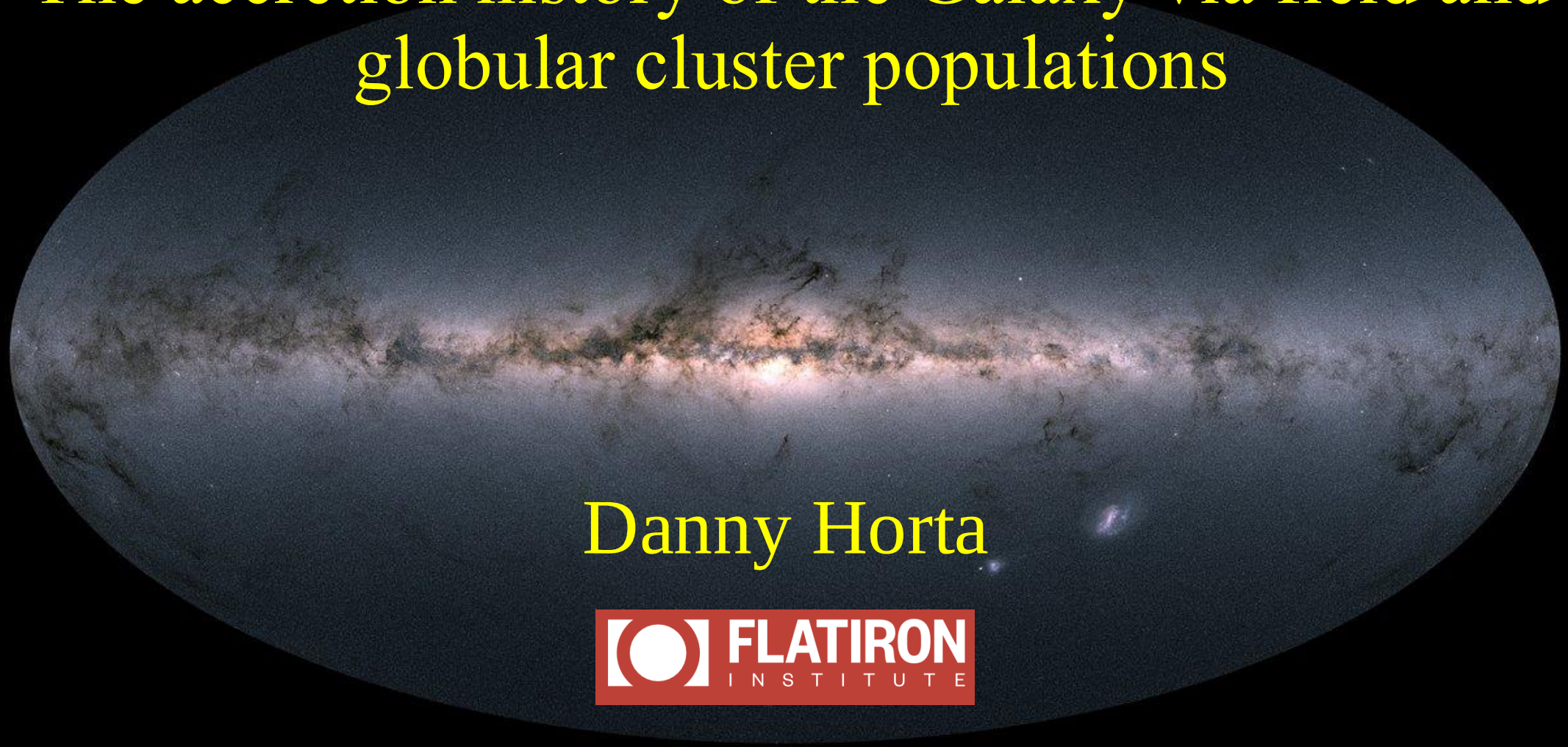
The accretion history of the Galaxy via field and globular cluster populations



Danny Horta

FLATIRON INSTITUTE

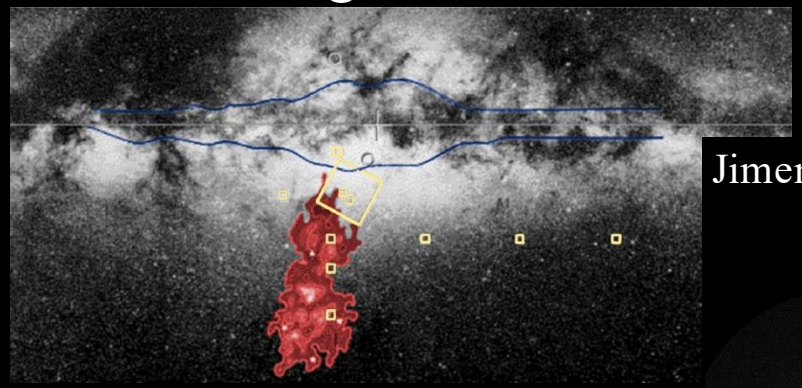
Stellar populations in the Milky Way and beyond
18/11/24

The MW is flocked with debris

Gaia-Enceladus/Sausage

Helmi+18, Belokurov+18,
Haywoood+18, Mackereth+19

Sagittarius



Ibata+94

LMC/SMC

Jimenez-Arranz+22

Heracles

Horta+21

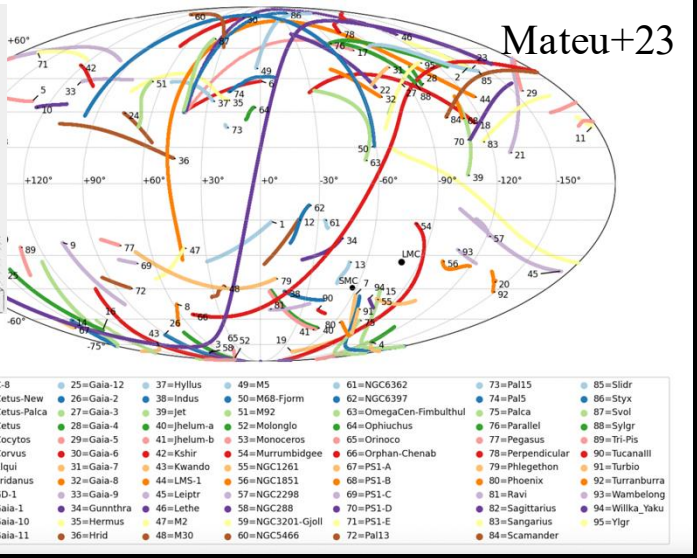
Helmi stream

Sestito+24

Helmi+99

Naidu+20

Stellar streams



Mateu+23

Many smaller stellar streams:
Cetus, LMS-1, GD-1, Pal5, OCS, ATLAS, AliqaUma, Indus, Jhelum, Phoenix, ED-1 ++

Sequoia (GCs)

Myeong+19
Barbá+19

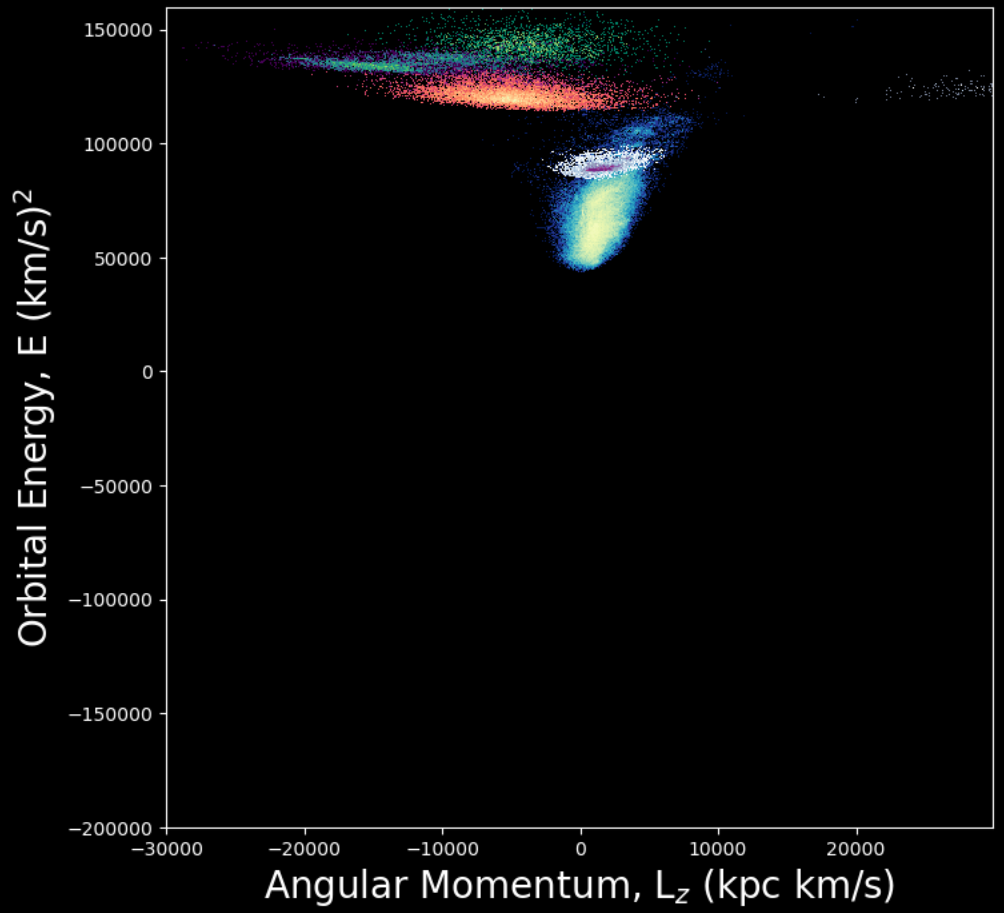
Thamnos

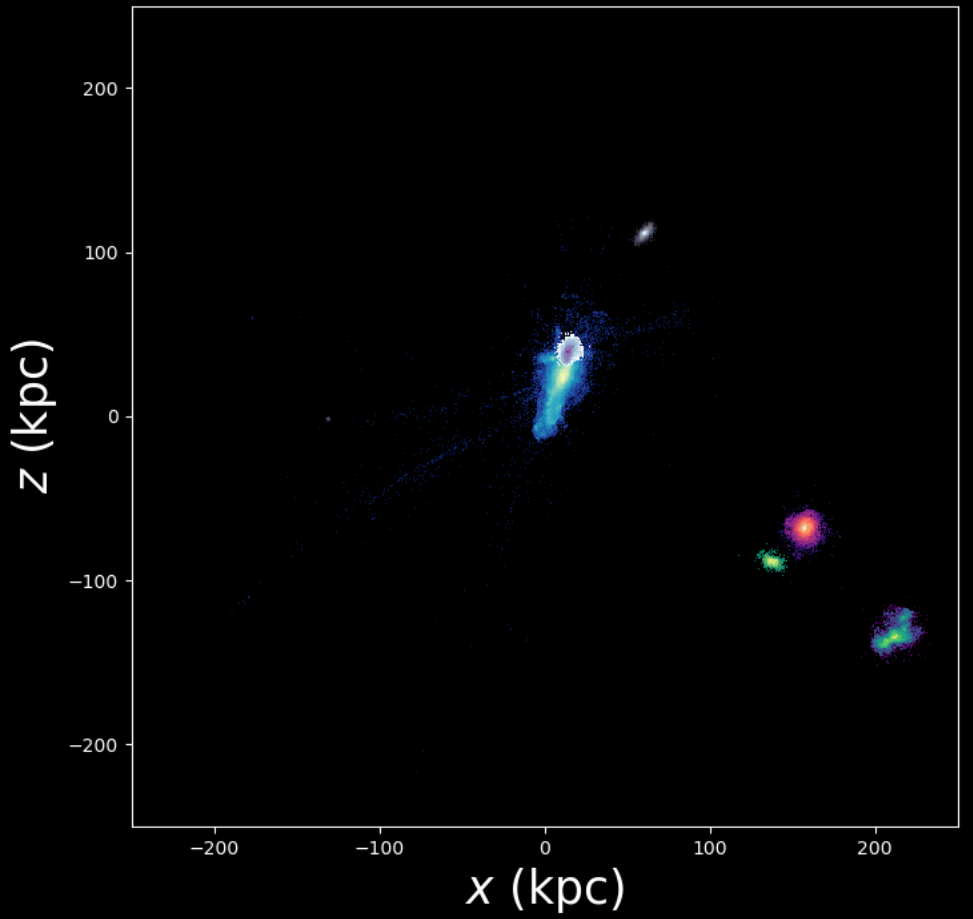
Koppelman+20

Arjuna I'itoi Aleph

Finding structures in kinematic/dynamic samples

- Accreted samples can overlap with *in situ* and other accreted populations
- Single debris can leave multiple clumps





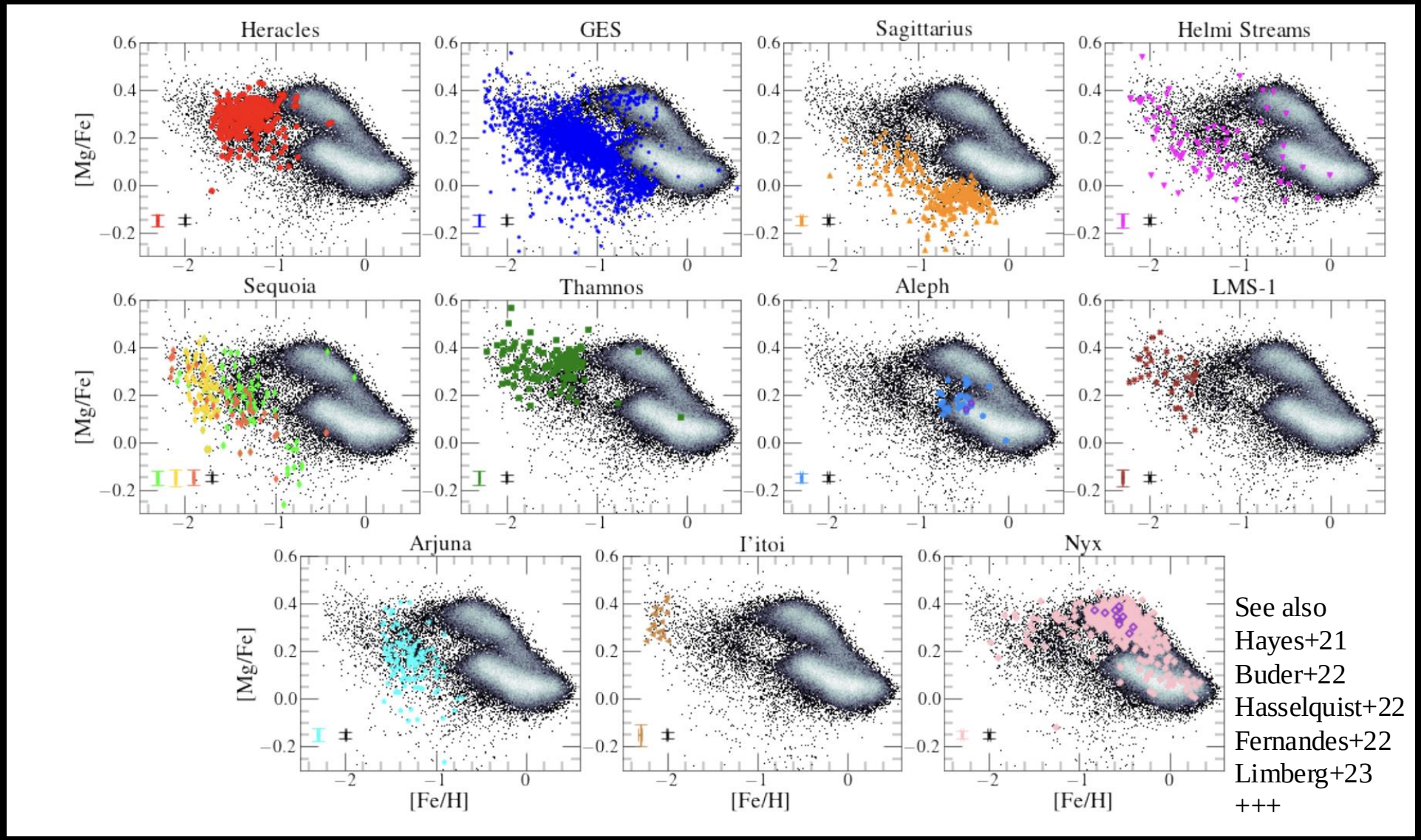
Spectral line information enables chemical tagging

"With sufficiently detailed spectral line information, it is feasible that the 'chemical tagging' will allow temporal sequencing of a large fraction of stars in a manner analogous to building a family tree through DNA sequencing."

- Ken Freeman & Joss Bland-Hawthorn

Chemical abundances help reveal nature of halo substructures

α-to-iron



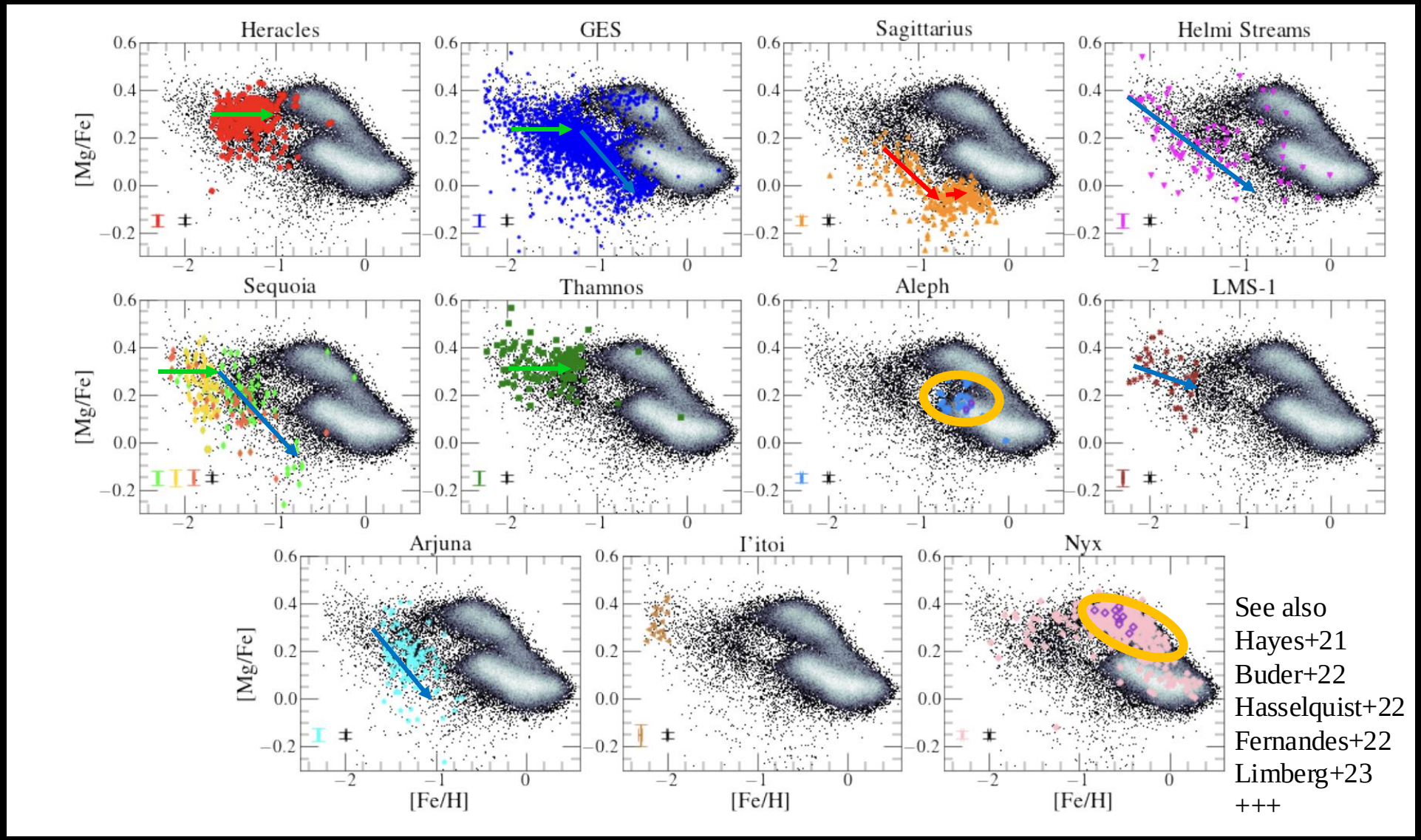
Horta+23

See also
Hayes+21
Buder+22
Hasselquist+22
Fernandes+22
Limberg+23
+++

Iron-to-hydrogen

Chemical abundances help reveal nature of halo substructures

α-to-iron



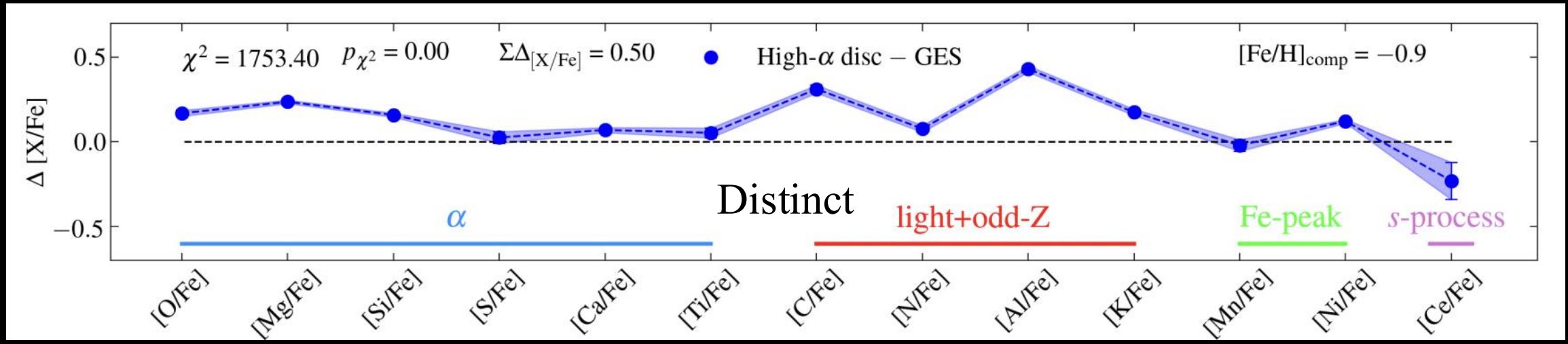
Horta+23

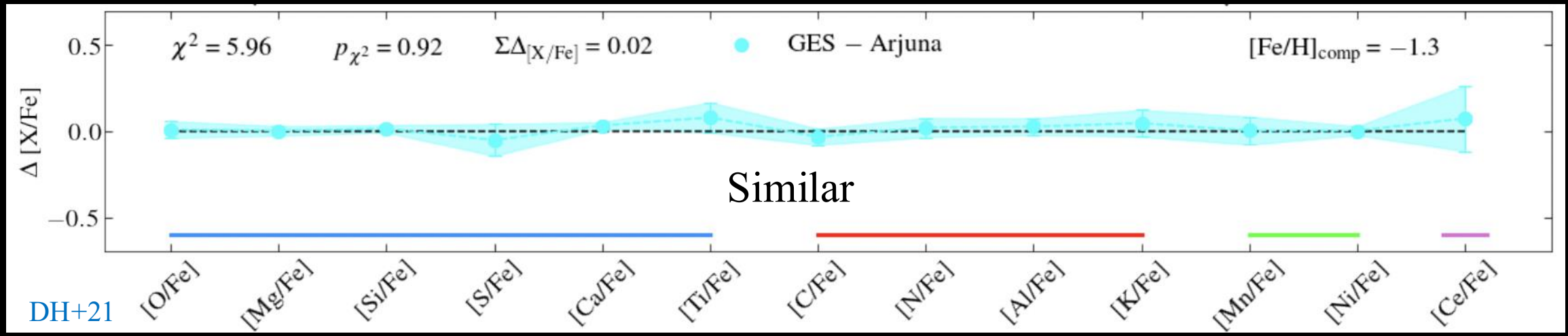
See also
Hayes+21
Buder+22
Hasselquist+22
Fernandes+22
Limberg+23
+++

Iron-to-hydrogen

Chemical abundances can help distinguish substructures

Horta+23

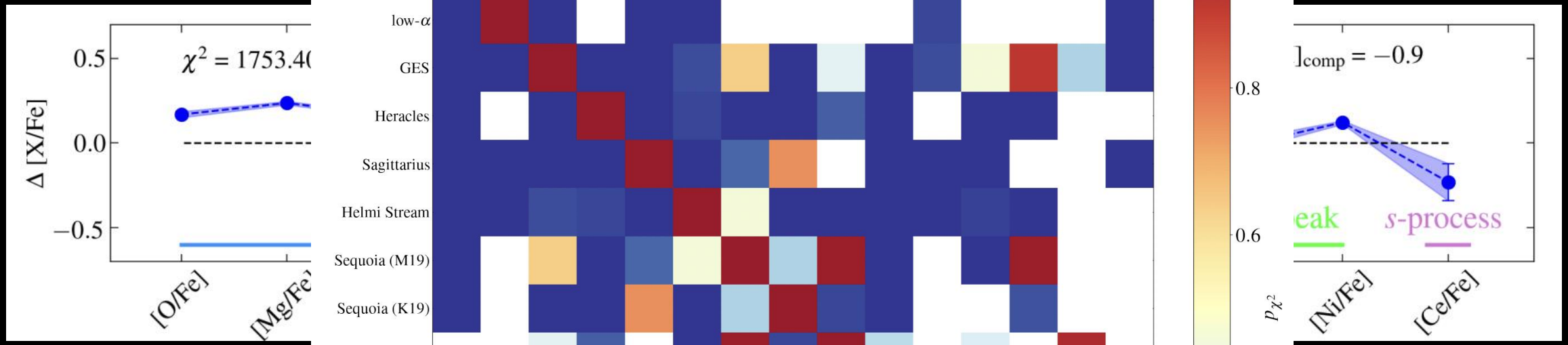


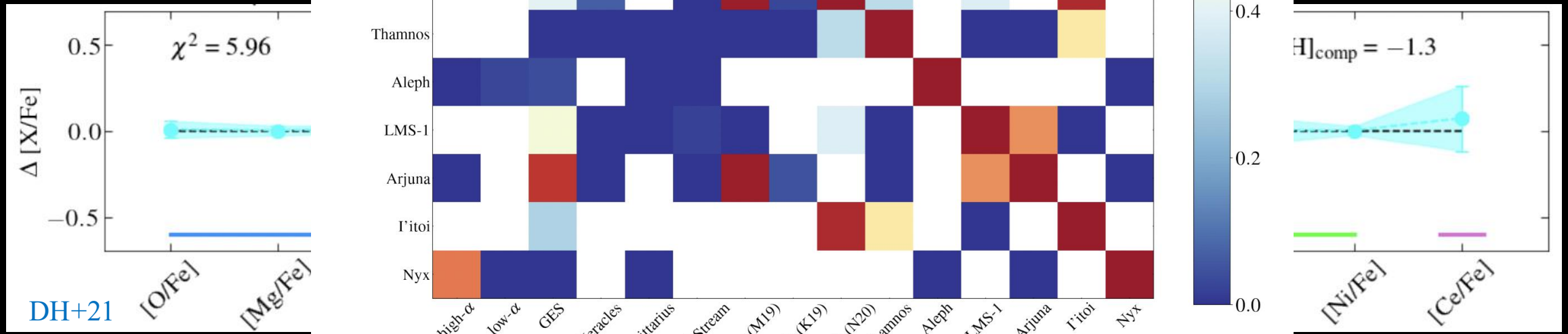


DH+21

Chemical abundances can help distinguish substructures

Horta+23





DH+21

The earliest stages of assembly of the MW

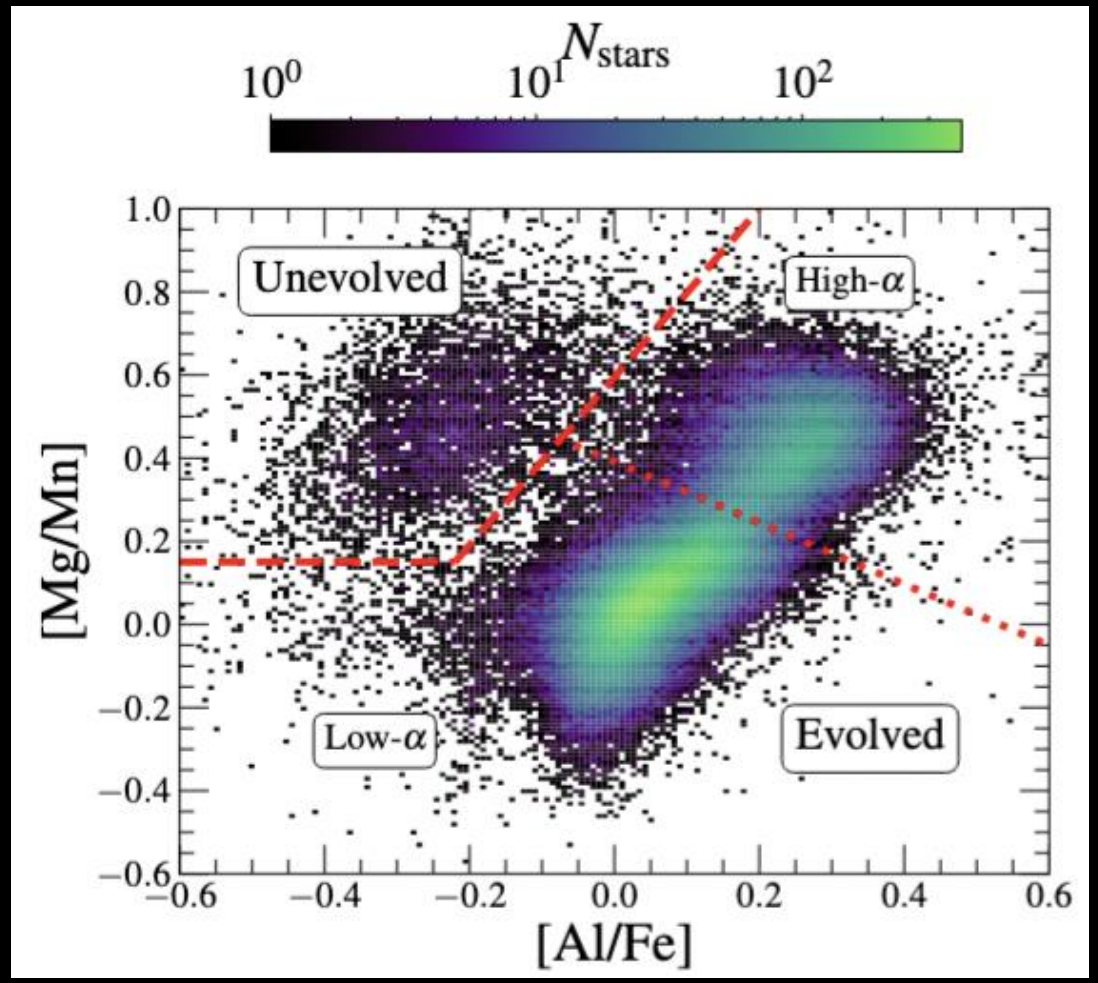
Evidence of the remnant of a major building block

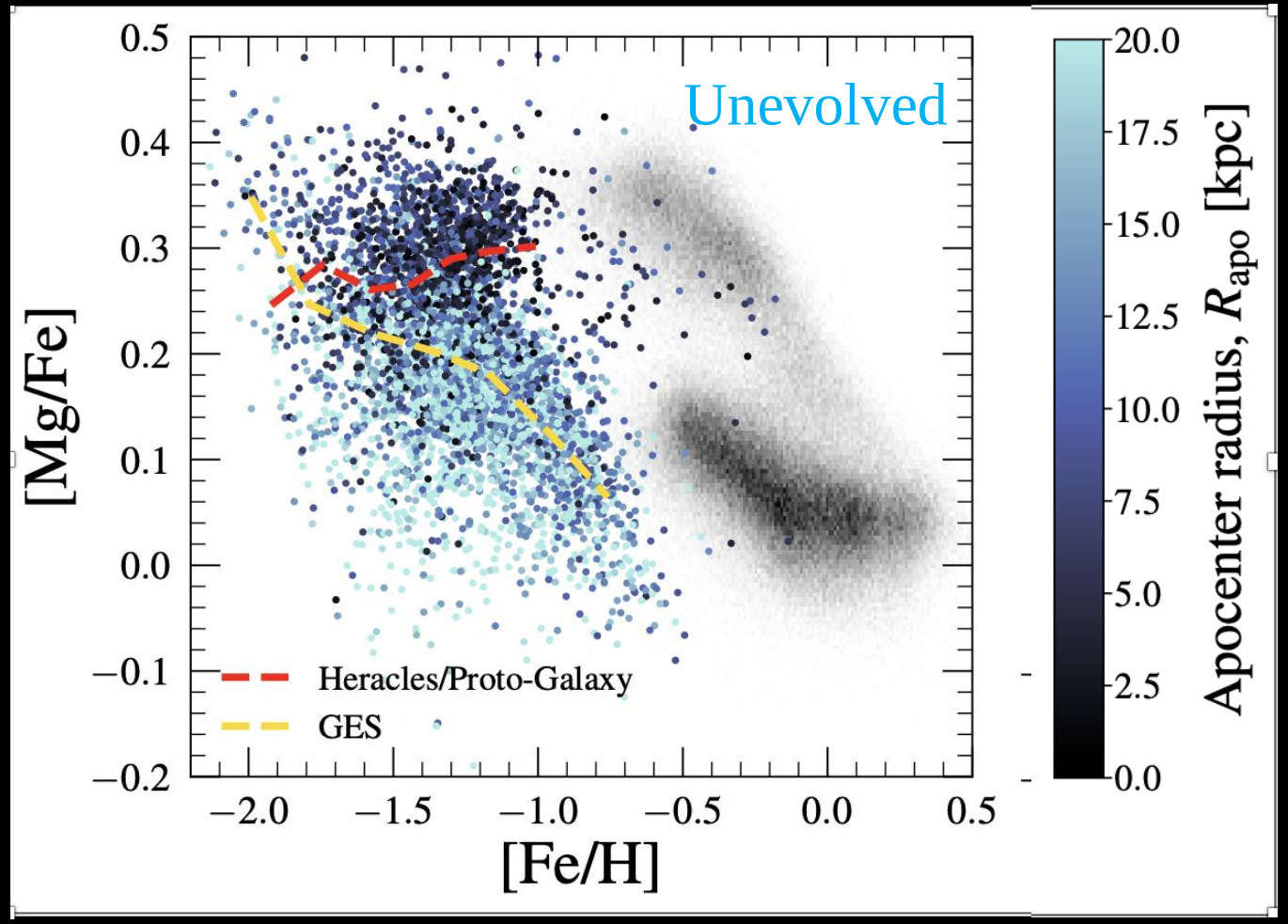
- likely major building block of MW
- qualitative agreement with simulations (i.e. El Badry+18, Fragkoudi+19, Orkney+23, Horta+23)
- only ~ 5% of the mass within 4-5 kpc

Horta+21

Chemically selecting Milky Way populations

Horta & Schiavon, submitted

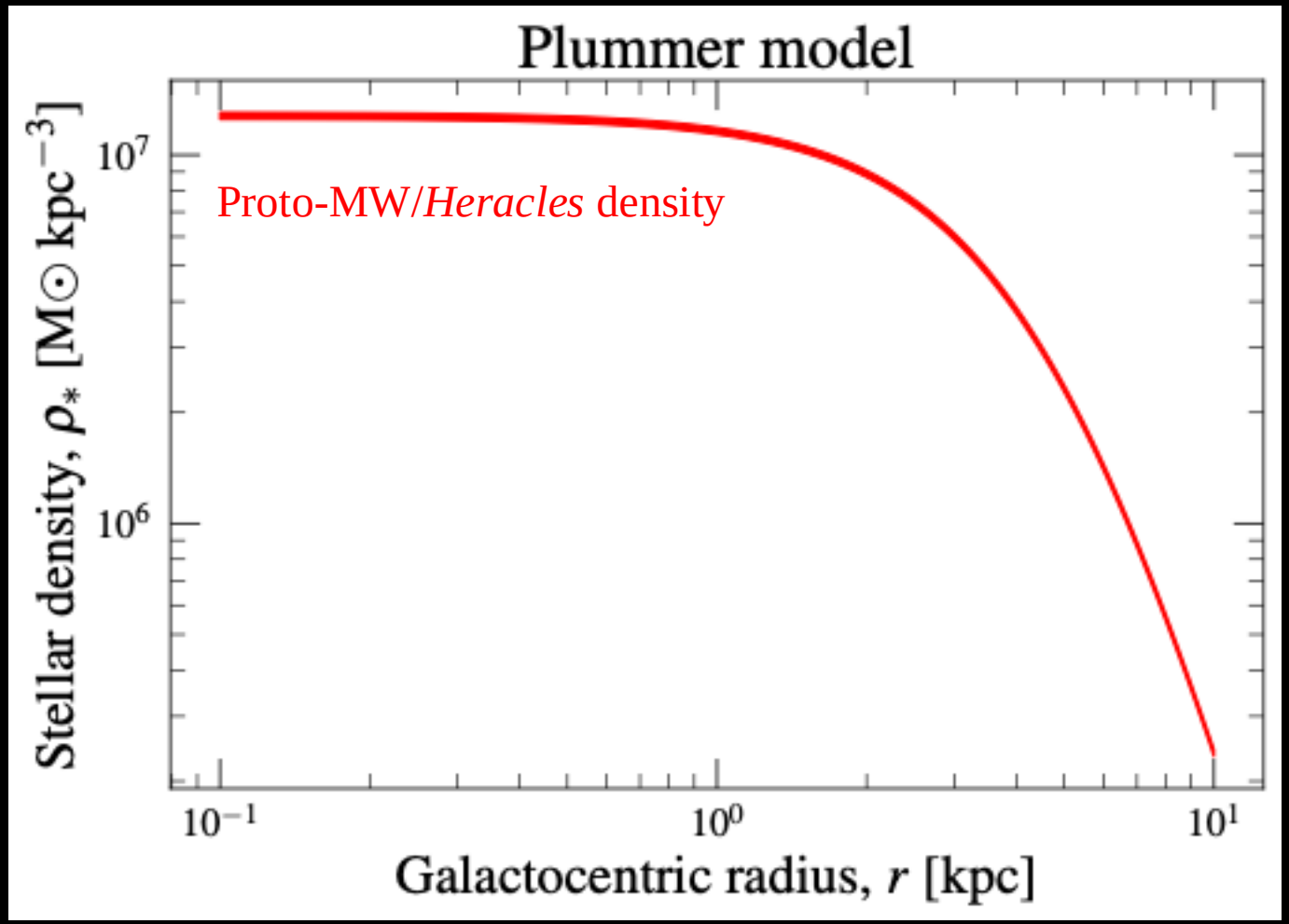




See also Hawkins +15, Das+20
Fernandes+23

Proto-MW/*Heracles* is tightly packed

Horta & Schiavon, submitted



Proto-MW/*Heracles* well described by oblate Plummer model

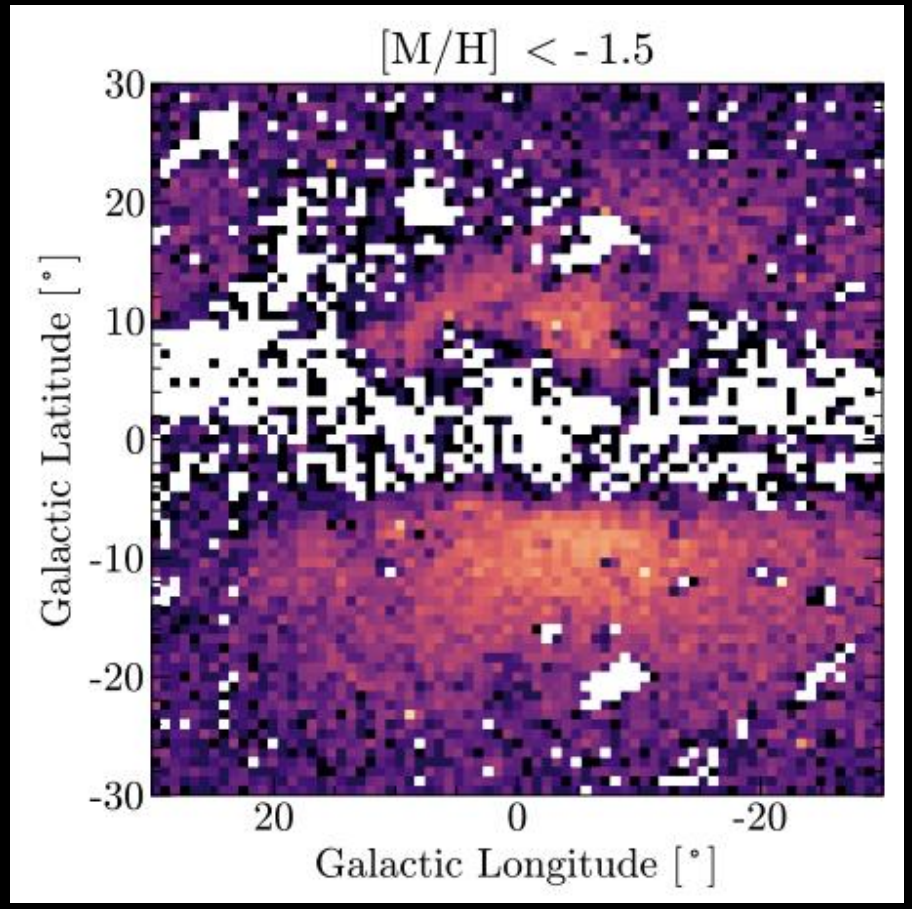
Proto-MW amounts to a mass of ~10^9 $M_\odot$ within r < 10 kpc, and *Heracles* accounts for ~7x10^8 $M_\odot$

- Plummer radius ~ 3.5 kpc, and flattening of q ~ 0.6

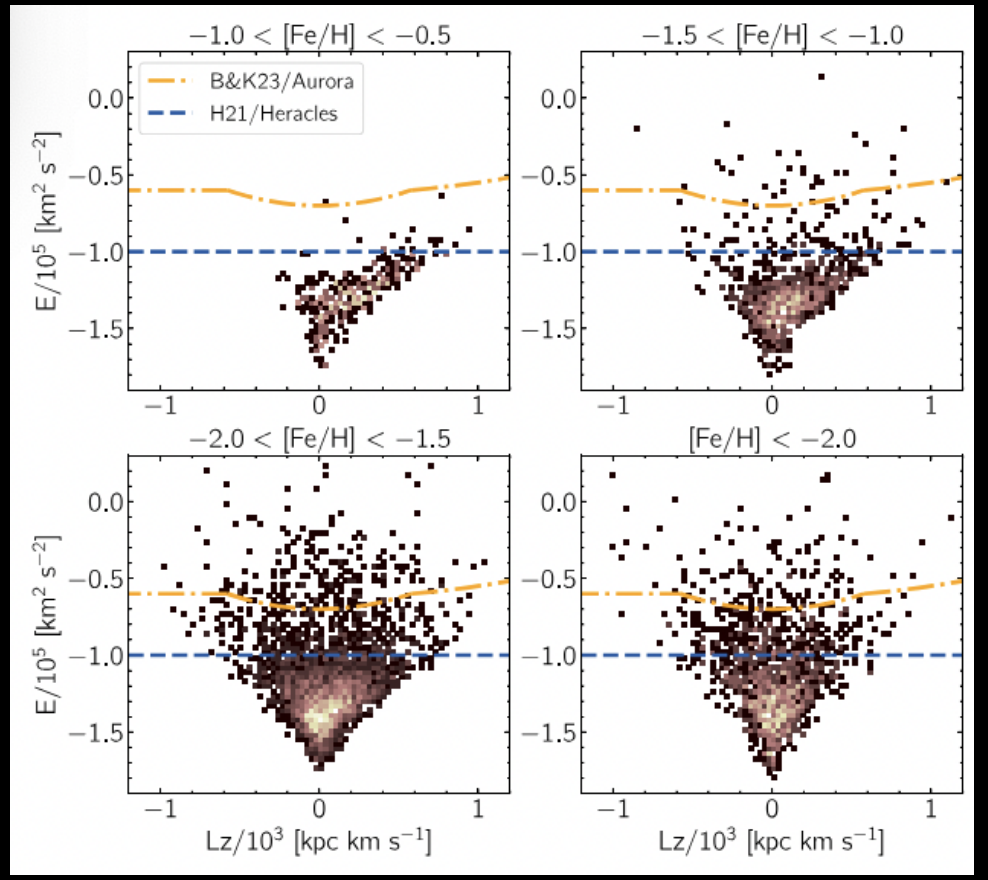
See also Belokurov & Kratsov 22

The very metal-poor stars

Rix+22

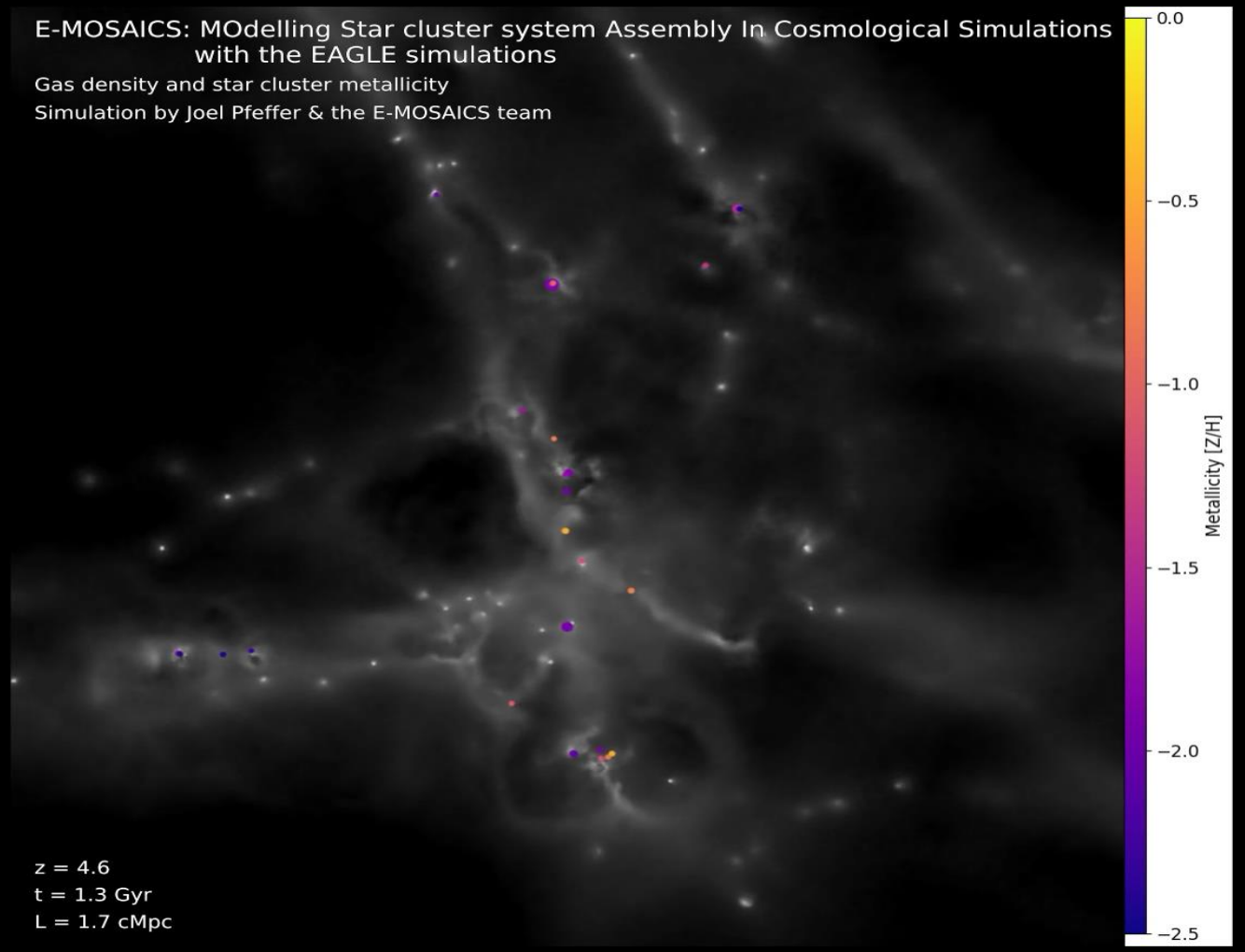


Ardern-Arentsen+24



See Anke's and Else's talk!

The role of globular clusters

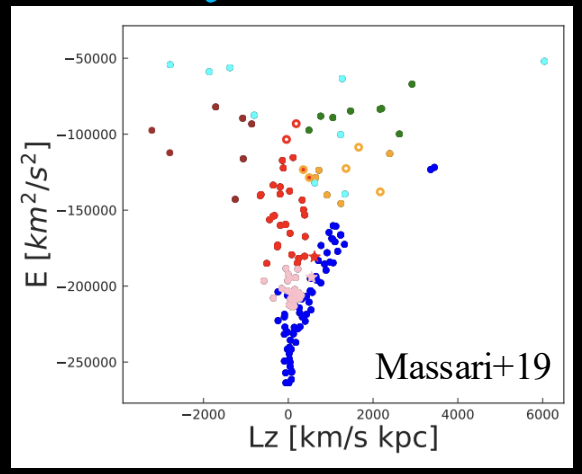


Video credit: Joel Pfeffer

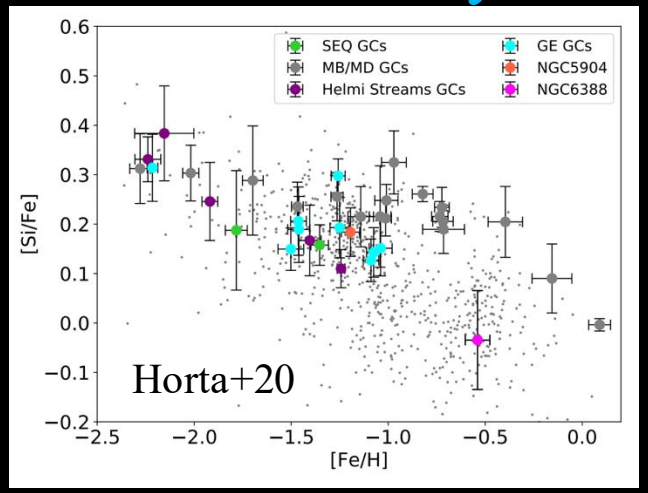
See also:
Forbes+18
Li & Gnedin 18
Choksi & Gnedin 19
+++

Globular clusters as tools for unravelling accretion histories

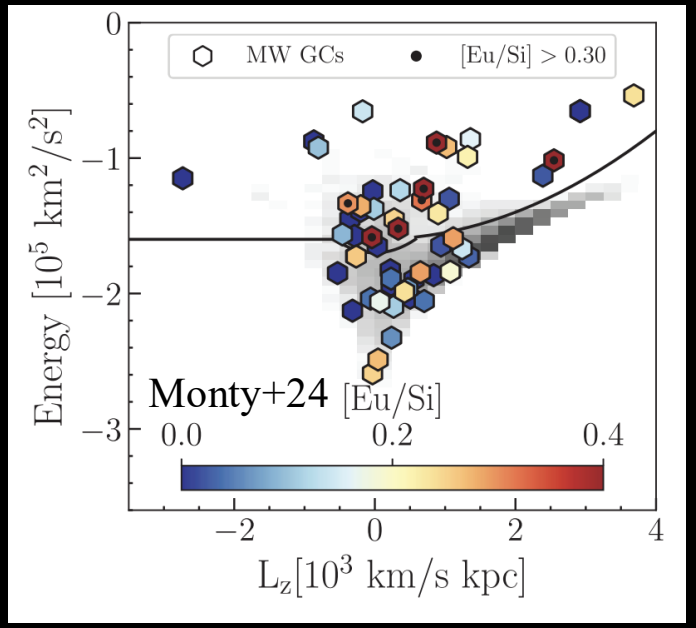
Dynamics



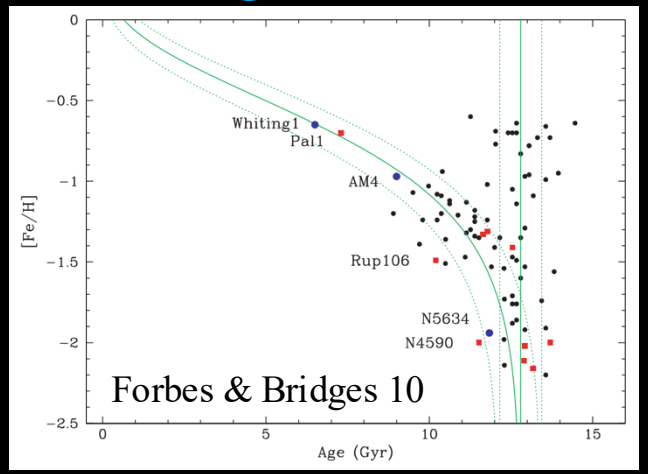
Chemistry



Chemistry + Dynamics



Age-[Fe/H]



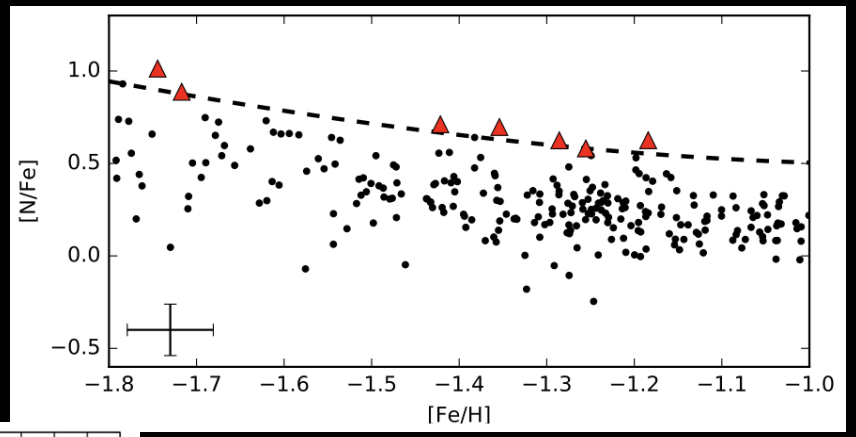
See also Vasiliev+22, Baumgardt+22, Callingham+22

See Davide's talk!

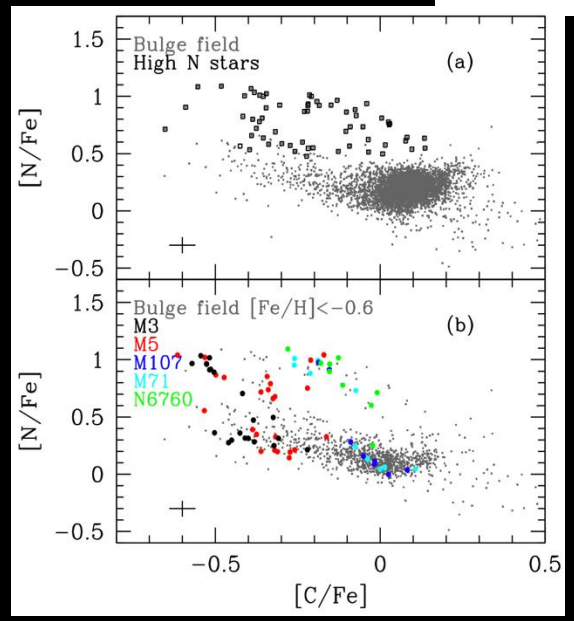
Globular clusters: mass contribution to stellar halo

Chemically finding globular cluster escapees

Martell+16



See Ricardo's and Carmela's talk!

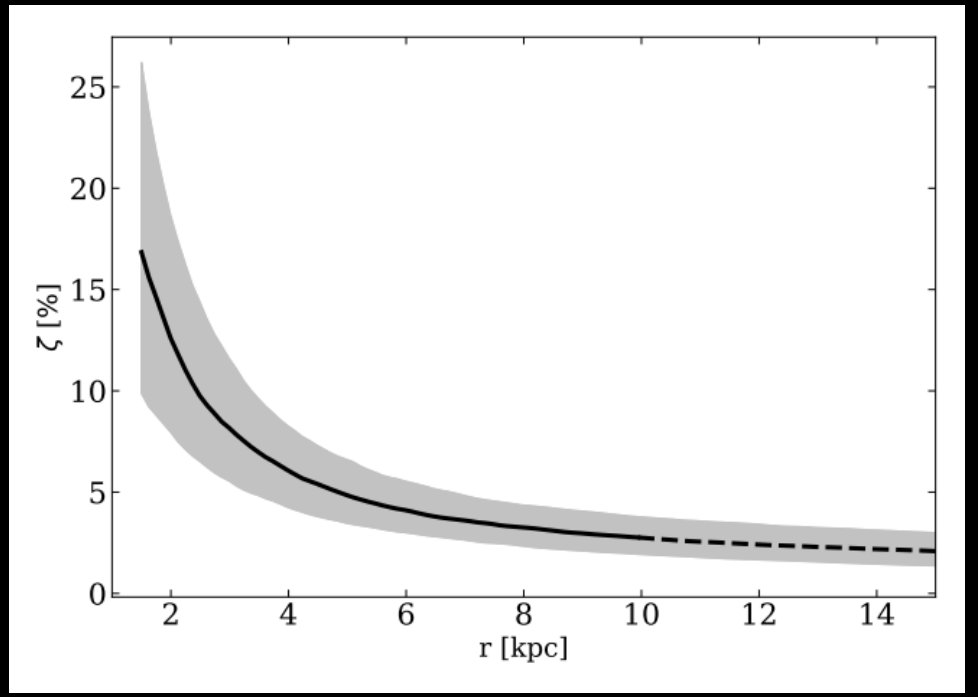


Schiavon+17

See also:
Martell&Grebel+10
FernandezTrincado+19
Lee+19
Hanke+20
Belokurov+23
more…

Fraction of globular cluster escapees

Mass fraction of globular cluster escapees



Horta+21

Summary and outlook:

- Many discoveries have led to a detailed picture of the intermediate ($5 < r < 30$) stellar halo; chemistry has helped elucidate the nature of these populations.

- We still don’t have a good understanding of the innermost ($r < 6$ kpc) and outermost ($r > 30$ kpc). Upcoming surveys will help tackle that.

- Globular clusters are a useful tool, and play a key role in the build up of stellar halos.