Homogeneity of dust depletion in various environments

Jens-Kristian KROGAGER (CRAL)
Christina KONSTANTOPOULOU (UNIGE) **& Annalisa DE CIA** (UNIGE)

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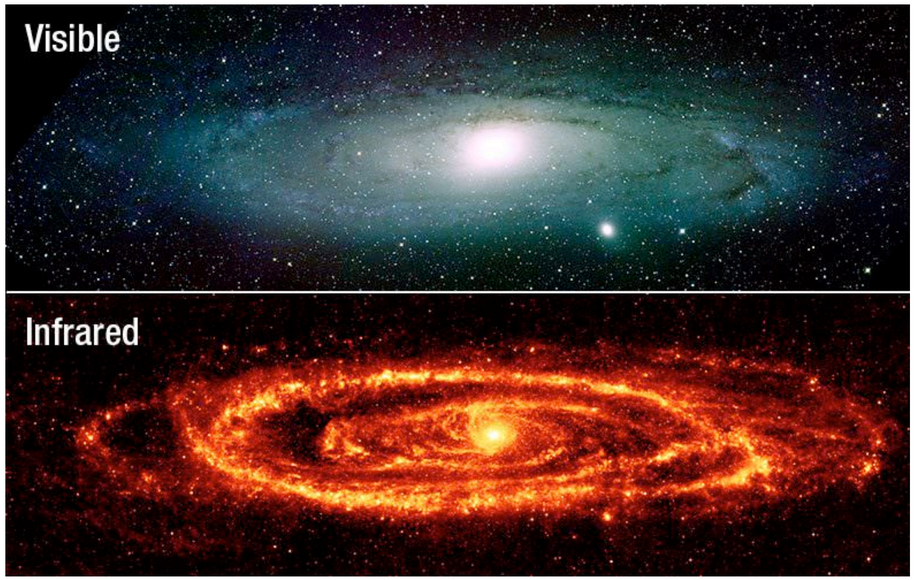
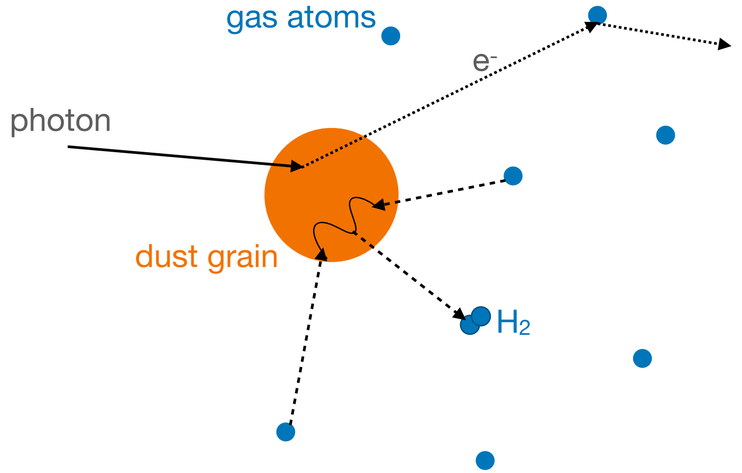
Dust grains are important ingredients in galaxies

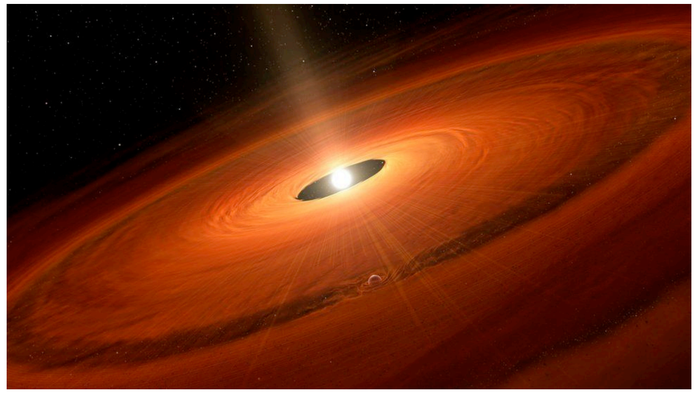
They absorb UV light and re-emit in IR



They heat the ISM and catalyse H_2 formation



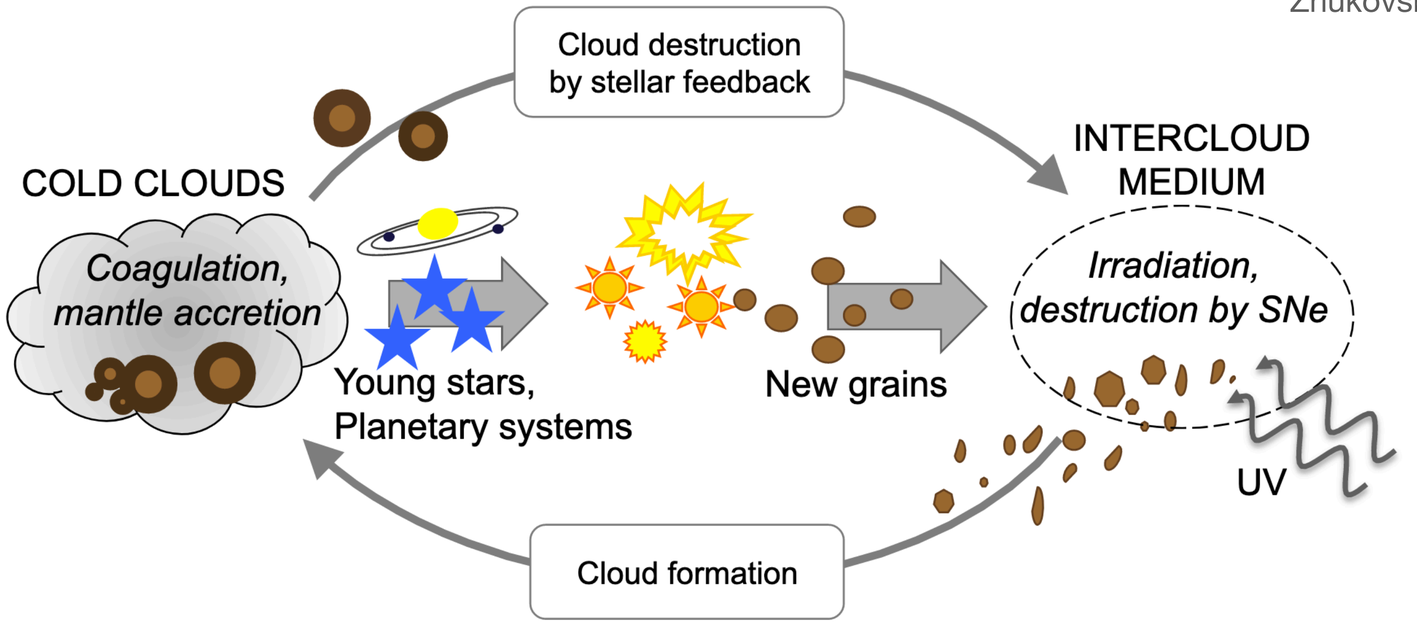
and they form planets when they stick together



We know very little about their formation and composition

Iron-rich or iron-poor silicates? PAHs? Carbonaceous grains?

Zhukovska & Henning (2014)



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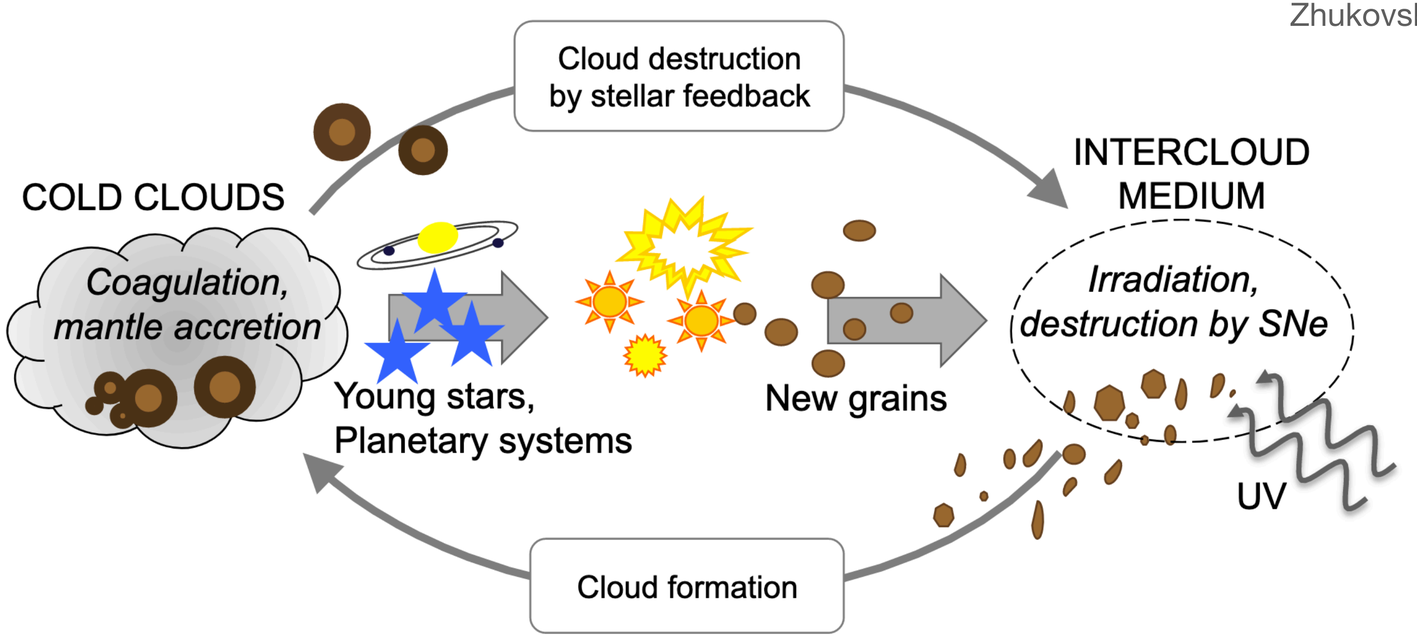

Supernovae and AGB stars result in different dust compositions
due to differences in metal production and physical conditions (T and n)

Dust composition should depend on star formation history

Constraining dust properties at high redshift

Most of what we know about dust properties comes from studying the Milky Way or local galaxies
(mostly high metallicity)

We target high-redshift galaxies in order to probe different environments and enrichment histories
(mostly low metallicity)

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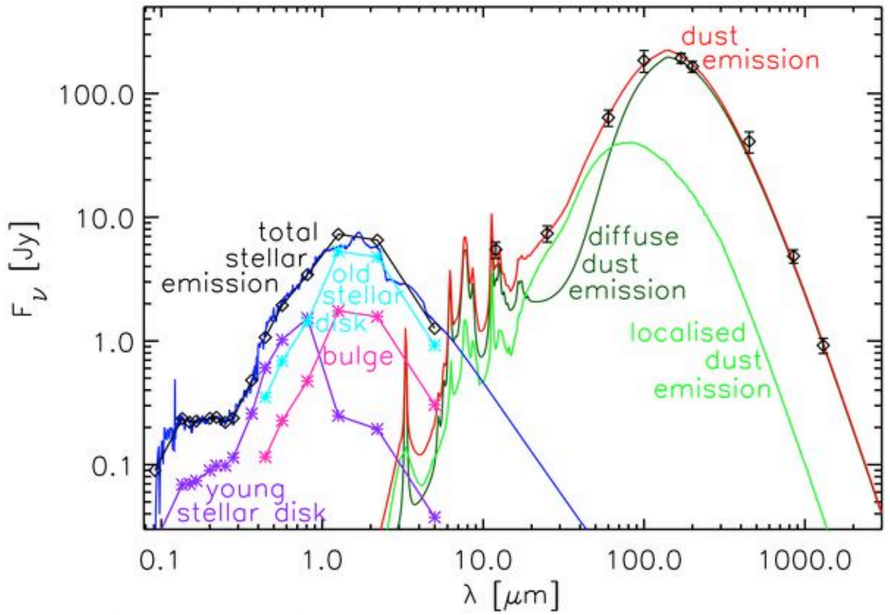
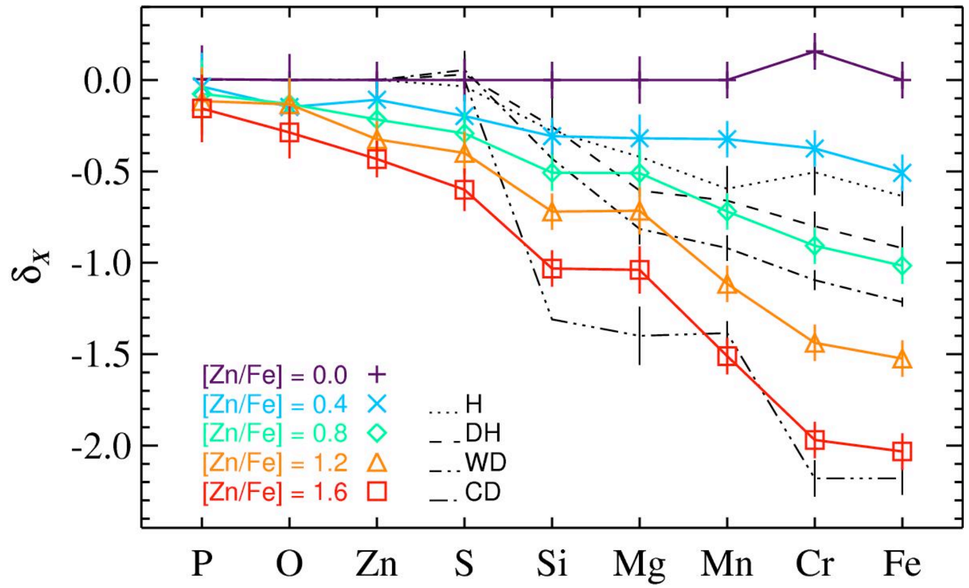
We can study dust using IR emission/absorption



Popescu et al. (2011)

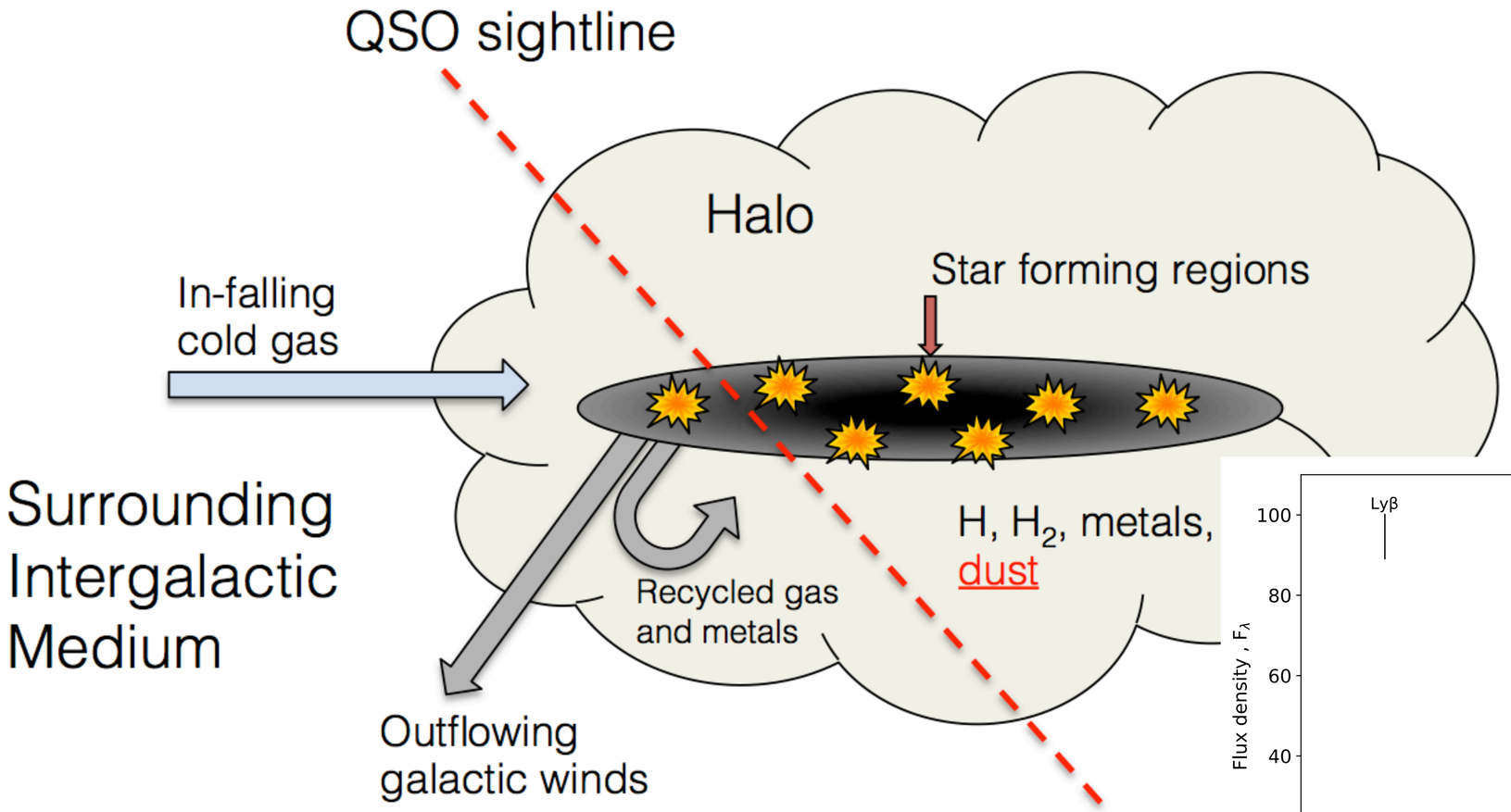
or by observing the amount of metals removed from the gas phase, i.e., depletion

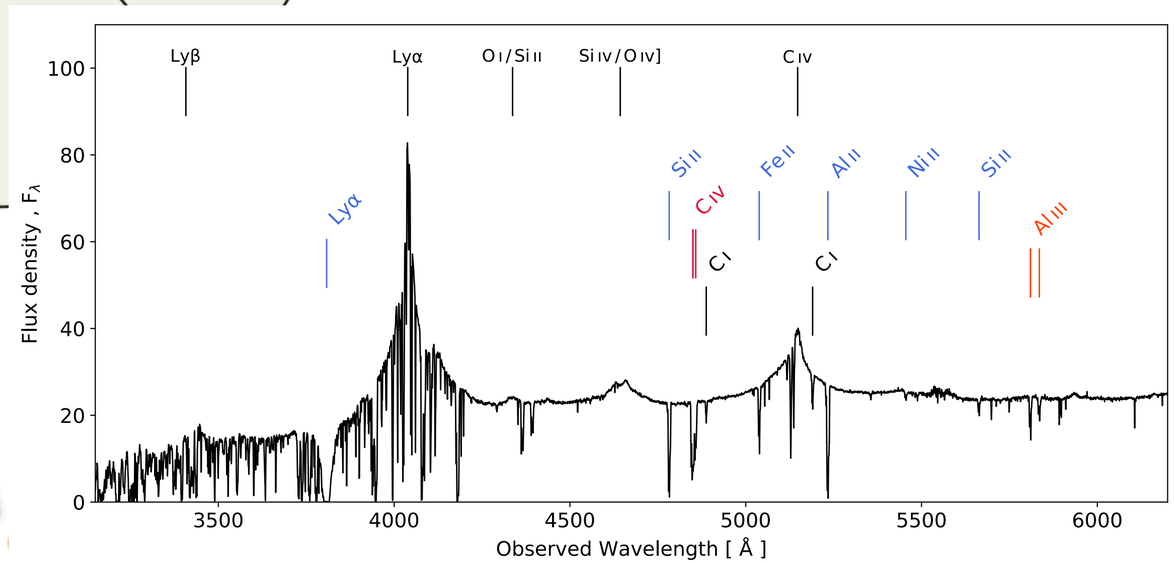


De Cia et al. (2016)

Measuring depletion at high redshift

We can measure accurate relative abundances of various metals in quasar absorption systems





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We can measure accurate relative abundances of various metals in quasar absorption systems

Sample:

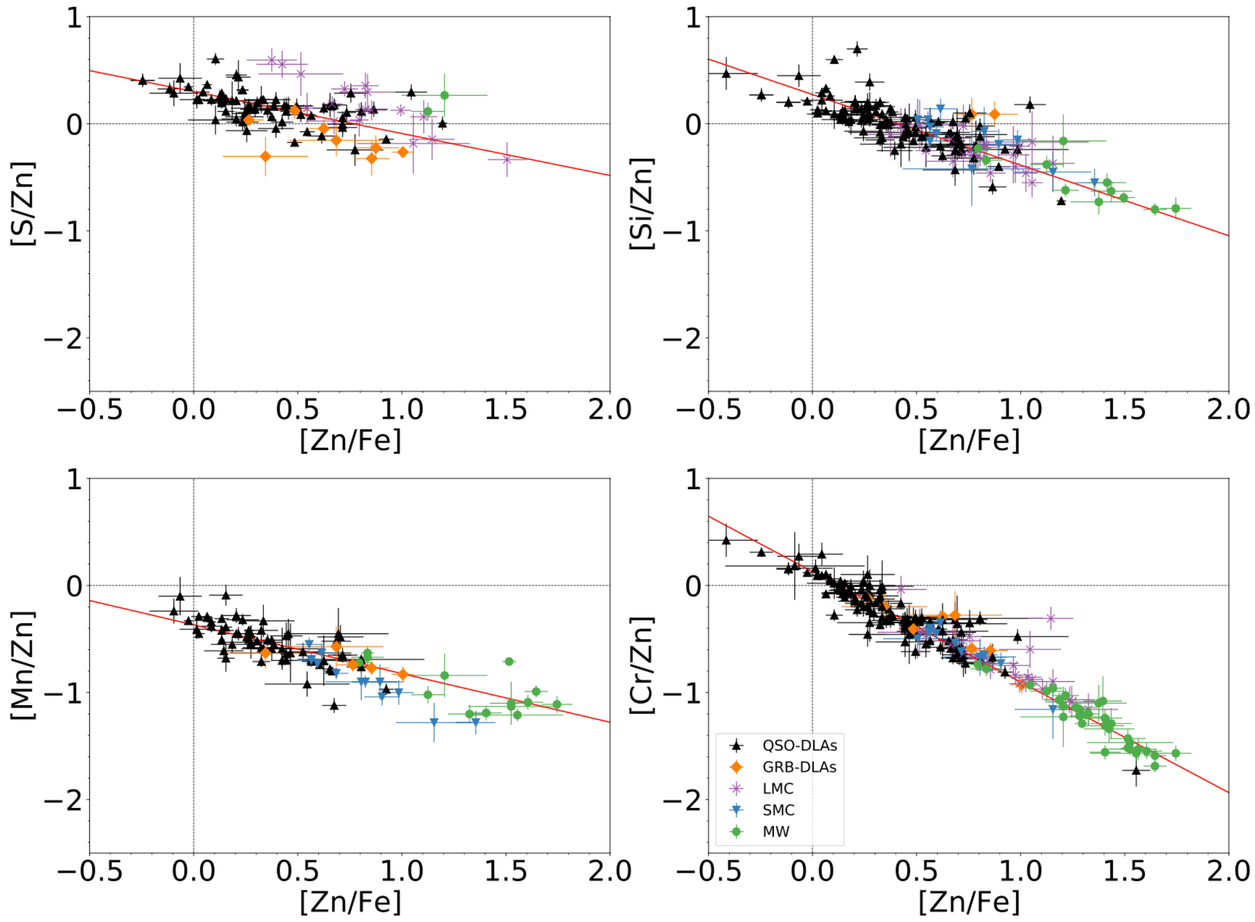
70 high-redshift absorption systems,

39 Galactic sightlines,

16 from the SMC,

and 31 from LMC.

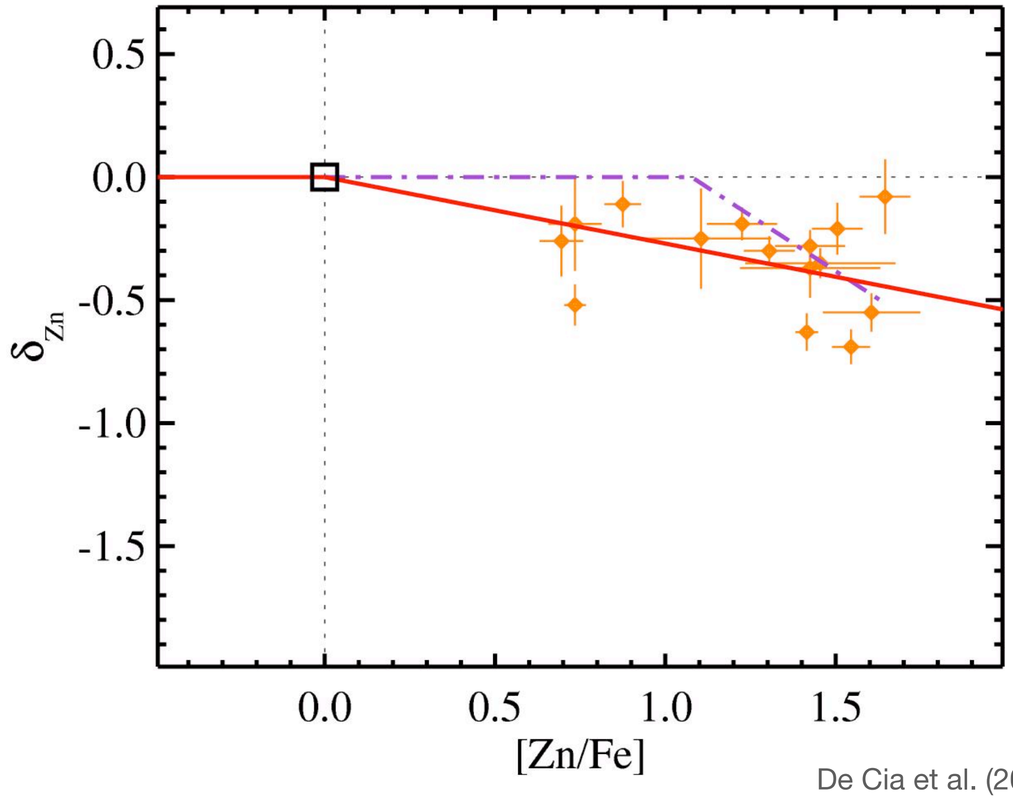
Requirements:
must have Zn and Fe measurements
+ high spectral resolution



Konstantopoulou et al. (in review)

Measuring depletion at high redshift

Two assumptions: depletion of Zinc follows that derived for the Milky Way and reaches 0 for [Zn/Fe] = 0



Orange points:
Milky Way data

Purple line:
Jenkins et al. (2009)

De Cia et al. (2016)

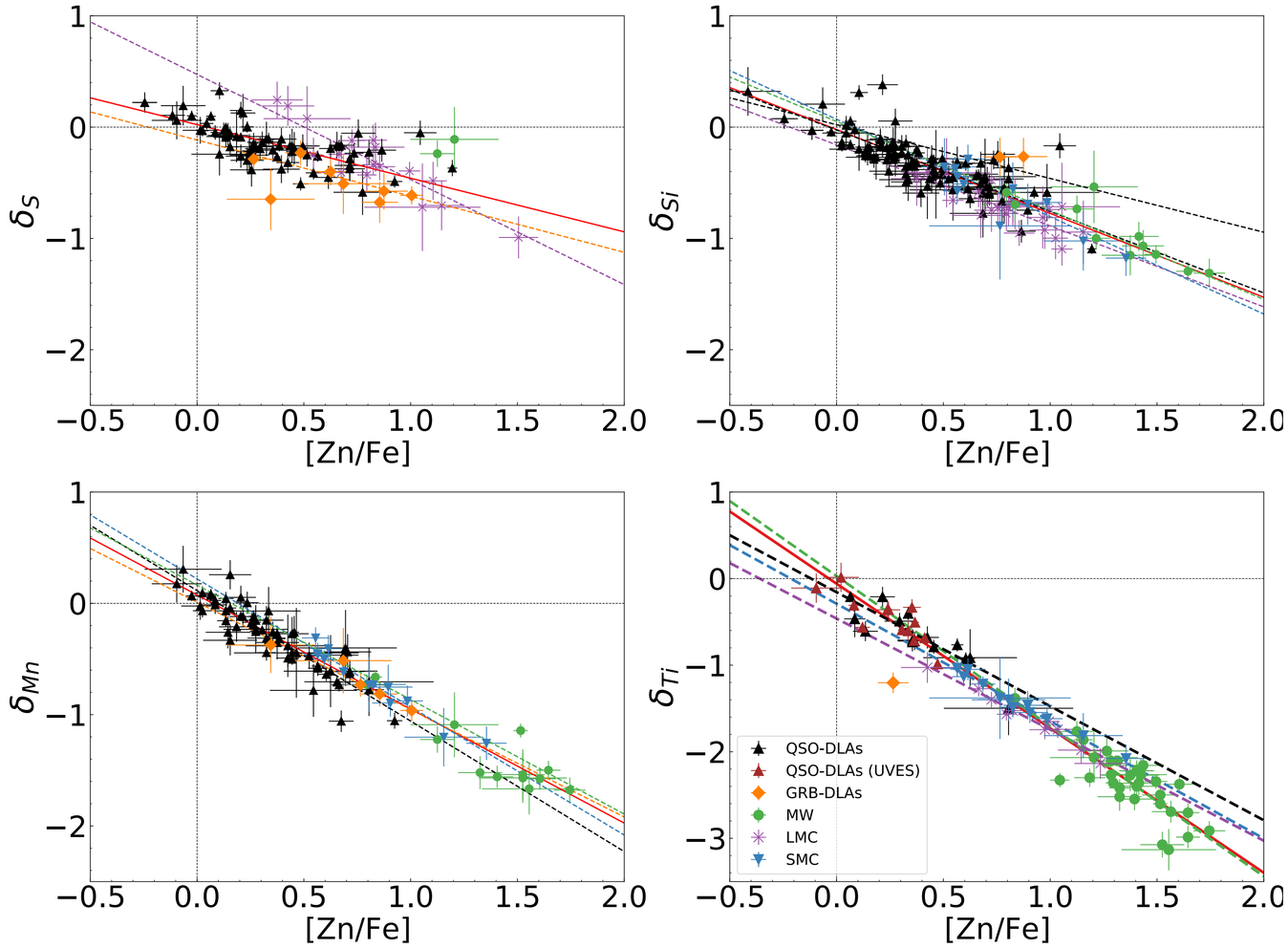
Measuring depletion at high redshift

We derive the depletion of various elements (P, S, Si, Mg, Mn, Ti, Ni, Cr)

Sulfur is tricky in MW and LMC
due to ionisation effects near young stars

We see a very homogeneous behaviour
of dust depletion in different environments!

The homogeneity indicates that dust grains
in the diffuse gas have a common formation
or destruction mechanism



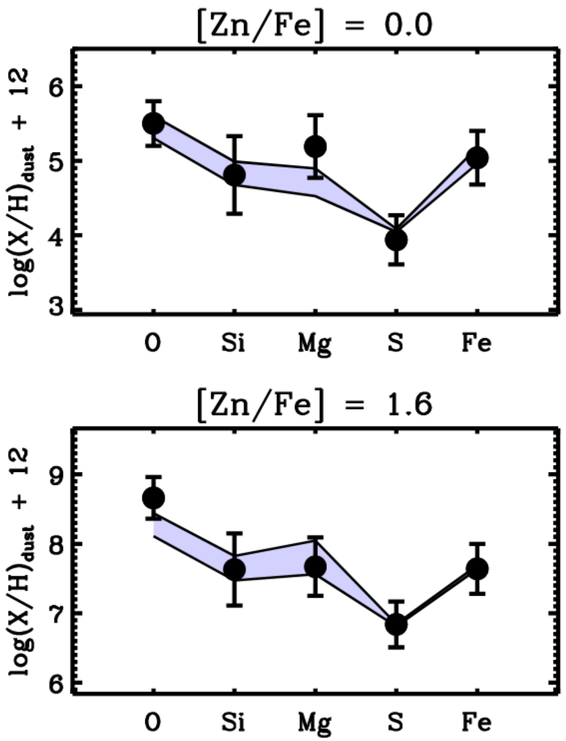
Konstantopoulou et al. (in review)

We can investigate the dust composition

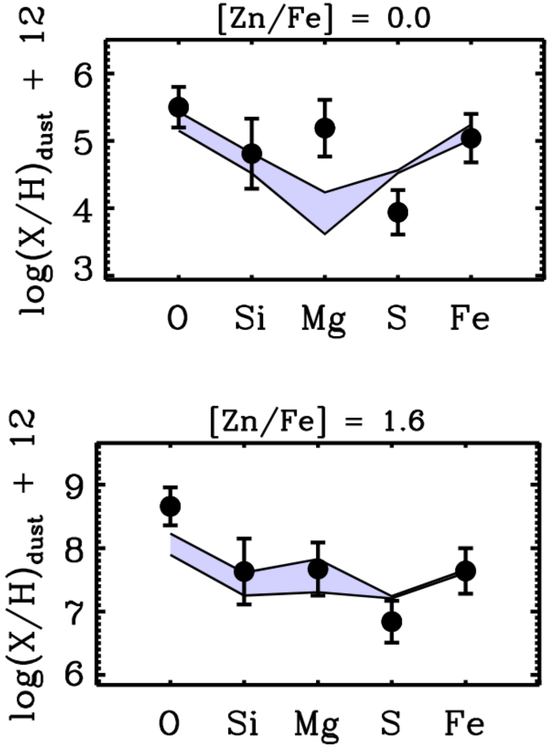
The observed dust abundances favour a mix of iron-rich and iron-poor silicates.

Though there are many degeneracies! And we currently do not constrain carbonaceous grains at all.

50-50 mix of iron-rich and iron-poor silicates
(Olivine, pyroxene, forsterite, enstatite)



Only iron-rich silicates
(Olivine and pyroxene)



Mattsson et al. (2019)

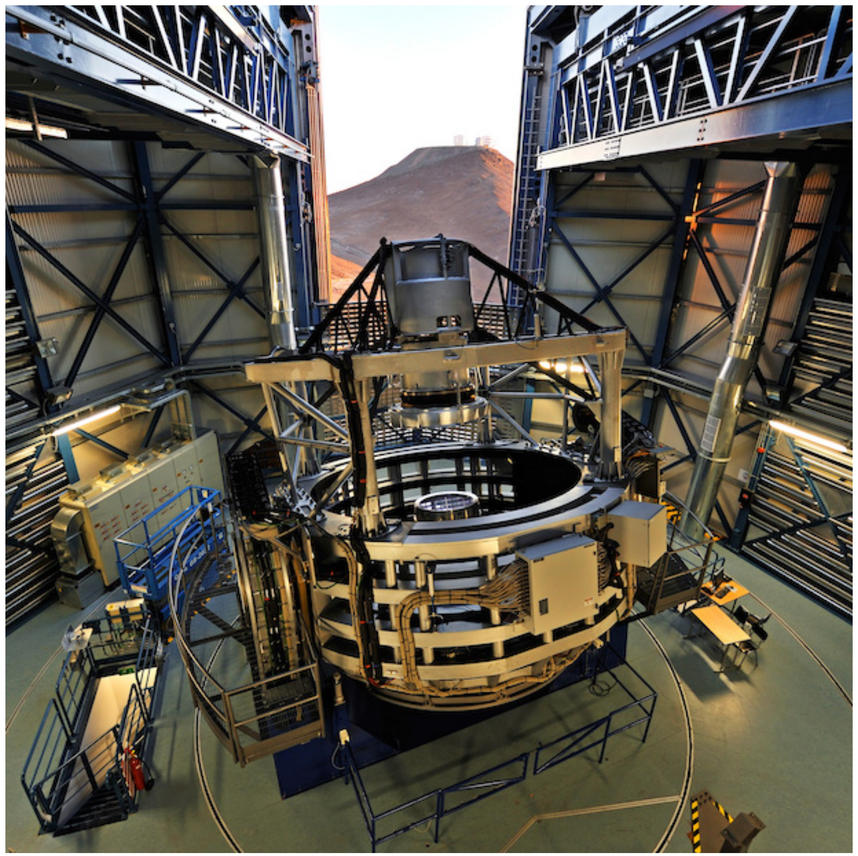
Outlook: larger samples from 4MOST

4MOST is a survey instrument carrying out 25 public surveys in parallel at the VISTA telescope in Chile.

The instrument observes **2436 targets simultaneously** using two low-resolution and one high-resolution spectrographs. Both low-resolution spectrographs are built by CRAL.

4MOST has ~4x higher spectral resolution than Sloan Digital Sky Survey which makes it much better at finding absorption lines in the spectra!

Survey start ~mid 2024!

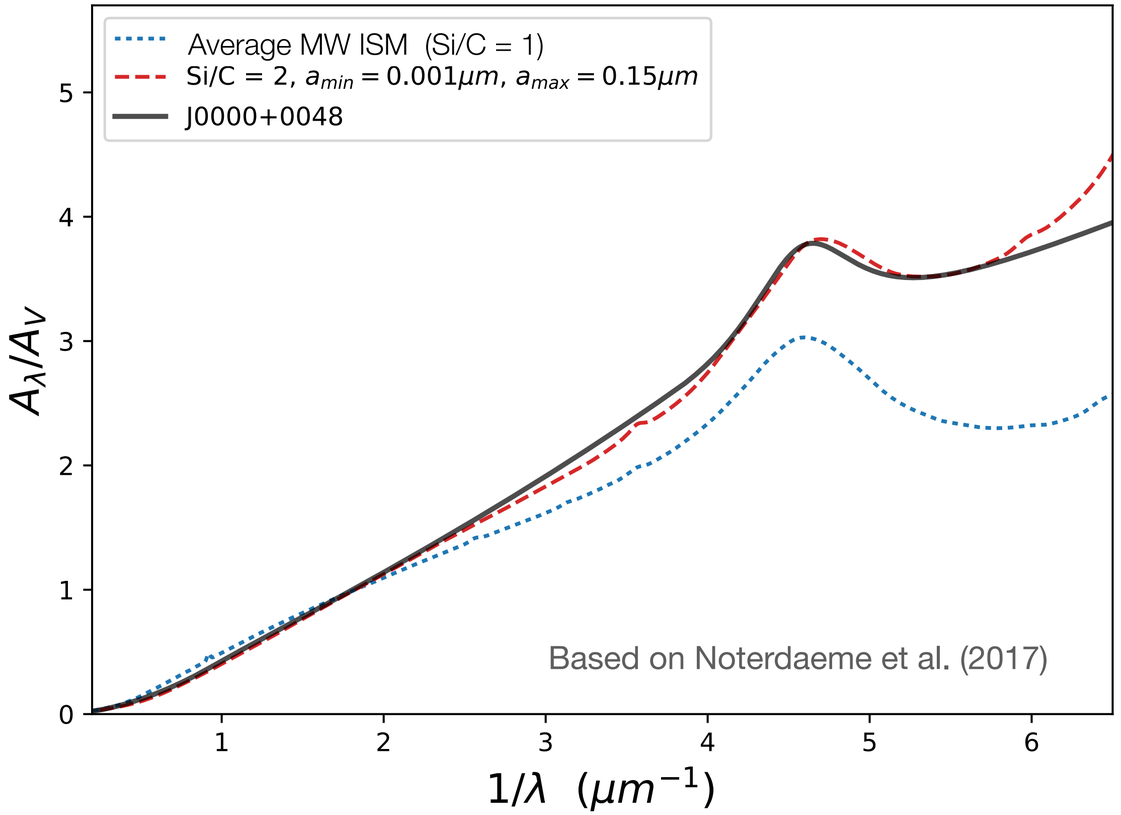


Outlook: larger samples from 4MOST

4MOST—Gaia Purely Astrometric Quasar Survey
(PI: Krogager)

~2000 precise abundance measurements
Thanks to the higher spectral resolution, we don't need follow-up spectra.
Current samples only ~200

Extinction curves for all depletion measurements
The combination of extinction and depletion is needed to break degeneracies in modelling of dust composition.
=> Constraints on Si/C ratio (possibly grain size distribution, but very difficult)



Summary

We study dust depletion in 70 high-redshift absorption systems,
39 Galactic sightlines, 16 from the SMC, and 31 from LMC.
(Requirements: must have Zn and Fe measurements + high spectral resolution)

see upcoming publication
by Christina Konstantopoulou

The dust depletion patterns are very homogeneous across all environments
(SMC, LMC, MW, high-z)

Watch out for first 4MOST results…

Stay tuned!

The homogeneity indicates that the dust grains in the diffuse gas have
A common origin (formation or destruction paths).

Merci, thank you, tak!

The dust depletion patterns can put constraints on the chemical composition of dust.

With up-coming 4MOST data we will obtain larger samples at high-redshift
and combine depletion and extinction measurements to constrain dust composition.

jens-kristian.krogager@univ-lyon1.fr (CRAL)