Optical high-resolution spectroscopy of young α-rich stars

Tadafumi Matsuno / 松野 允郁

(Sokendai / NAOJ)

In collaboration with David Yong (ANU), Wako Aoki (NAOJ),
Miho N. Isihigaki (IPMU/U-Tokyo)

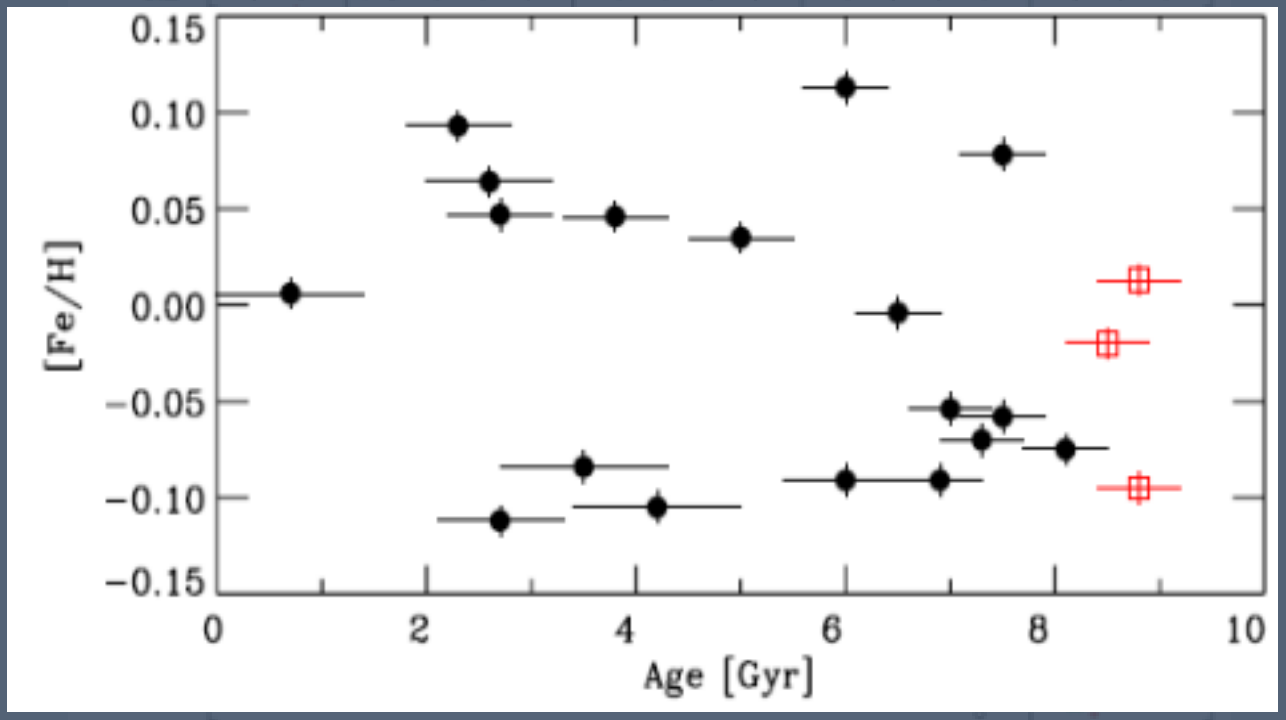
Matsuno+18, ApJ

Galactic Archaeology

We want to know chemical enrichment history

Stellar age estimates have been limited

[Fe/H] is not a perfect age-indicator



Nissen 15

[Fe/H]: Proxy of age

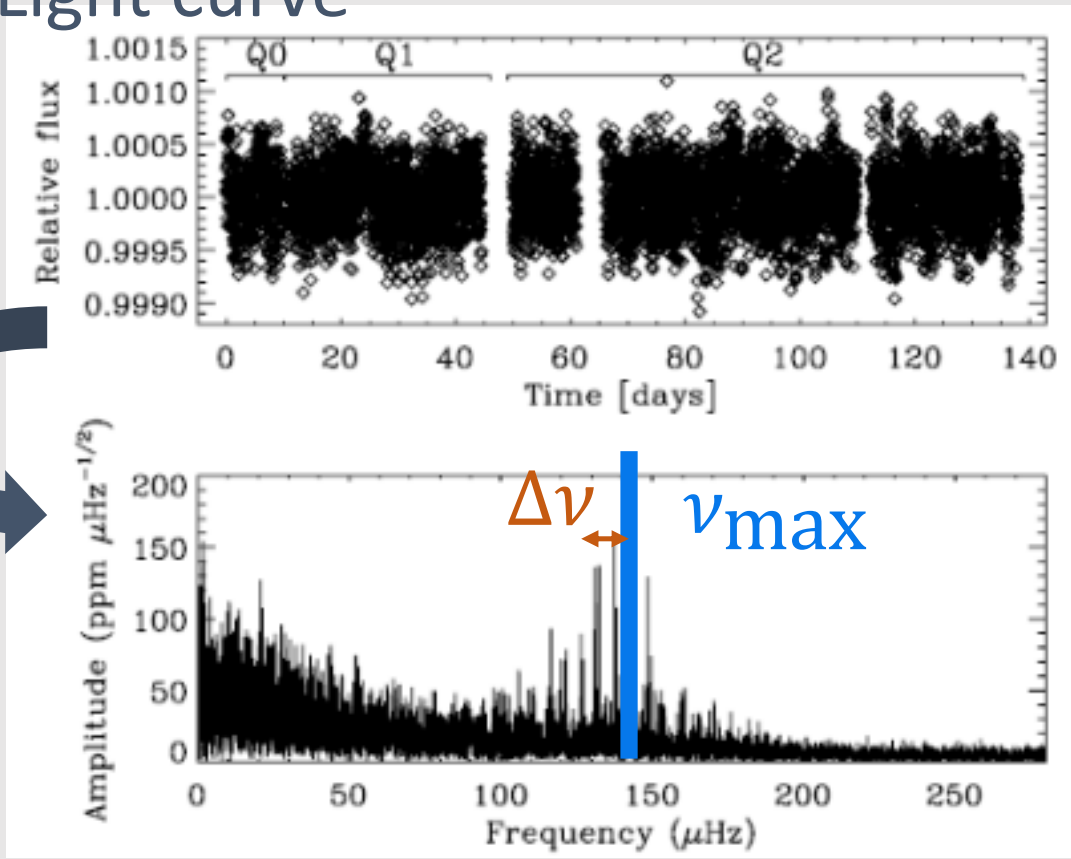
Reddy+06

Age Estimates from Asteroseismology

Kepler / CoRoT enabled age estimates for red giants

Light curve

Fourier transform



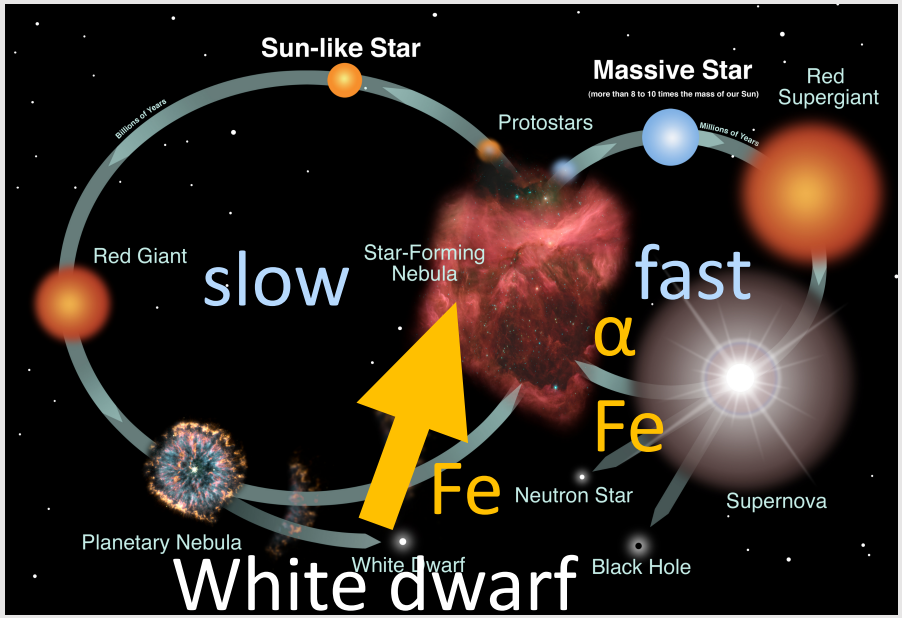
0.1%

Huber+10

$$M \propto \nu_{\max}^{3} \Delta\nu^{-4} T^{1.5}$$

age ~ $t_{MS}(M)$ <- stellar evolution theory

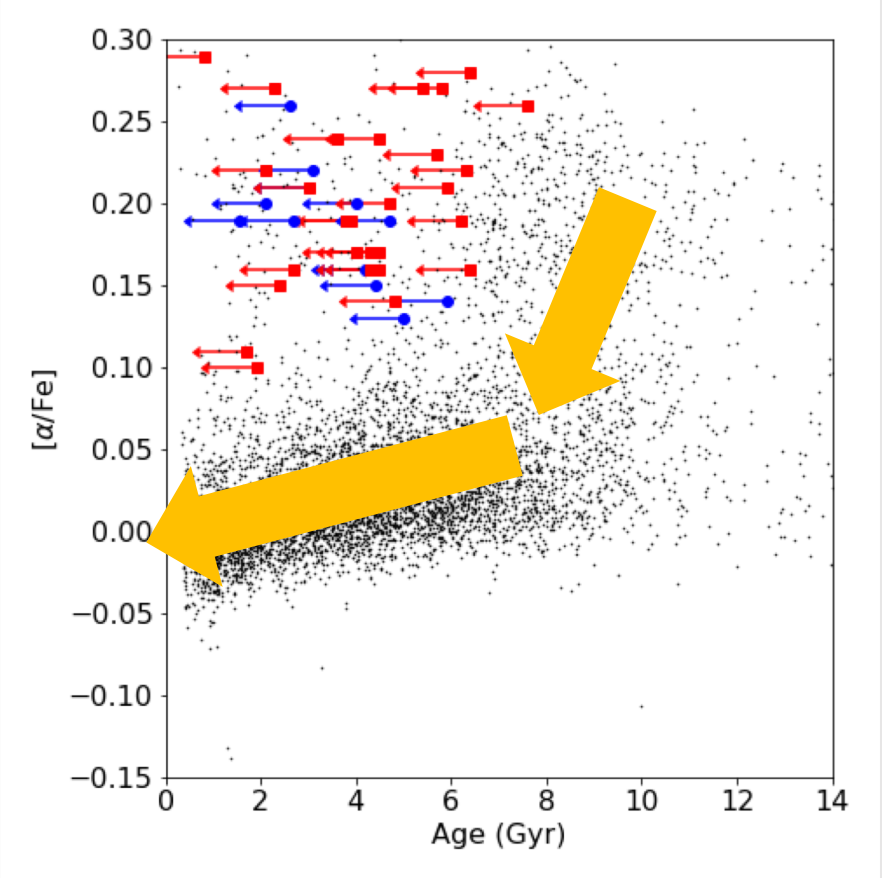
Discovery of Young α-rich Stars



[α/Fe] decreases with time

α: O, Mg, Si, S, Ca, Ti

Observations

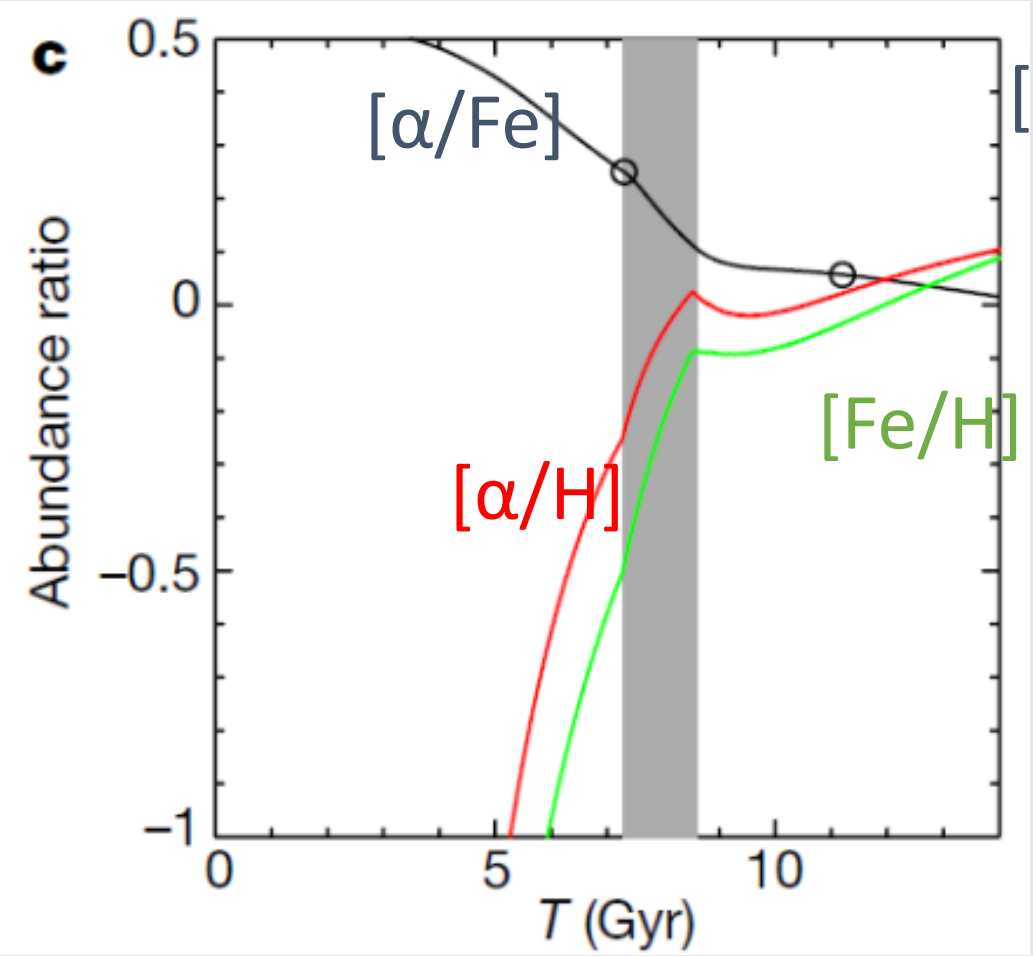


Asteroseismology revealed the existence of young α-rich stars

APOKASC-2, Chiappini+15, Martig+15

Why do we have to care about them?

They must not exist in standard Galactic chemical evolution models



Noguchi+18

[α/Fe] cannot increase

- Peculiar formation site?
- Binary interaction?

(Chiappini+15, Martig+15, Yong+16 Jofre+16, Izzard+18)

Optical will Shed a New Light

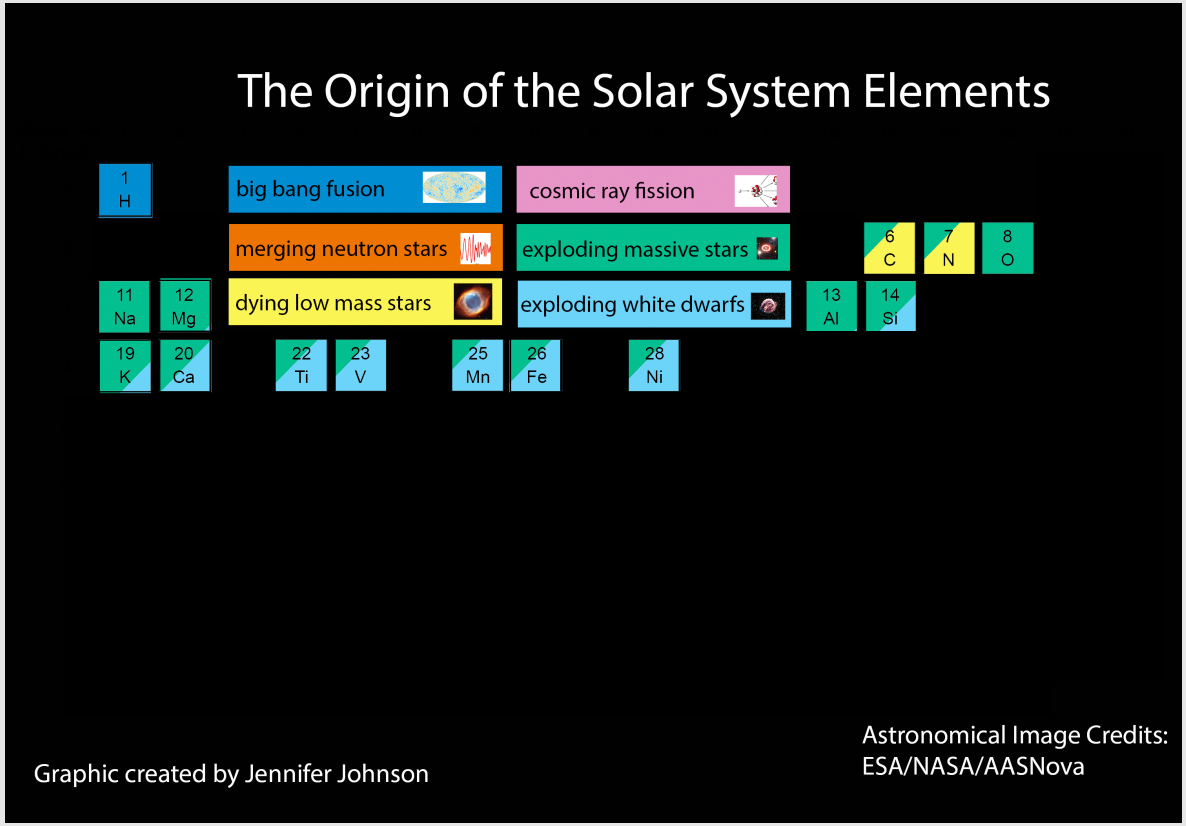
Martig+15, Chiappini+15: Discovery of young α-rich stars based on APOGEE survey

APOGEE (in infrared)
R~22500 (~13km/s)

Optical high-res. spectrographs
up to R~10^5 (~3km/s)

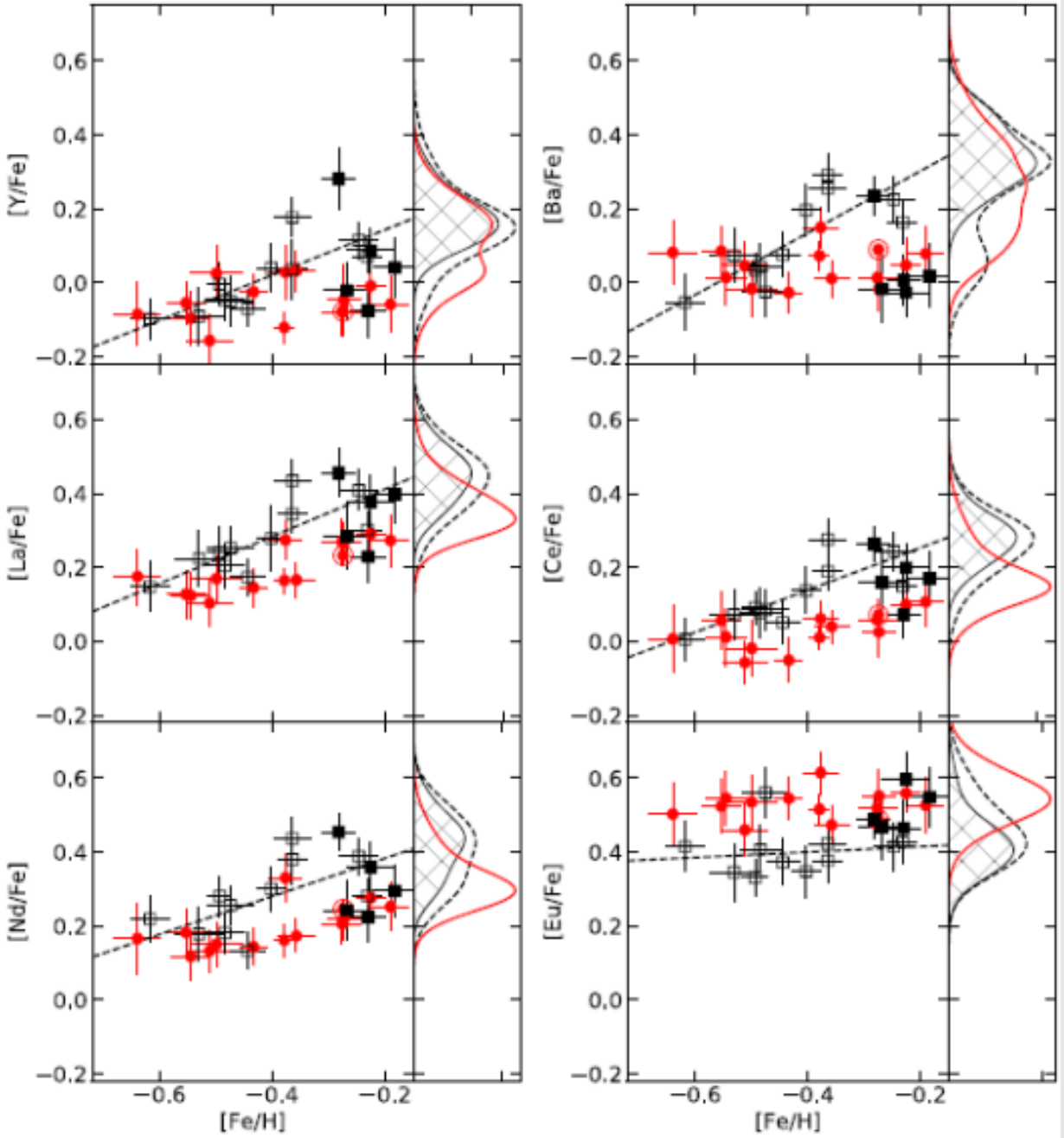
more elements,
higher resolution

HIRES obs. for 14 stars
(+16 comparison stars)



What you can get from APOGEE

Chemical Abundances

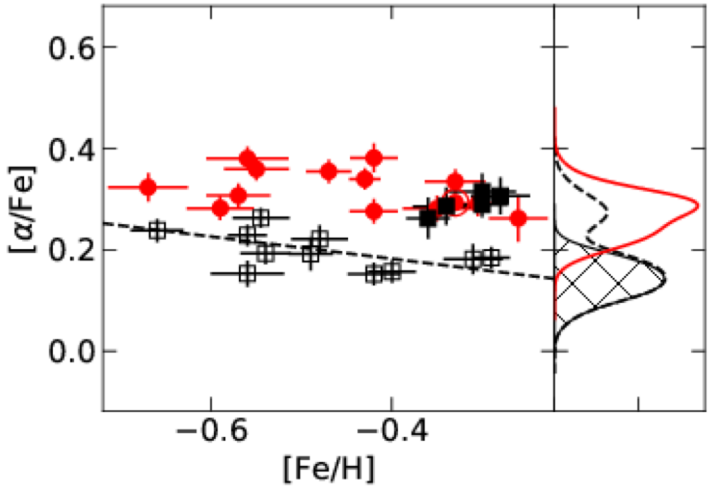


■□ comparison stars

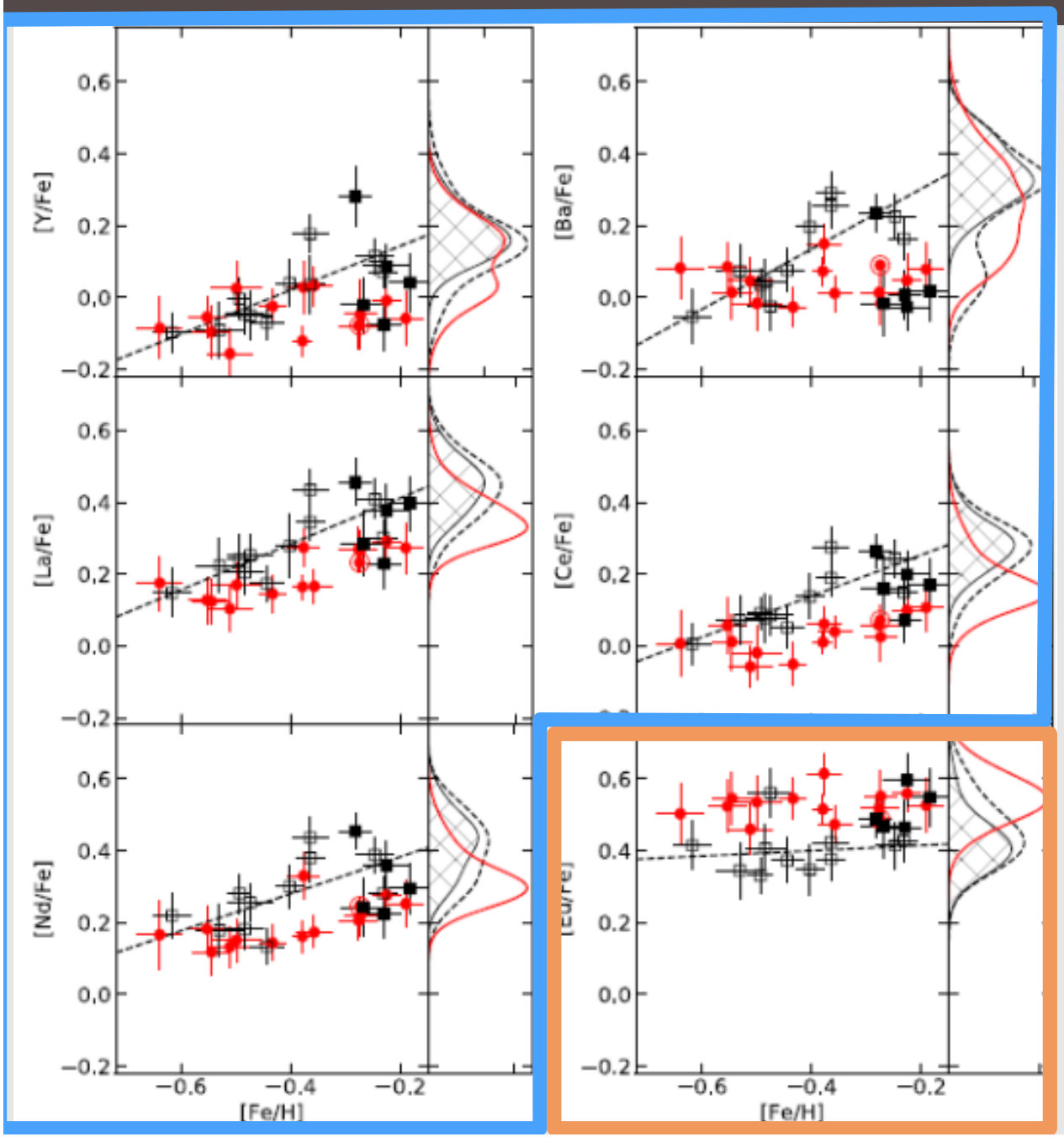
● young α-rich stars

[α/Fe]

fast slow



High-r / low-s Process Abundances



■□ comparison stars

● young α-rich stars

[α/Fe]

fast slow

s-process (AGB)

(slow-enrichment)

young α-rich: low

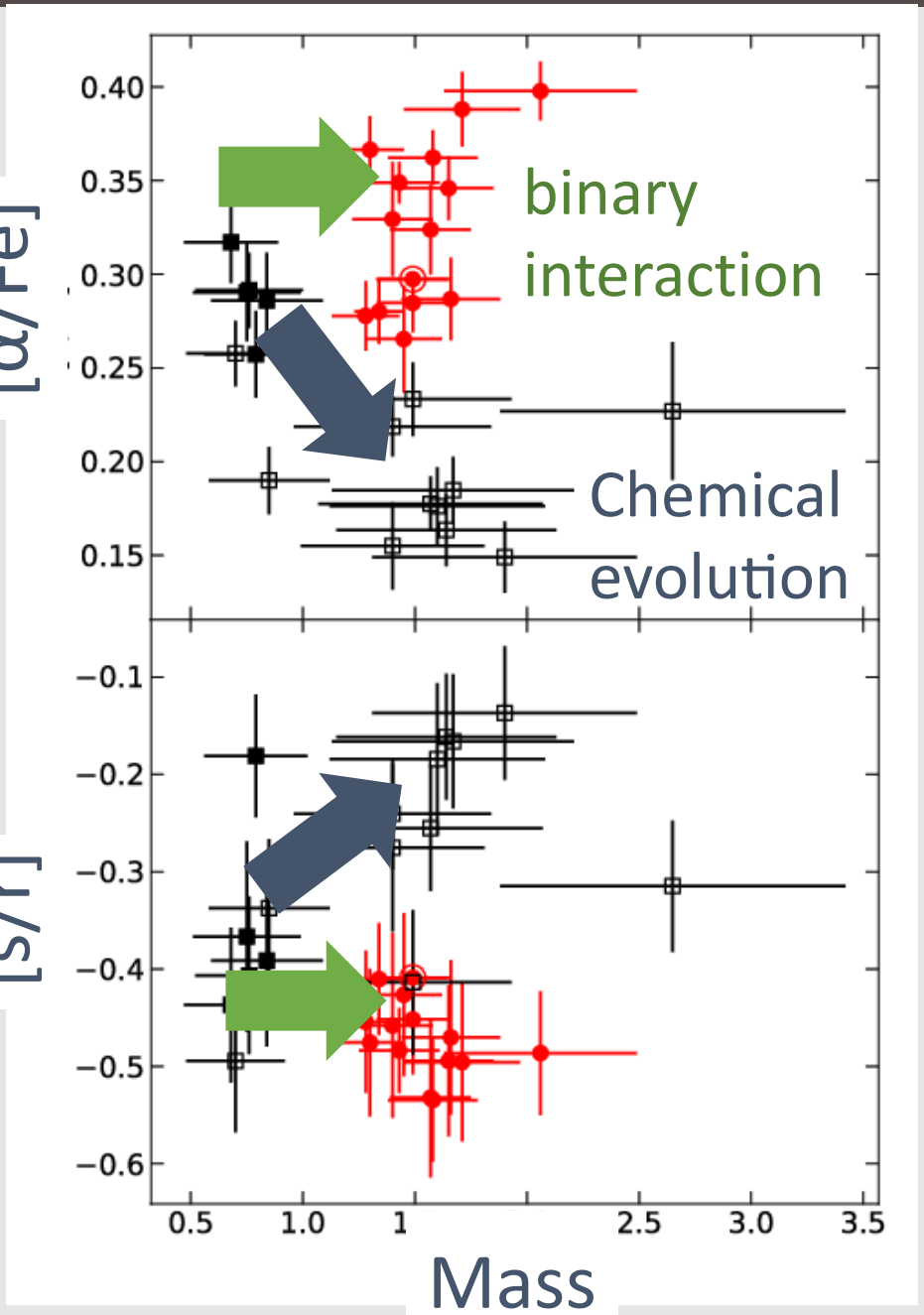
r-process

(fast enrichment)

young α-rich: high

Chemically-old again

Peculiar Formation Scenario is Unlikely

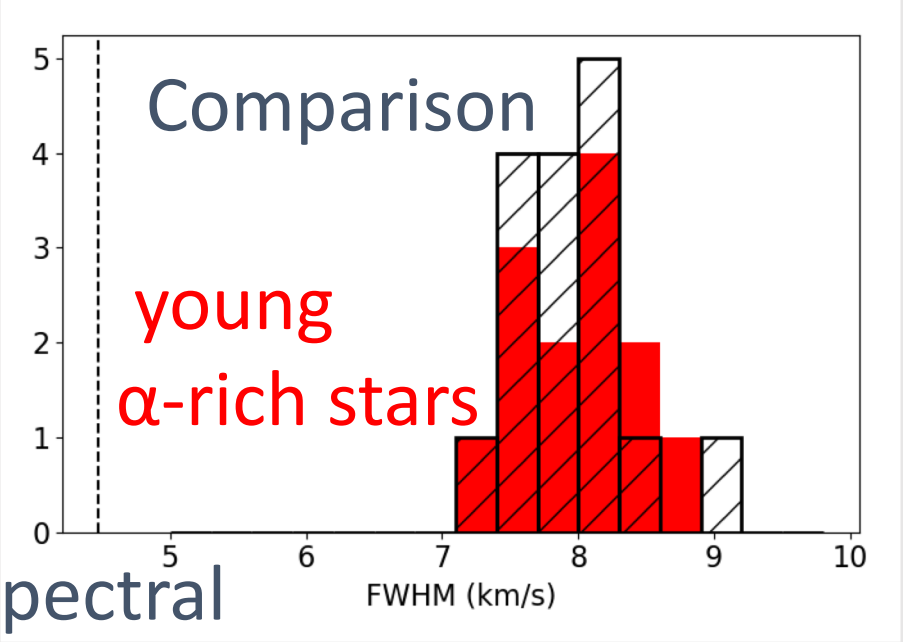


Mass-abundance relations

If they shared the birth place, they would show similar trend to comparison stars with offset

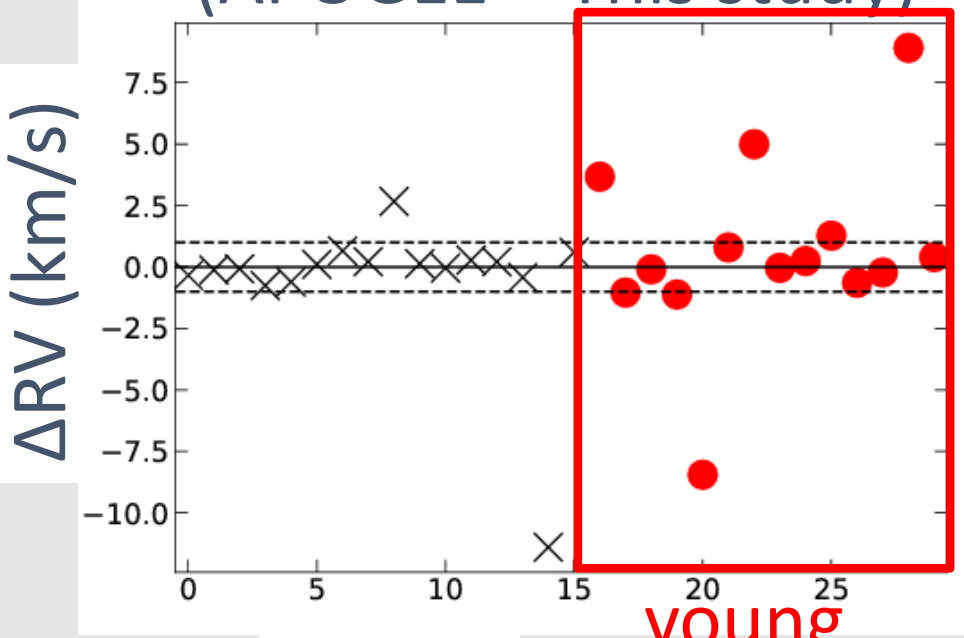
Line Widths / Radial Velocity

Line widths



Spectral resolution

RV difference (APOGEE – This study)



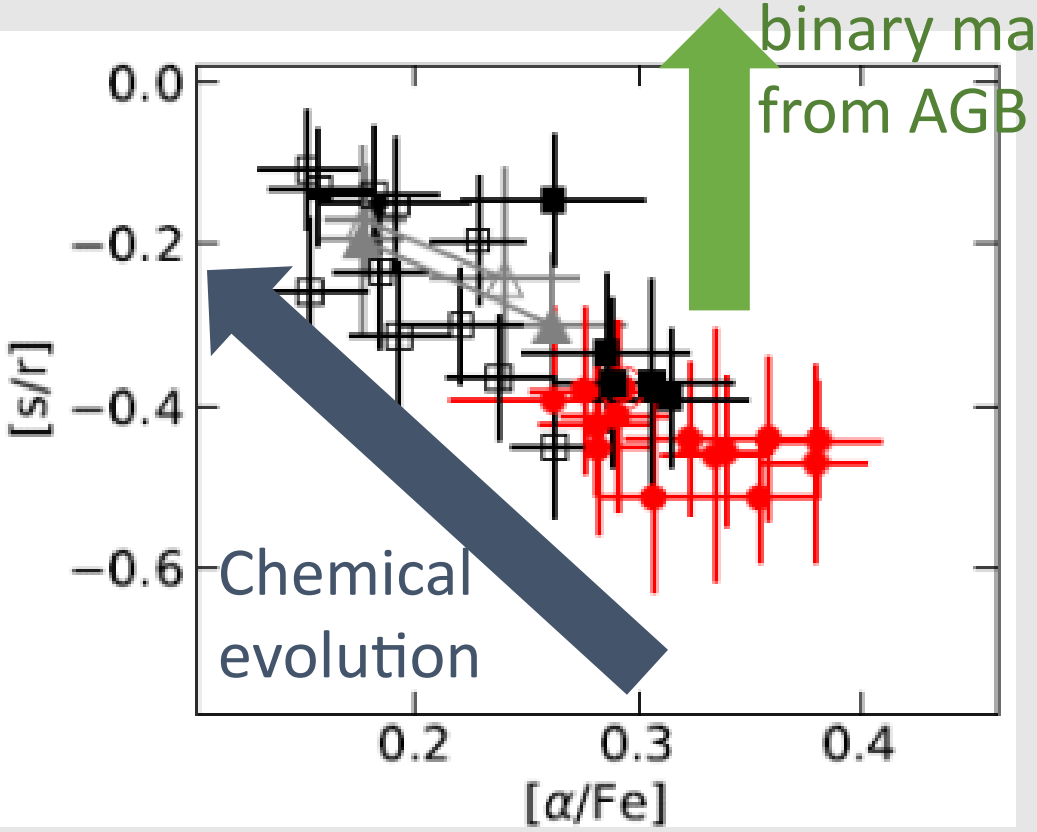
- No signature of rapid rotation
- Higher binary frequency (see also Jofre+16)

-> binary interaction

No Clear Signature of Mass-Transfer

Surface anomalies due to binary mass transfer?
high *s*-process element abundances:
signature of mass accretion from AGB stars

young α-rich stars have normal *s*-process abundances



Summary

Young α-rich stars are α-rich like old stars but estimated to be young

By obtaining optical spectra, we
- reveal similar *n*-capture element abundances to old stars
- find no signature of rapid dotation
- find higher binary frequency

Conclusion:
- Young α-rich stars are likely to be formed by binary interaction without any signature in a single spectrum
- We have to keep in mind that some of stars are affected by binary interactions

Matsuno+18, ApJ