

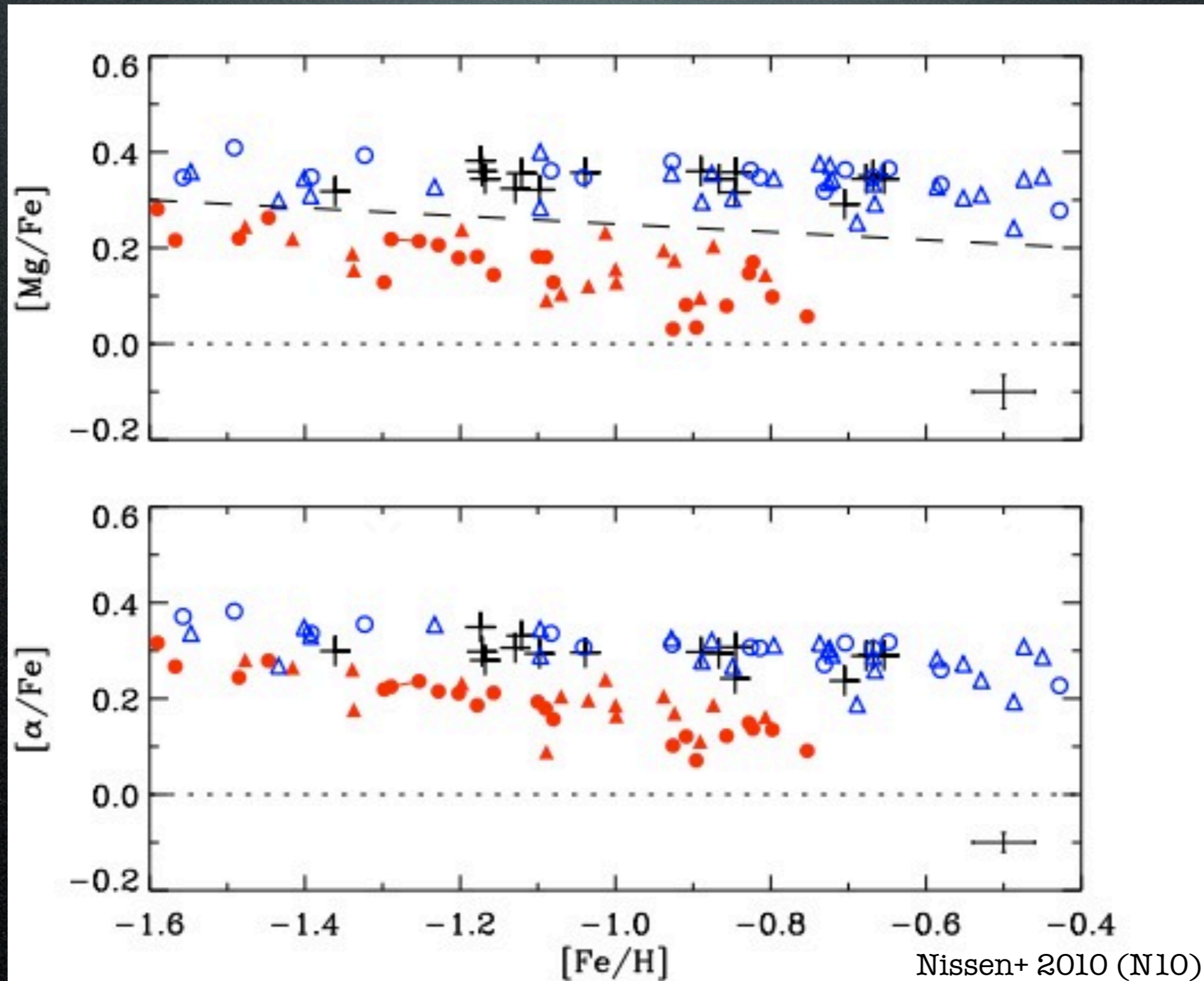
# The Ages of the $\alpha$ -Rich and $\alpha$ -Poor Populations in the Galactic Halo



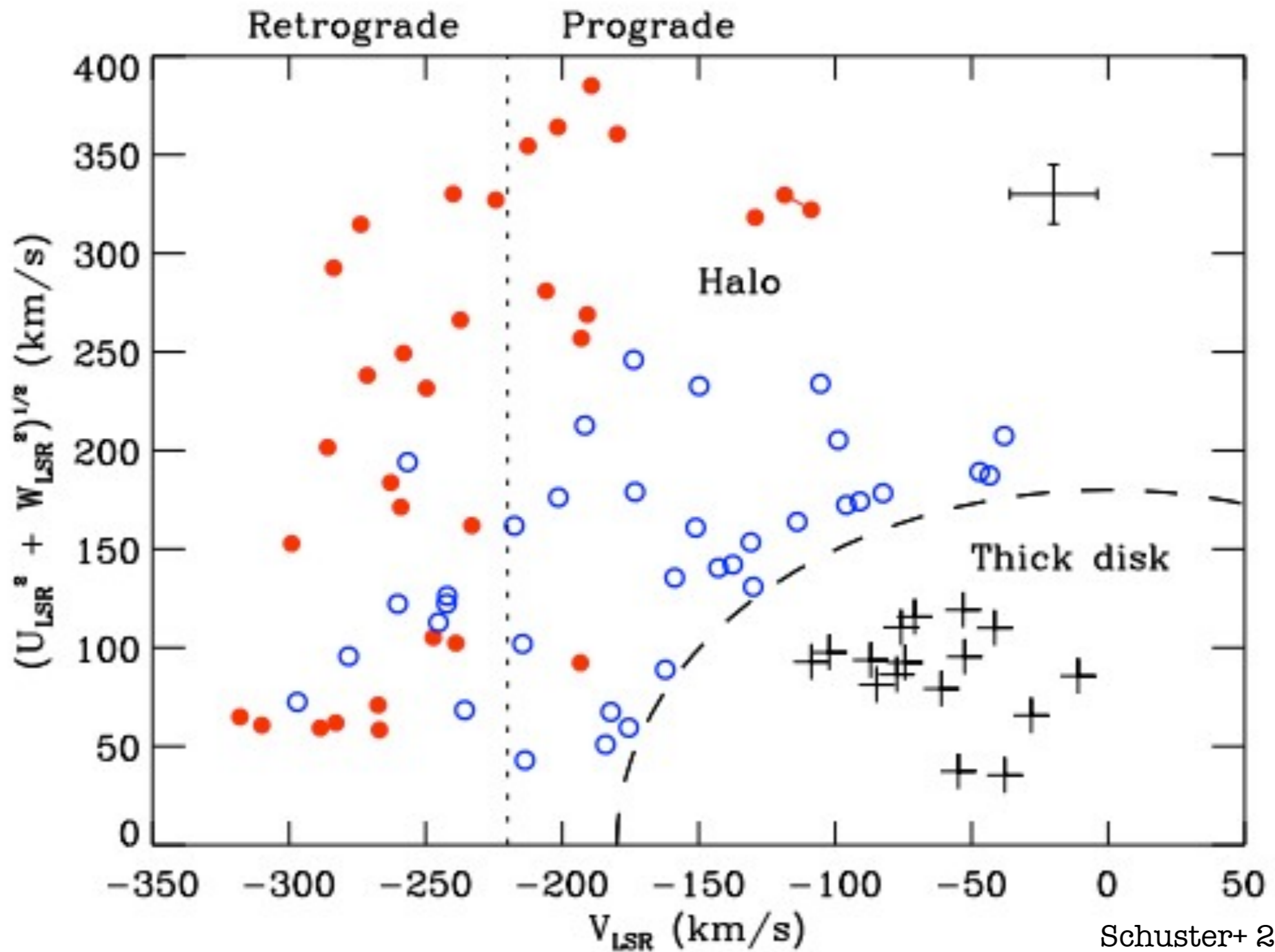
Keith Hawkins  
Collaborators: P. Jofre, T. Masseron, G. Gilmore  
GES Meeting  
10 November 2014  
Hawkins+2014, MNRAS 445 2575



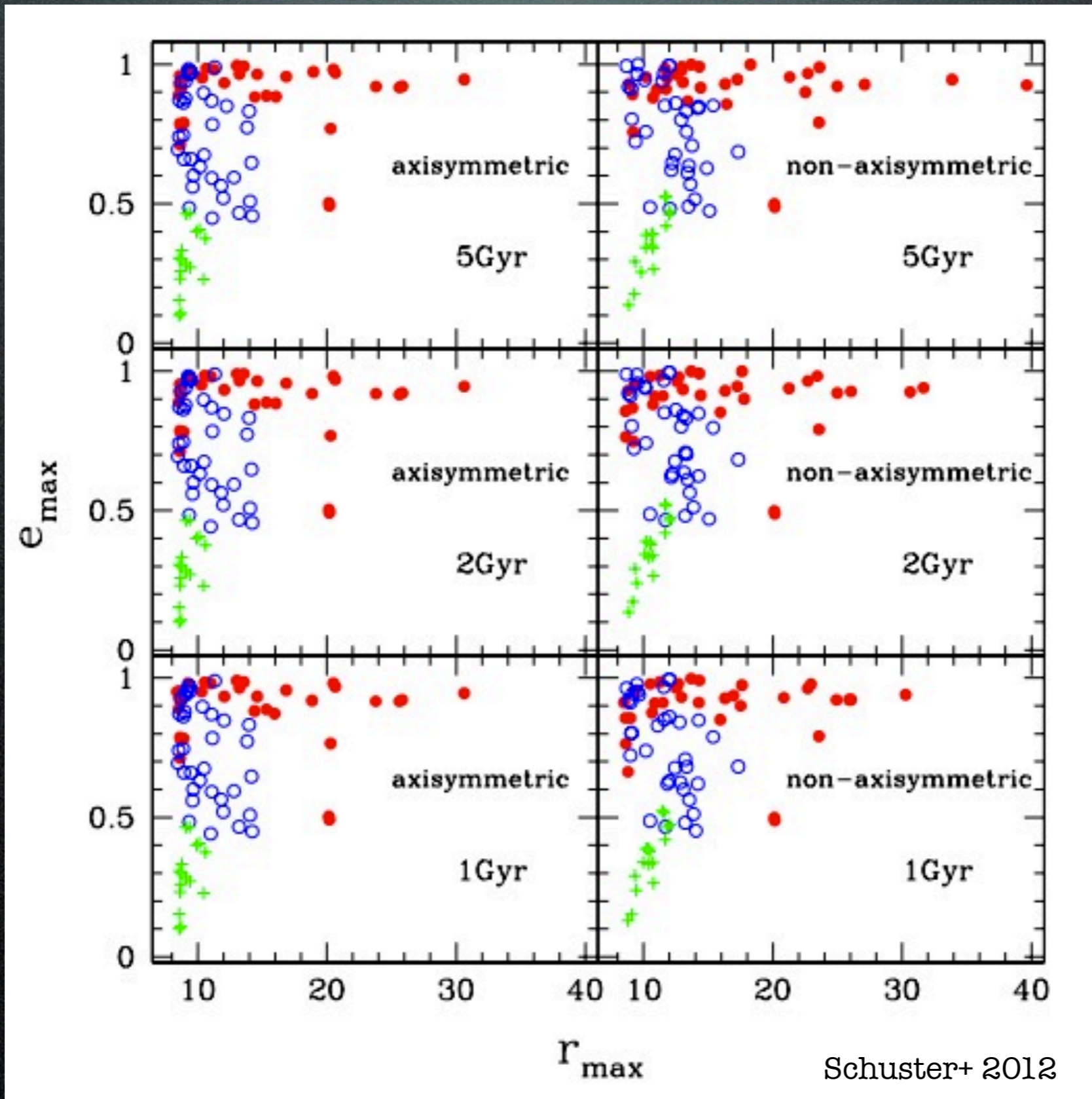
# Two Populations in the Inner Halo



# Two Populations in the Inner Halo



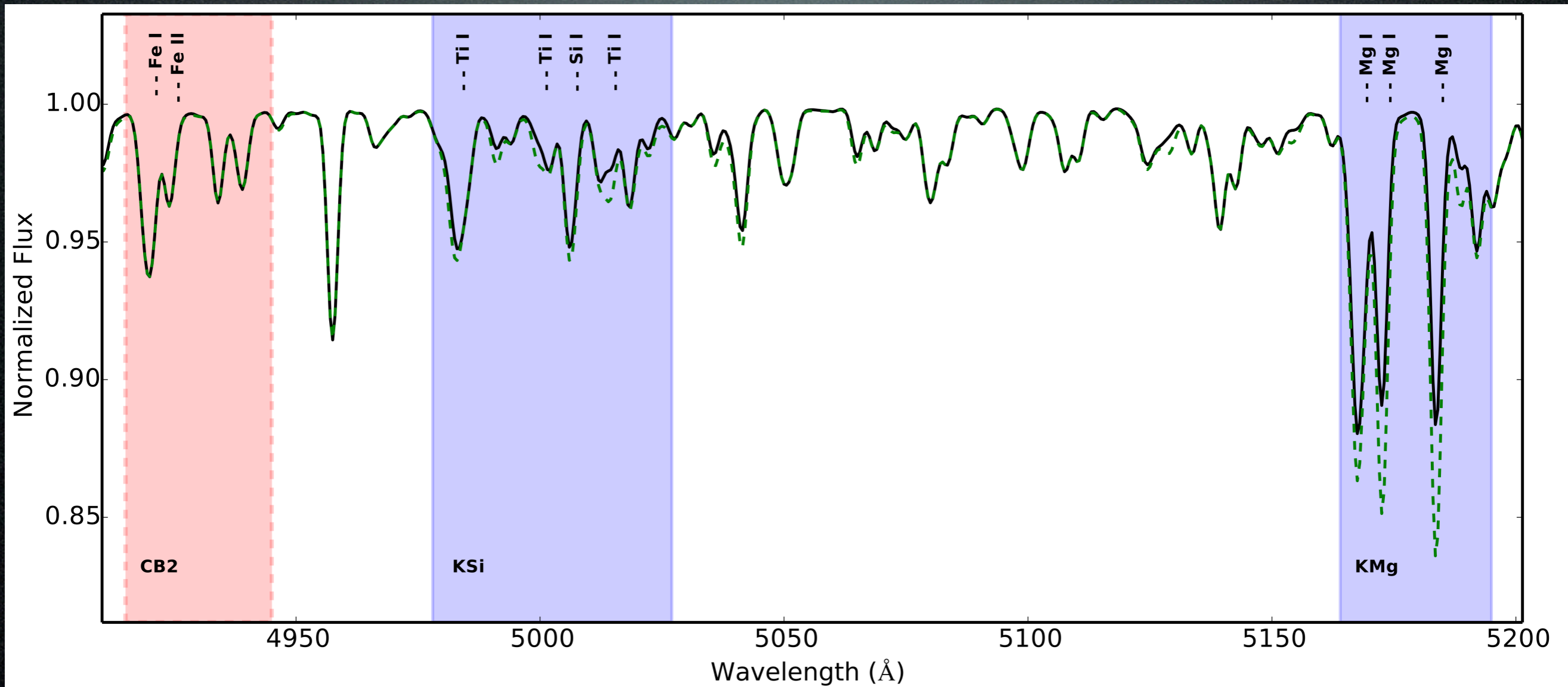
# Two Populations in the Inner Halo



# Current Methods to Extract $[\alpha/\text{Fe}]$ in Low-Resolution Spectra

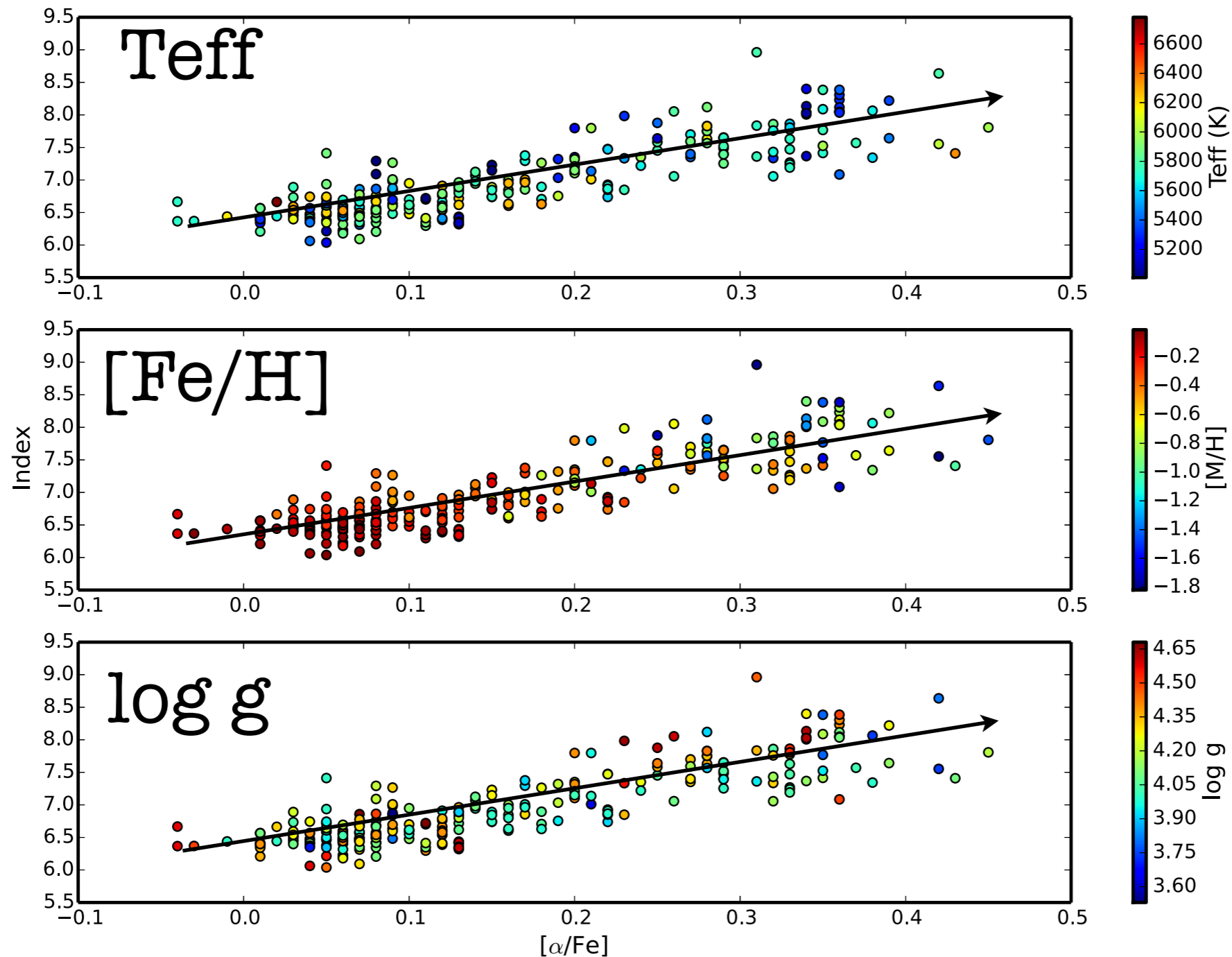
- SSPP - Spectral Grid Matching: Lee+, (2011), obtain  $[\alpha/\text{Fe}]$  down to  $[\text{Fe}/\text{H}] \sim -1.5$  dex with errors  $\sim 0.1$  dex
- Co-adding Mg line to obtain Mg abundances: Fernandez+, (in prep)
- Lick Indices: Franchini+(2010,2011)
- **Spectral Index: Hawkins+2014**

# [ $\alpha$ /Fe] and Low-Resolution Spectra



# Converting the Index to [ $\alpha$ /Fe]

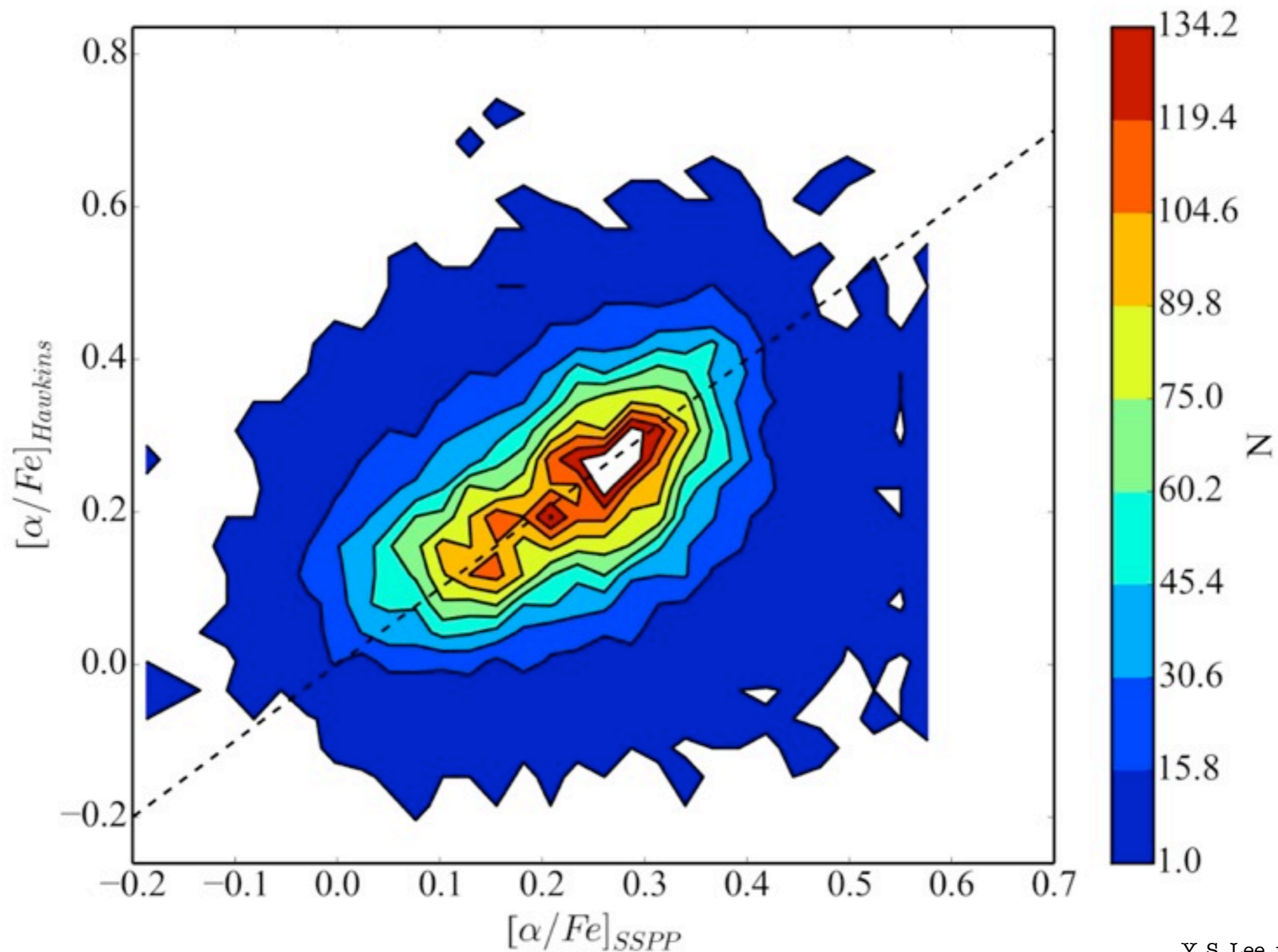
$$\text{Index} = [\alpha/\text{Fe}] \times 4.32 + 6.28$$



# Our $[\alpha/Fe]$ VS SSPP

Random sampling of 10,000 stars

Offset = 0.00 dex; Dispersion = 0.12 dex

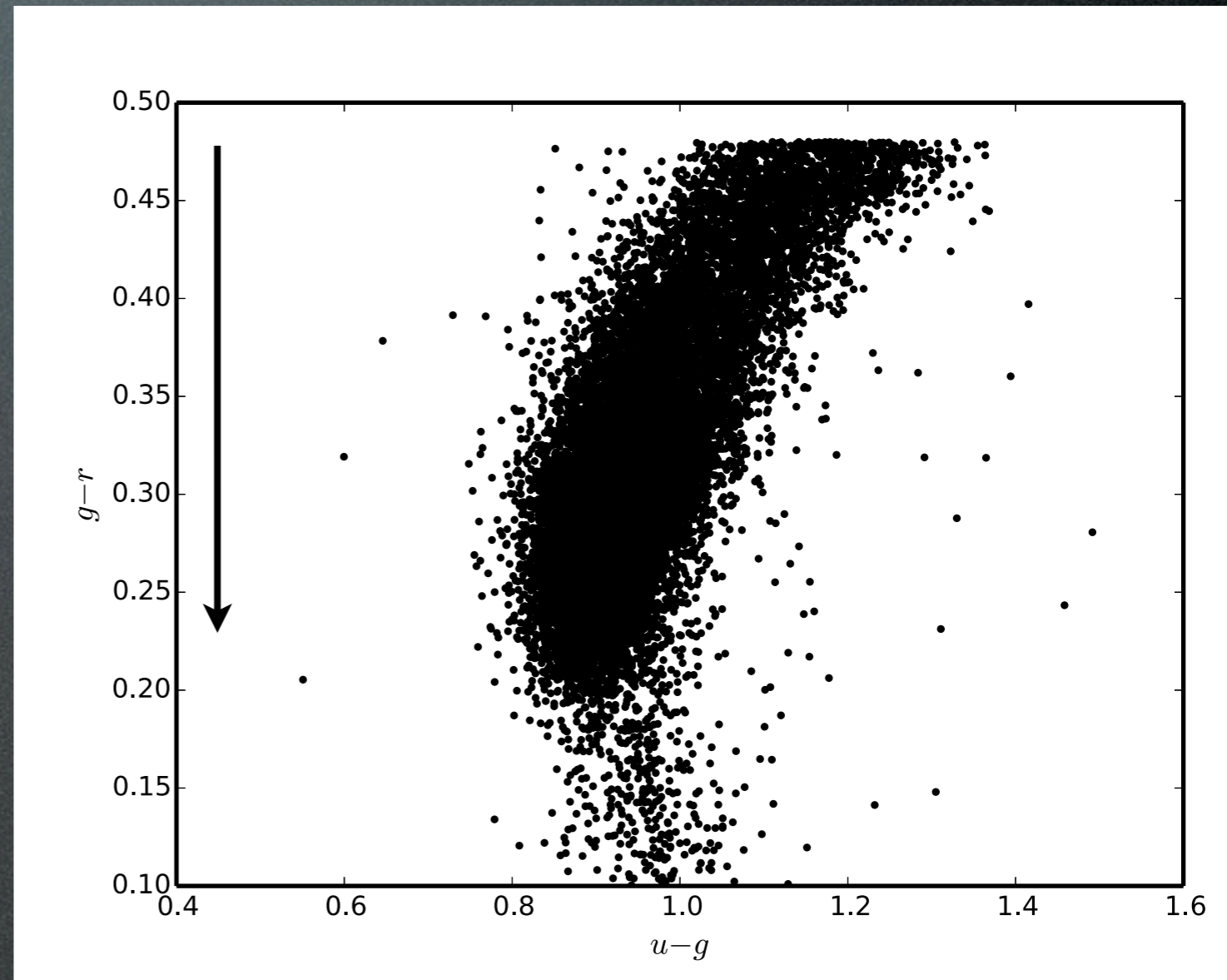




# SDSS Sample: Main-Sequence Turnoff Stars (MSTO)

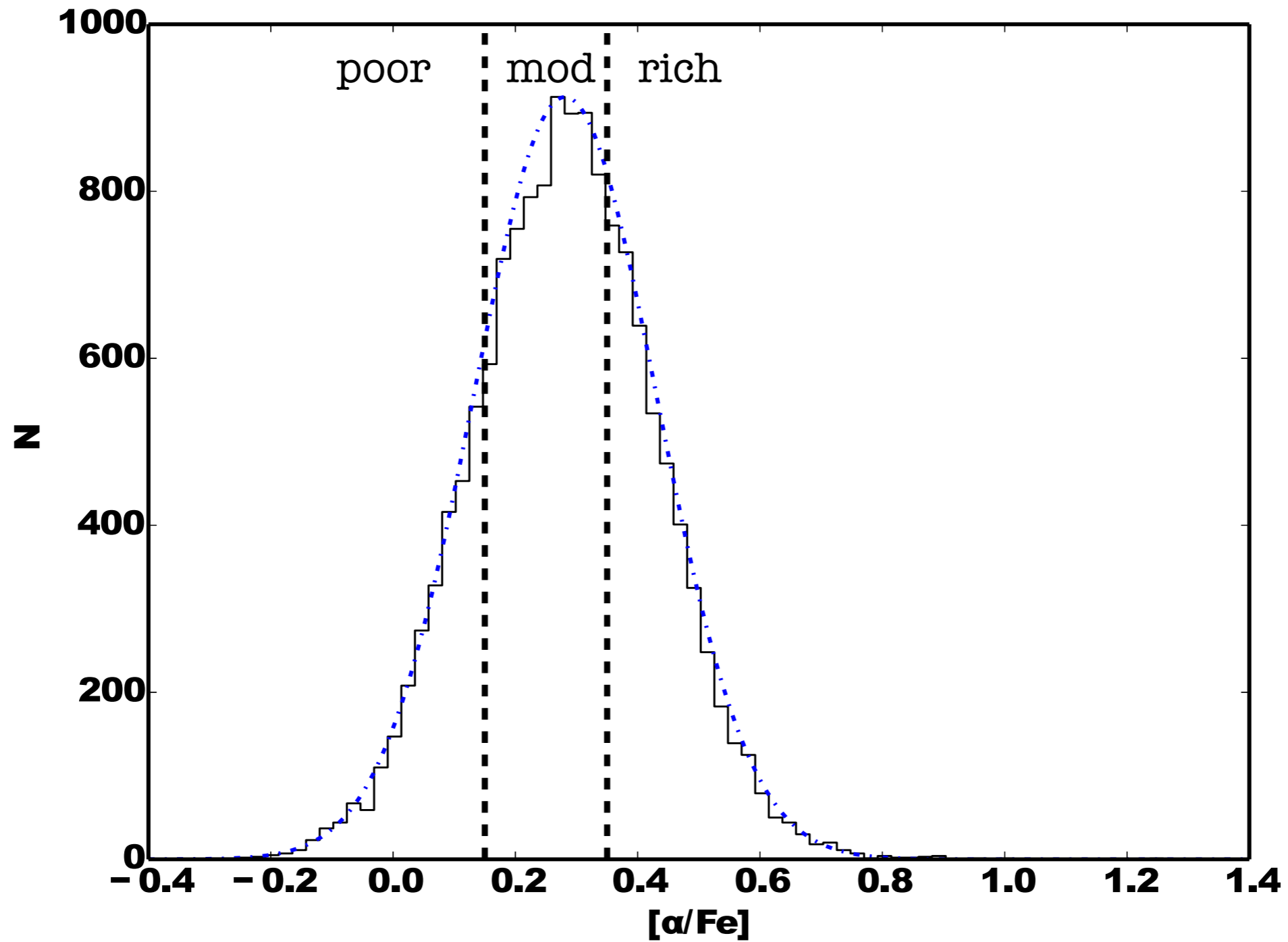
Smaller  $T_{\text{eff}}$

- $0.1 < (g-r) < 0.48$
- $-0.8 < [\text{Fe}/\text{H}] < -2.0$
- $b > 30$  degrees
- $\log g > 3.5$
- $\text{SNR} > 40$



Larger  $T_{\text{eff}}$

# $[\alpha/\text{Fe}]$ Distribution



# Ratio of $\alpha$ -rich to $\alpha$ -poor for metal-poor stars in Gaia-ESO

Astronomy & Astrophysics manuscript no. GEShaloalphas  
October 24, 2014

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LETTER TO THE EDITOR

## The Gaia-ESO Survey: $\alpha$ -abundances of metal-poor stars

R. Jackson-Jones<sup>1</sup>, P. Jofré<sup>1</sup>, K. Hawkins<sup>1</sup>, A. Hourihane<sup>1</sup>, G. Gilmore<sup>1</sup>, G. Kordopatis<sup>1</sup>, C. Worley<sup>1</sup>, S. Randich<sup>2</sup>, A. Vallenari<sup>3</sup>, T. Bensby<sup>4</sup>, A. Bragaglia<sup>5</sup>, E. Flaccomio<sup>6</sup>, A. J. Korn<sup>7</sup>, A. Recio-Blanco<sup>8</sup>, R. Smiljanic<sup>9</sup>, M. T. Costado<sup>10</sup>, U. Heiter<sup>7</sup>, V. Hill<sup>8</sup>, C. Lardo<sup>11</sup>, P. de Laverny<sup>8</sup>, G. Guiglion<sup>8</sup>, S. Mikolaitis<sup>8,12</sup>, S. Zaggia<sup>3</sup>, and G. Tautvaišienė<sup>12</sup>

*(Affiliations can be found after the references)*

Received ; accepted

### ABSTRACT

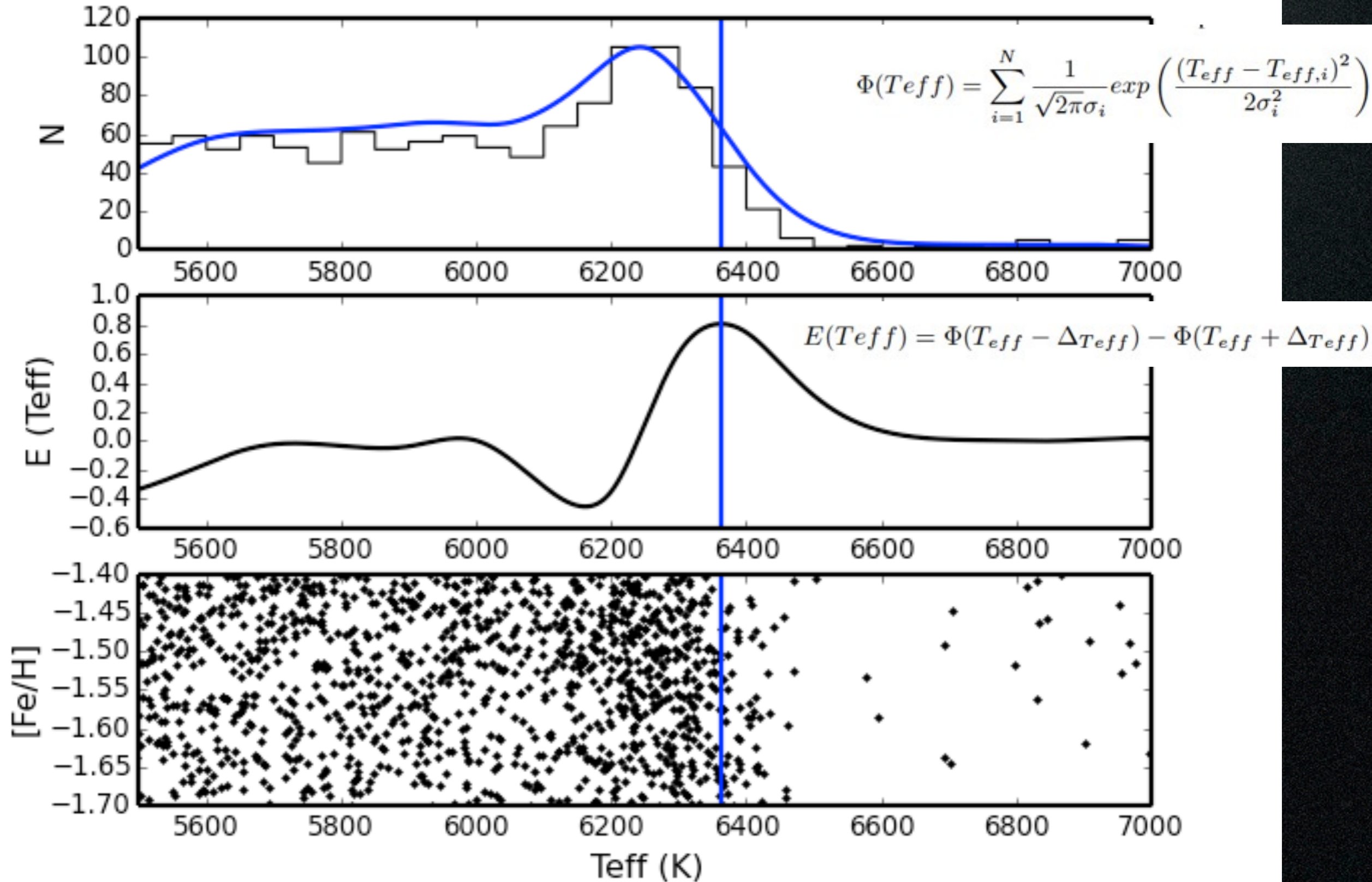
We performed a detailed study of the ratio of low- $\alpha$  to high- $\alpha$  stars in the Galactic halo as observed by the Gaia-ESO Survey. Using a sample of 381 metal-poor stars from the second internal data release, we found that the value of this ratio did not show evidence of systematic trends as a function of metallicity, surface gravity, Galactic latitude, Galactic longitude, height above the Galactic plane, and Galactocentric radius. We conclude that the  $\alpha_{\text{poor}}/\alpha_{\text{rich}}$  value of  $0.28 \pm 0.08$  suggests that in the inner halo, the larger portion of stars were formed in a high star formation rate environment, and about 15% of the metal-poor stars originated from much lower star formation rate environments.



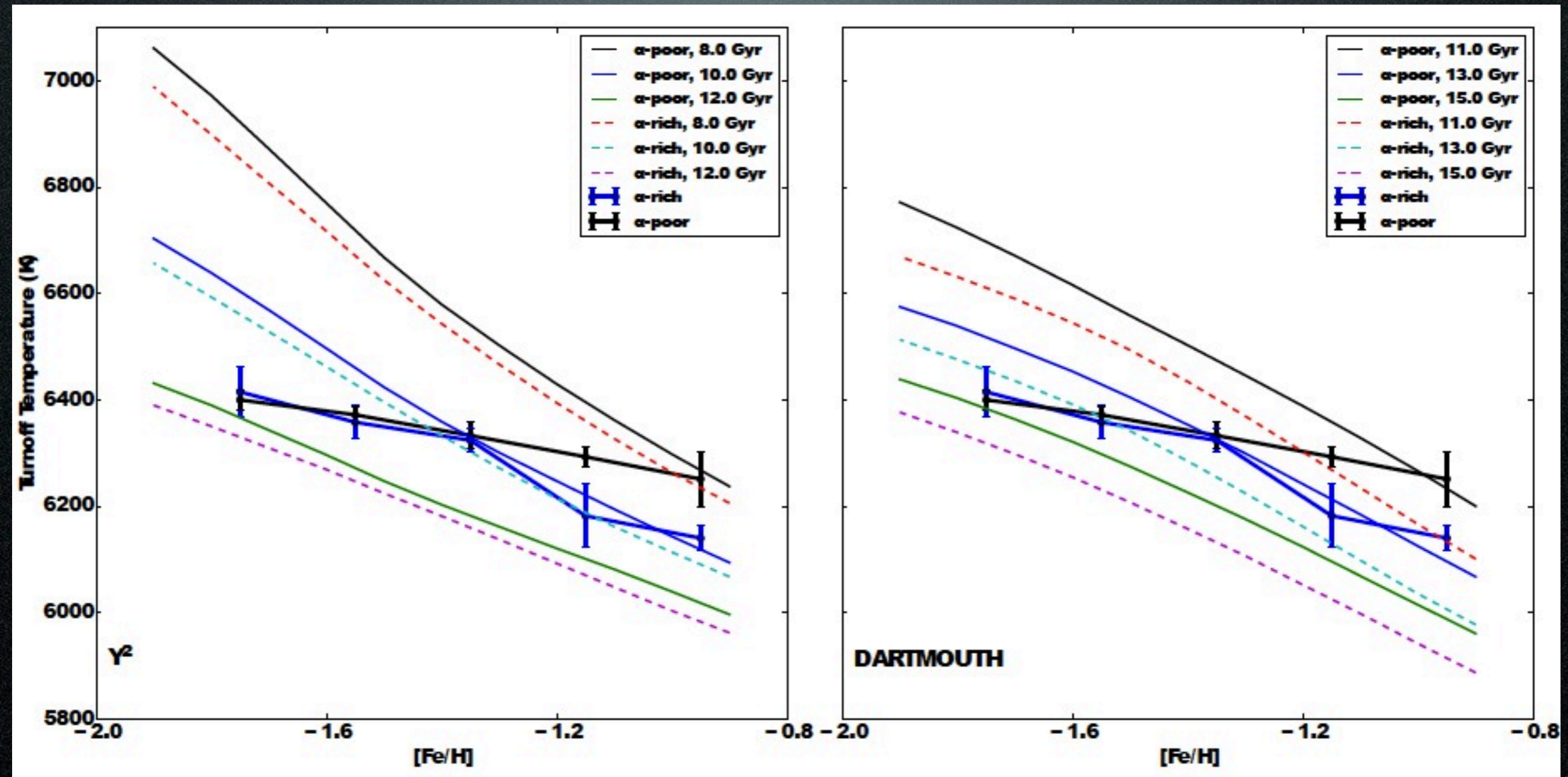
23 Oct 2014

See Poster by Reece-Jackson-Jones

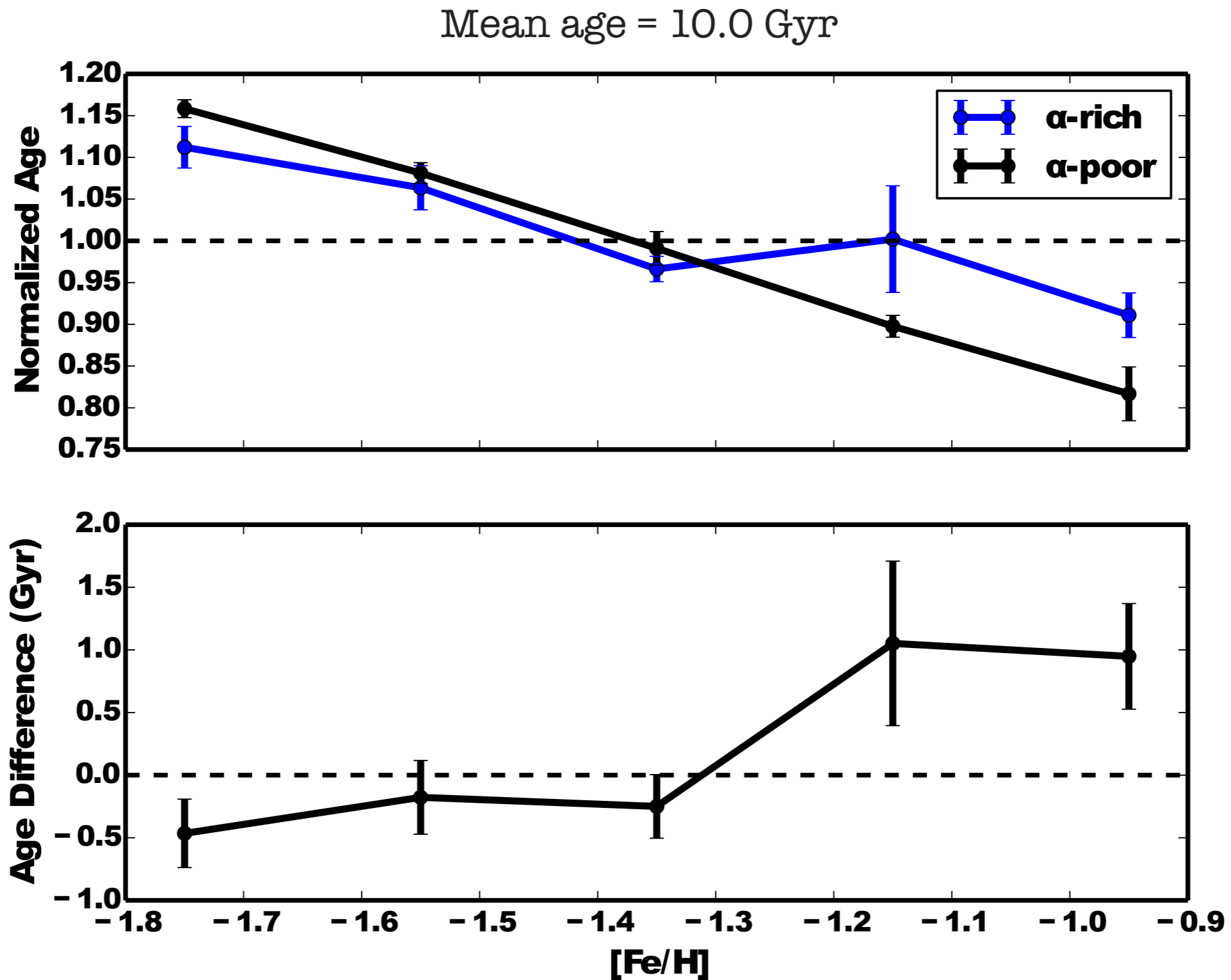
# MSTO Detection: Sobel-Edge



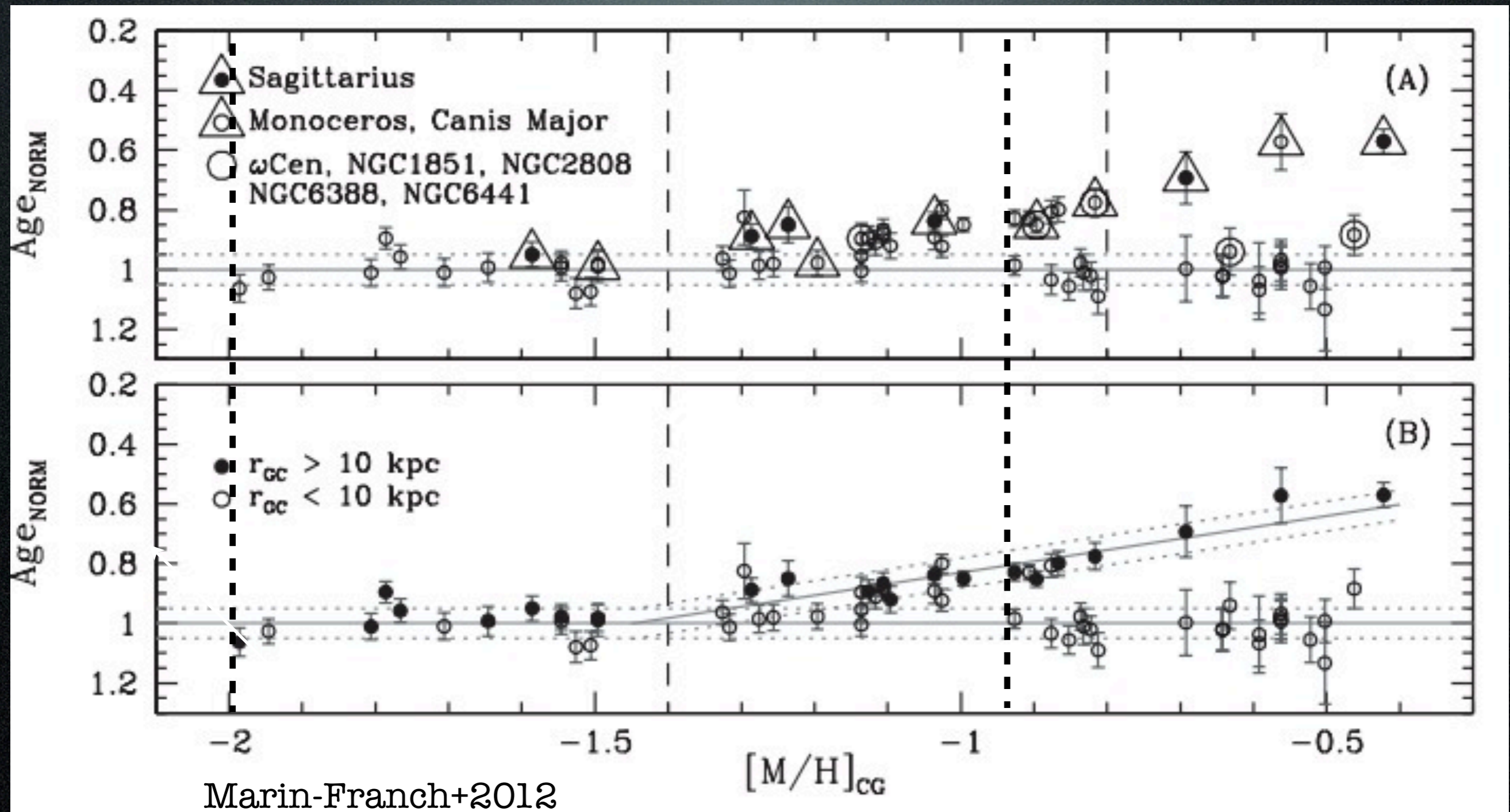
# MSTO-Metallicity



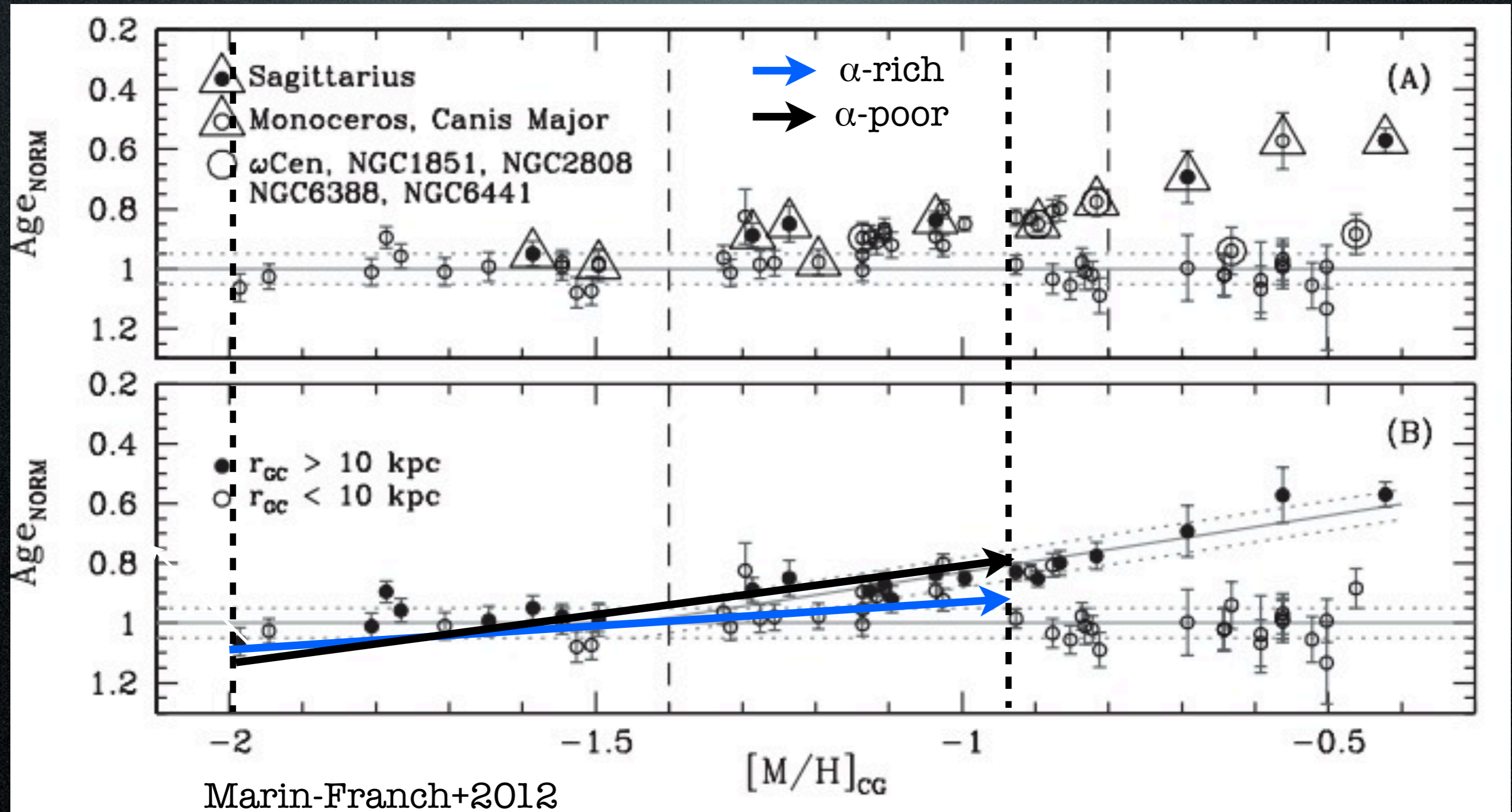
# Age-Metallicity Relation (AMR)



# GCs VS Field AMR



# GCs VS Field AMR





# Summary

- Developed simple method estimate  $[\alpha/\text{Fe}]$  from low-res spectra
- Distribution in  $[\alpha/\text{Fe}]$  not well fit by a single Gaussian
- The Galactic halo formed/assembled quickly
- At high metallicity  $\alpha$ -rich stars are older than  $\alpha$ -poor stars and become coeval at low metallicity
- $\alpha$ -poor stars may have formed in chemically slower environments than their  $\alpha$ -rich counterparts (AMR)

# Future Work:

- Study ratio of  $\alpha$ -poor to  $\alpha$ -rich stars as a function of Galactic parameters (b-latitude, pointing towards or away from dwarf galaxy, etc.) in SDSS
  - Completed with a moderate sample of Gaia-ESO stars (Jackson-Jones +2014)
- Improve index to giants, more metal poor and add soft priors on stellar parameters

END

