Do we still care about α-elements?

A few observational tests in the Galaxy and beyond

Francesca Primas – ESO

INT programme 14-2b

Maybe not that exciting …

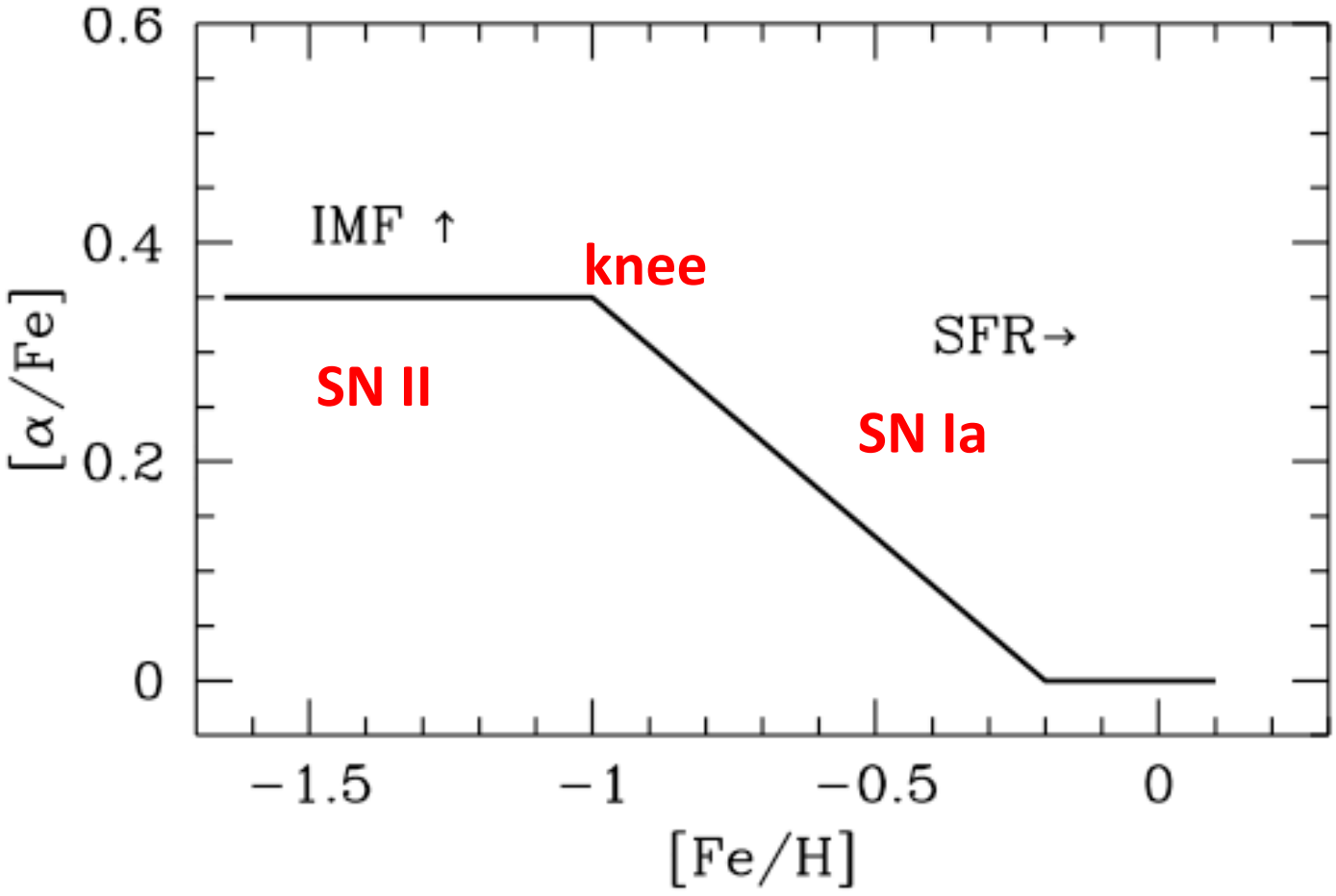
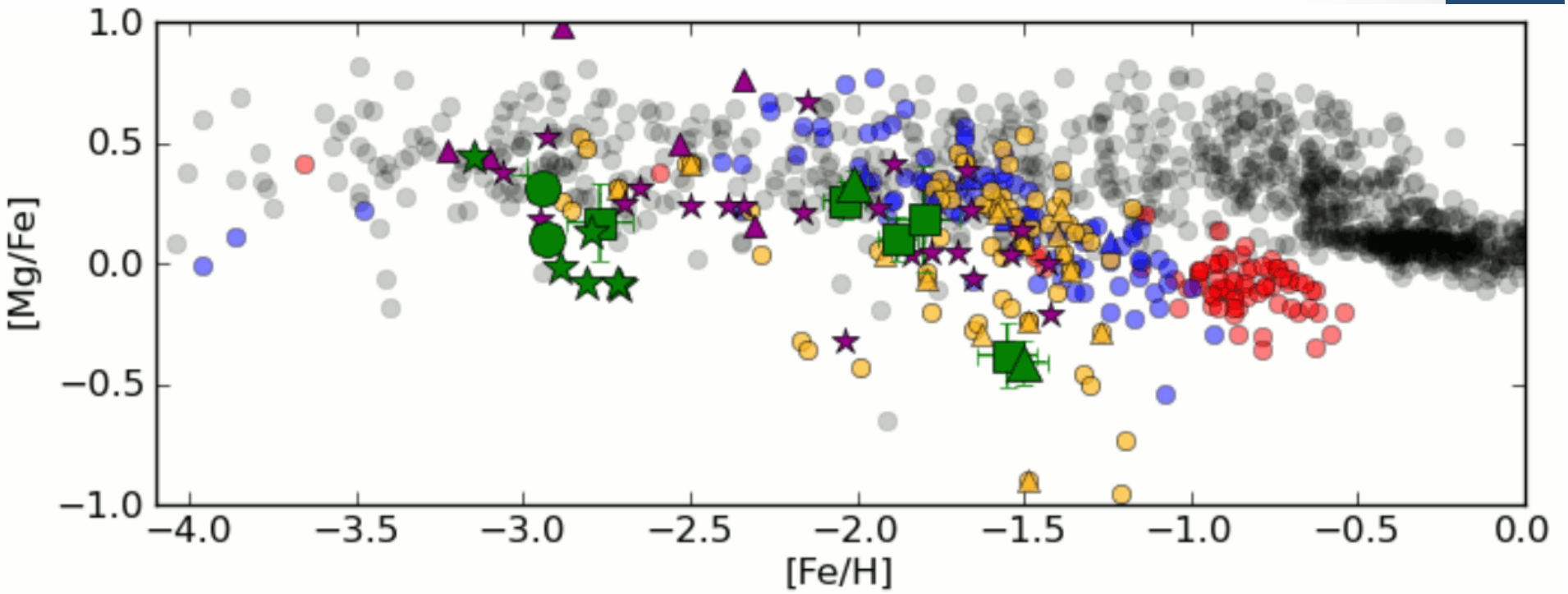


Figure 1 A schematic diagram of the trend of α-element abundance with metallicity. Increased initial mass function and star formation rate affect the trend in the directions indicated. The knee in the diagram is thought to be due to the onset of type Ia supernovae (SN Ia).

… but key to constrain the chemical history



UMaII, ComberI, Draco, Umi
Sculptor
Fornax
Carina
Sextans

Cf. Andreas and Thomas' talks

Source: Jablonka 2013

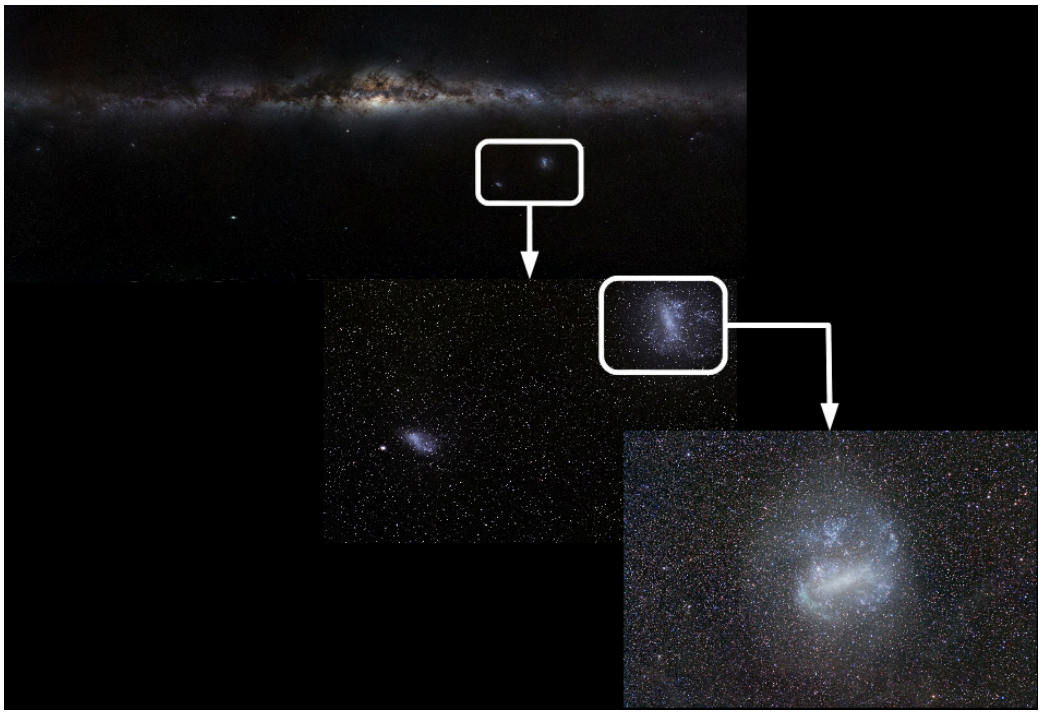
Today

1. LMC chemical history

2. GCs chemistry

1. A bar and a disk: stellar fitness in the LMC

Van der Swaelmen 2013 PhD
Van der Swaelmen, Hill, Primas & Cole 2013, A&A



LMC

Irregular
D=50kpc, M~$10^{10}M_o$
Face-on

Gravit. interacting with SMC and MW

Gas-rich
Active SF

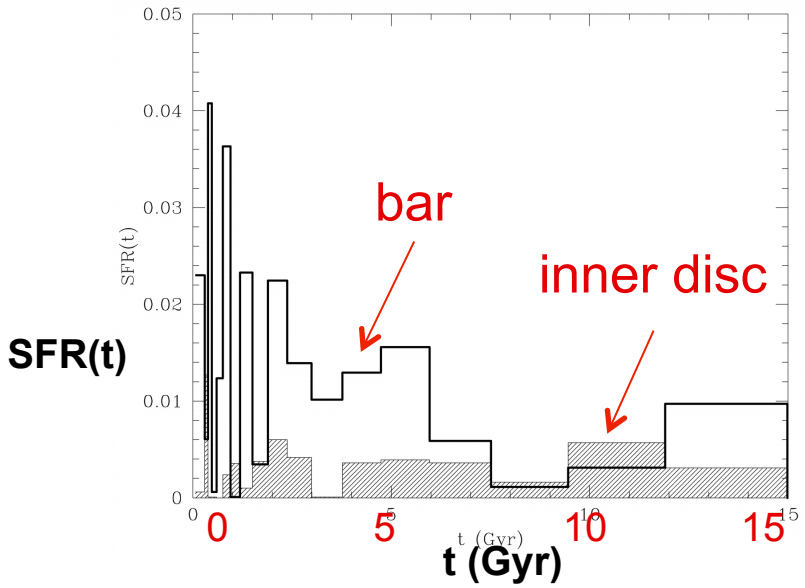
What we know

Young+Intermediate+Old
populations

LMC-SMC bridge: gas+stars

SFH: similar at old ages

Bar: dramatic increase of SFR,
4-6Gyrs (epoch of bar formation)



What we don't

LMC-SMC
first encounter? when?
related to the bar?
are star burst (cor)related?

Bar
dynamical or stellar over-density?
how and where did it originate?

Age gap (~6-10Gyr)
no SF activity?
tidally stripped/destroyed?

Abundance studies

Before 2000: first metallicities (e.g. Russell & Bessell 1989, Olszweski+ 1991)

high-res mostly restricted to the brightest objects:

young supergiants (Hill+ 1995, Geisler+ 1997, Luck+ 1998)

HII regions

After 2000: first high-res studies of individual RGBs in GCs

(Hill+ 2000, Johnson+ 2006, Mucciarelli+ 2008,10,11)

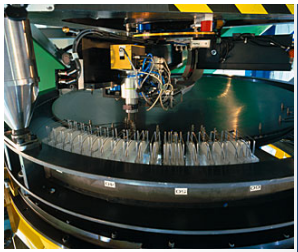
low-medium res studies (Cole+ 2005; Grocholski+ 2006; Carrera+ 2008)

MOS

>>> HUNDREDS of OBJECTS <<<

first high-res large sample in the field (Pompeia+ 2006)

LMC @ FLAMES



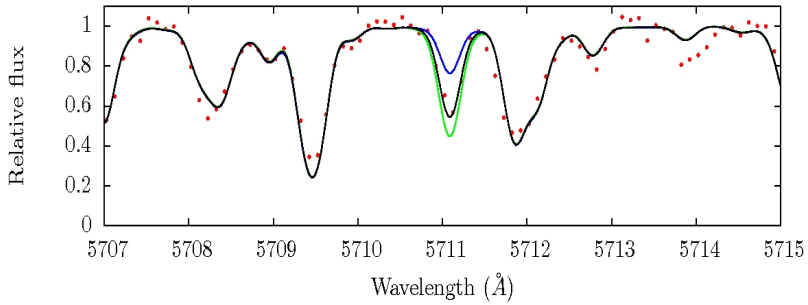
RGB stars in 2 fields: one in the bar and one in the inner disc

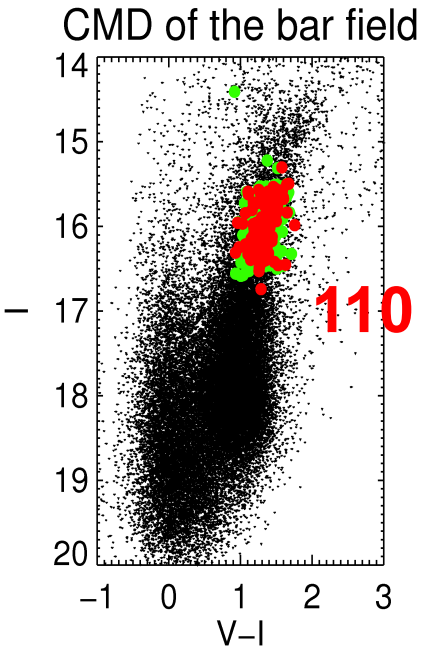
Targets selection: from low-res survey (Cole+ 2005)

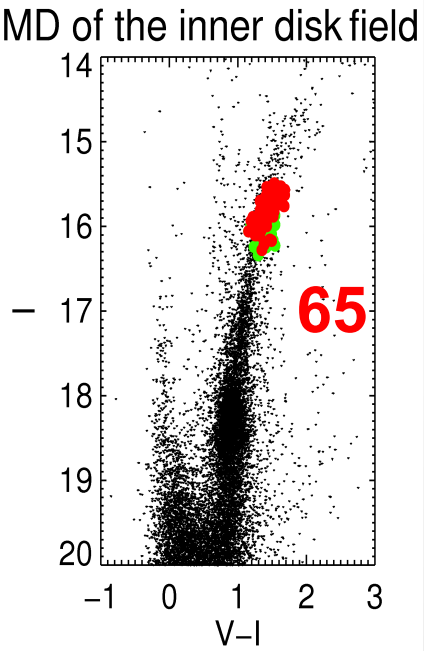
Abundances: HR with FLAMES/GIRAFFE
3 settings > ~700A coverage
several elements

Analysis:

Reddening: Zaritsky's maps
T_{eff}: photometric (VIJHK)
log *g* : isochrones fitting
V_t + metallicity: spectr.



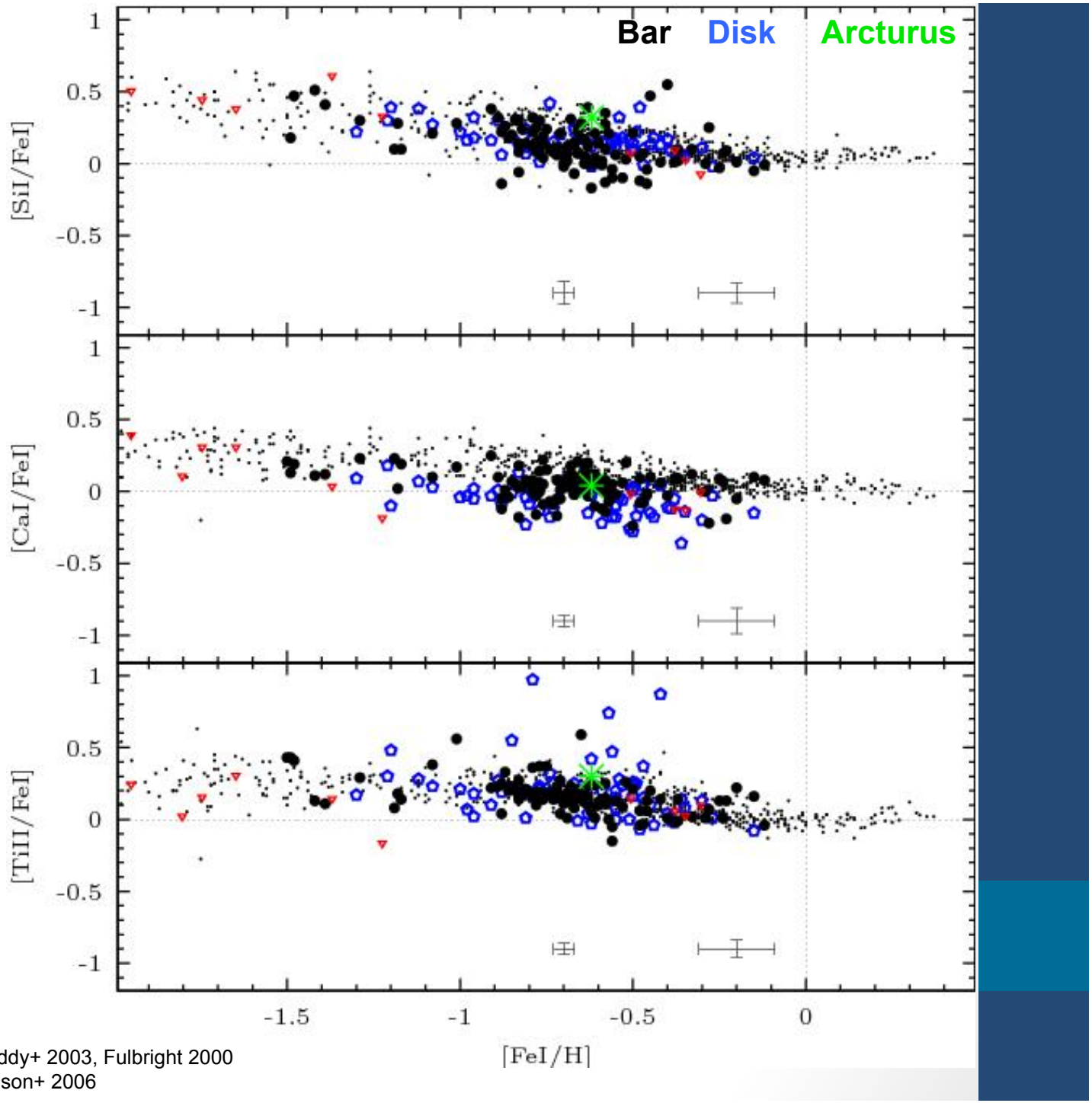




Si, Ca, Ti

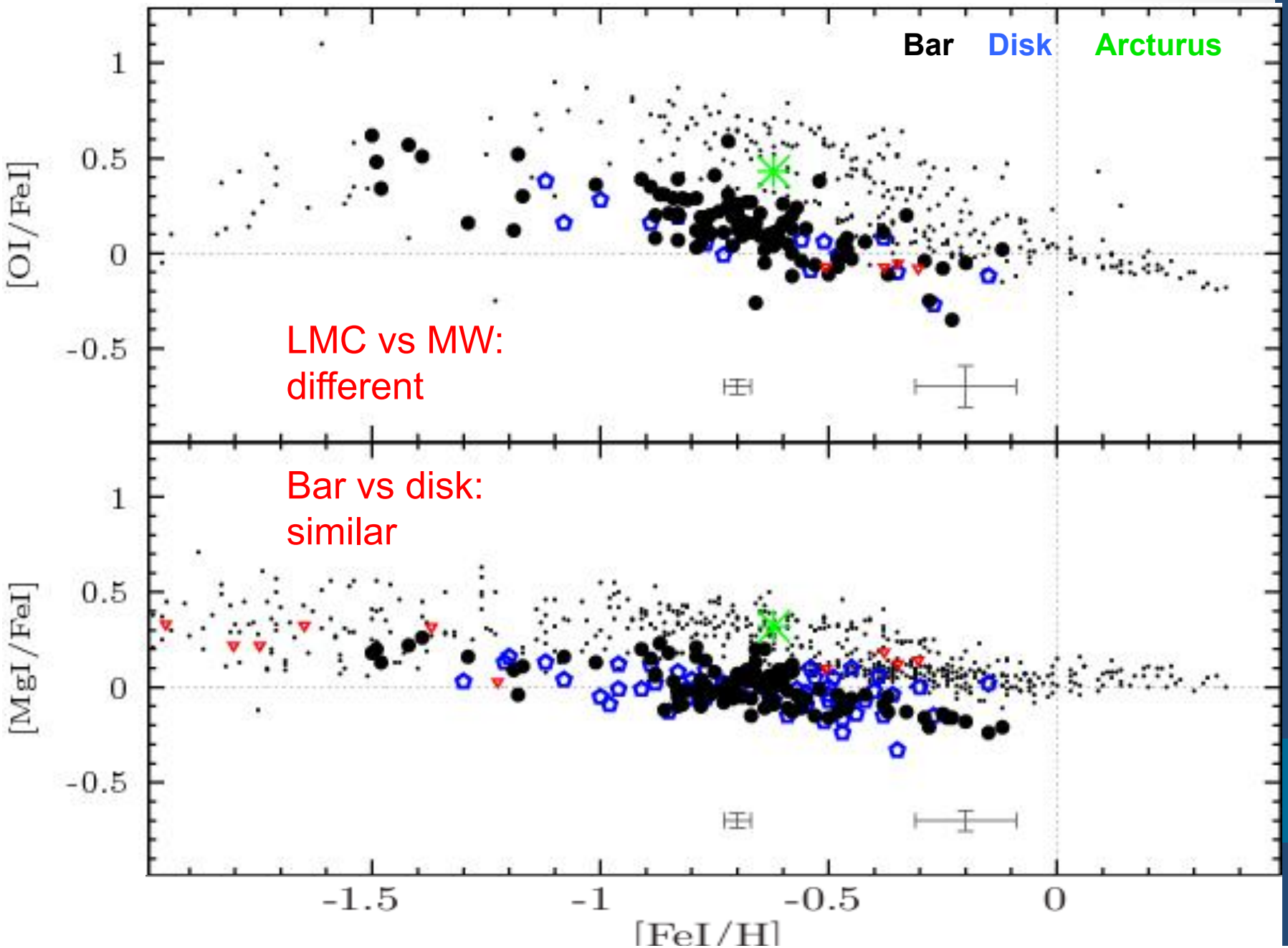
LMC vs MW:
similar

Bar vs disk:
similar [Ca]

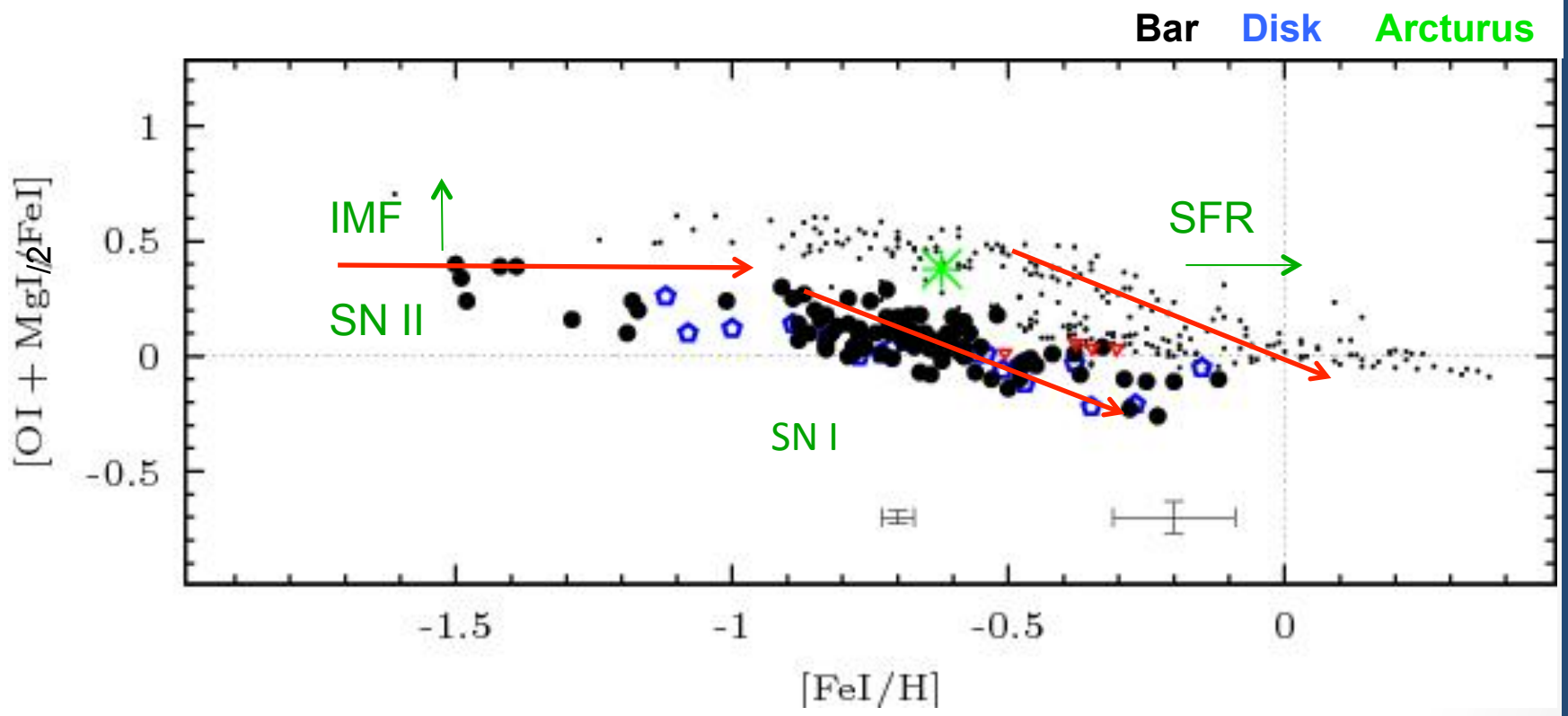


MW: Bensby+ 2003, Bensby+ 2005, Reddy+ 2003, Fulbright 2000
LMC GC: Mucciarelli+ 2008, 2010; Johnson+ 2006

O and Mg


Bar
Disk
Arcturus
LMC vs MW:
different
Bar vs disk:
similar
[OI/FeI]
[MgI/FeI]
[FeI/H]
1
0.5
0
-0.5
-1.5
-1
-0.5
0

LMC vs MW: the alphas



Different chemical enrichment
Slower SFH

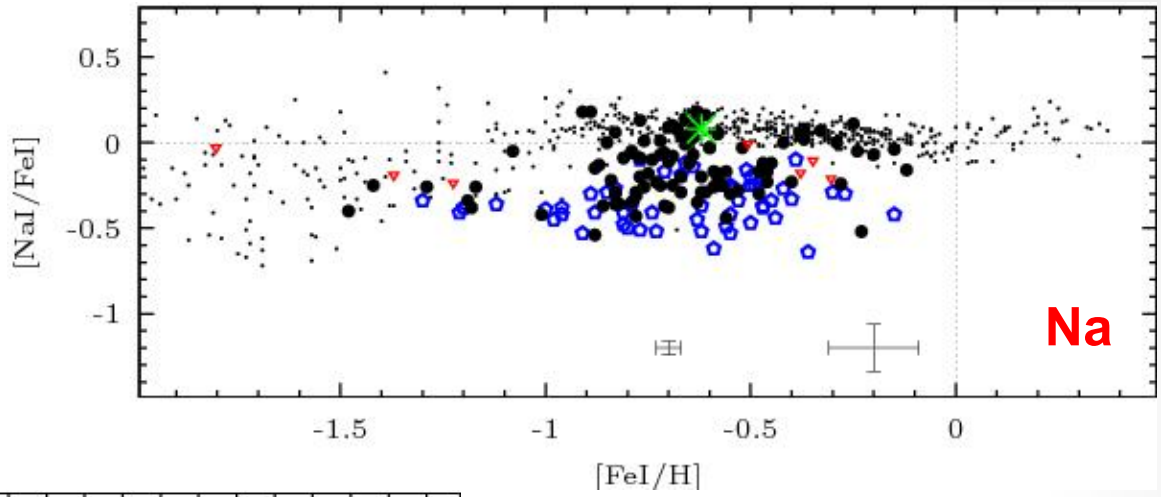
Larger dispersion in the bar

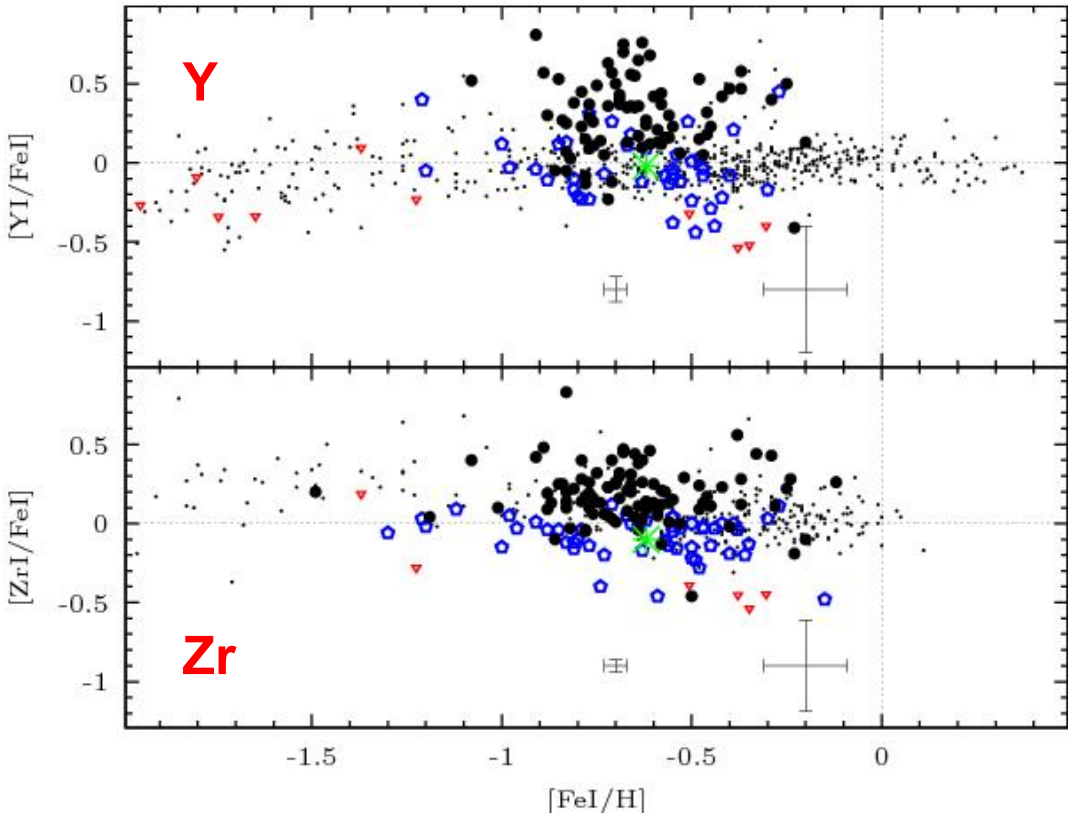
Bar vs disk: there is more

Bar Disk Arcturus

Similar for some elements, but:

Increased scatter (α)
Offset (Na, V, Y, Zr)





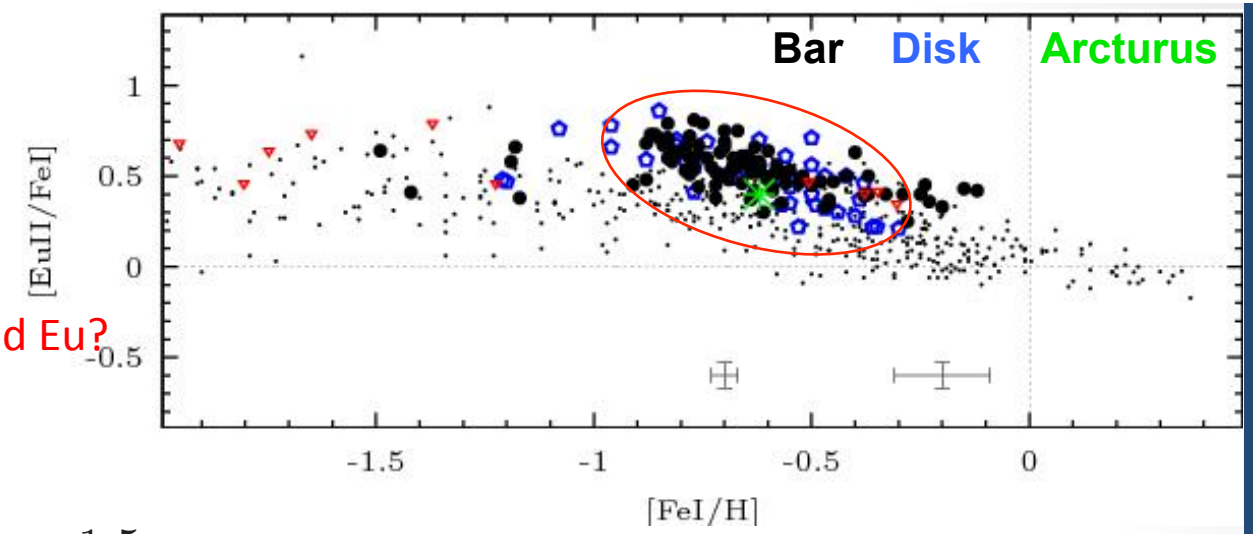
Scatter
-0.8 < [Fe/H] < -0.4
2-6 Gyrs ago

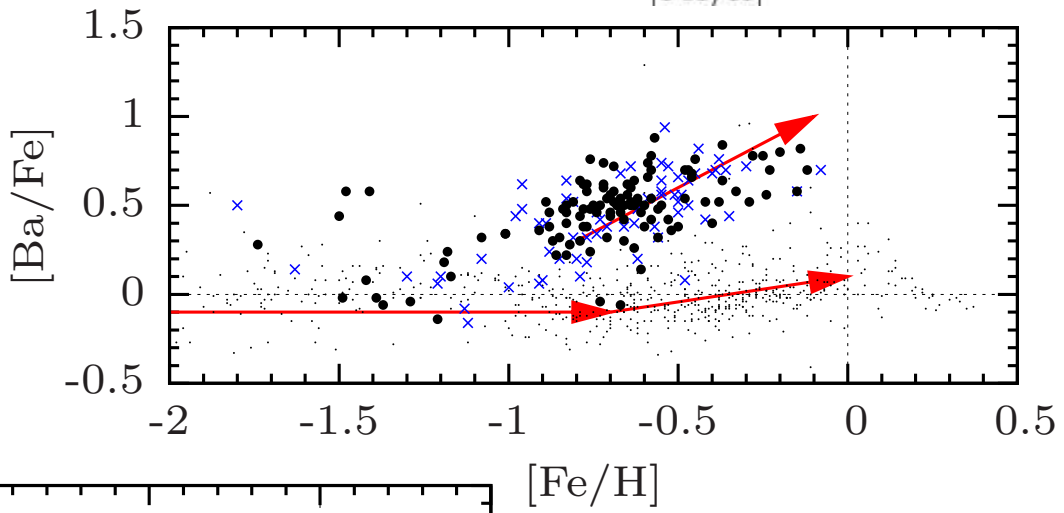
Offsets
Na, Y, Zr: AGB products

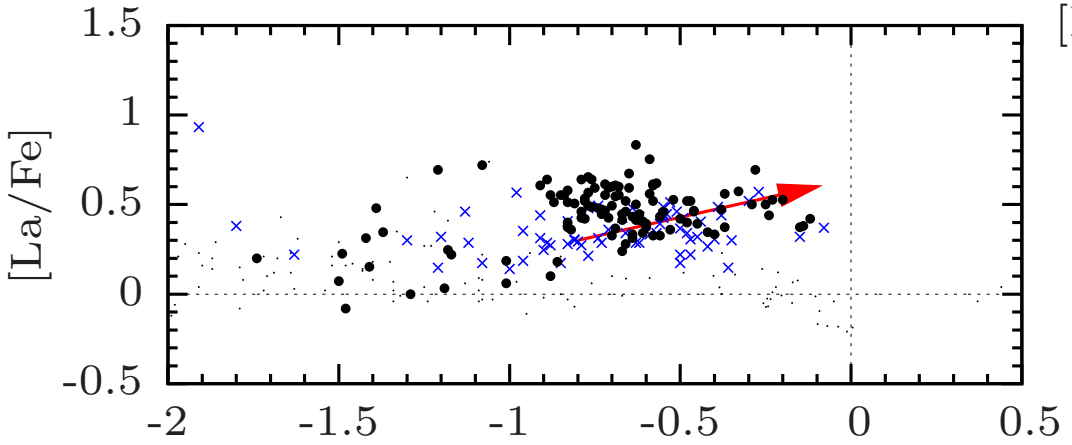
Burst-born bar

Ba, La and Eu

Recent star bursts?
Other source of r-processed Eu?
More s-processed Eu?

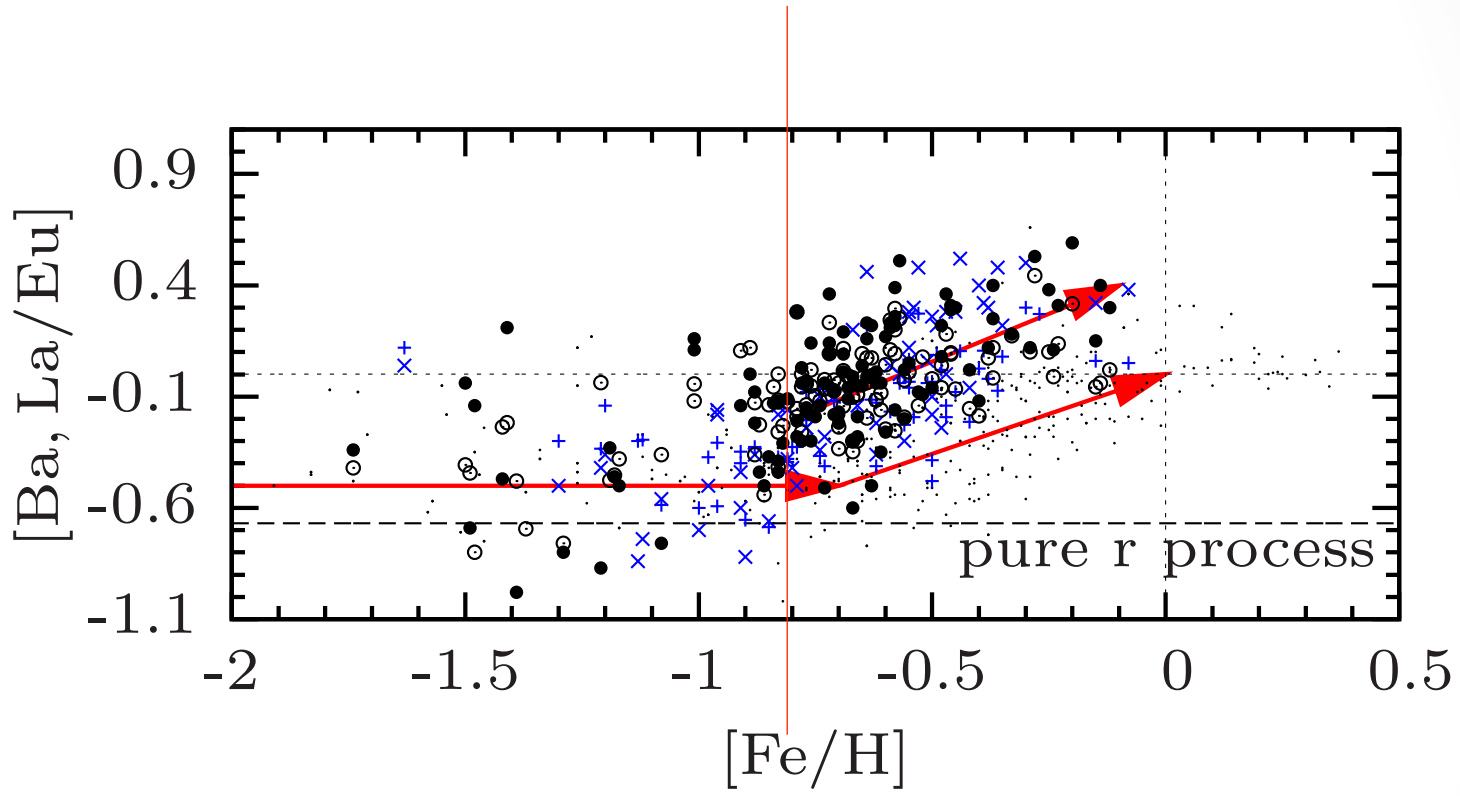




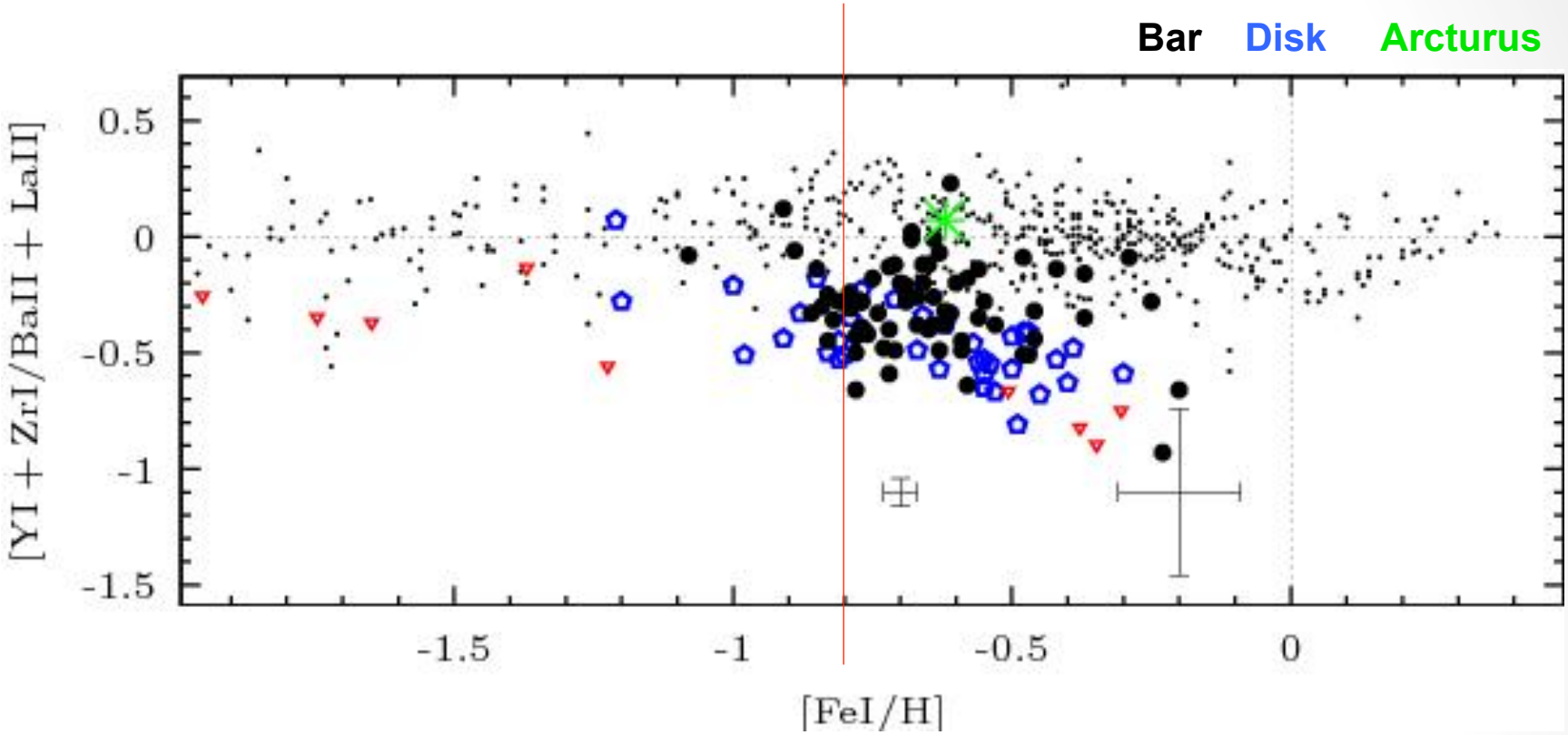


Bar = Disk
LMC > MW

Ba, La and Eu



LMC vs MW



s-process

[ls/hs]

Metal-poor vs metal-rich AGB

MW: Bensby+ 2003, Bensby+ 2005, Reddy+ 2003, Fulbright 2000

2. Globular Clusters: the ideal lab

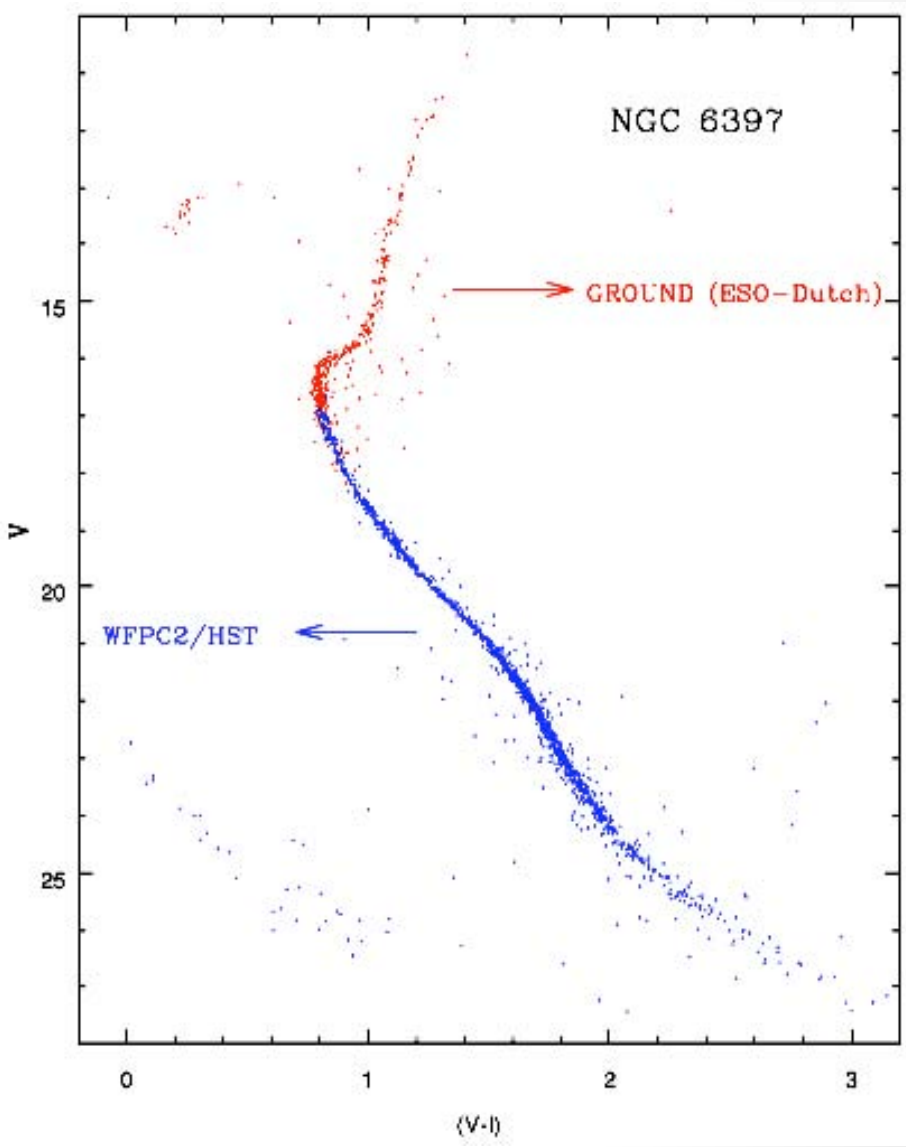
80s

Simple Stellar Population

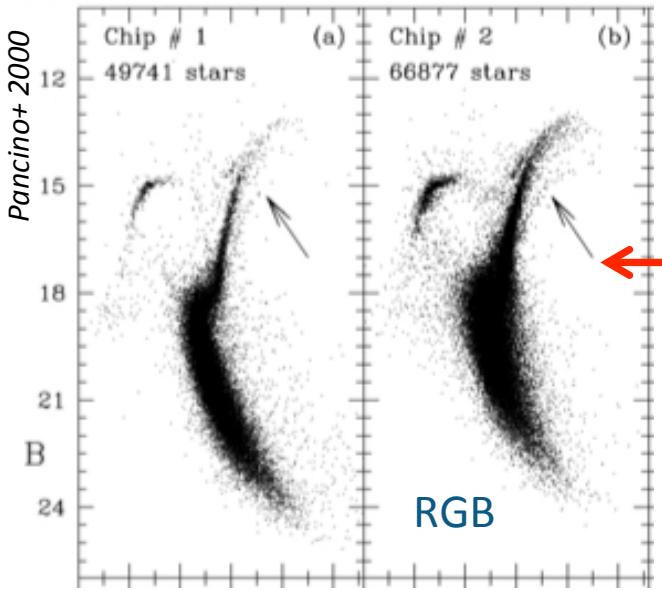
Coeval

Same metallicity

Simple



The ideal lab !?^!?#^!?



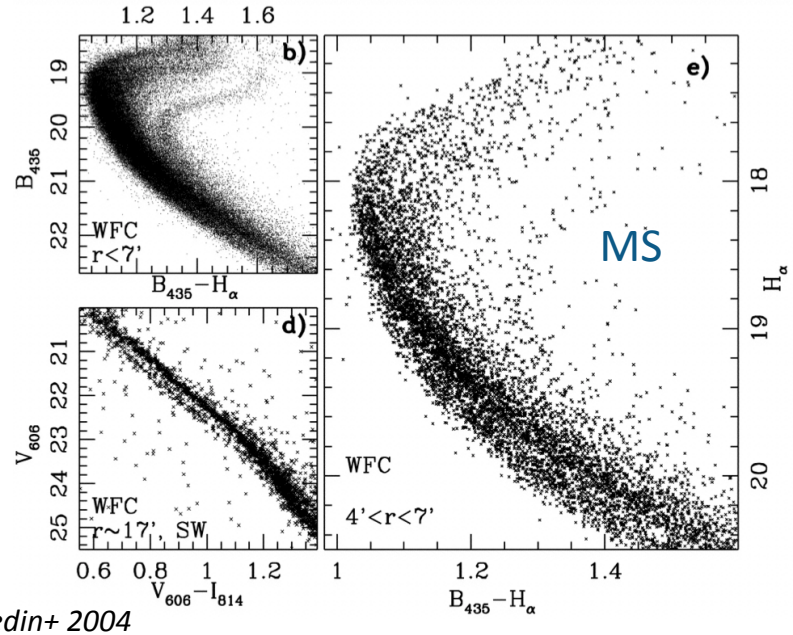
Pancino+ 2000

photometric

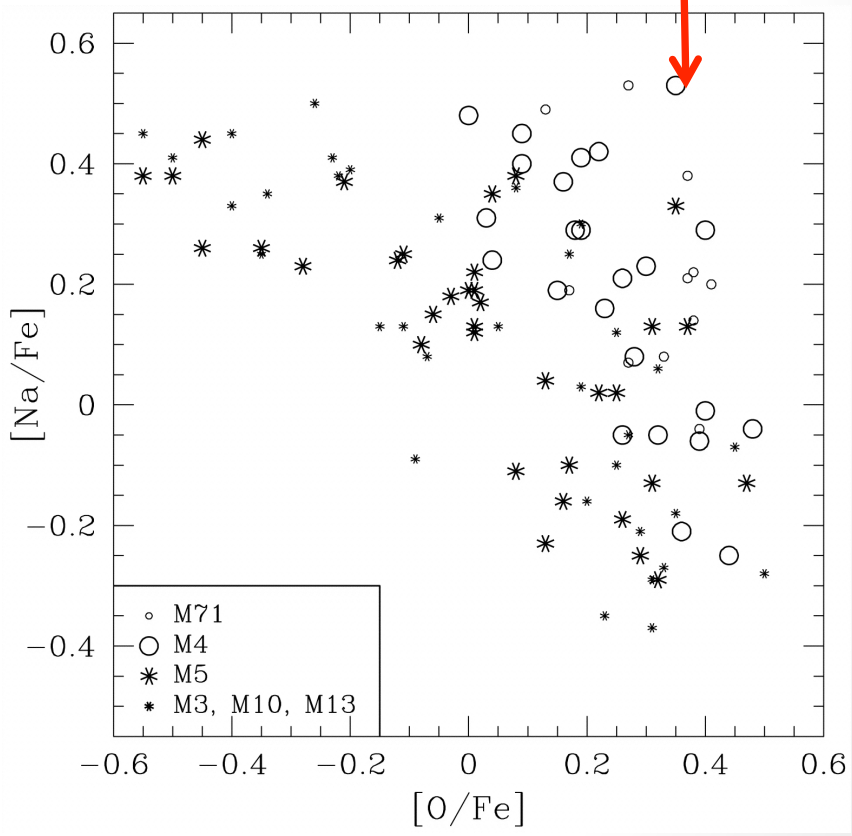
They are **not** SSPs

Revolutions

spectroscopic

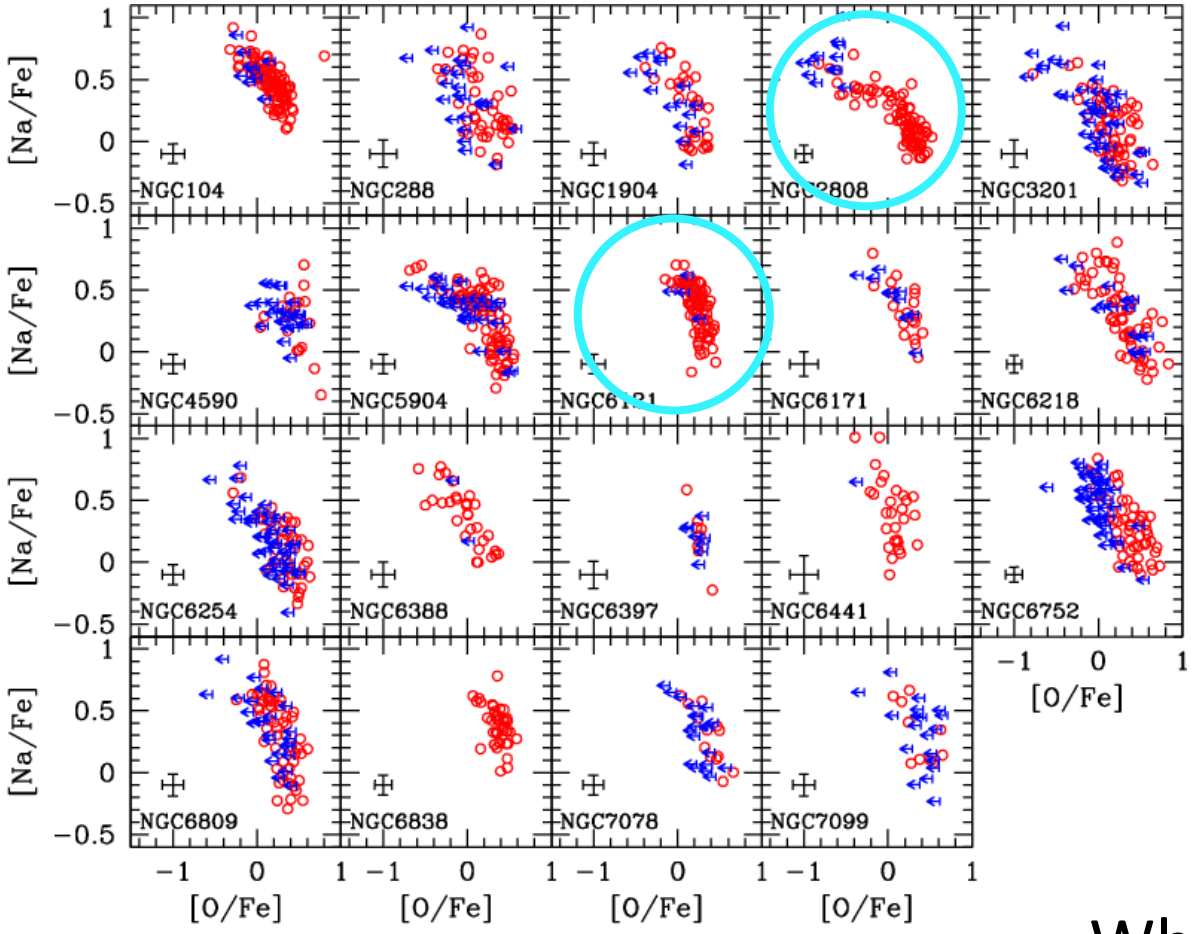


Bedin+ 2004



Ivans+ 2001

Everywhere? Chemically yes …



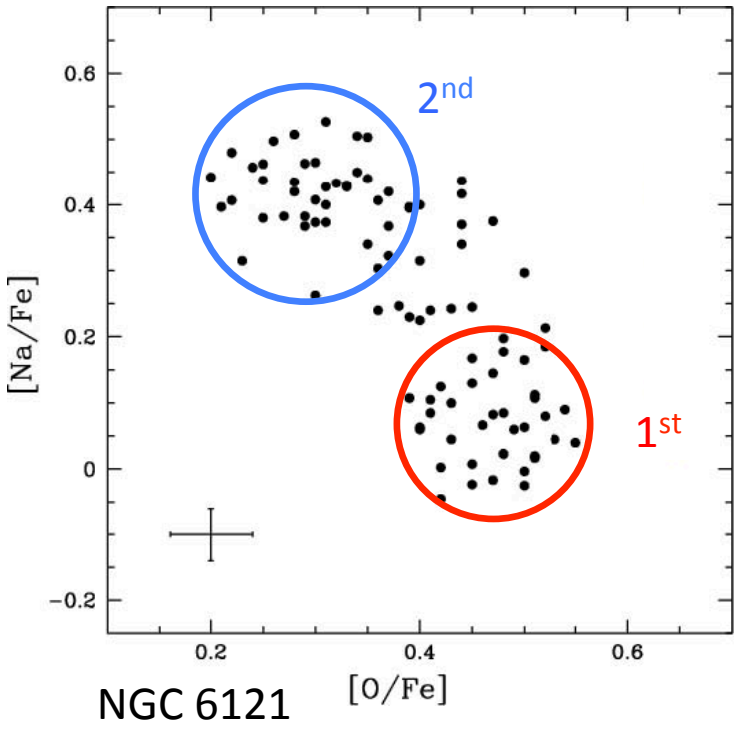
different shapes

What is then a GC?

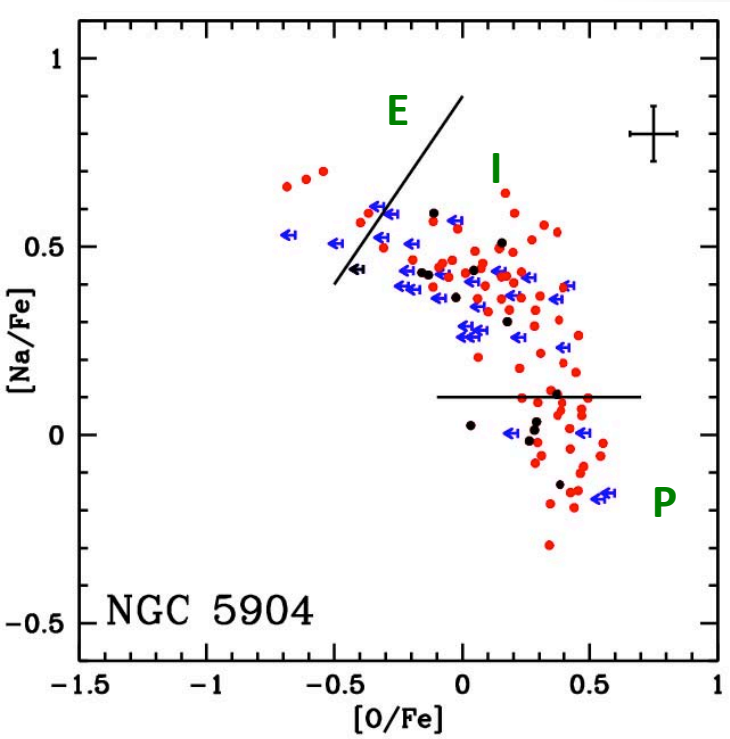
A *bona fide* GC is a stellar aggregate showing the Na-O anti-correlation

[Carretta]

At least 2 stellar generations …



NGC 6121



Not seen in the field (1.4%)

1st generation stars: Na,O abundances ≈ halo stars at similar [Fe/H]
2nd generation stars: Na overabundant, O deficient

Marino+ 2008; Carretta+ 2010

Chasing the polluters

- FRMS (fast-rotating massive stars)
- AGB

++ massive binary stars
++ FRMS+AGB or FRMS+massive binaries

Key parameter for second star formation
Constrains initial GC mass

33% (from 1500 red giants in 15 GCs)

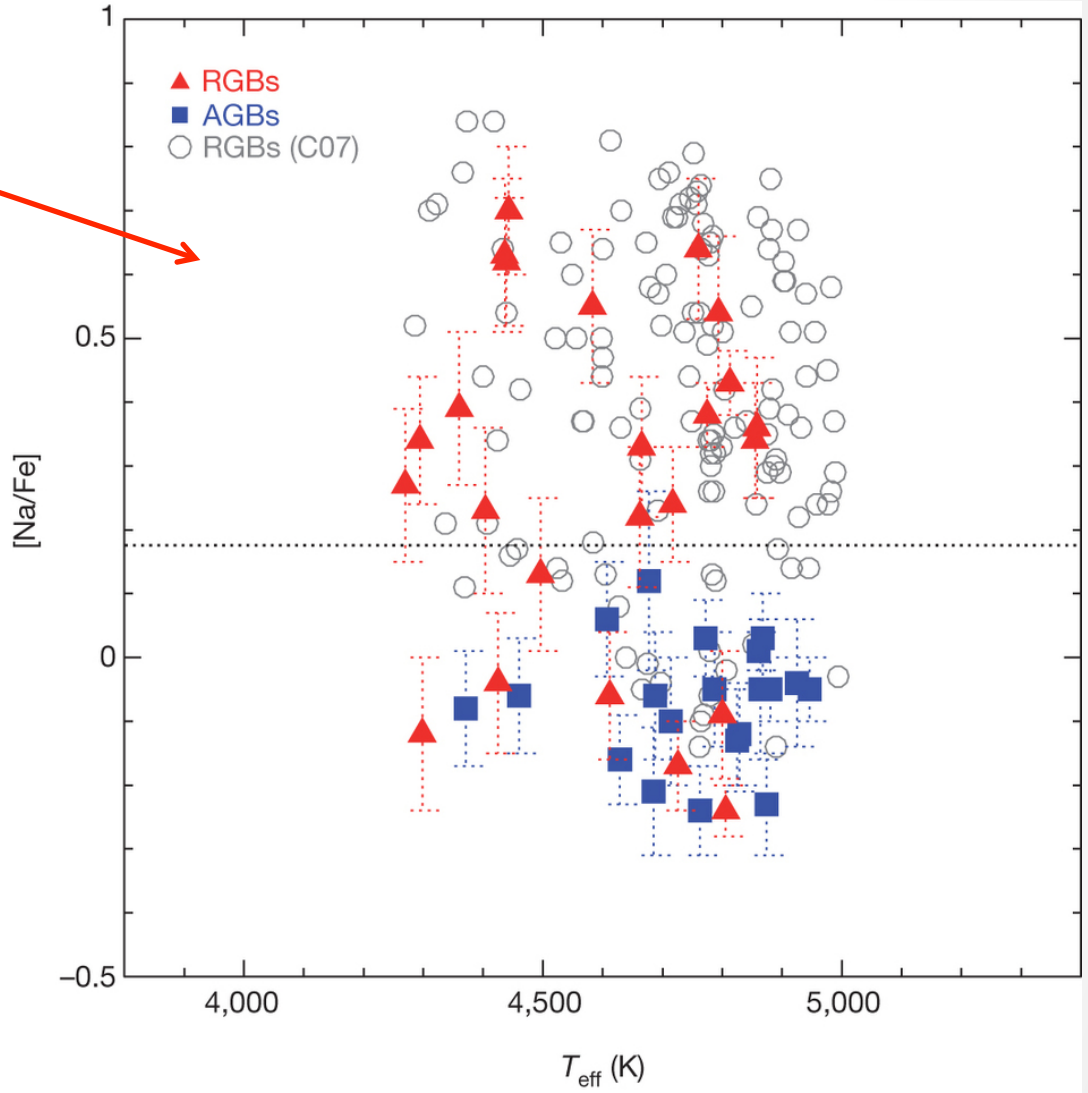
95% 1G stars ejected from GCs which M_{init} > 8-25M_{today}

Mass-budget problem : fast gas expulsion

What we are up to …

NGC 6752

Is this really a problem for stellar evolution?



30h @ FLAMES

4 GCs, ≠ metallicities

~100 stars / GC

Mainly AGB+RGB, some HB

Na–O pattern in AGBs

Y. Wang – PhD student
FP, Charbonnel, Prantzos, Chantereau

Campbell+ 2013

Progress status

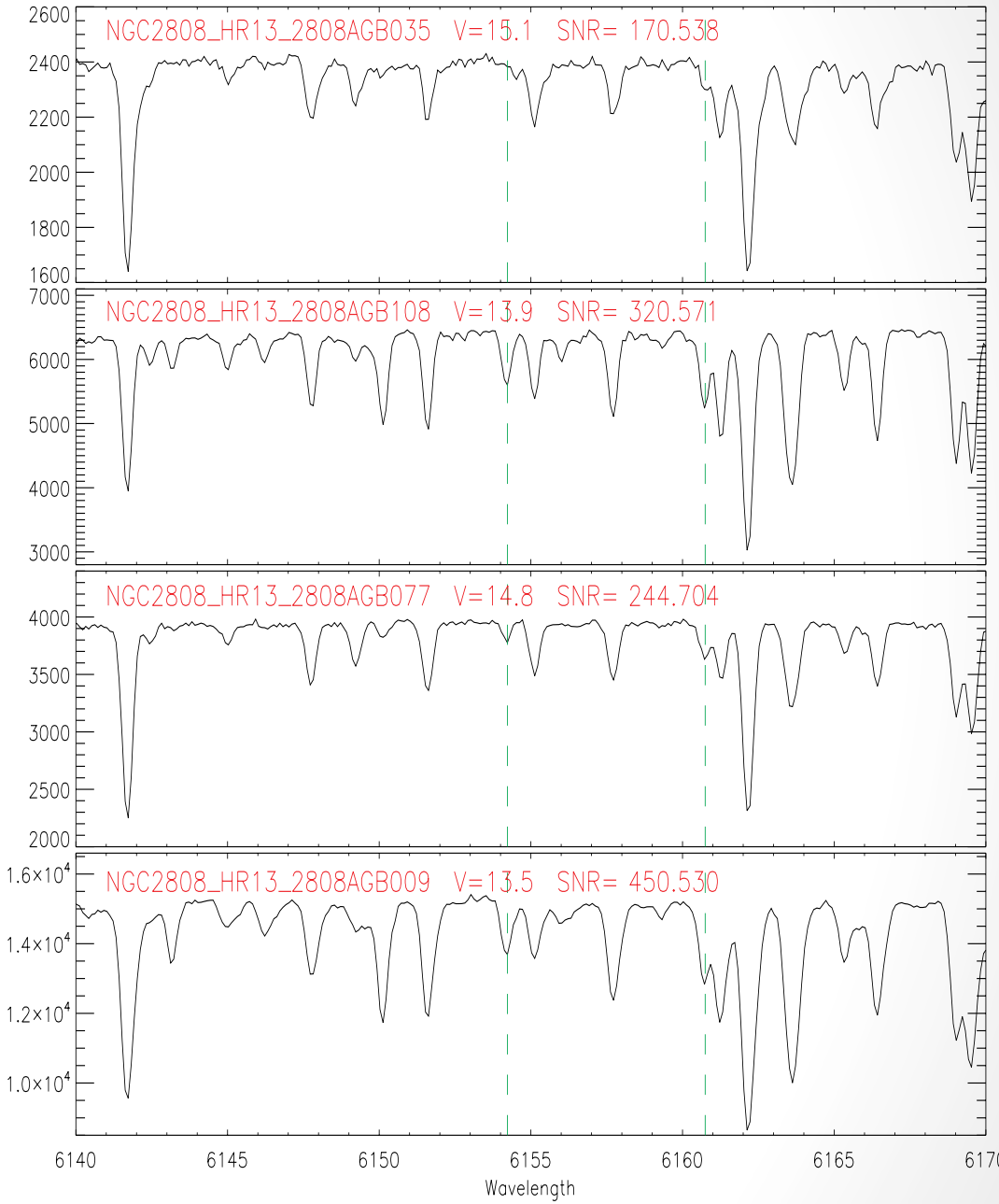
Observations: completed

Data reduction: on-going

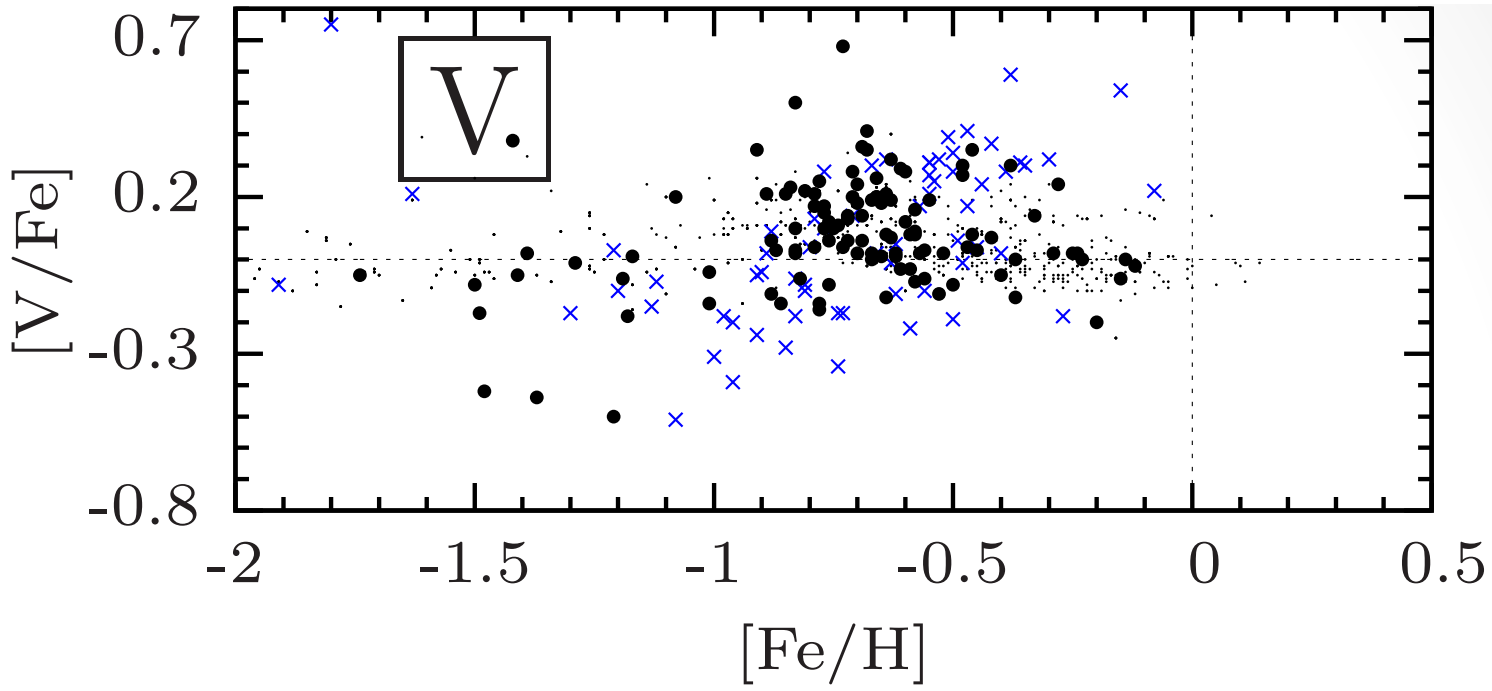
3 set-ups
~1000Å

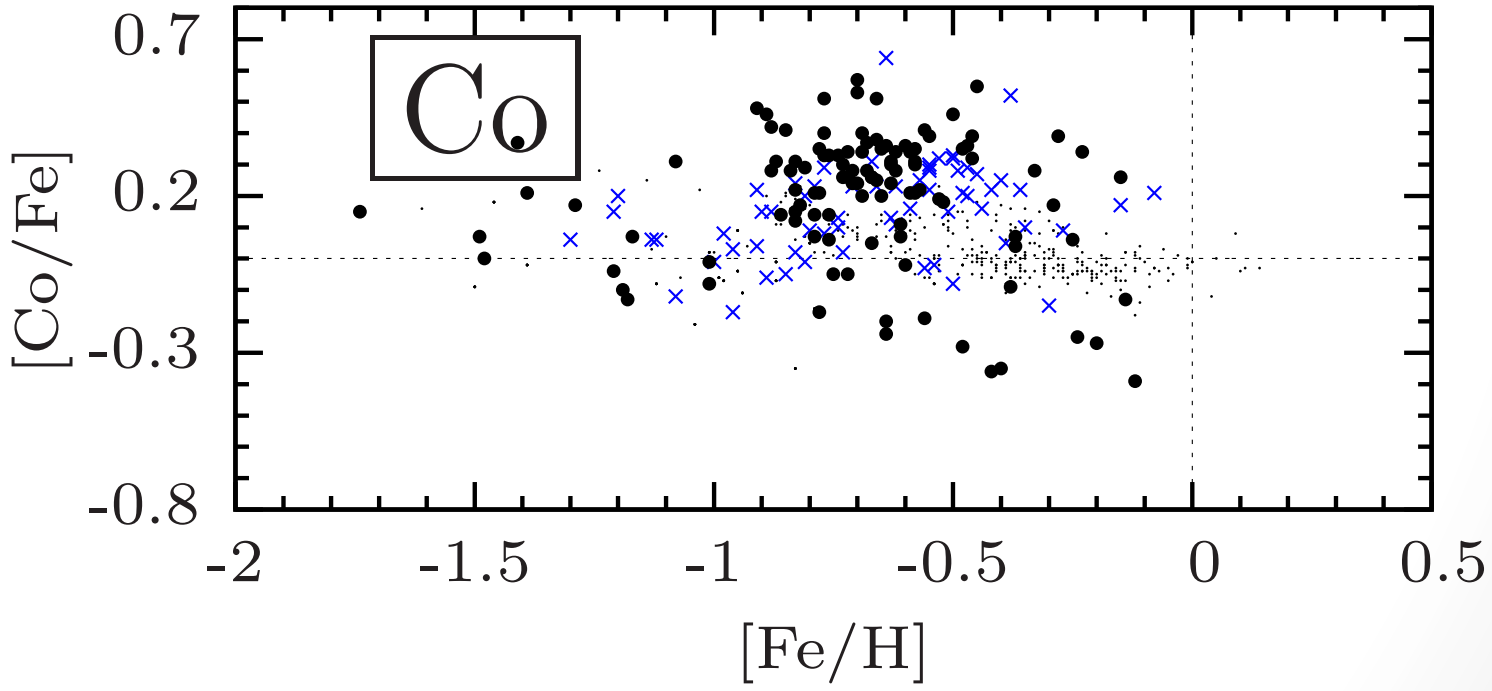
Stellar parameters/analysis:
some preliminary tests

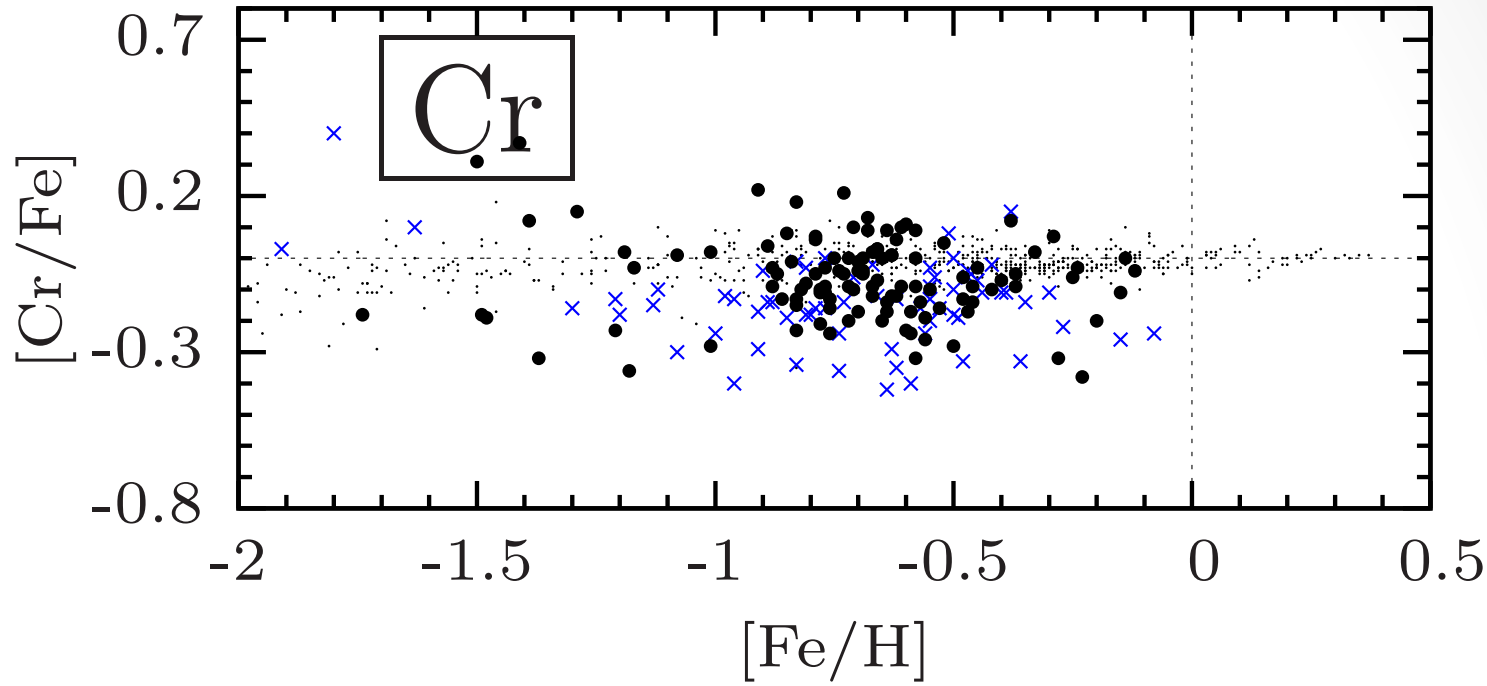
Stay tuned!

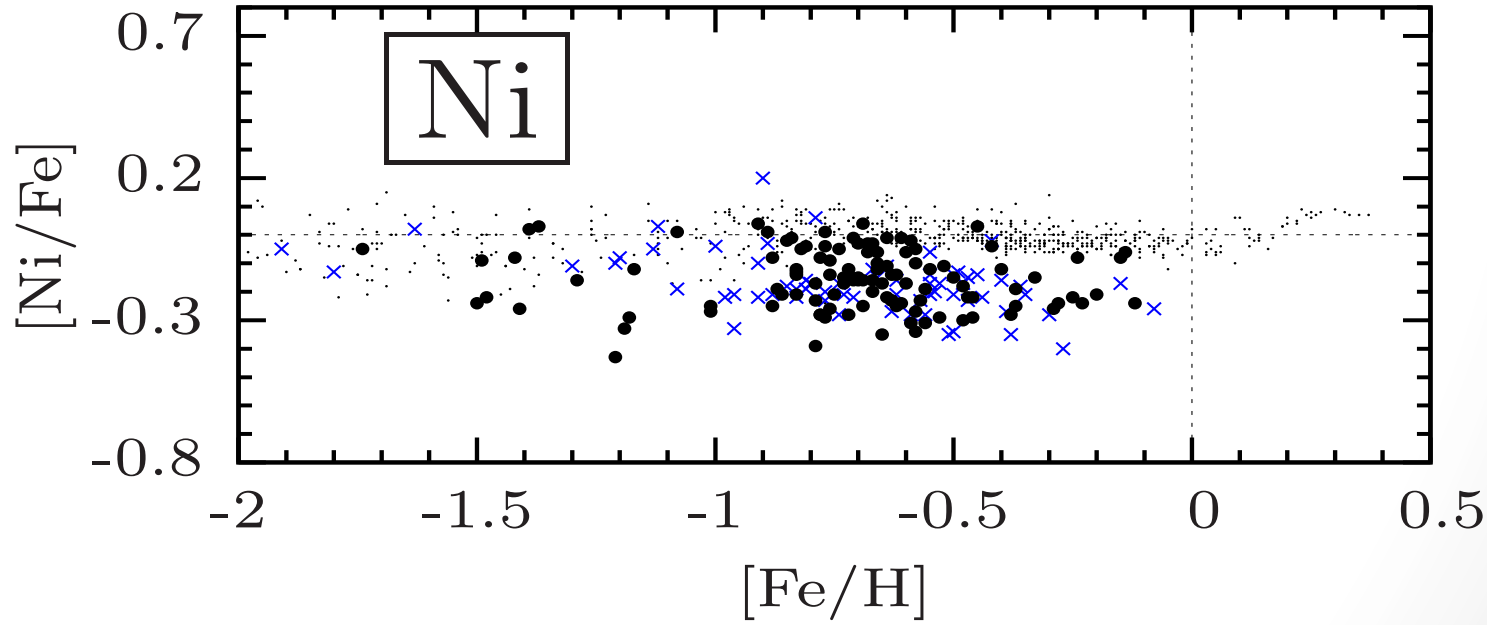


Thank You.


V
0.7
0.2
-0.3
-0.8
[V/Fe]
-2
-1.5
-1
-0.5
0
0.5
[Fe/H]


Co
0.7
0.2
-0.3
-0.8
[Co/Fe]
-2
-1.5
-1
-0.5
0
0.5
[Fe/H]


Cr
[Cr/Fe]
0.7
0.2
-0.3
-0.8
-2
-1.5
-1
-0.5
0
0.5
[Fe/H]


Ni
[Ni/Fe]
0.7
0.2
-0.3
-0.8
-2
-1.5
-1
-0.5
0
0.5
[Fe/H]