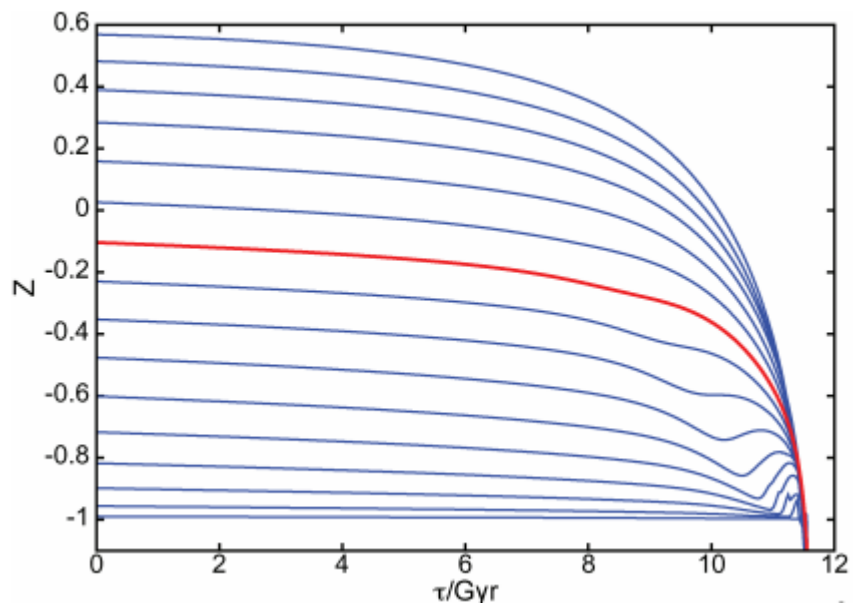


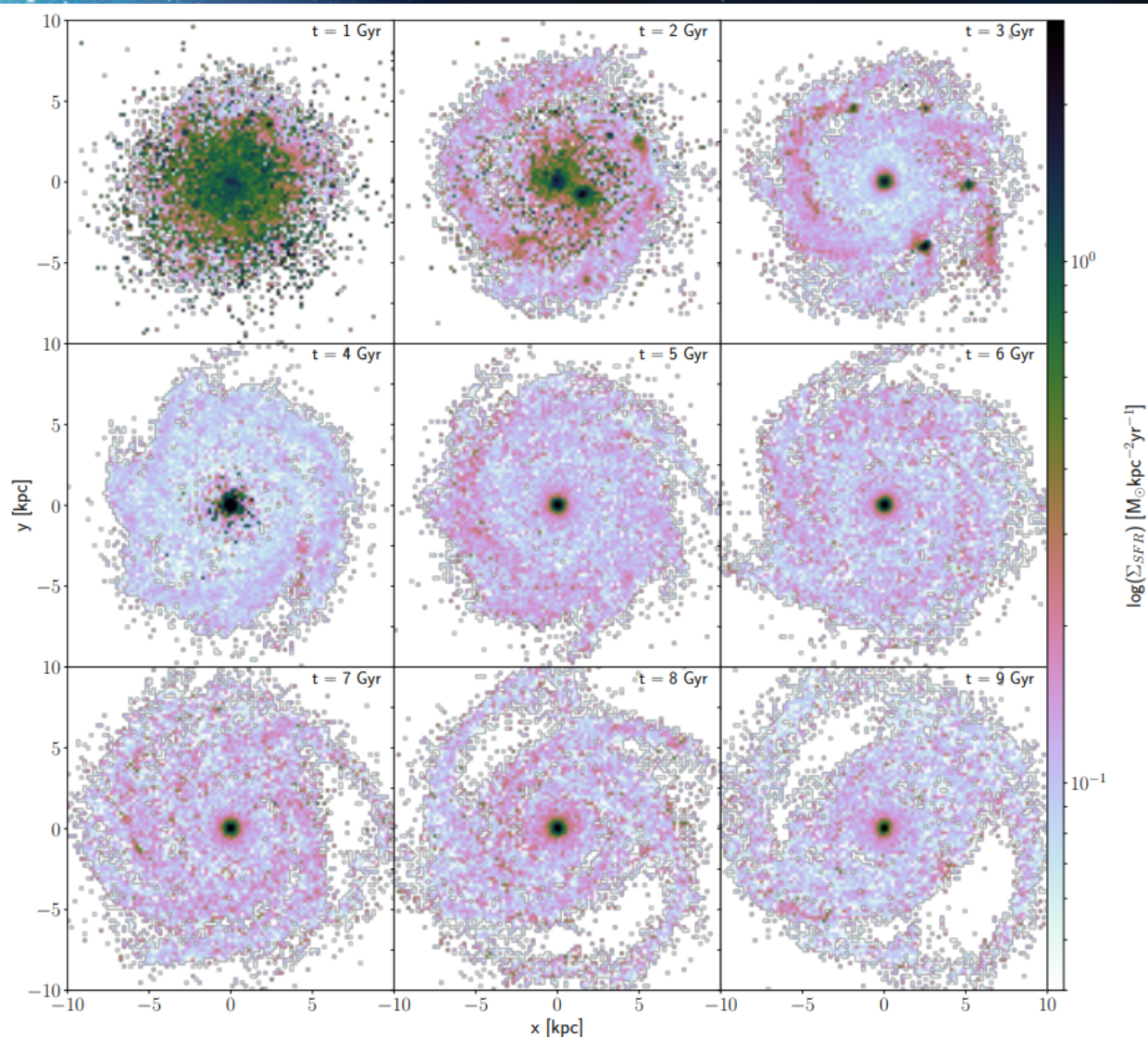
Hayden+201

7

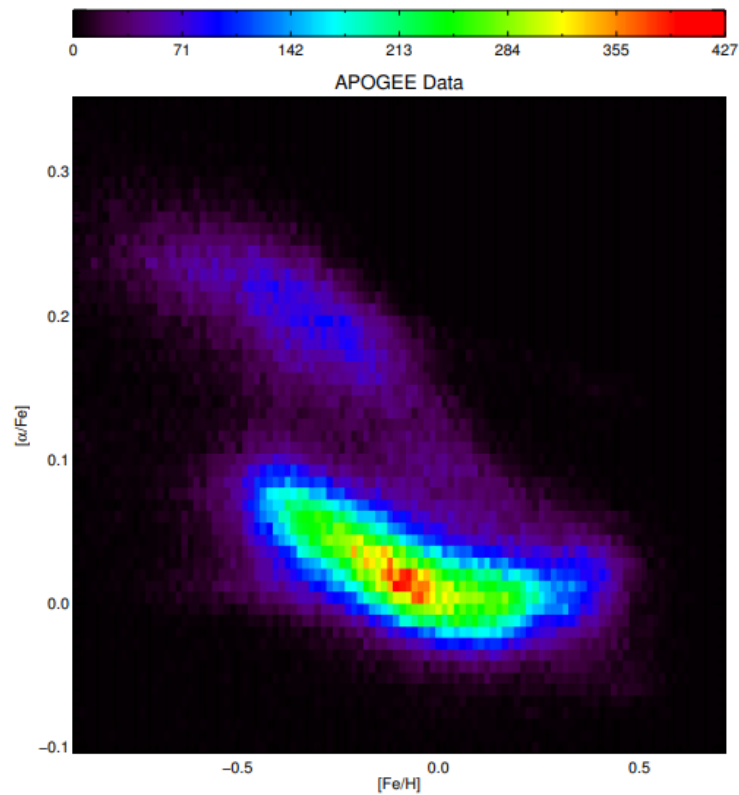
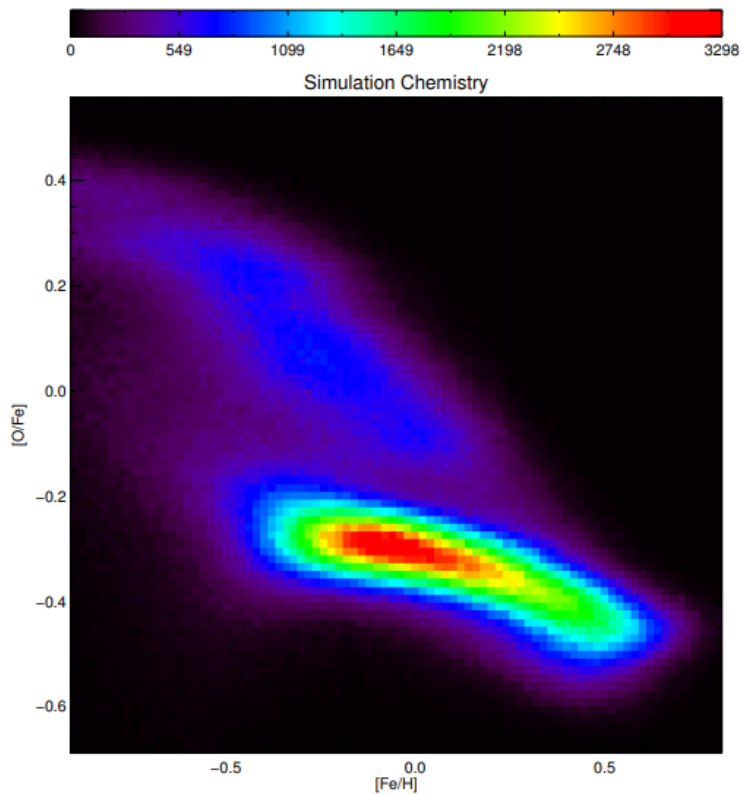


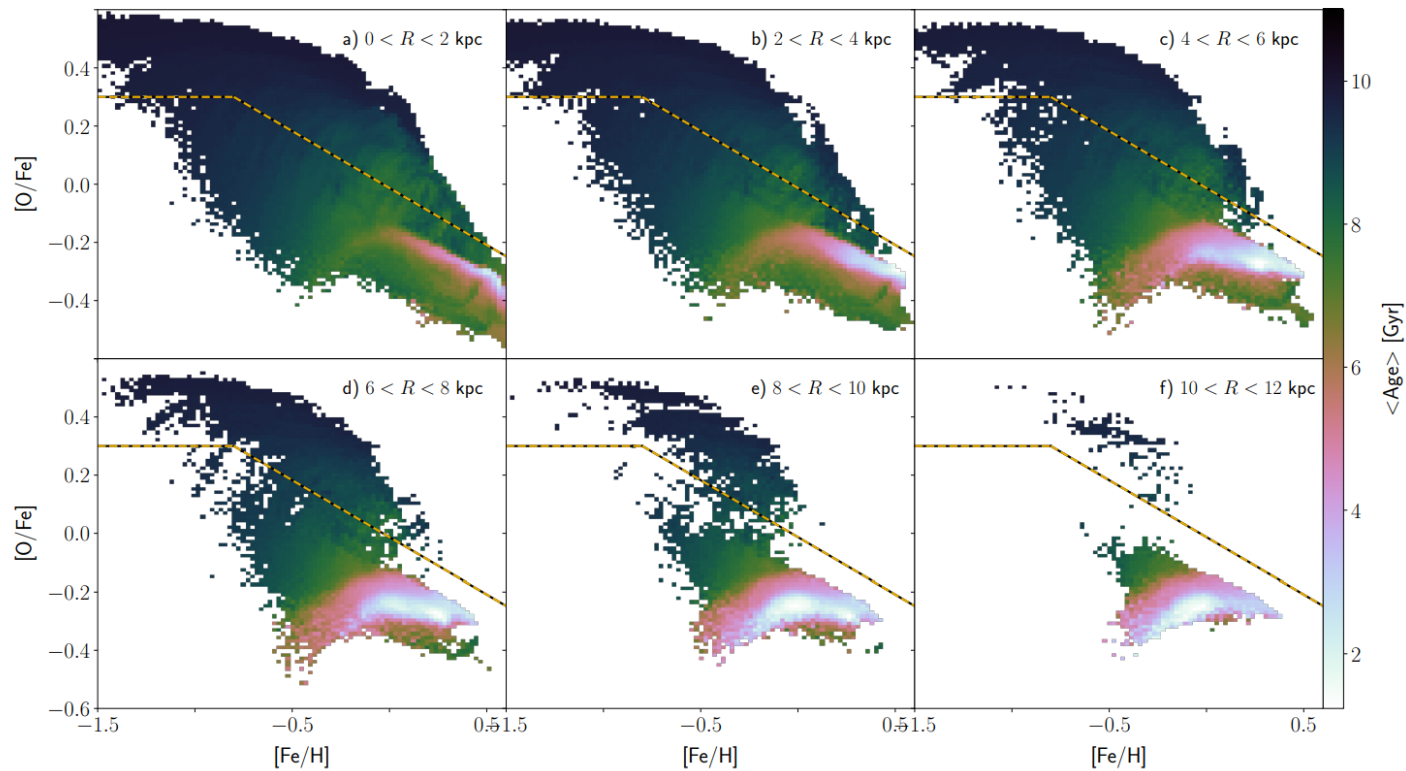
Schönrich & Binney 2009

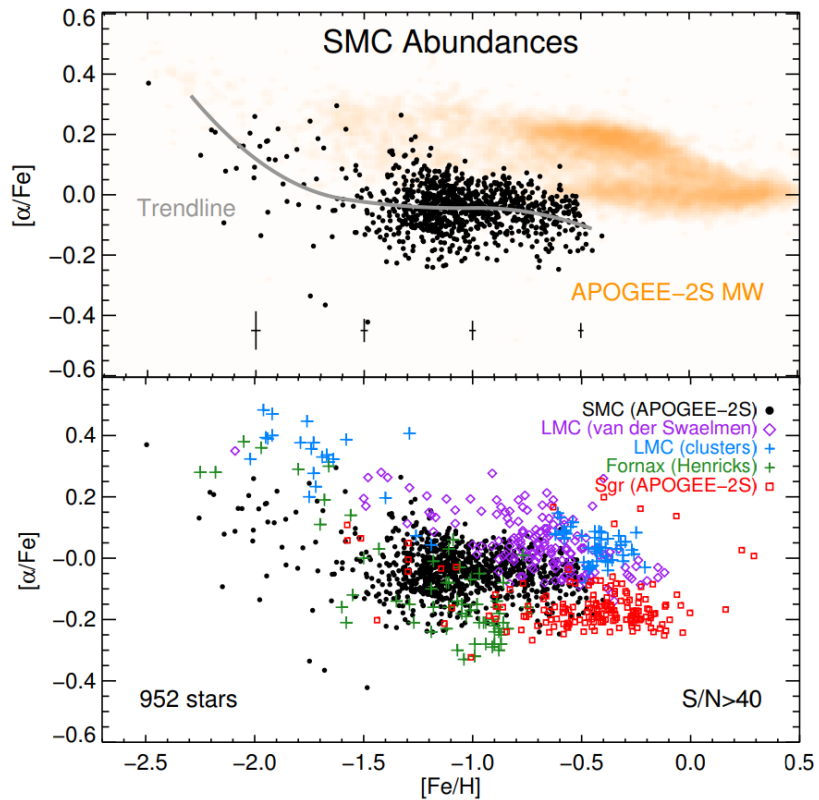
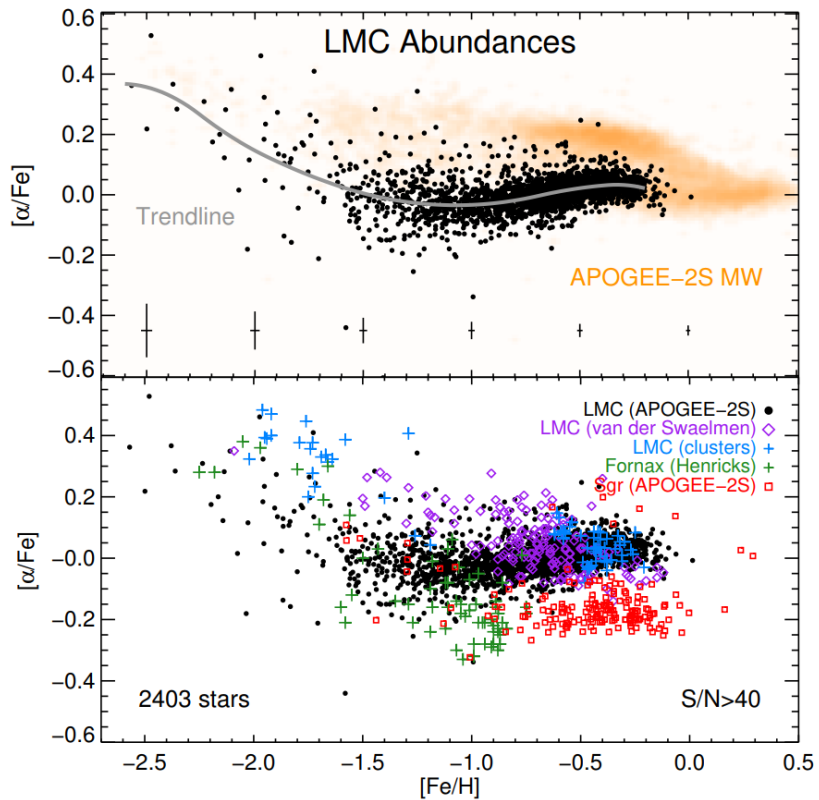




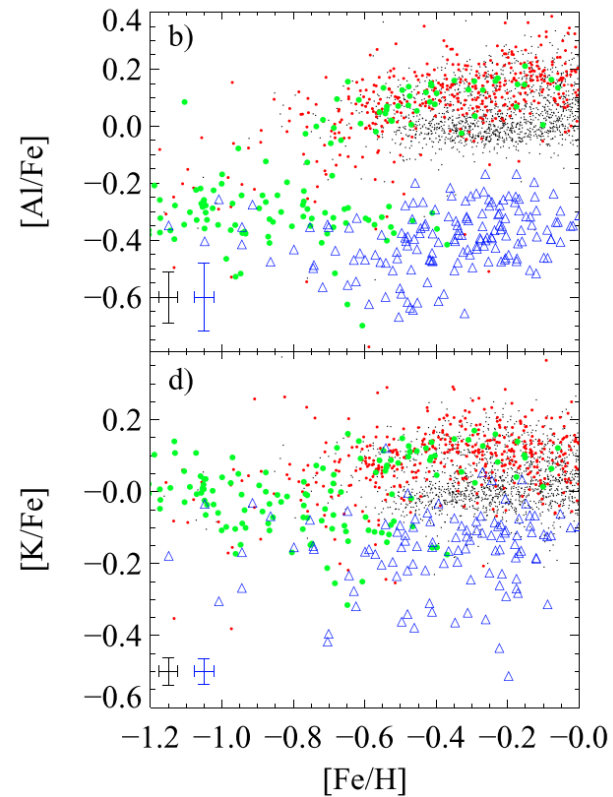
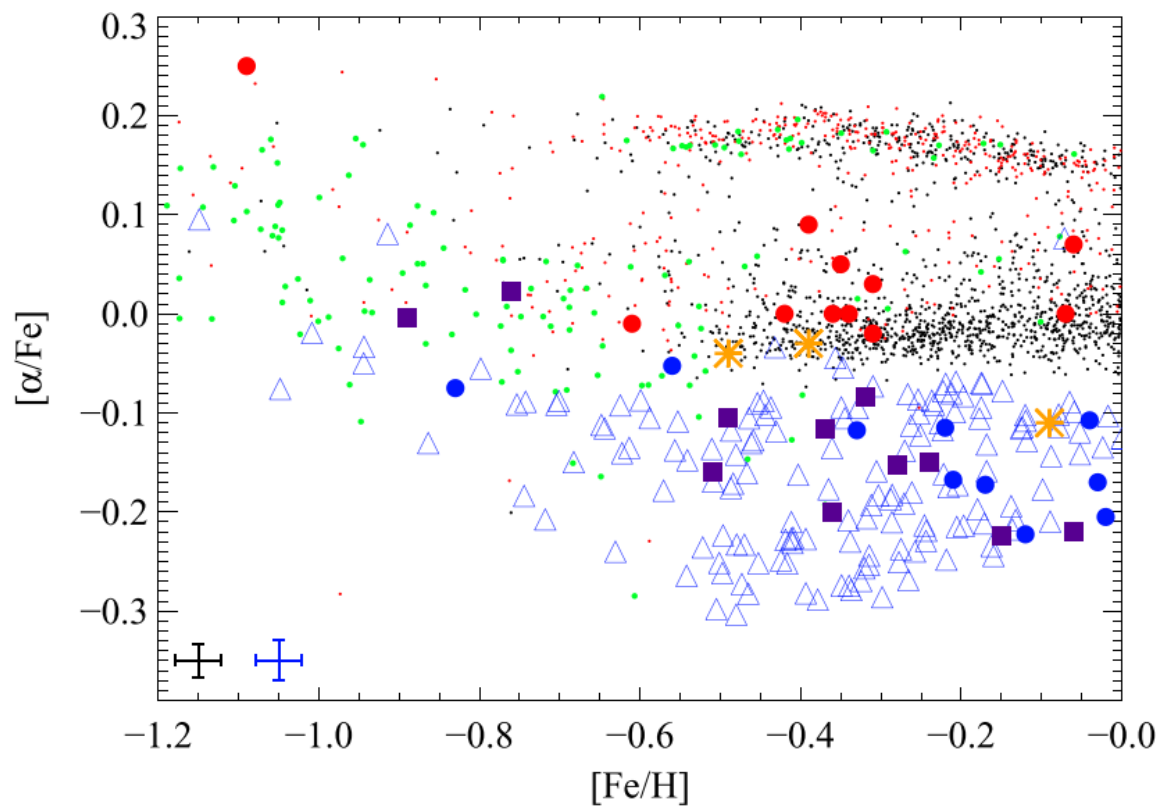
Clarke+2019



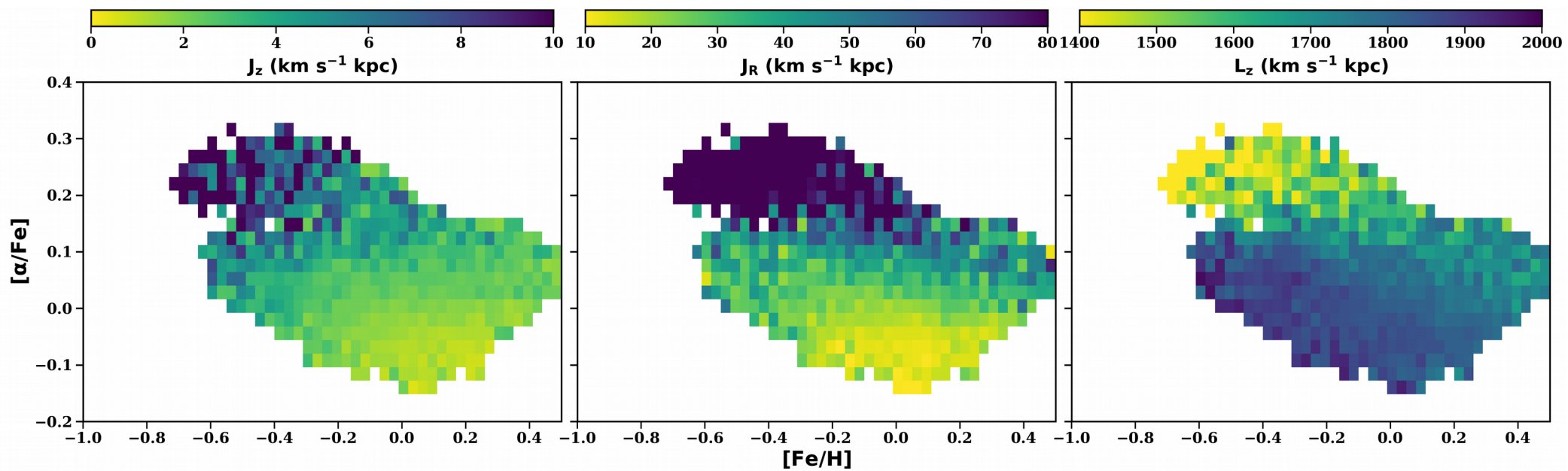


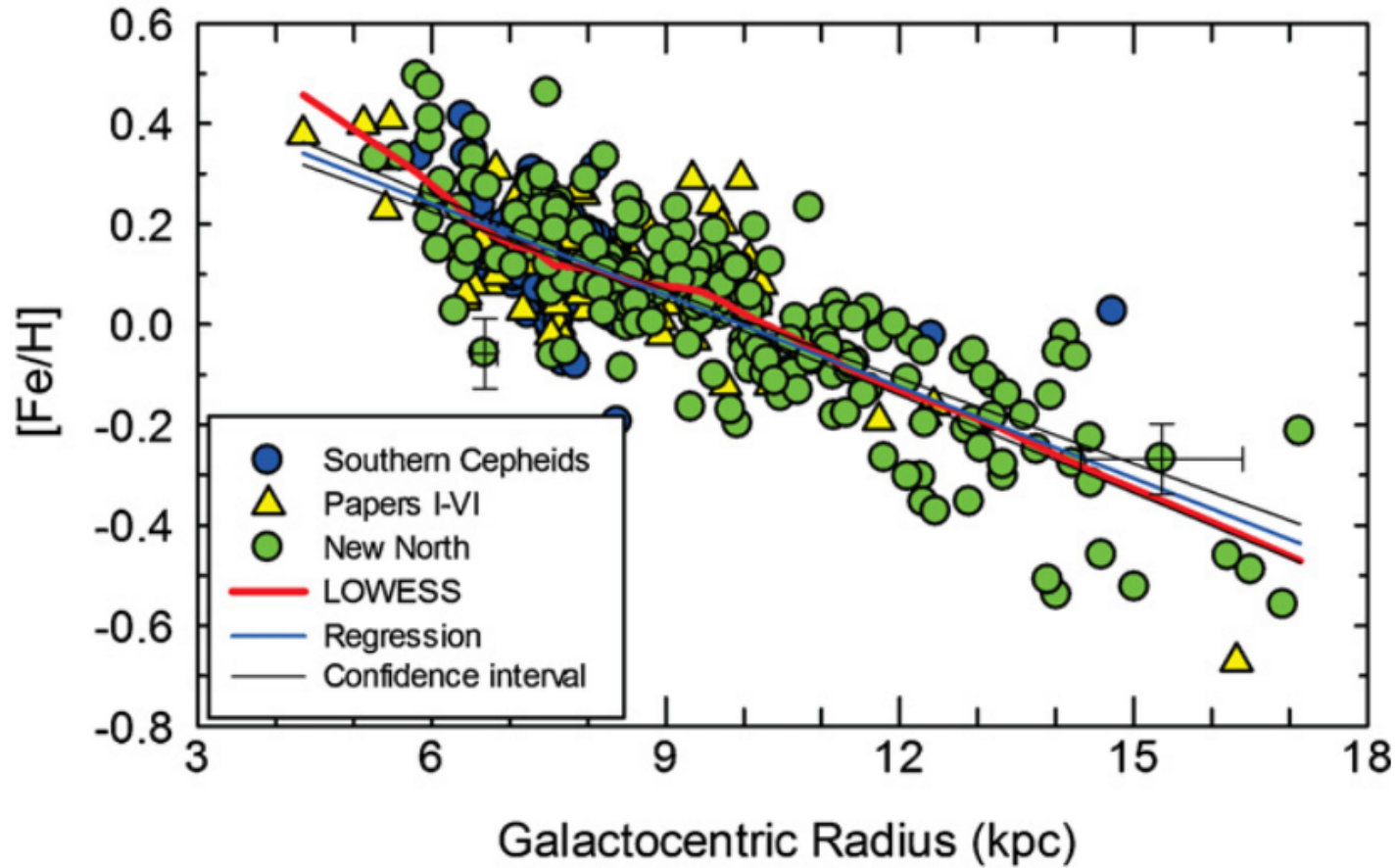


Nidever+201

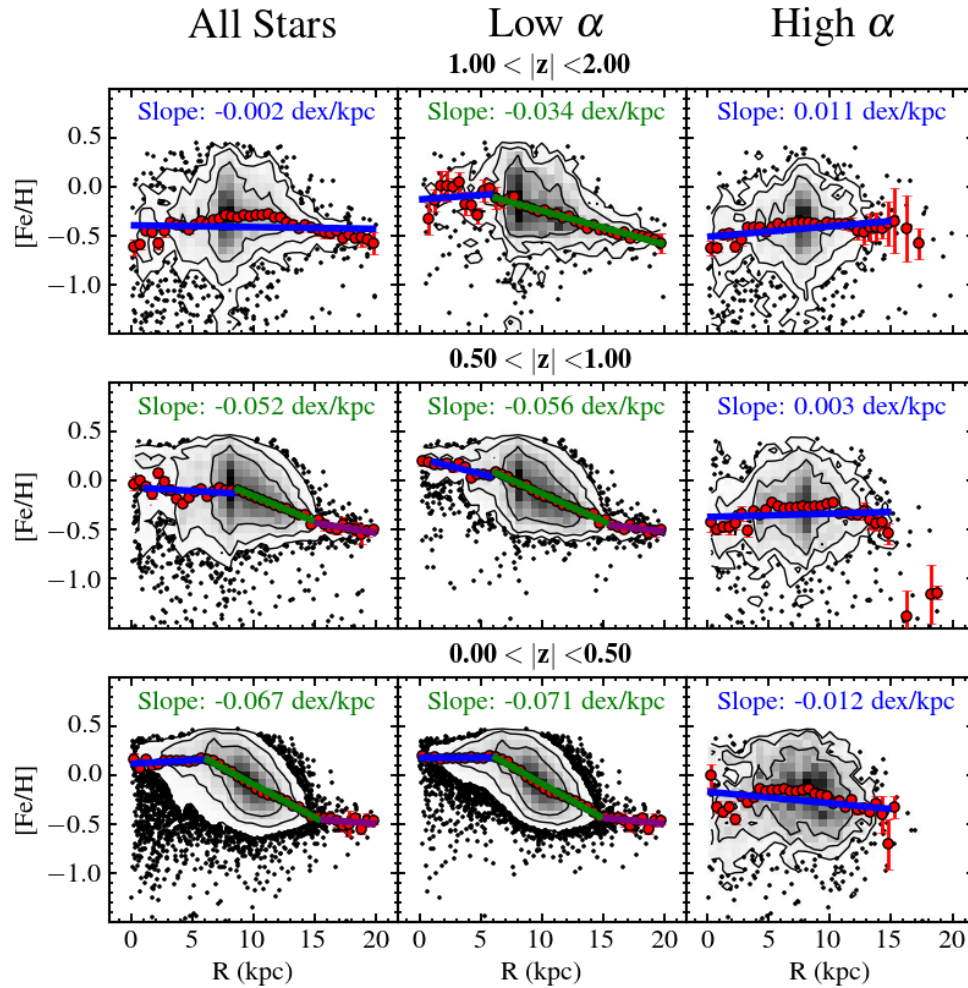


Hasselquist+
2017

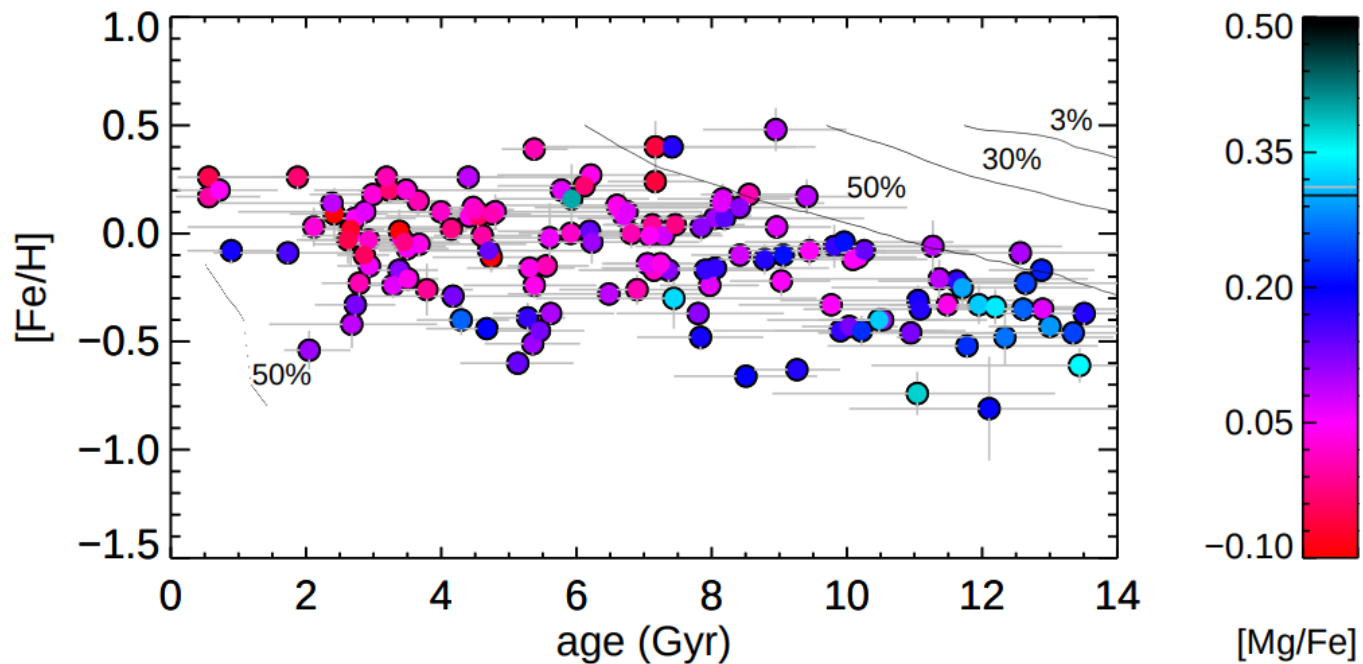




Luck+
2011

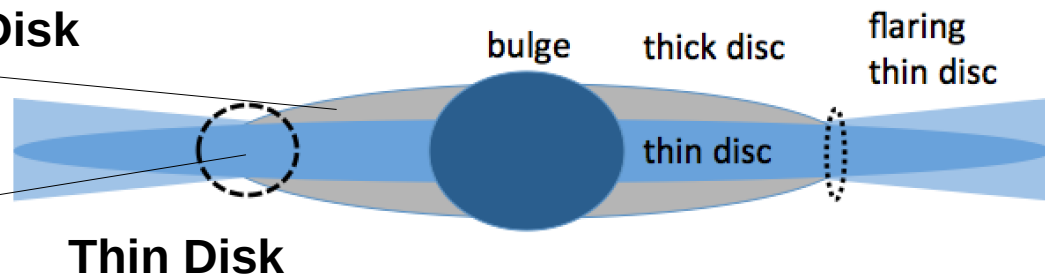
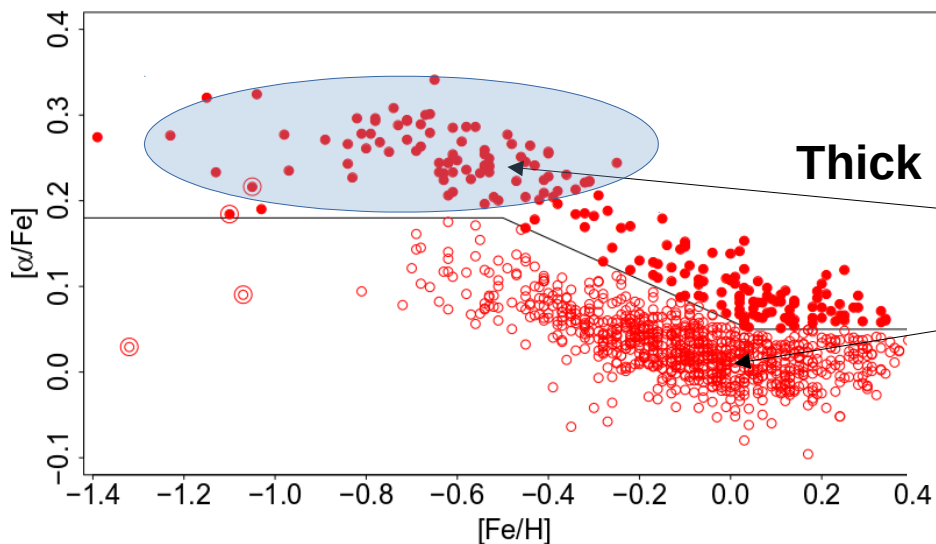


Hayden+
2014



Bergemann+201
5

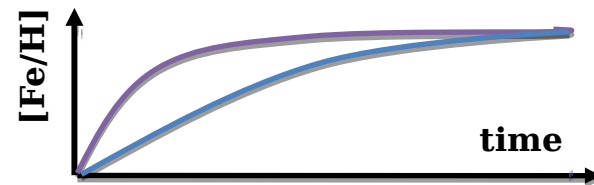
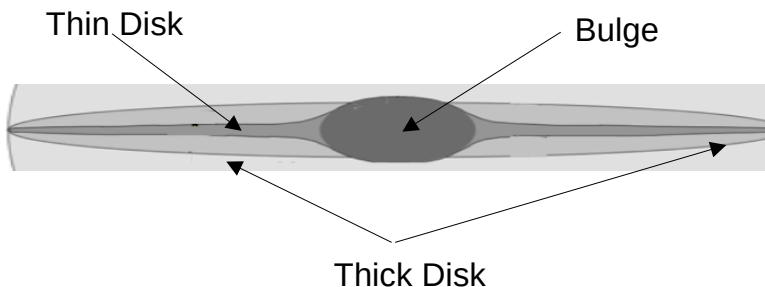
The Disk of the Milky Way



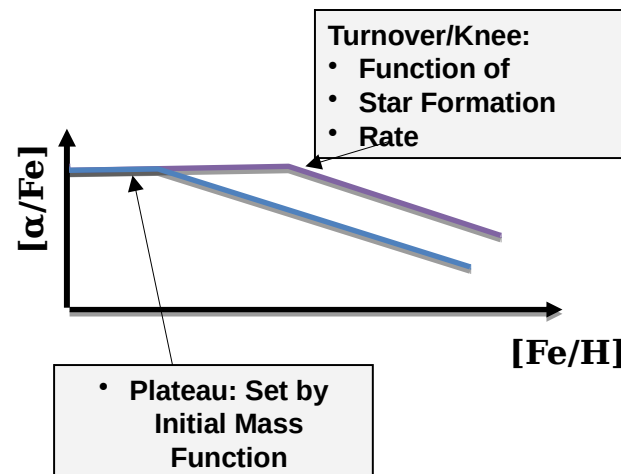
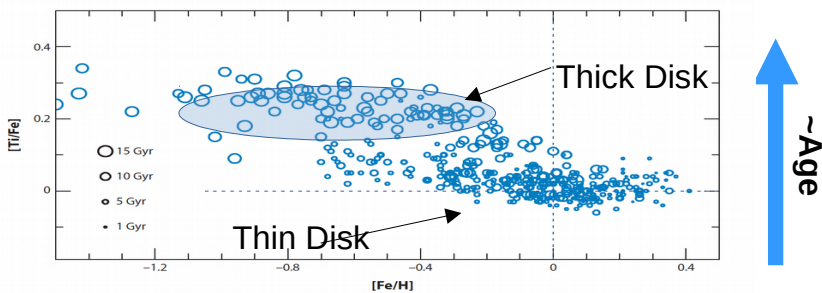
Bland-Hawthorn+ 2019

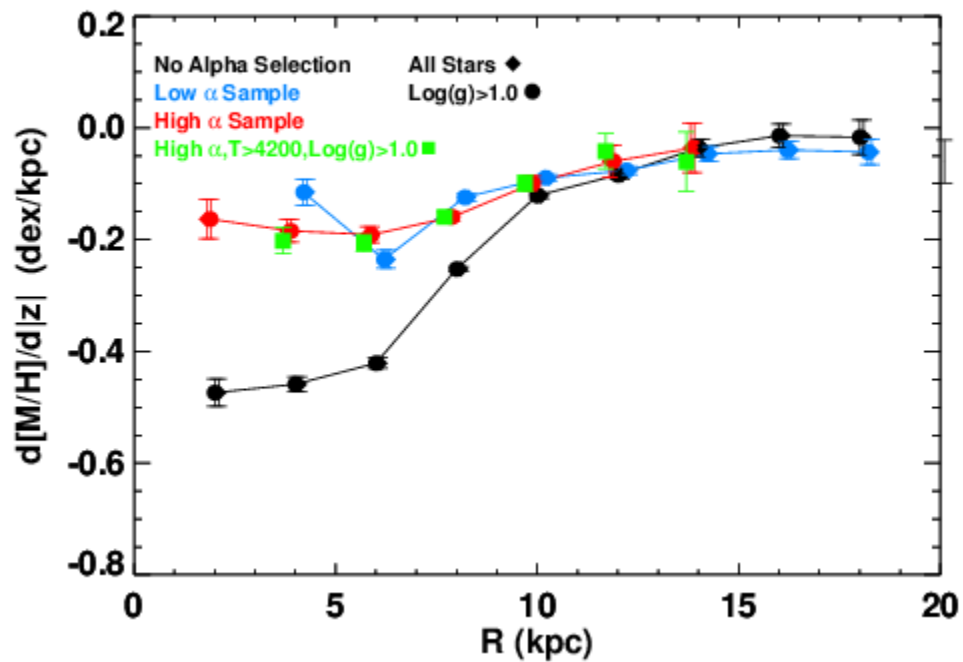
Adibekyan+2012, Haywood+ 2013

Chemical Evolution Crash Course



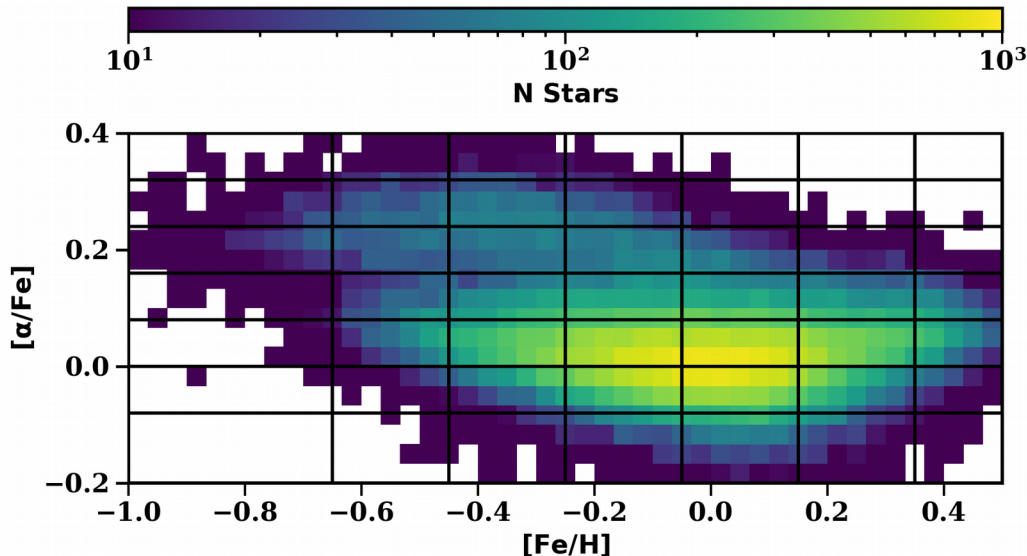
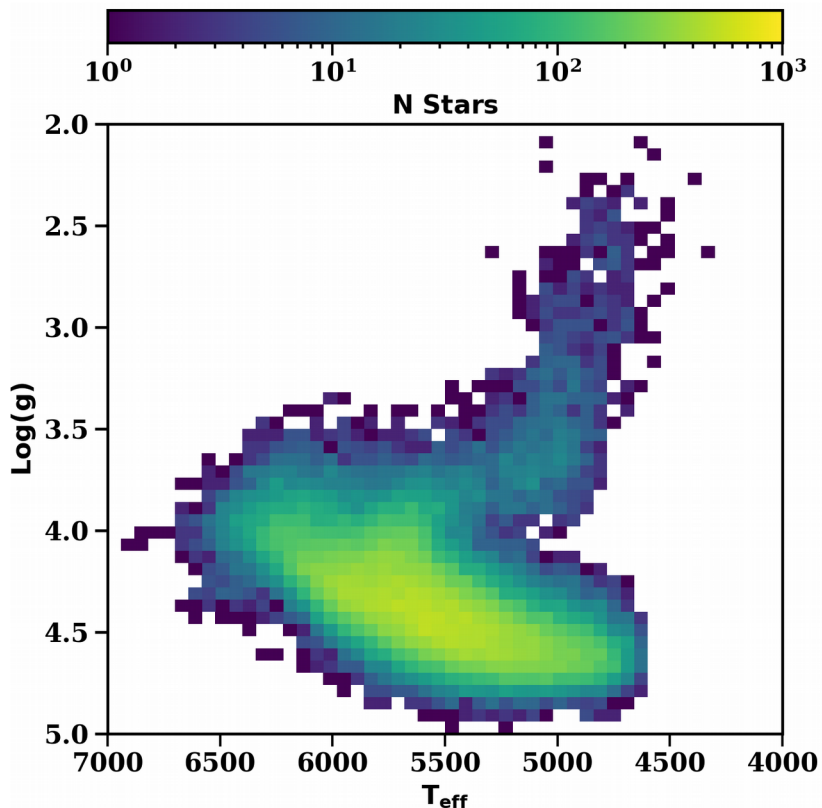
Bland-Hawthorn+Gerhard 2016





Hayden+
2014

GALAH: Solar Neighborhood



- 62 814 stars within 500pc of sun with high S/N, good abundances
- Mostly dwarfs
- Split sample based on $[\alpha/\text{Fe}]$, $[\text{Fe}/\text{H}]$