The Chemical connection between Damped Lyman-alpha systems and dwarf galaxies
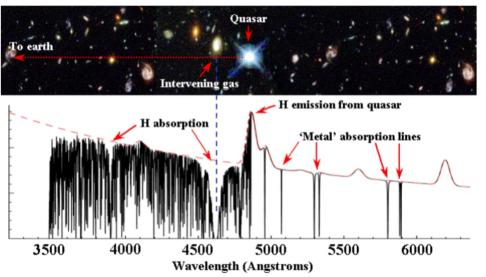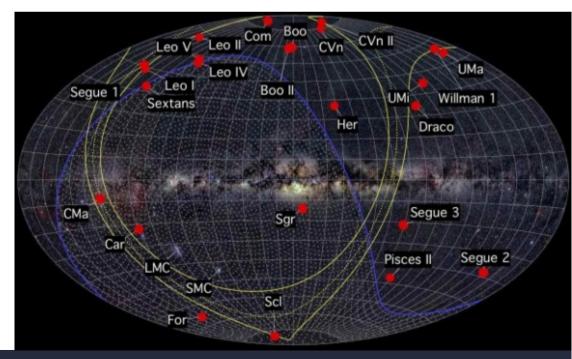
Ása Skúladóttir
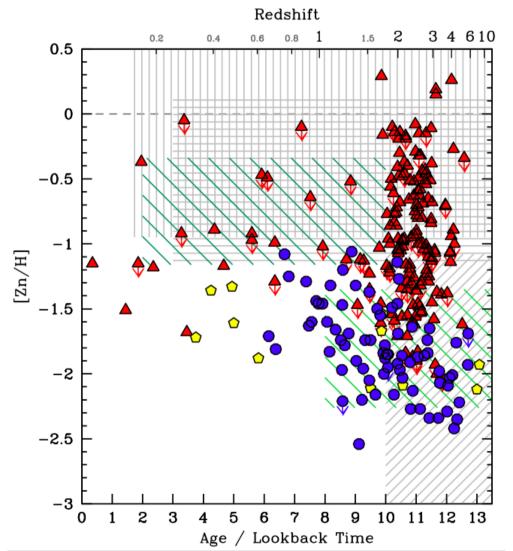
MPIA, Heidelberg

DLAs vs Local Dwarf Galaxies

* DLA systems are reservoirs of neutral gas, visible due to absorption.

* Sulphur & Zinc not depleted onto dust

* [Zn/H] often used as proxy for [Fe/H]

* [S/Zn] often used as proxy for [α/Fe]

* In the Local Group we are able to observe individual stars and get detailed chemical abundances.

* 50+ known dwarf galaxies around the Milky Way

* Sulphur & Zinc observationally expensive in dwarf galaxy stars

Right: H. Jerjen & Eso

Metallicity Comparison

* DLAs are most likely a mixed bag of objects.

* [Zn/H] is often used as a metallicity tracer, since Fe is depleted onto dust.

* [Zn/H] measurements in DLAs challenging at z<1.5 and for [Zn/H]<-2.

* [Zn/H] measurements in dwarf galaxy stars usually only with one blue line.

* Stellar ages are very uncertain

DLAs: Quieret+16; Milky Way: Cayrel+04, Reddy+06, Nissen+07, Bensby+2013; Sculptor: Skúladóttir+17, deBoer+12; Carina: Shetrone+03, Venn+12, Lemasle+12; Sagittarius: Sbordone+07. Age models: Salvadori+10, Aparicio+11, Bellazzini+06, Siegel+07, deBoer+15
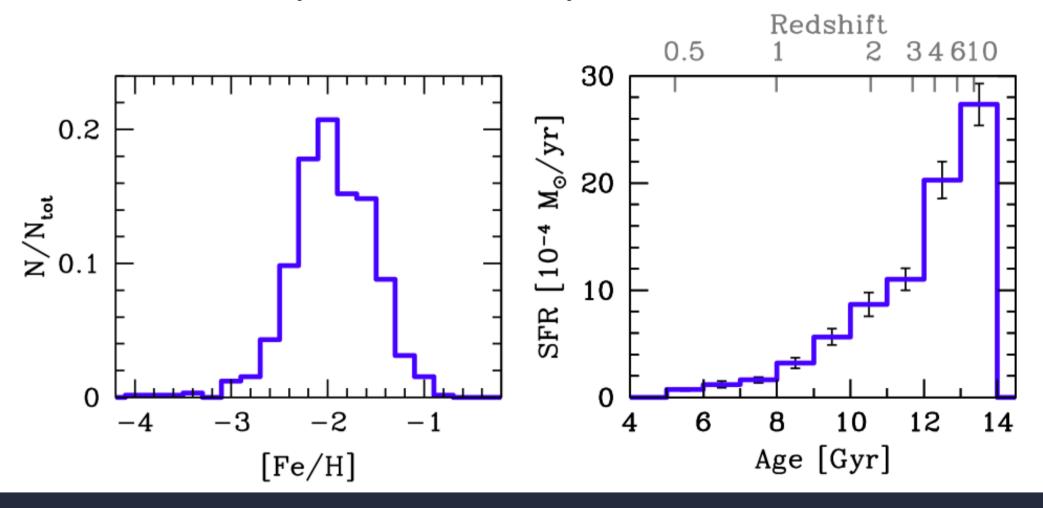
The Sculptor dwarf spheroidal

* Discovered in 1938

* $M_{tot} = 3.4 \times 10^8 \, M_\odot$

* $M_{stars} = 8 \times 10^6 \, M_\odot$

* Distance of 86±5 kpc

* At high Galactic latitude

Shapley 1938, Battaglia et al. 2008b, de Boer et al. 2012, Pietrzyński et al. 2008
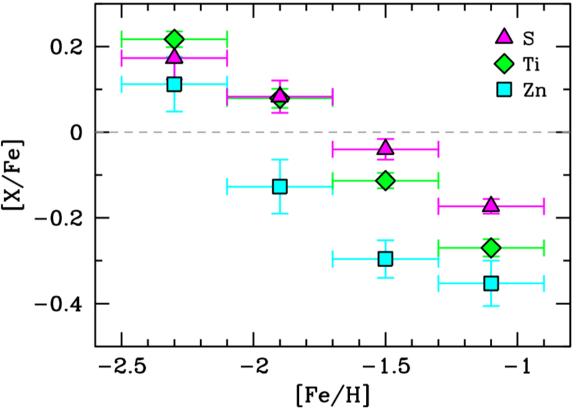
The stellar population in Sculptor
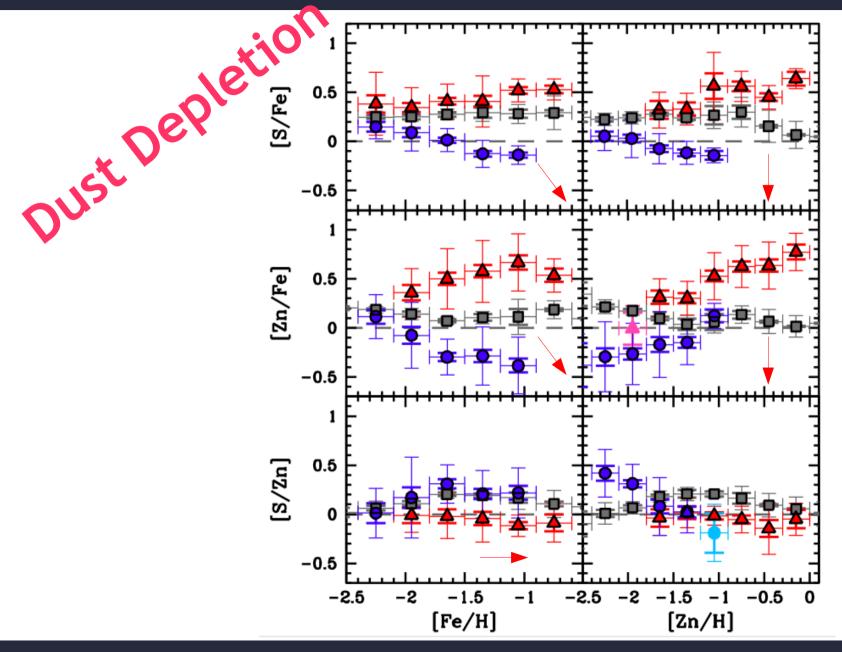
* Dominated by old stars (>10 Gyr old)

Metallicity Distribution Function
(Starkenberg et al. 2010)

Star Formation History
(de Boer et al. 2012)

Chemical abundances in Sculptor

* Measurements of ≈90-100 stars in Sculptor with ESO VLT/FLAMES

* R≈20,000

* α-elements are mainly distributed through Supernova Type II

* SN Ia create mostly Fe-peak elements

* S shows a typical α-element behavior in Sculptor
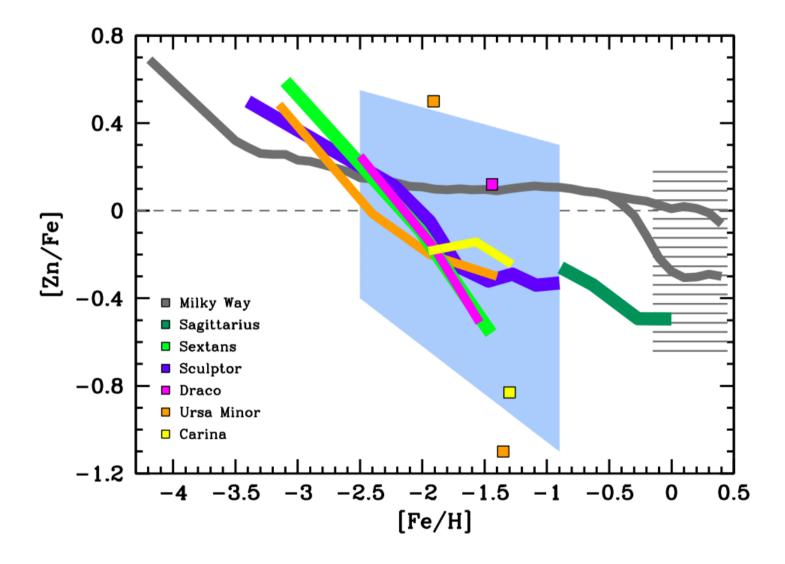
* Zn as well!

Dust Depletion
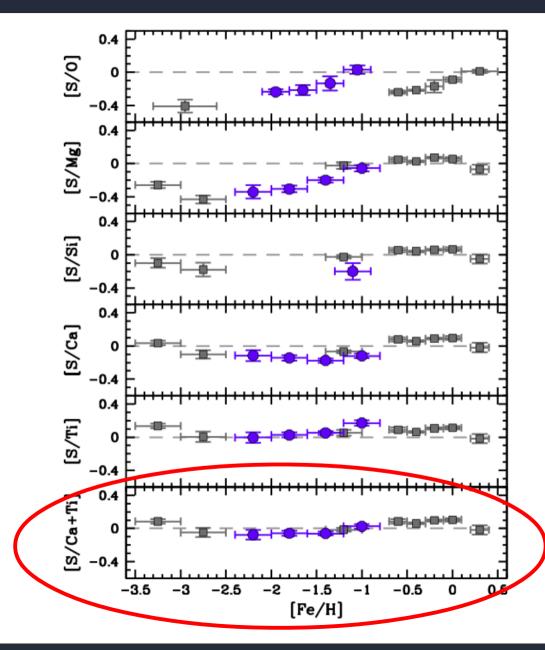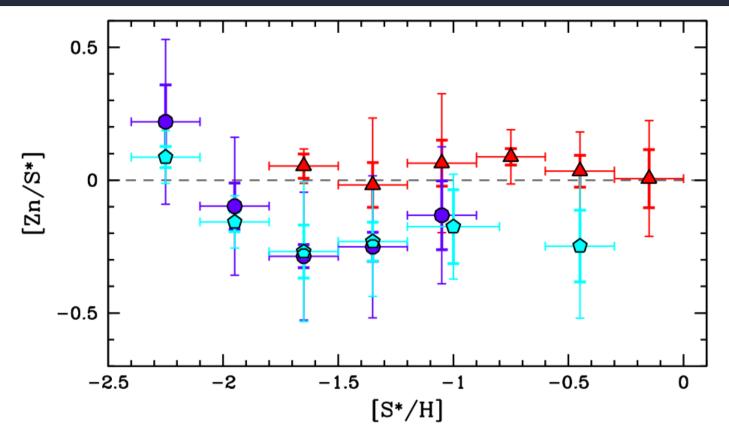
Closer Look - Zinc

Closer Look - Sulphur

* Zn is not well understood in stars, so S is a better reference element

* S is created both in Supernovae Type II and Type Ia

* S is not commonly measured in dwarf galaxy stars

* Mg and O are not good proxies for S

* Ca and Ti are reasonable proxies for Sulphur

DLAs vs dwarf galaxies

* The average of Ca and Ti abundances are used as proxy for S in dwarf galaxies (cyan)

* Sculptor and other Local dwarf spheroidal galaxies show comparable results, DLAs are different.

Conclusions

* **Zn is not Fe**

* Contrary to Fe, Zn is **<u>not</u>** significantly created in Supernova Type Ia

* **$[S/Zn] \neq [\alpha/Fe]$**

* Zn is still not fully understood in the Local Group

* $[Ca/H]$ and $[Ti/H]$ reasonable tracers of $[S/H]$ in stars

* S can be used as a metallicity tracer, created both by SN Type II and Ia

* DLA abundance ratios of $[Zn/S]$ consistent with earliest phases of dwarf galaxy evolution

Thank you!