Galactic Archaeology with the WFMOS high-resolution mode

Wako Aoki
National Astronomical Observatory of Japan

Galactic Archaeology with the WFMOS high-resolution mode

Purposes and goals:

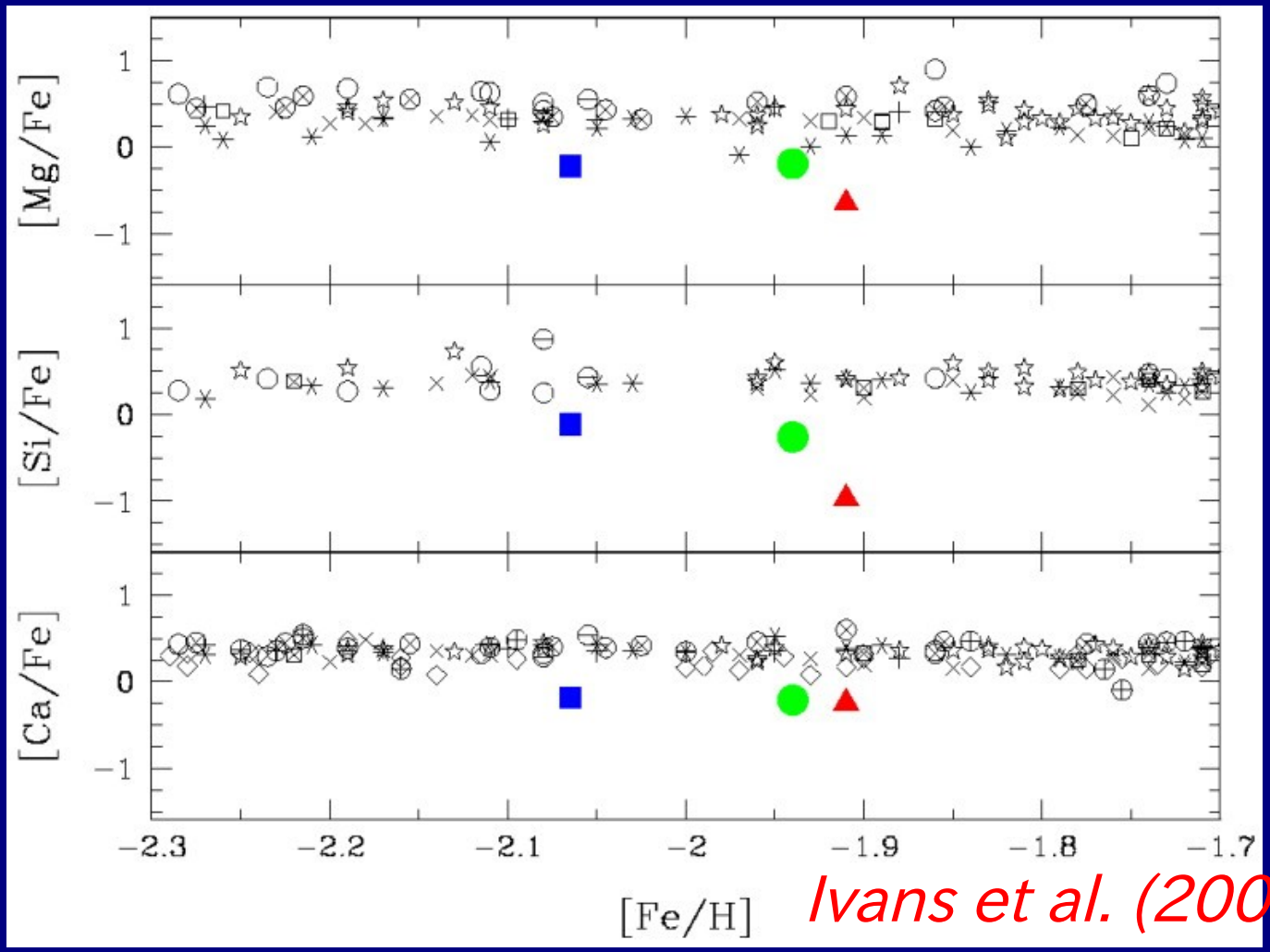
Determining chemical abundances for individual stars to reveal (1) the evolutionary history of stellar components and substructures, and (2) the nature of clusters that have contributed to structure formation.

Contents:

- Separations of groups by α/Fe
  - -thick disk stars
  - -halo stars
- other useful elements for chemical tagging
- other possible (PI-type) projects

An extreme case: stars with low abundances of α elements

A goup of stars may be identified from elemental abundances



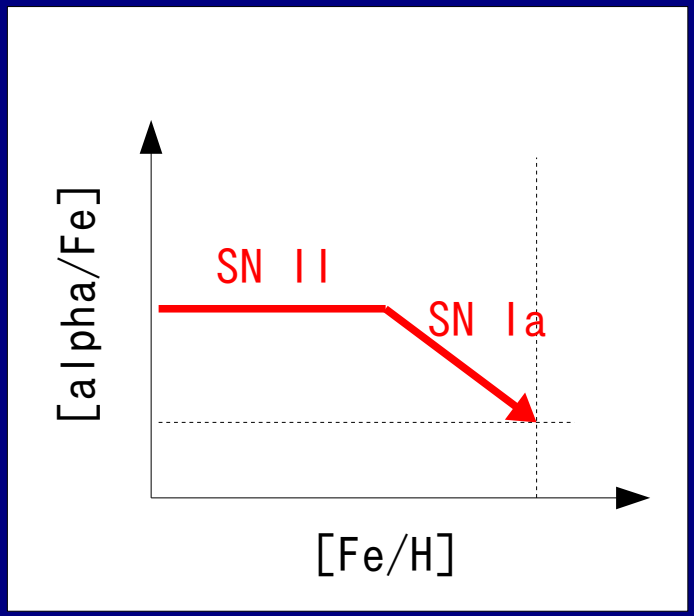
Ivans et al. (2003, ApJ)

Origins and implications of individual elements

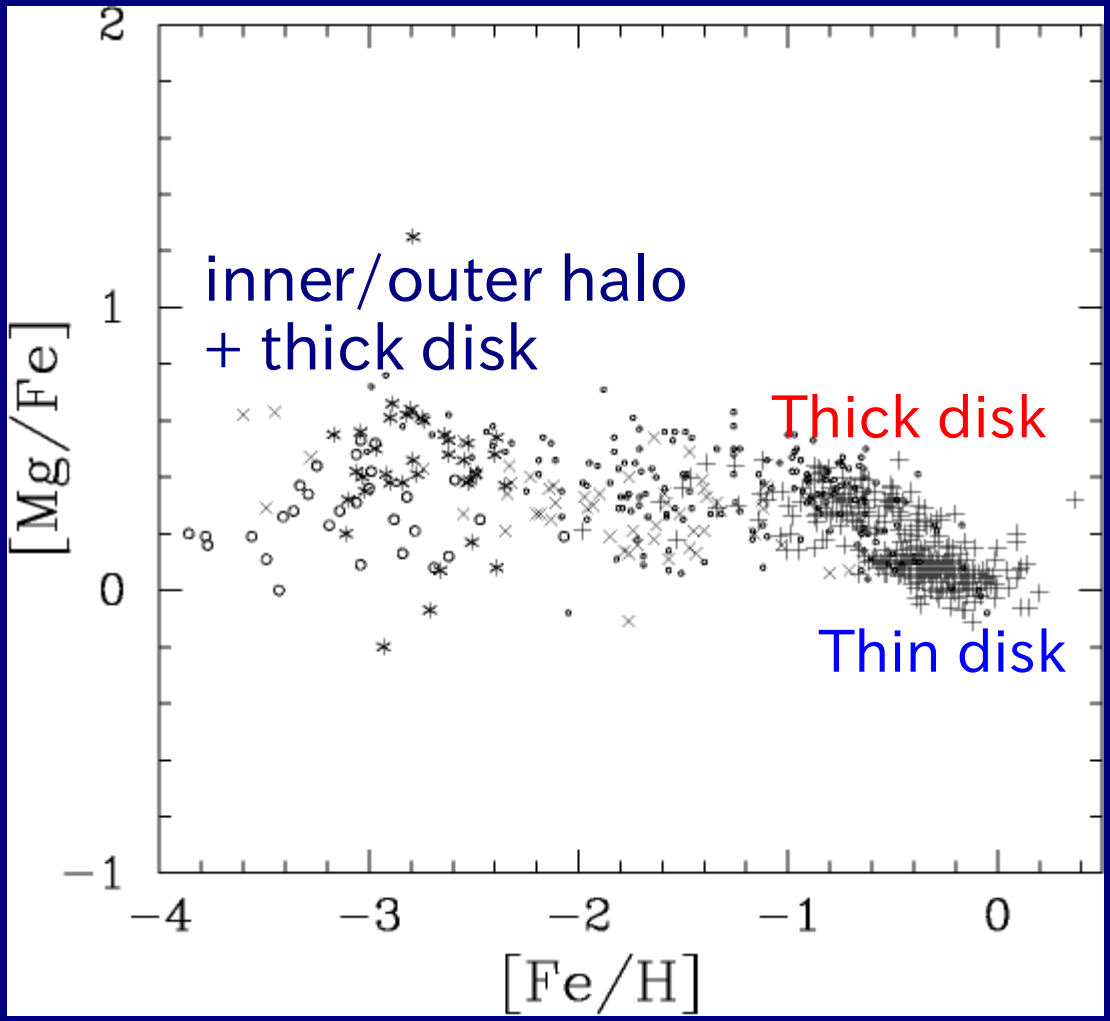
- O, Mg: SN II (M≧20Msun)
- Si, Ca, Ti, Cr (even-Z): SN II(not only massive ones)
- Fe, Ni: “metallicity”. SN Ia contribution
  (determination of atmospheric parameters)
- Mn, Co: SN II, metallicity dependent
  explosion energy dependent
- Eu: r-process. low-mass SN II?
- Y, Zr, Ba, La: s-process (+r-process at low metallicity)

α /Fe ratios of Galactic field stars

Simplified view



Observational results



Elemental abudnance studies for disk stars

- Thin disk: Reddy et al. (2003, MNRAS, 340, 304)

  181 F & G dwarfs
  27 elements
  stellar space motion

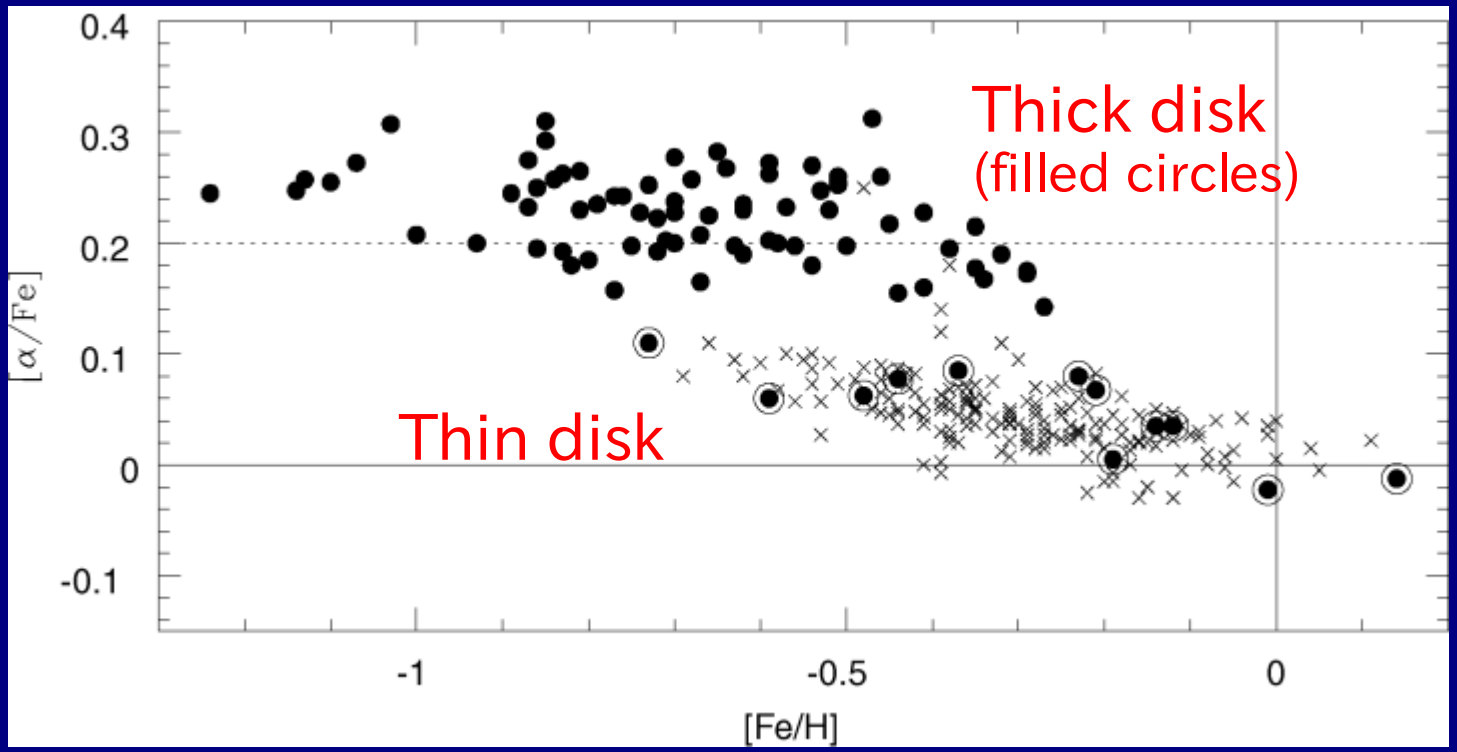
- Thick disk: Reddy et al. (2006, MNRAS, 367, 1329)

  176 stars → 95 thick disc stars
  22 elements

α/Fe ratios in thick/thin disk stars

- Thick/thin disks are distinguished by kinematics
- There is metallicity overlap, but alpha/Fe is different
- A fraction of thick disk stars have similar elemental abundances to thin disk stars

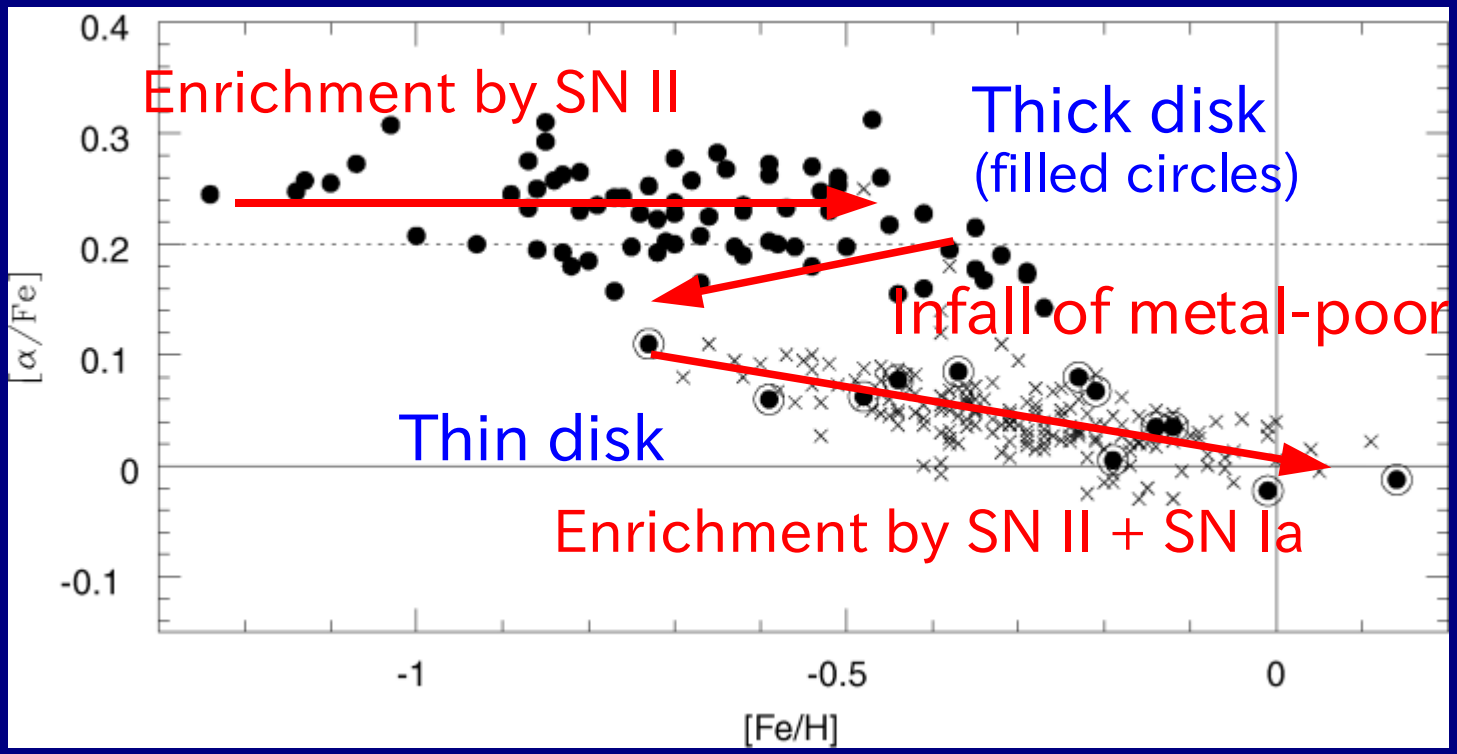
Reddy et al. (2003)



α /Fe ratios in thick/thin disk stars

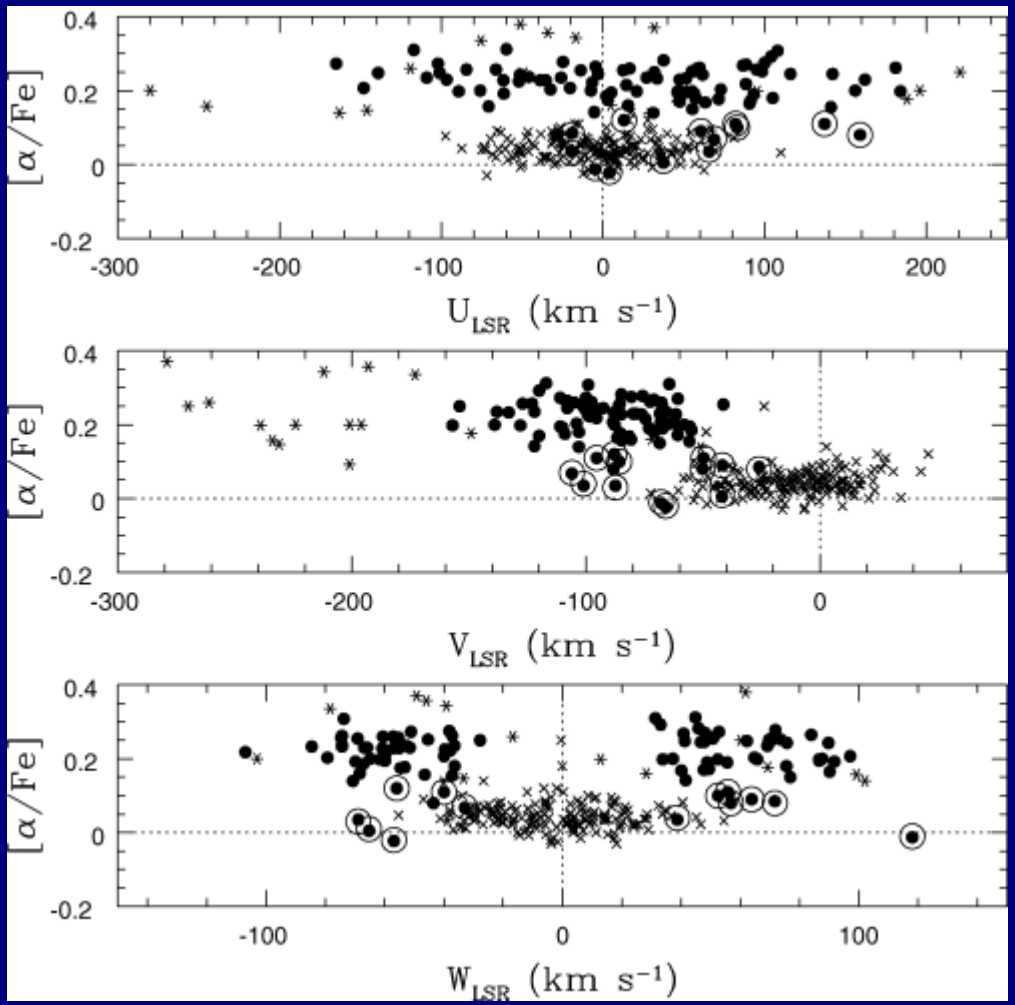
A scenario to explain the abundance ratios in the disk stars:
-enrichment by SNe and dilution by metal-poor gas

Reddy et al. (2003)



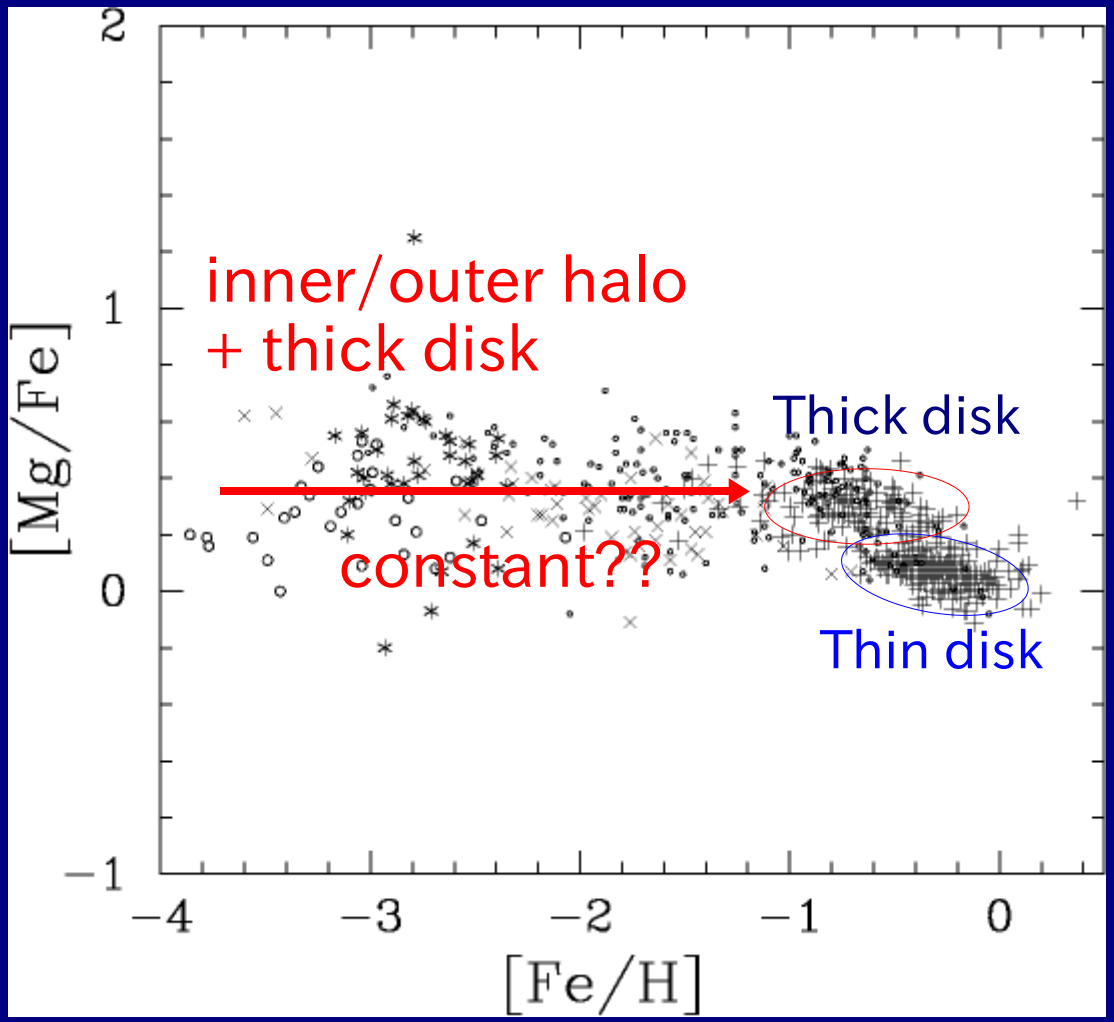
Stars having kinematics of the thick disk but abundances of the thin disk:
the second component scattered from the thin disk?

Reddy et al. (2003)



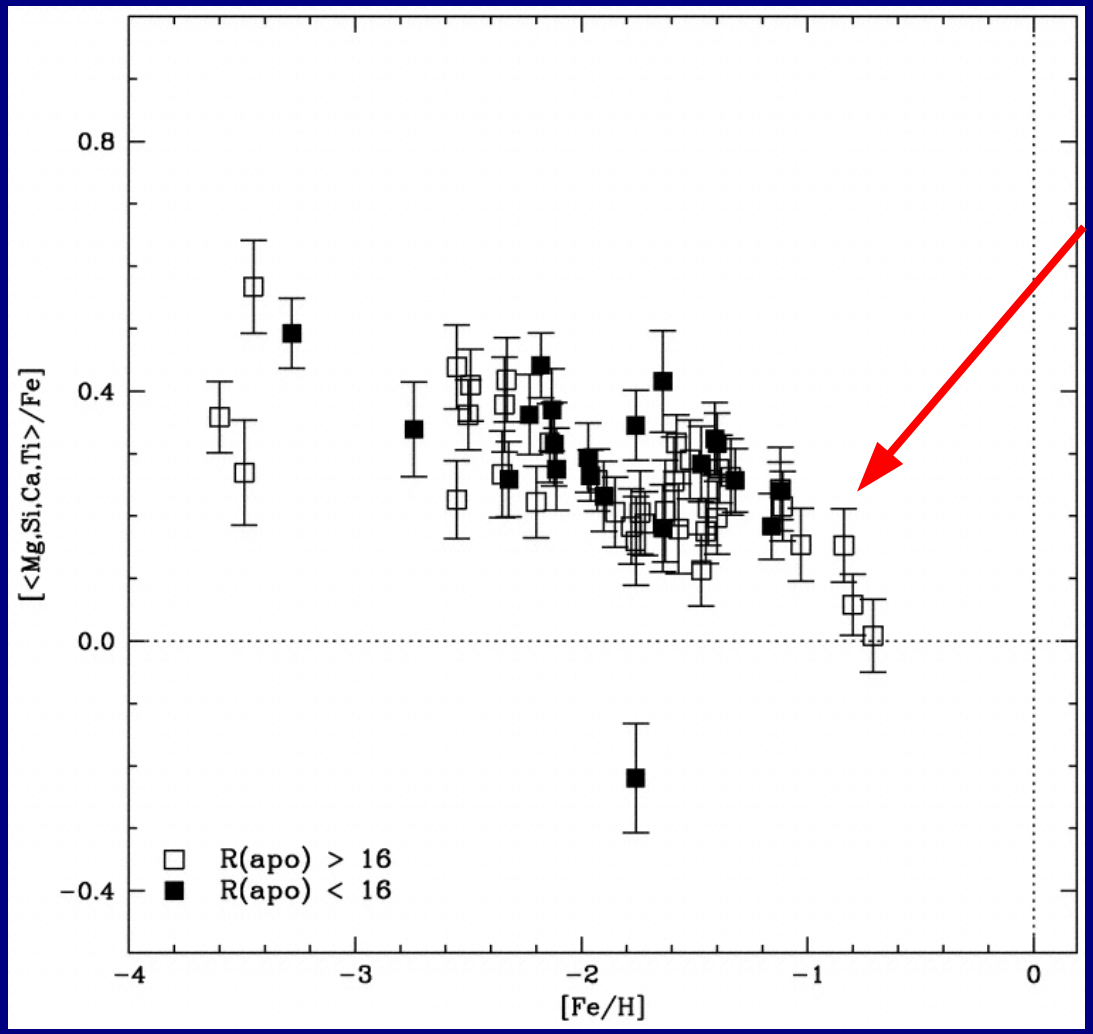
α/Fe ratios in halo stars

- Galactic halo consists of at least two components: outer and innter halos
- alpha/Fe ratios of halo stars show some variations



α /Fe ratios in *outer* halo stars

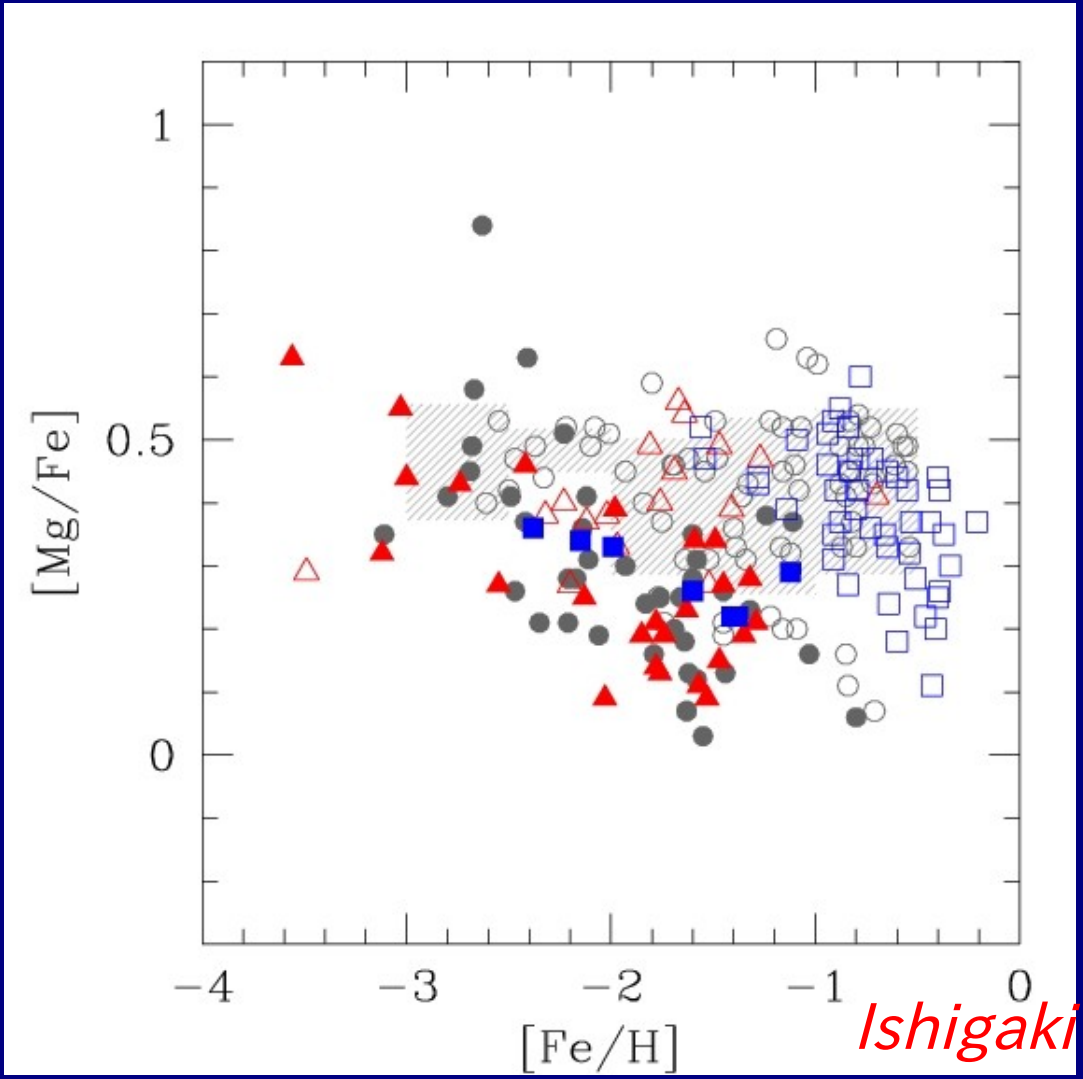
Stephens & Boesgaard (2002)



Stars having large Rapo (=outer halo) show low alpha/Fe?

α /Fe in *outer* halo stars : a new result

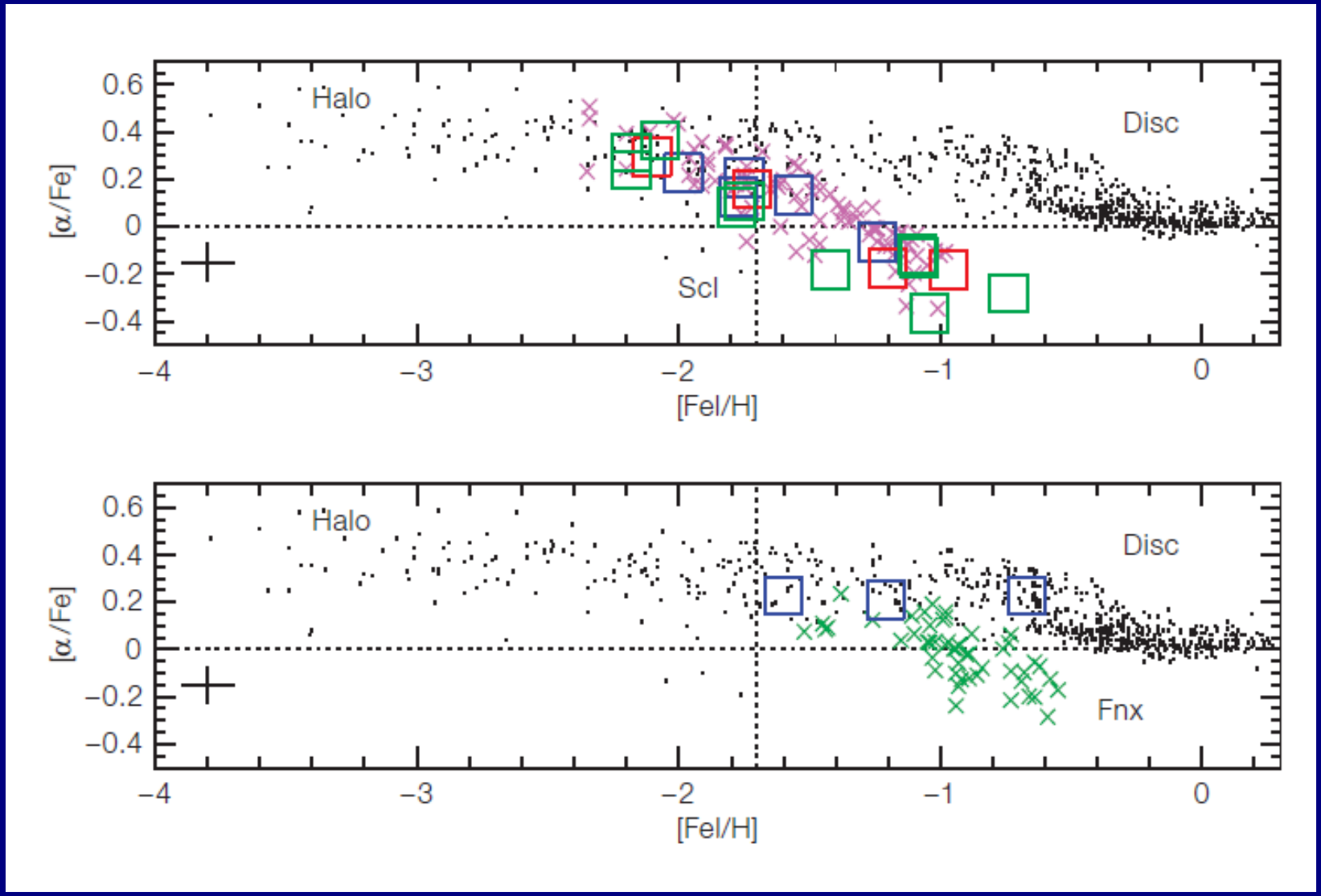
Outer halo stars show decrease of α /Fe in [Fe/H]>-2.
→See Ishigaki et al. for details.



Filled symbols:
outer halo stars
(Zmax>5kpc)

Ishigaki et al., in prep.

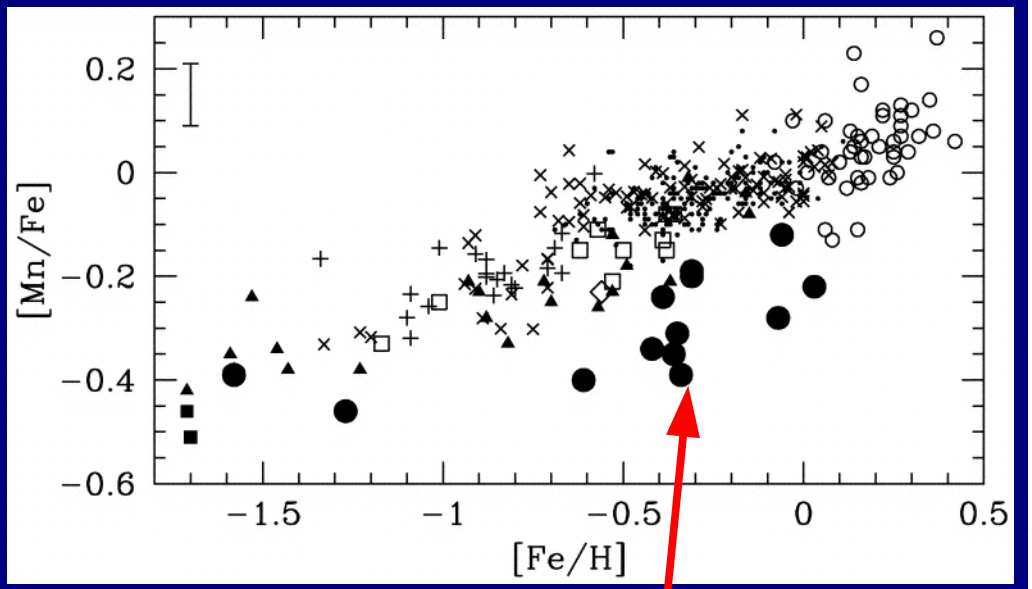
Low α/Fe in outer halo stars
→connection to dwarf galaxies?



Tolstoy et al. (2006, ESO messenger)

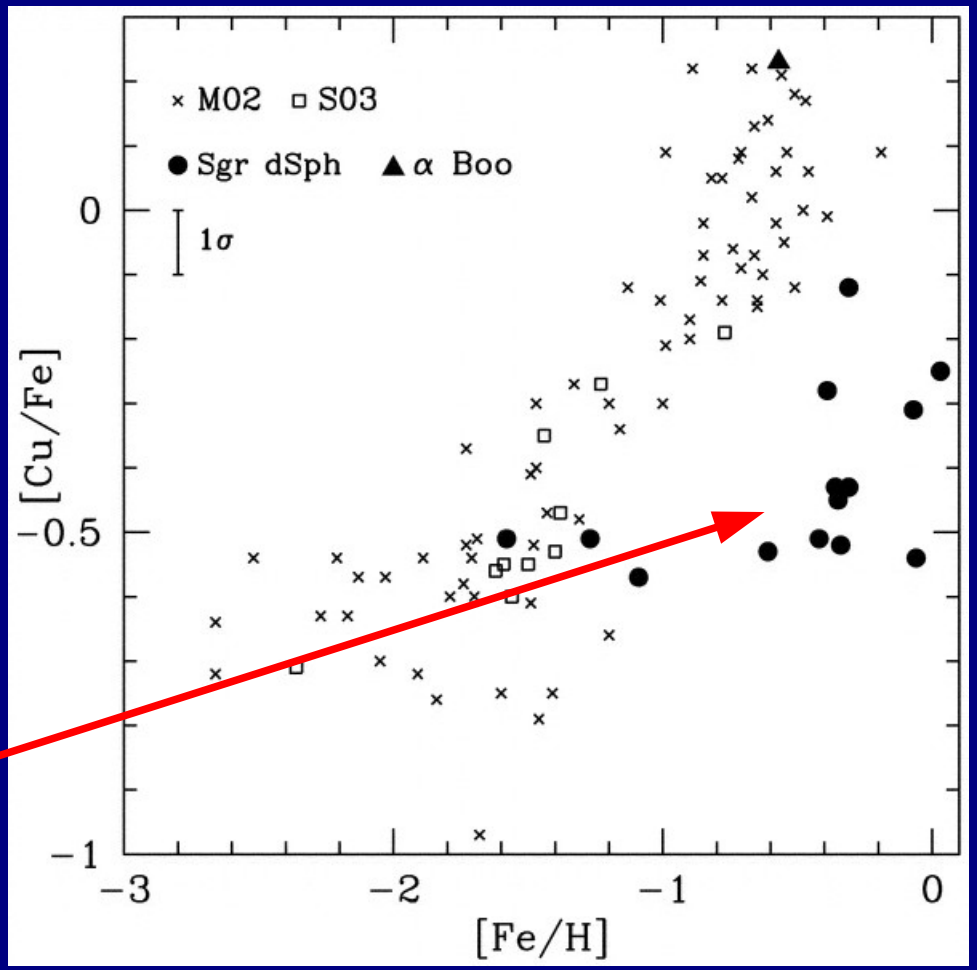
Other elements for chemical tagging
1. Odd elements Mn and Cu

Stars in Sgr dwarf have lower Cu/Fe and Mn/Fe than in field stars
... such dwarf galaxies are *not* the origin of field stars *near the sun*



McWilliam et al. 2003

Sgr dwarf galaxy stars



McWilliam & Smecker-Hane 2003

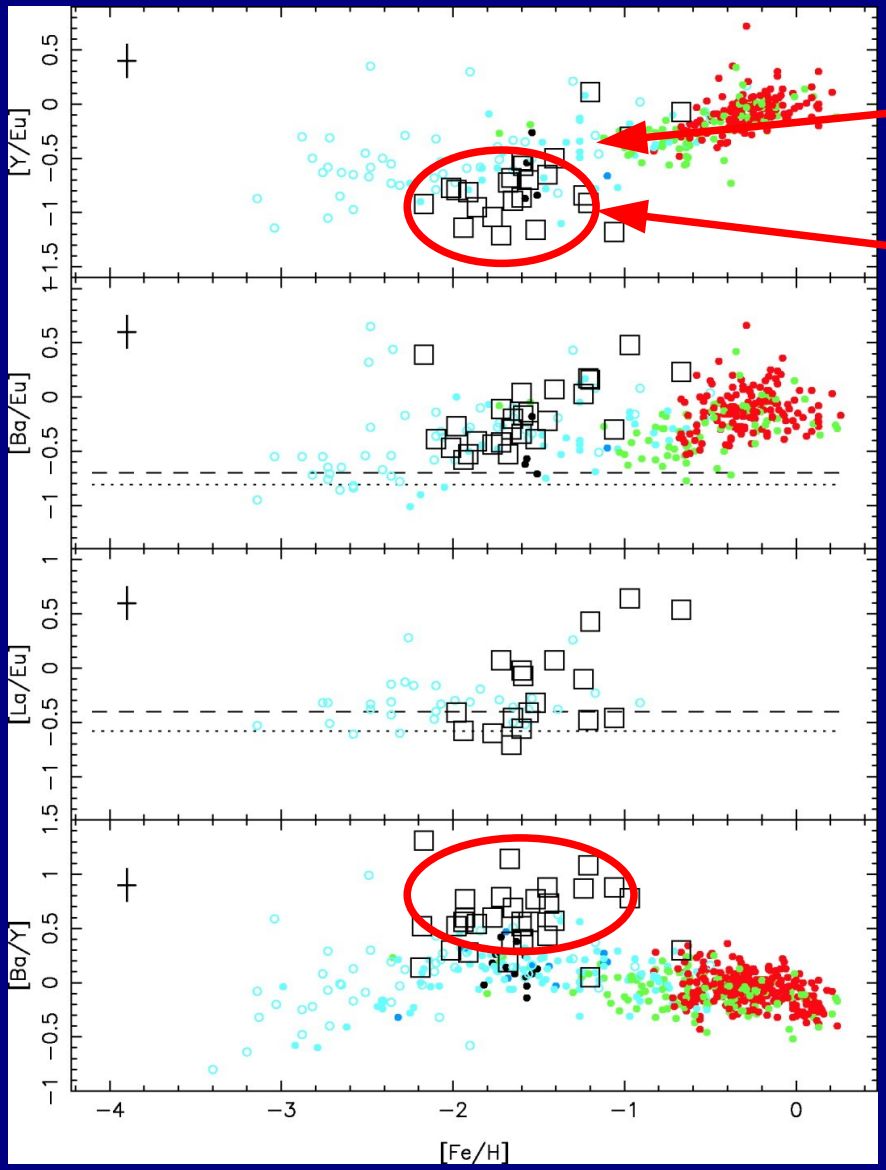
Other elements for chemical tagging
2. neutron-capture elements

[Y/Eu]

[Ba/Eu]

[La/Eu]

[Ba/Y]



Field stars

Dwarf galaxies

Venn et al. (2004)

An examble of survey program

•A lage sample of stars is required to study *individual* stellar compornents
•The survey must be extended to cover the range beyond the solar neighborhood

A survey program obtimized for thick disk studies:
-High resolution mode
(R=30,000, limited wavelength coverage)
-Area sueveyed: 1000 sq. deg.
-Total number of specta: 600,000
thin disk: 300,000
thick disk: 250,000
halo: 10,000
-observing time: 300 nights

Possbile PI-type programs

- Searches for population III stars and their evidence
  - -searches for metal-free or hyper metal-poor stars
  - -searches for stars showing evidence of pair instability SNe
  - -surveys for the outer halo and the bulge

- Astrophysical sites of explosive nucleosynthesis (r-process)
  - → see Honda et al.
  - -searches for r-process-enhanced stars
  - -intensive studies for globular clusters and dwarf galaxies

- dwarf galaxies, clusters, and streams
  - → see Okamoto et al.
  - -enrichment history of individual galaxies
  - -chemical nature of disrupted clusters and streams