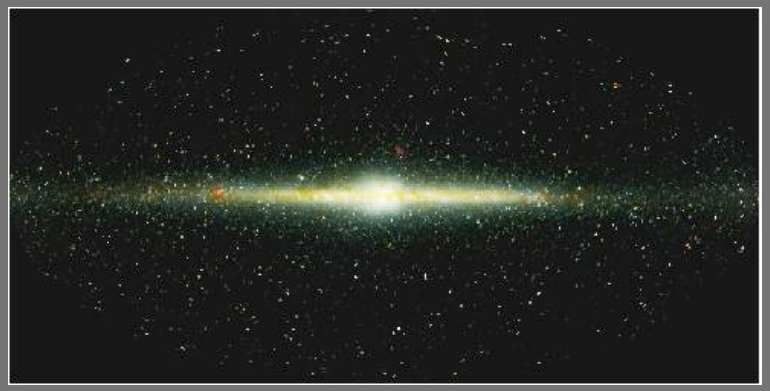
Chemically Tagging the Galactic Disk



Gayandhi M. De Silva

ESO Fellows Symposium 2007

How did the Milky Way Form?

- Details of formation and evolution largely unknown
- A physical understanding of the sequence of events that led to the MW Disk
- ***Fossil records:*** dynamical / chemical substructures
- Sign posts for an array of events
- Disentangle their relative contributions

Chemical Tagging

Long Term Goal: Re-assemble the individual star-forming aggregates in the disk (Freeman & Bland-Hawthorn, 2002)

Use detailed elemental abundance ***signatures*** of individual stars to tag them to common ancient star-forming events

Looking for sub-structure within the disk chemical abundance inventory ([X/H]: *C*-space)

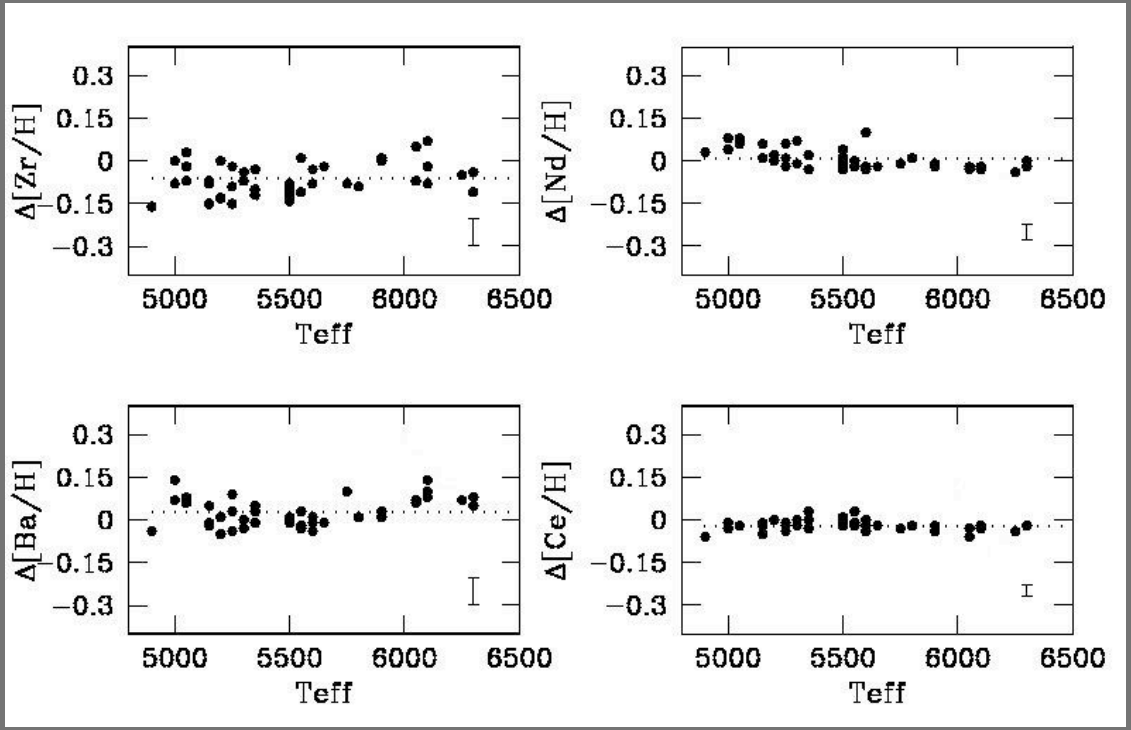
Primary requirement: Chemical homogeneity in star-forming aggregates, e.g. Open clusters

Observational data:

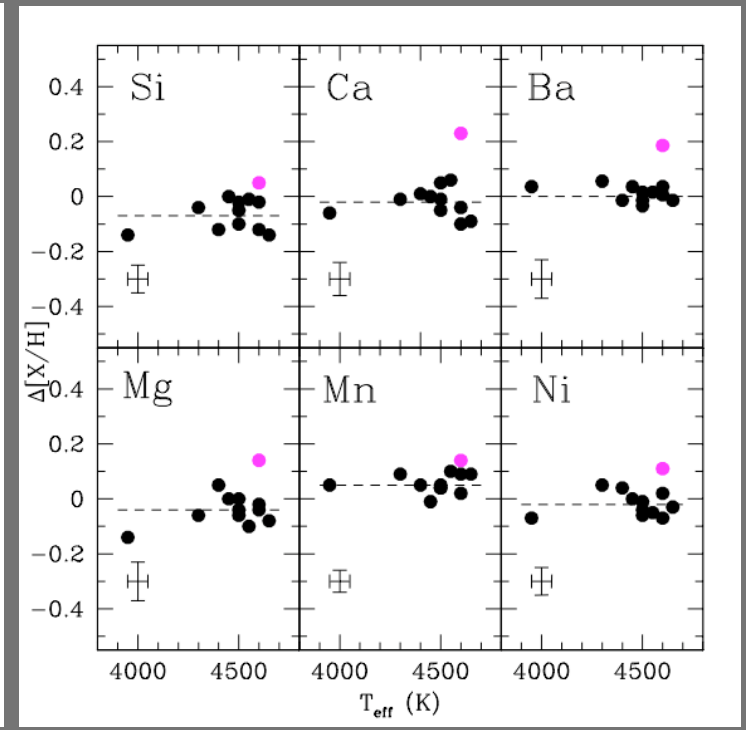
- High resolution ~ 50,000
- High S/N ~ 100
- Prefer main sequence turn-off stars
  (use giants due to magnitude limits)
- Established memberships from literature

Cluster	Telescope/ Instrument	Age	[Fe/H]	Stars	Date
Hyades	Keck/HIRES	650 Myr	0.13	48	1996 – 2002
IC 4756	APØEchelle	700 Myr	0.04	10	Jul 2004
NGC 752	APØEchelle	2 Gyr	-0.09	12	Oct 2003
NGC 3680	VLT/UVES	1.5 Gyr	-0.17	24	Feb 2004
Collinder 261	VLT/UVES	10 Gyr	-0.03	13	May 2004
IC 4651	AAT/UCLES	1.7 Gyr	0.10	20	Jul 2004
Blanco 1	AAT/UCLES	100 Myr	0.04	10	Jul 2004
NGC1901	AAT/UCLES	500 Myr	0.00	10	Nov 2003
HR1614 group	AAT/UCLES	2 Gyr	0.25	25	Nov 2003
Arcturus group	AAT/UCLES	10 Gyr	-0.60	32	Nov 2003

Hyades Open Cluster:



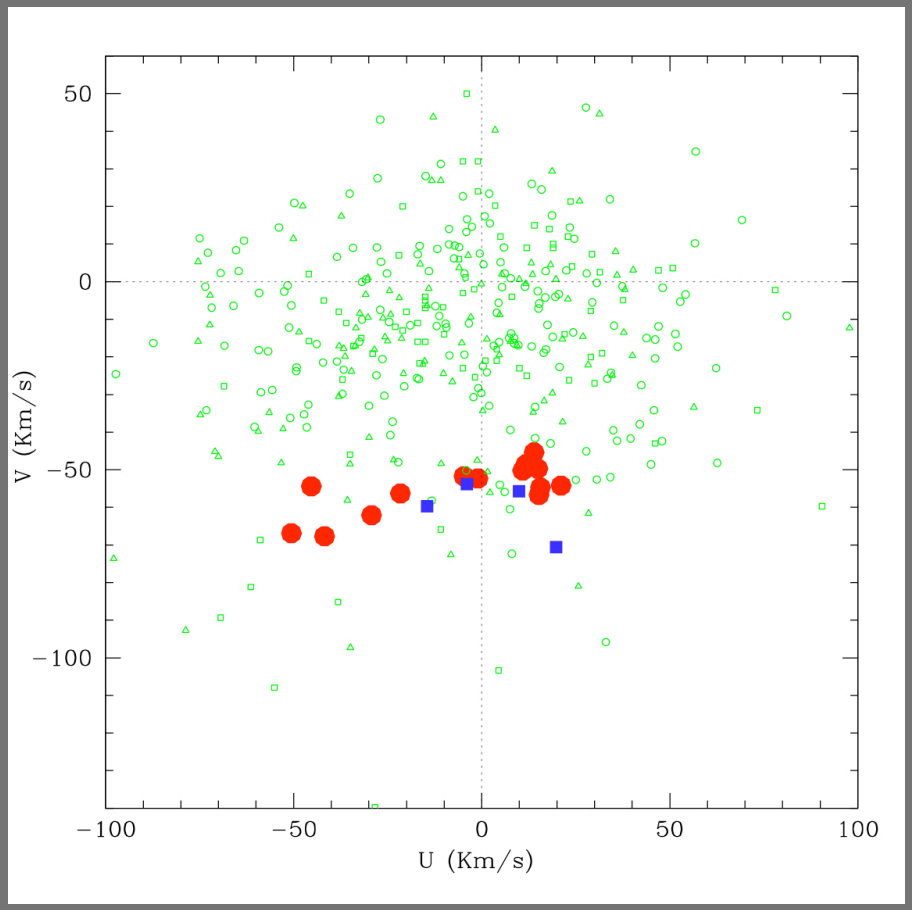
Collinder 261:

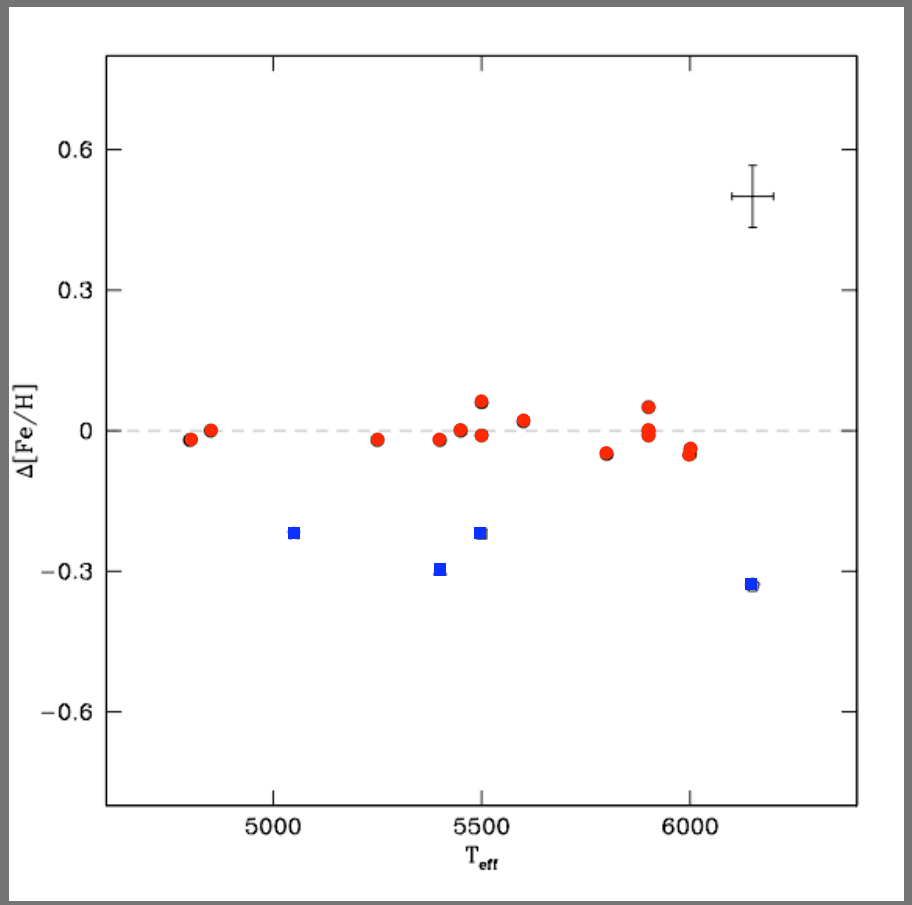


De Silva et al. 2006 & 2007

Dispersing clusters: Moving groups

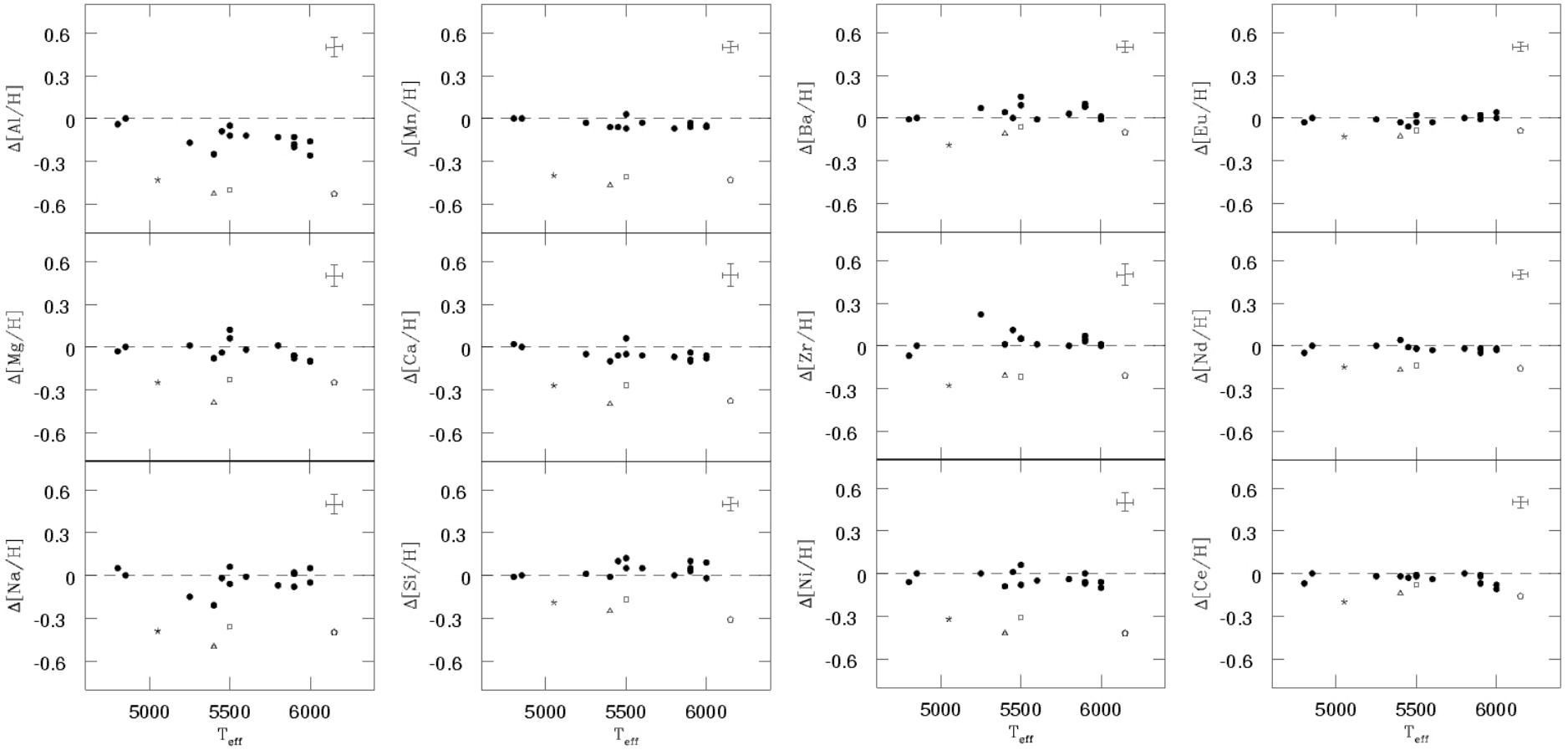
HR1614 moving group:





Memberships: Feltzing & Holmberg 2000, Eggen 1998

HR1614 moving group: Other element abundances



Likely contamination from field stars

Besancon models:

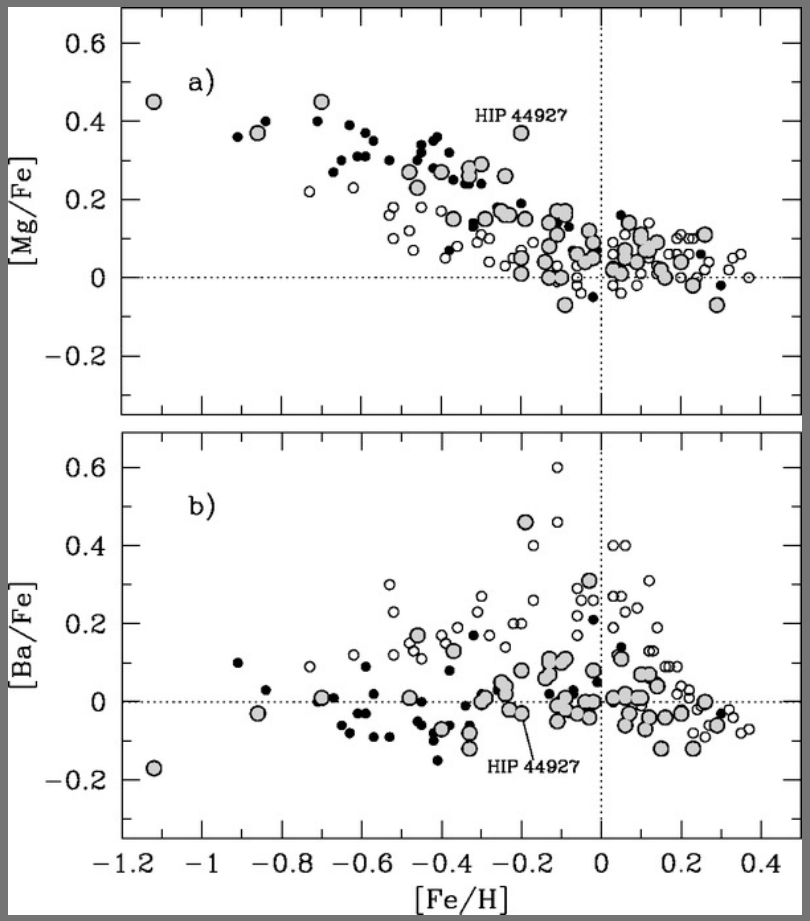
1 in 7 stars within the groups' colour, magnitude and space velocities to have solar level metallicities

Homogeneity demonstrates that the chemical history is preserved despite potential pollution

Can chemically identify dispersed aggregate

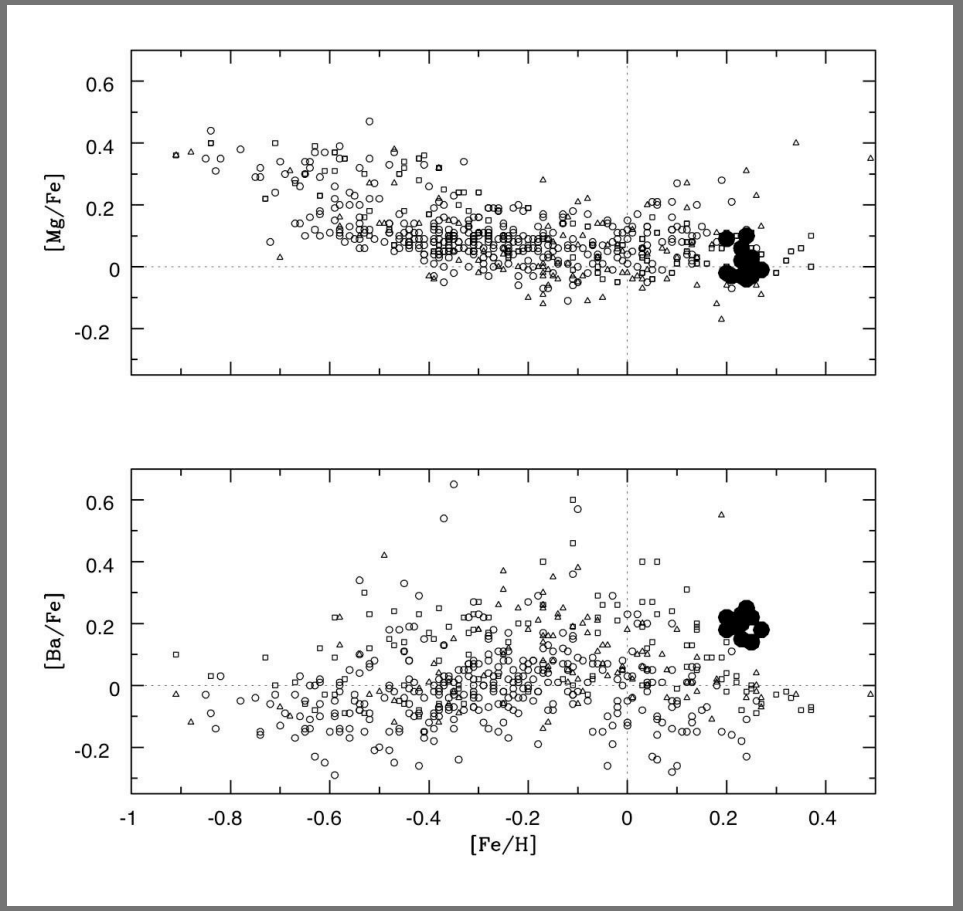
Dynamical streams vs. Moving groups

Herculis stream:

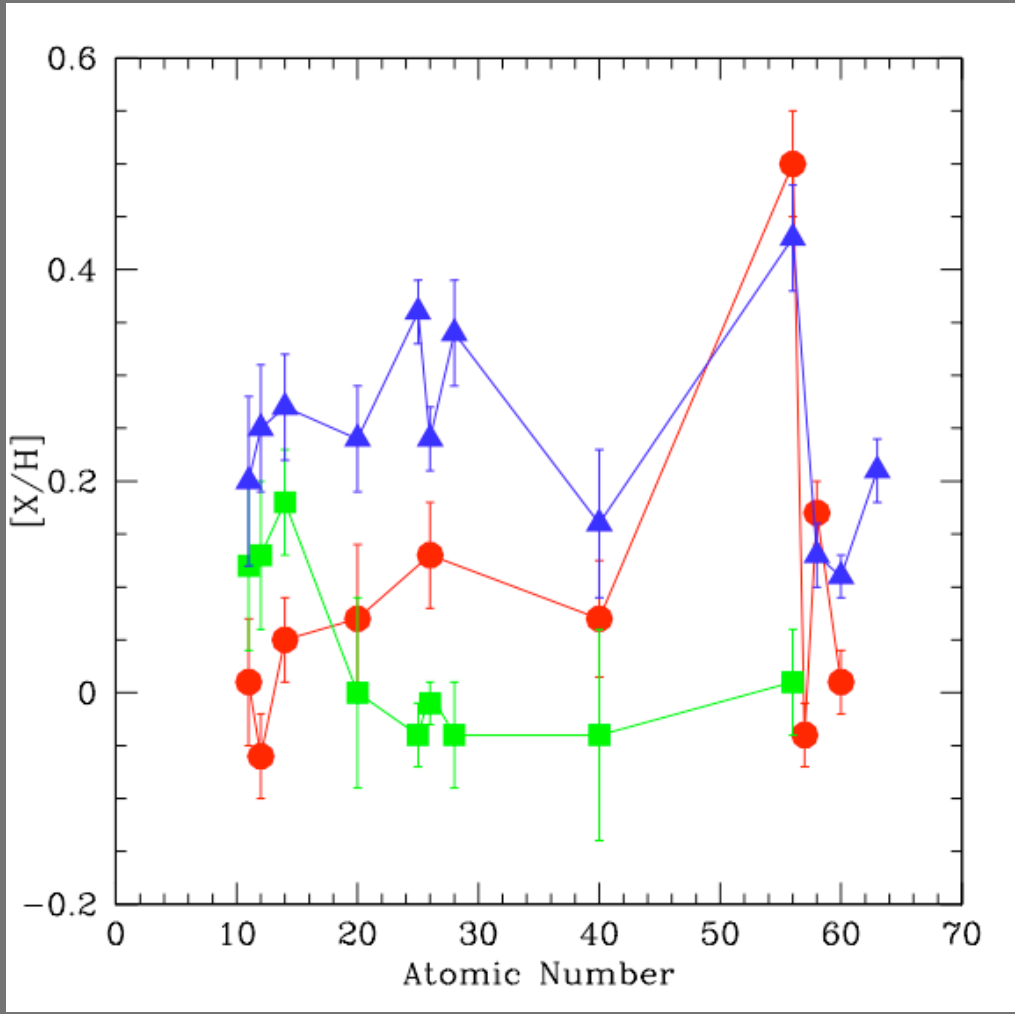


Bensby et al., 2007

HR1614 moving group:



Clusters have different chemical signatures
They are distinguishable in abundance space

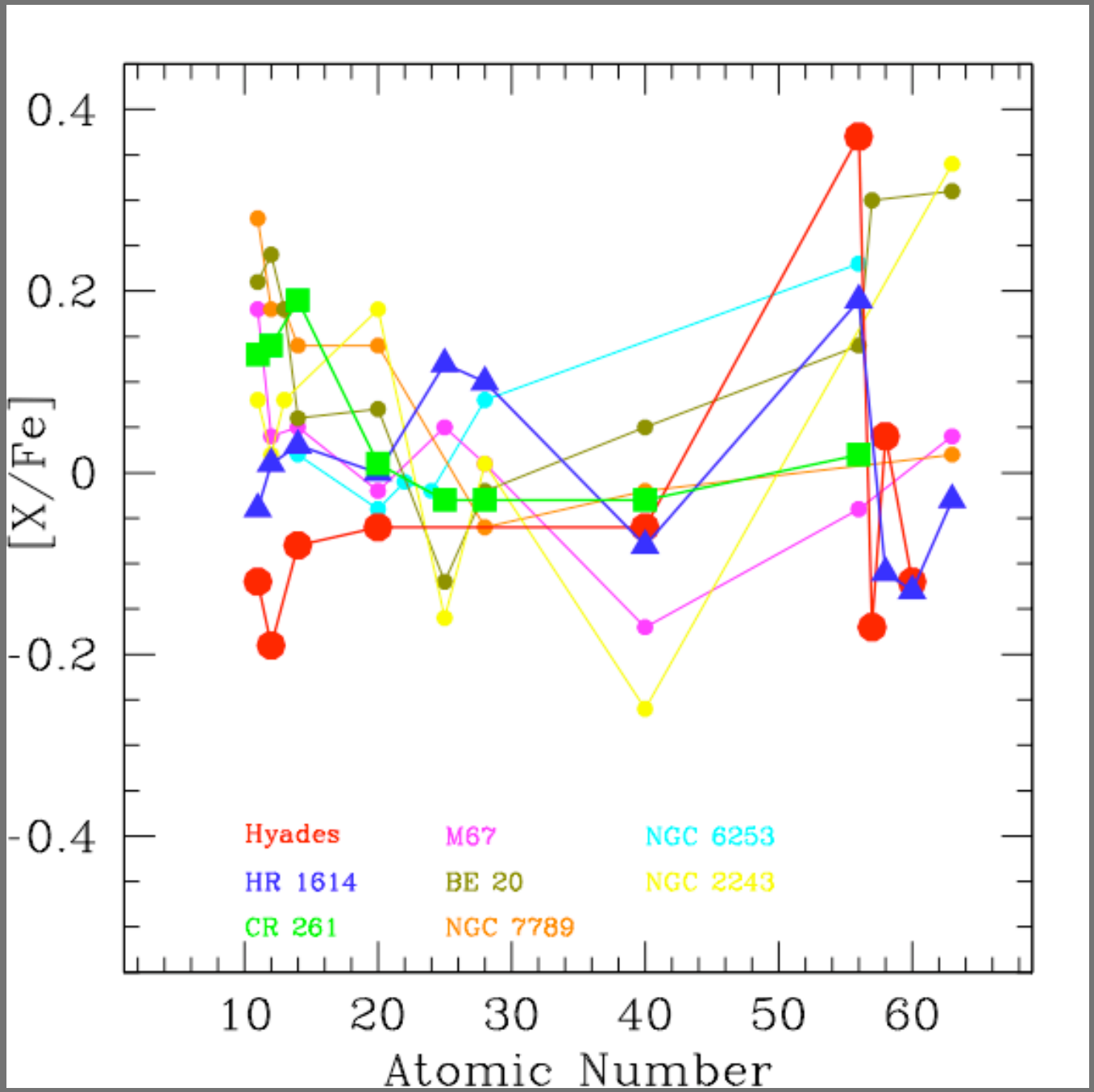


Hyades

Cr 261

HR1614 moving group

Other Clusters:



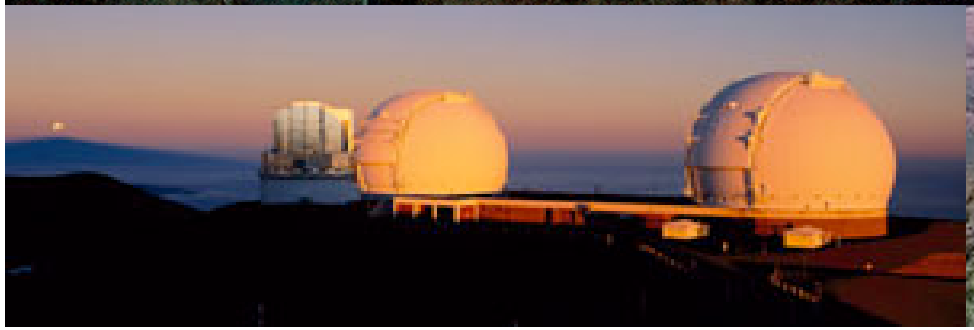
Tautvaisiene, et al., 2000 & 2005
Yong et al., 2005
Sestito et al., 2007
Gratton & Contarini, 2004

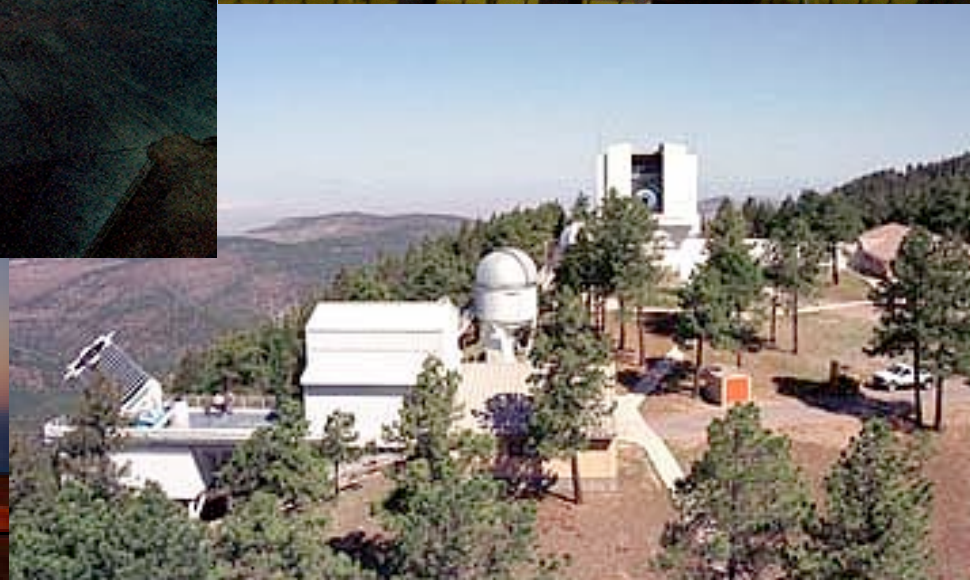
Continuing studies

Explore more loose groups, Eg. Hyades, HR 1614 super-clusters

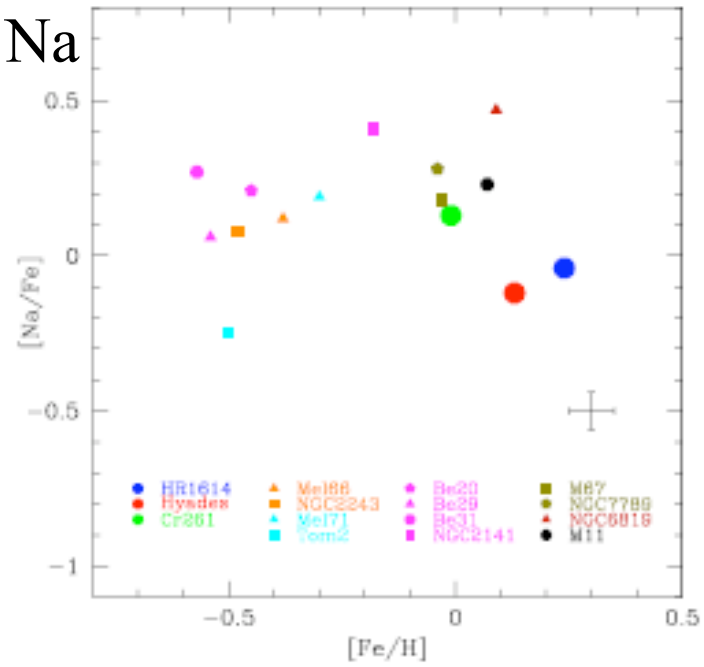
Do they share the chemical signature of open cluster and moving group?

Chemistry yet to be studied …





Na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0
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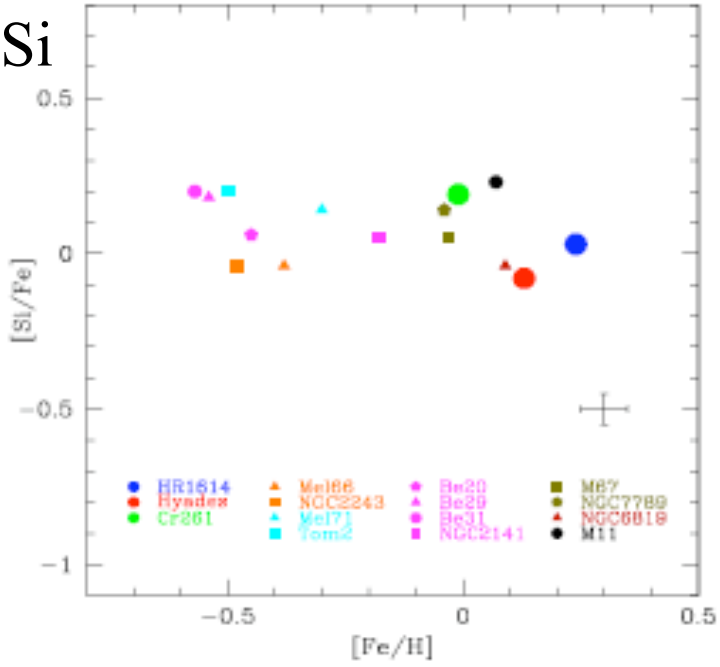
[Fe/H]
HR1614
Hyades
Cr261
Mel66
NGC2243
Mel71
Tom2
Be20
Be29
Be31
NGC2141
M67
NGC7789
NGC6819
MII

Si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NGC2243
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Tom2
Be20
Be29
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NGC2141
M67
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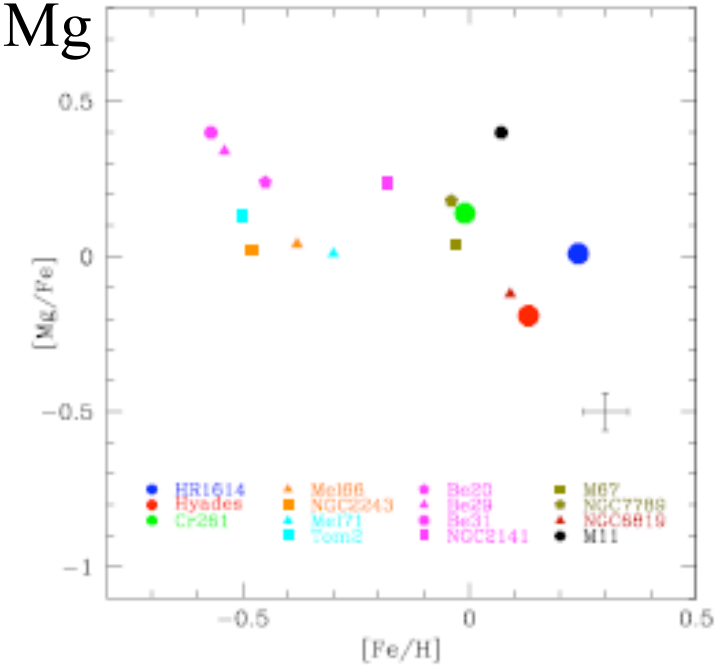
NGC6819
MII

Mg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NGC2141
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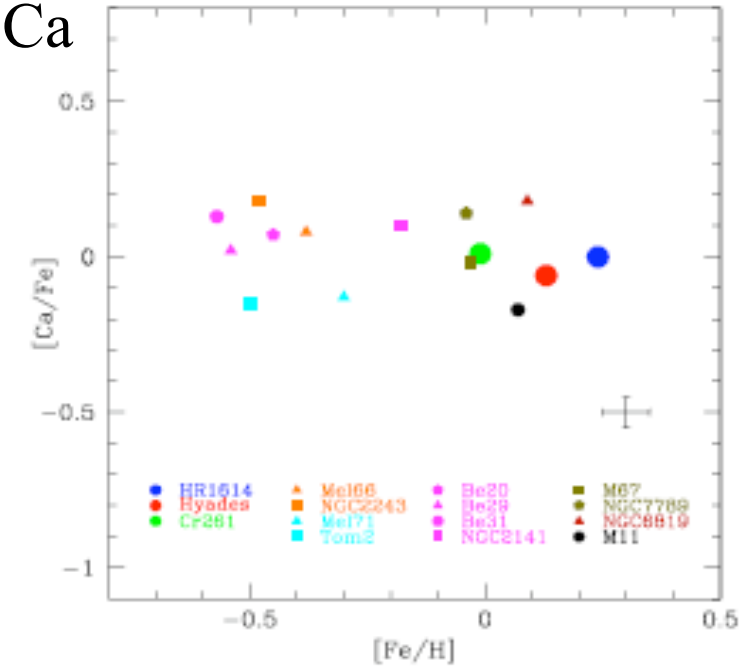
MII

Ca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Hyades
Cr261
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Mel71
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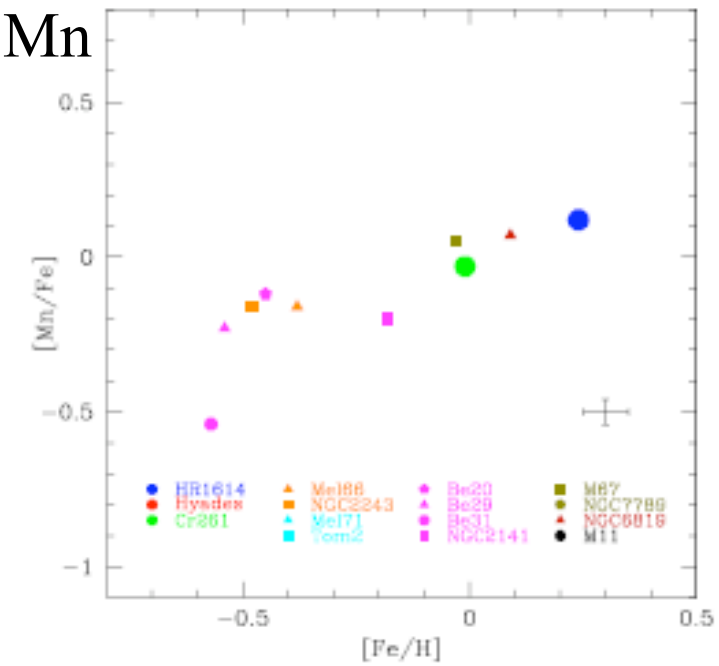
NGC7789
NGC6819
MII

Mn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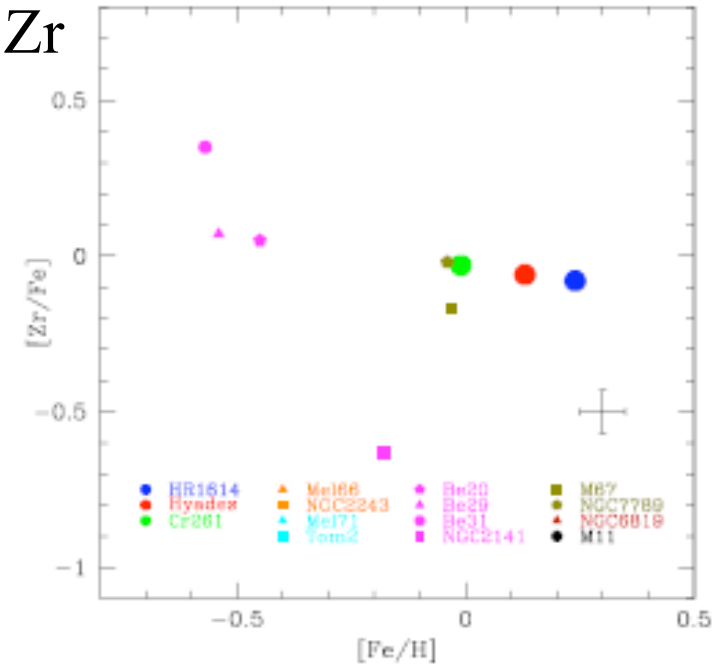
Hyades
Cr261
Mel66
NGC2243
Mel71
Tom2
Be20
Be29
Be31
NGC2141
M67
NGC7789
NGC6819
M11

Zr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Hyades
Cr261
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Be29
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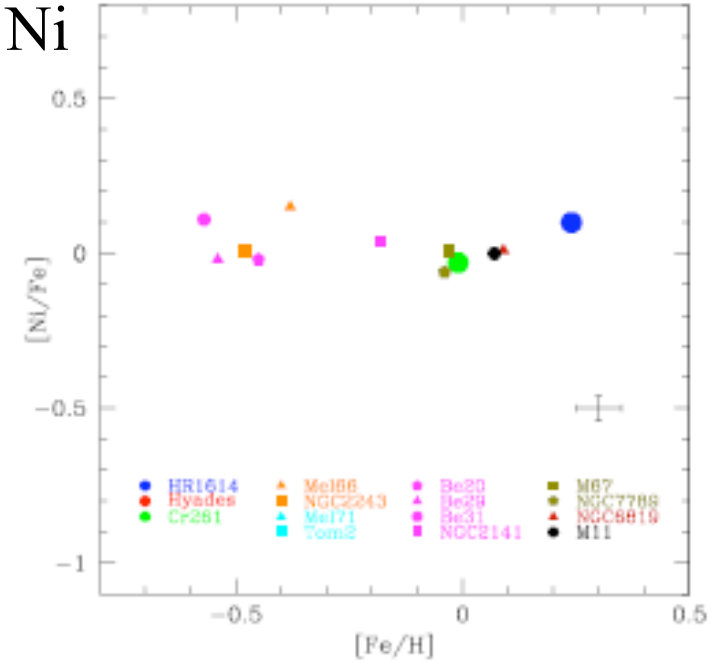
M67
NGC7789
NGC6819
M11

Ni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Hyades
Cr261
Mel66
NGC2243
Mel71
Tom2
Be20
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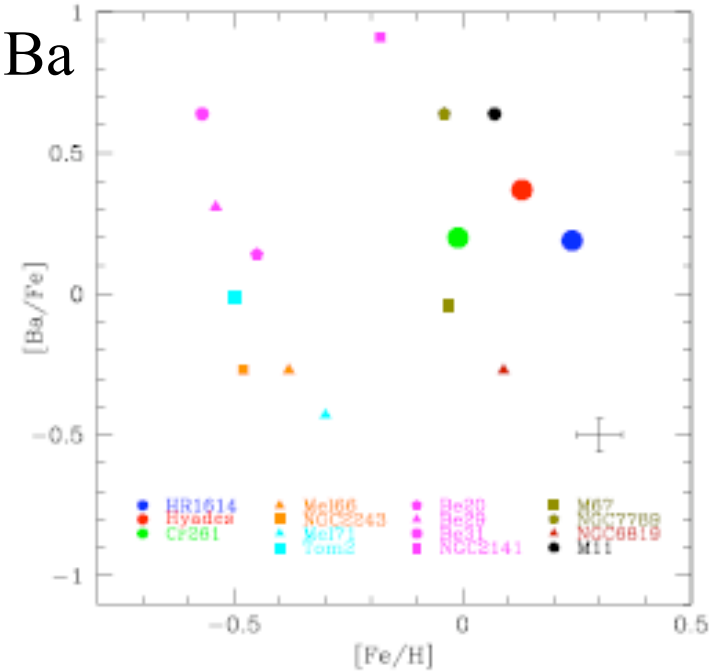
M67
NGC7789
NGC6819
M11

Ba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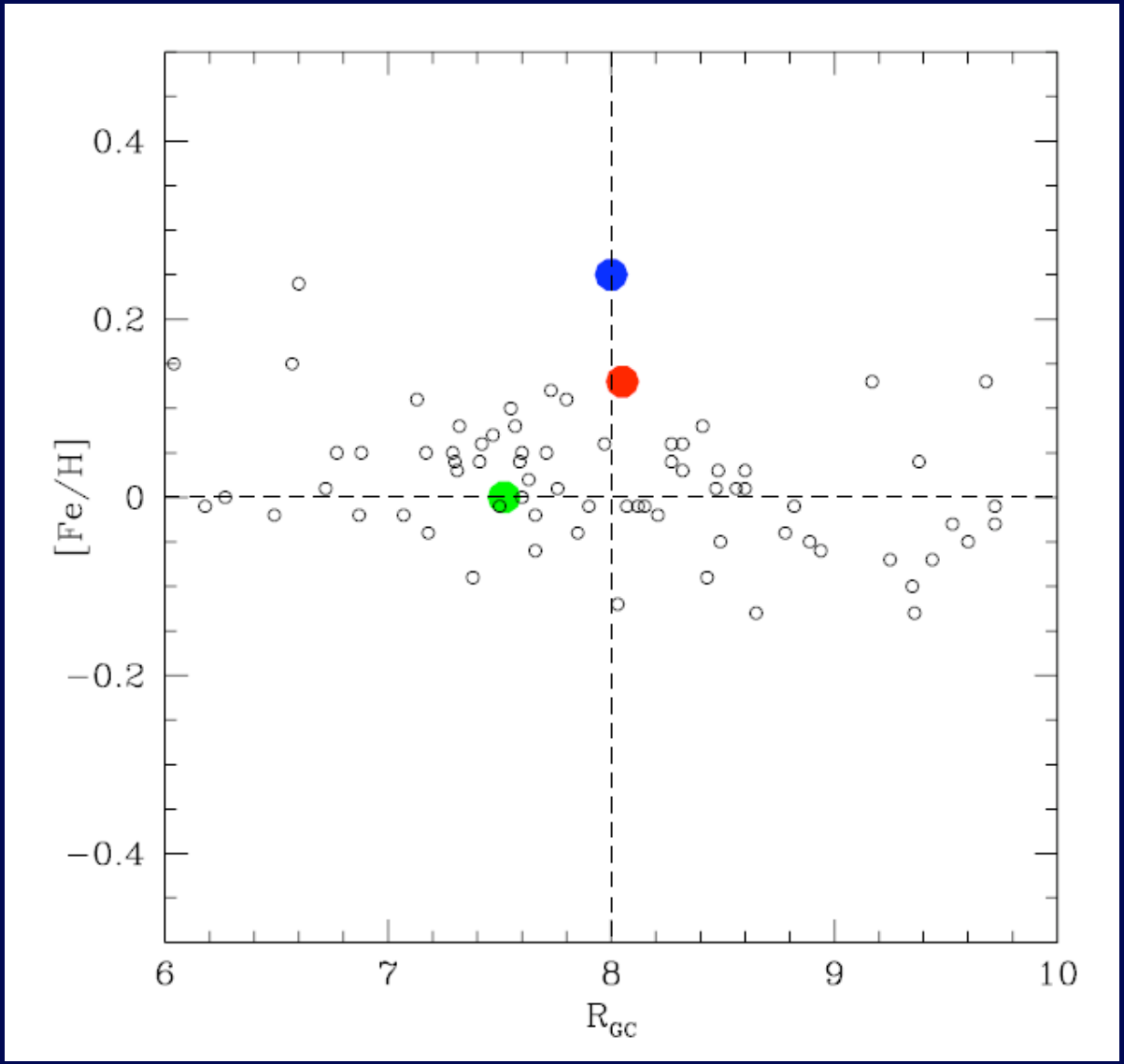
Hyades
Cr261
Mel66
NGC2243
Mel71
Tom2
Be20
Be29
Be31
NGC2141
M67
NGC7789
NGC6819
M11

Compare to disk cepheids

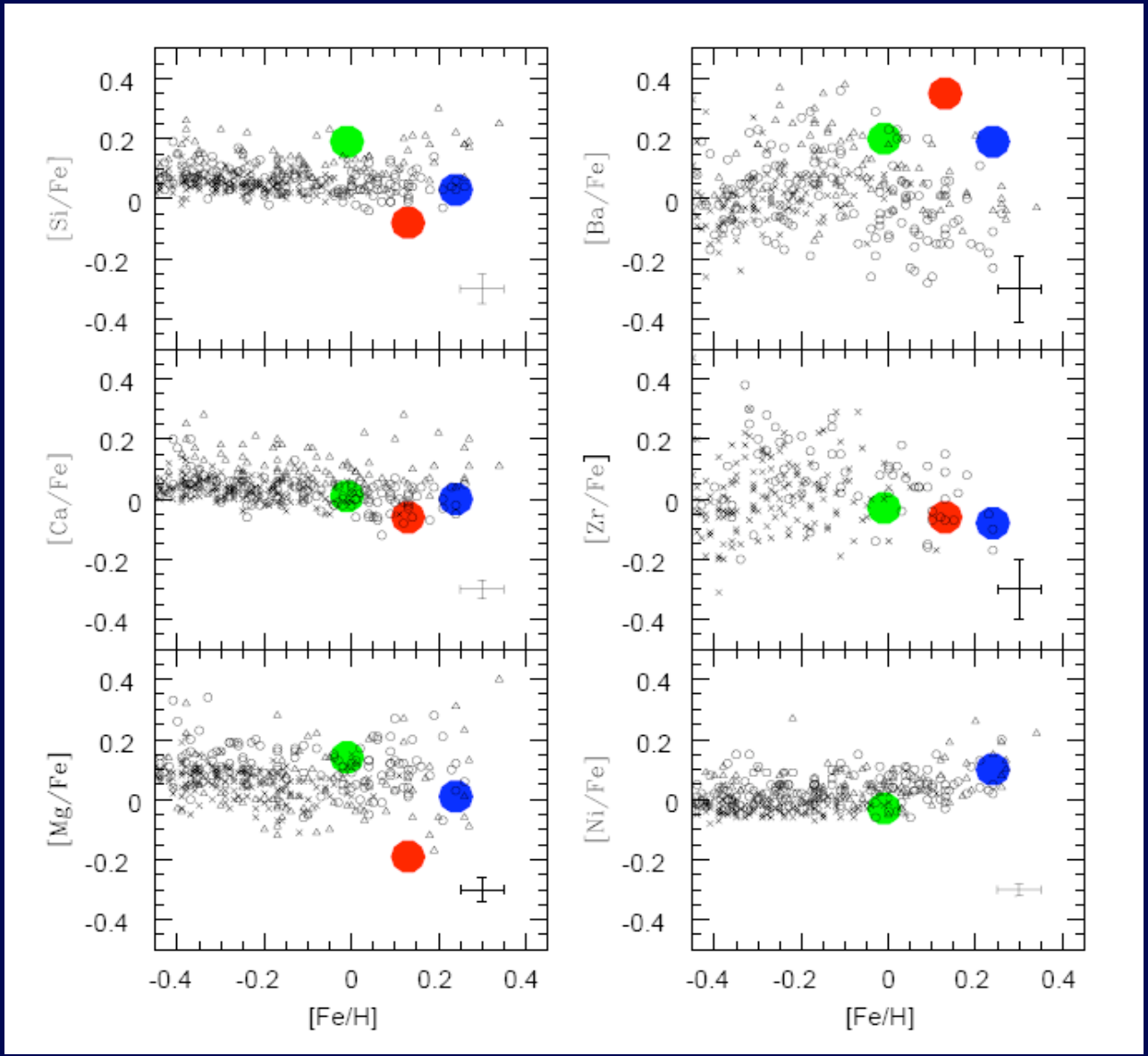


Comparable with young cepheid metallicities

=> No significant chemical evolution

Cepheid abundances: Andrievsky et al. 2002

Compare to local disk stars



Deviations may indicate uniqueness of clusters

Disk abundances from:
Allende Prieto et al. 2004
Reddy et al. 2003
Edvardsson et al. 1993