



Other Conference Item

## The distribution of metals in the intergalactic medium

**Author(s):**

Schaye, Joop

**Publication Date:**

2003

**Permanent Link:**

<https://doi.org/10.3929/ethz-a-004584455> →

**Rights / License:**

[In Copyright - Non-Commercial Use Permitted](#) →

This page was generated automatically upon download from the [ETH Zurich Research Collection](#). For more information please consult the [Terms of use](#).

# The Distribution of Metals in the Intergalactic Medium

Joop Schaye (IAS, Princeton)

JS et al. 2003, ApJ, in press (astro-ph/0306469)

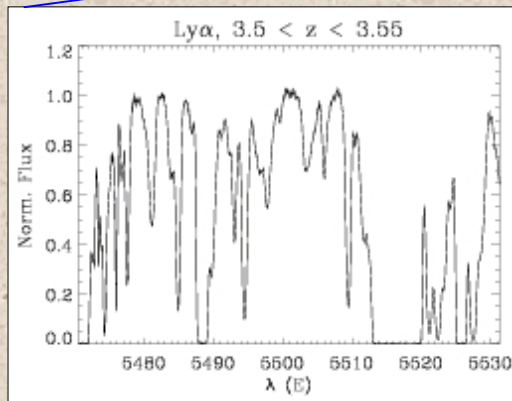
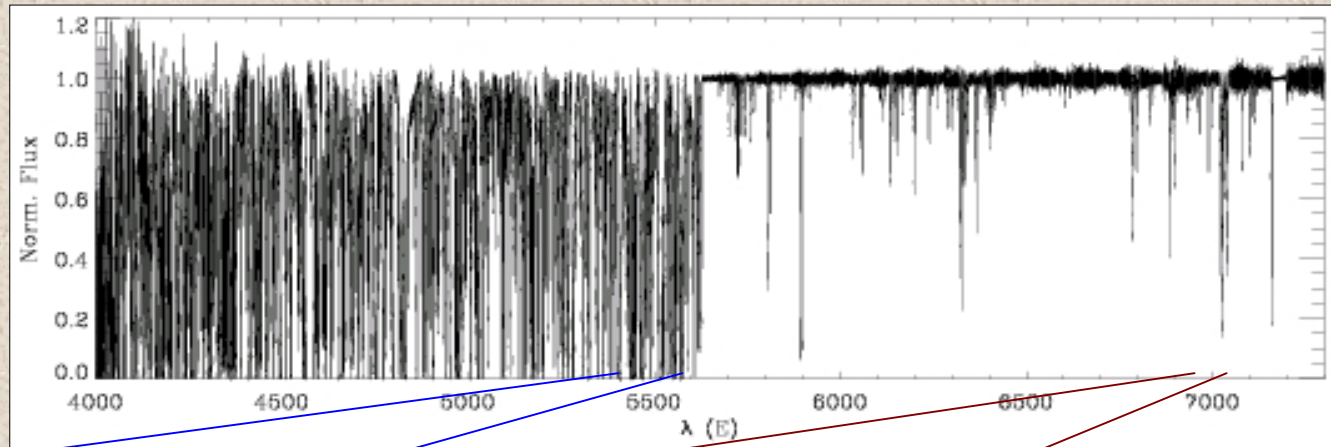
# Collaborators

- Anthony Aguirre
- Tae-Sun Kim
- Tom Theuns
- Michael Rauch
- Wal Sargent

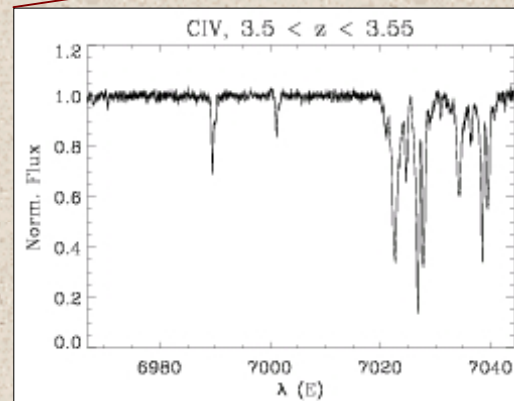
# Why do we care about IG metals?

- Learn about feedback from star formation (galactic winds)
- Fossil record of past star formation (e.g., Pop III)
- Metals are important coolants

# A QSO absorption spectrum



HI 1216



CIV 1548,1551

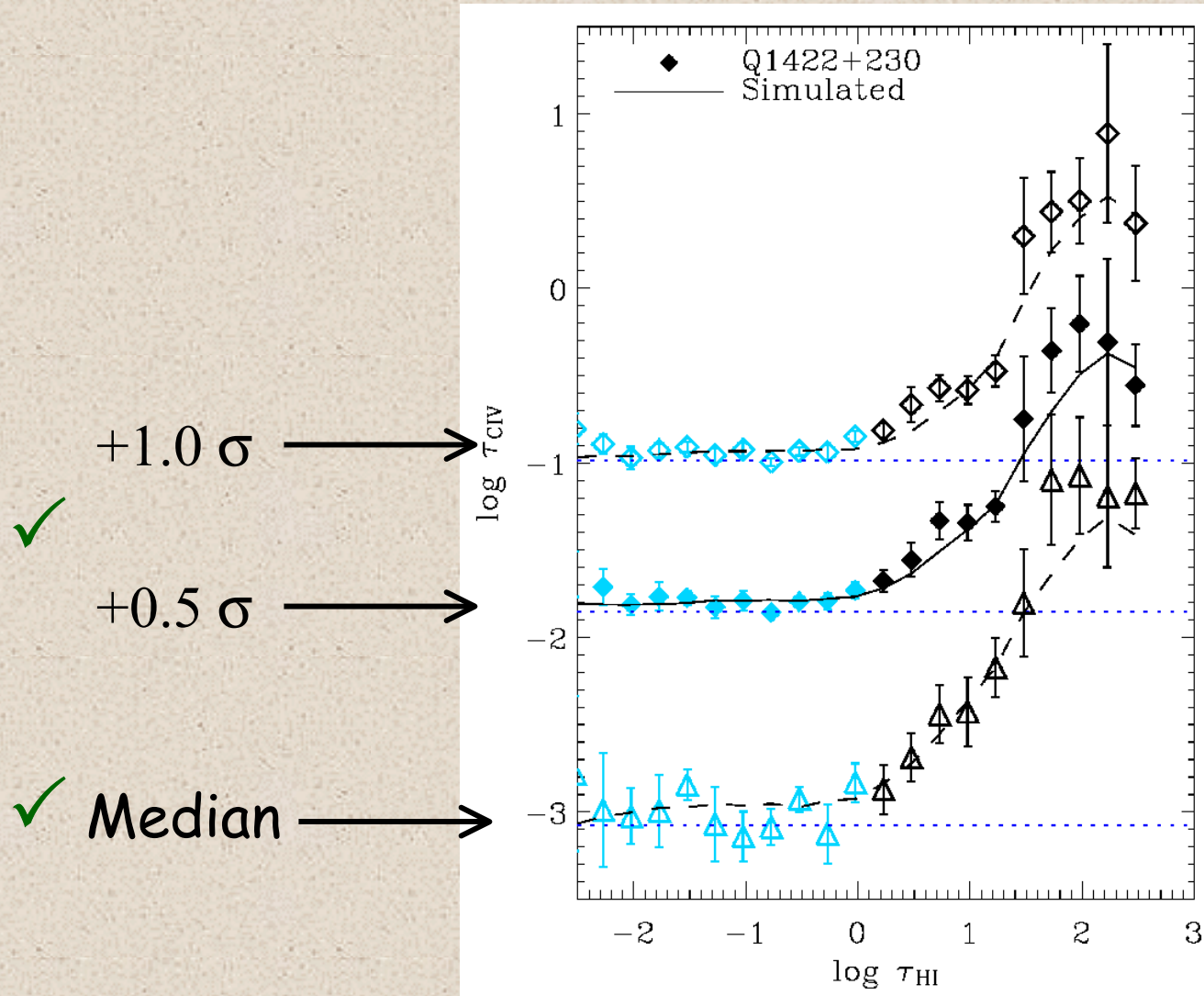
Q1422+230

$z_{\text{em}} = 3.62$

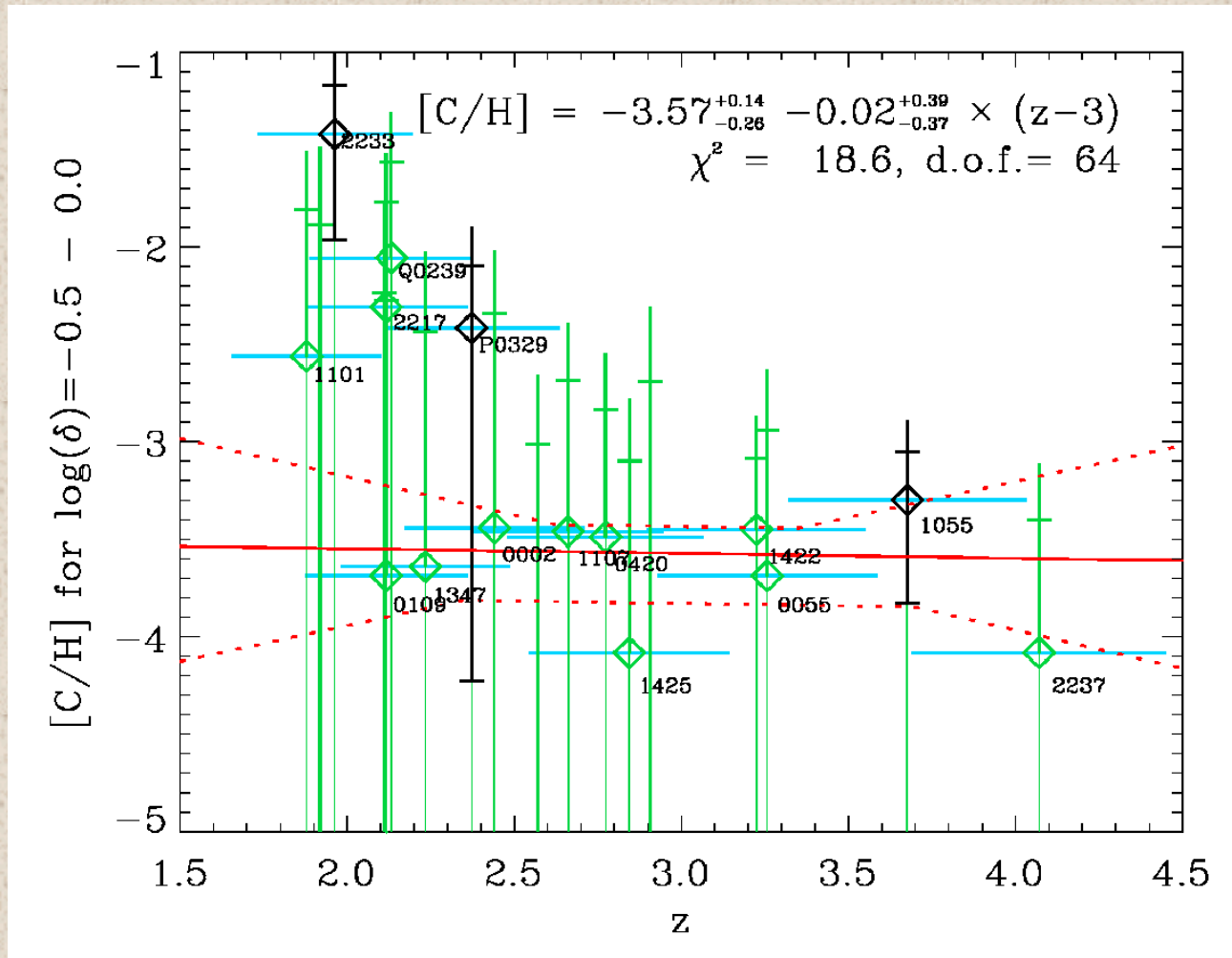
# Questions

- Are metals generally present at  $\delta \sim < 1$ ?
- How does  $Z$  vary with  $\delta$ ?
- How does  $Z$  vary with  $z$ ?
- How much scatter is there in  $Z(\delta, z)$ ?
- Does the scatter depend on  $\delta$  or  $z$ ?
- Are the observed metal absorbers photoionized?

# Pixel statistics



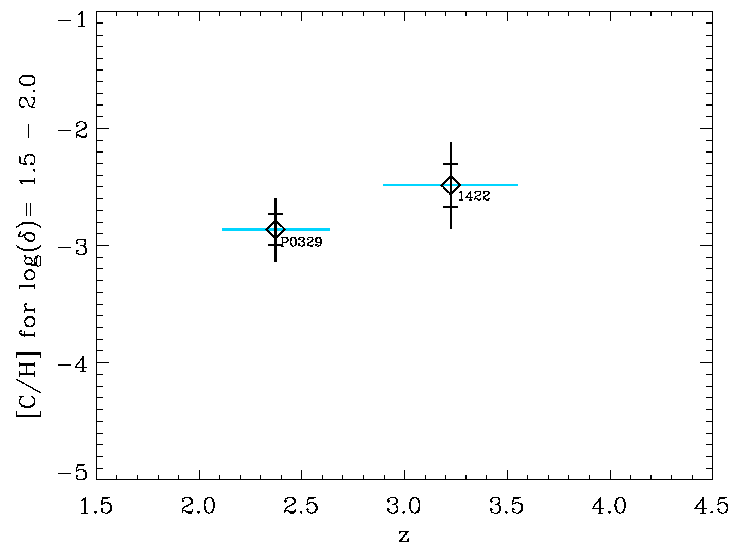
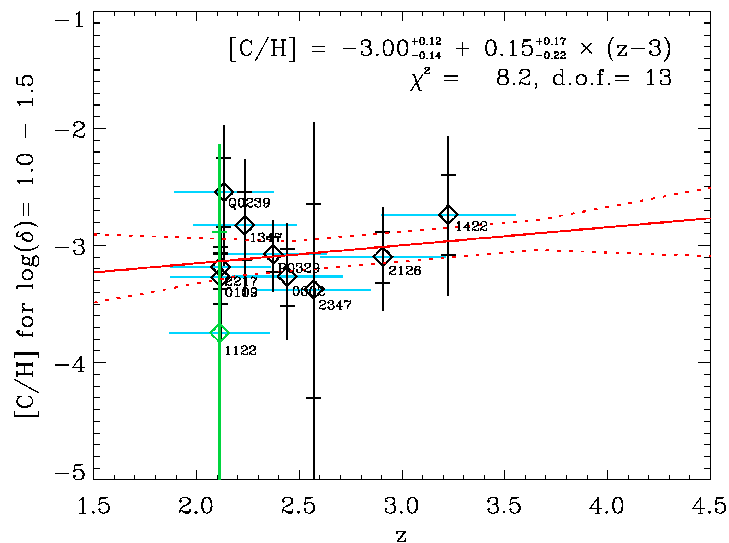
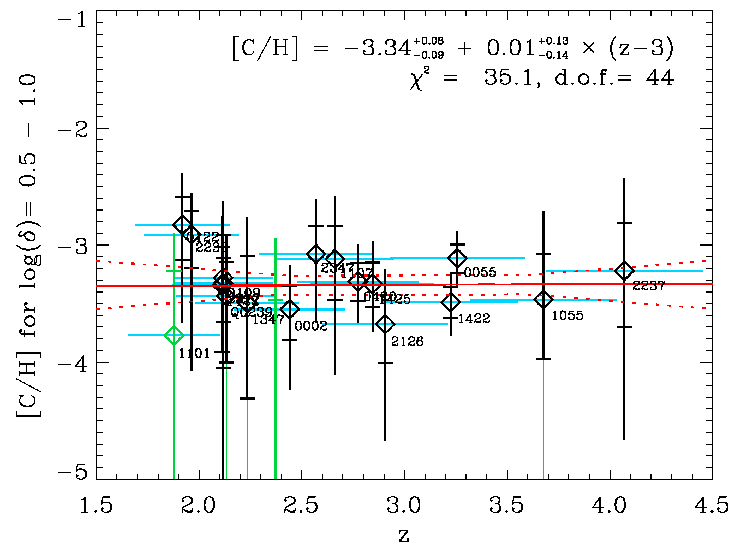
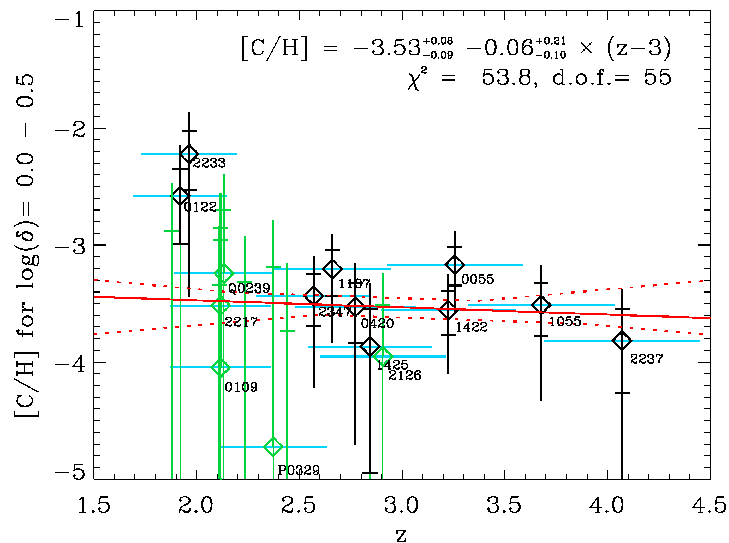
# Metallicity of underdense gas



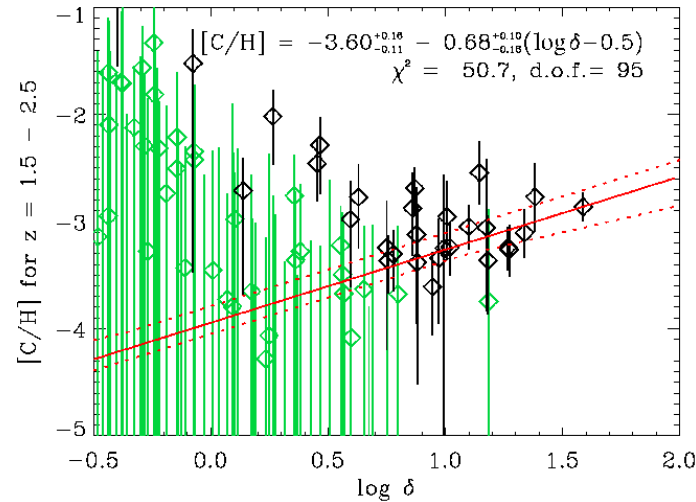
2.4 $\sigma$  detection (i.e., 99.2% CL)



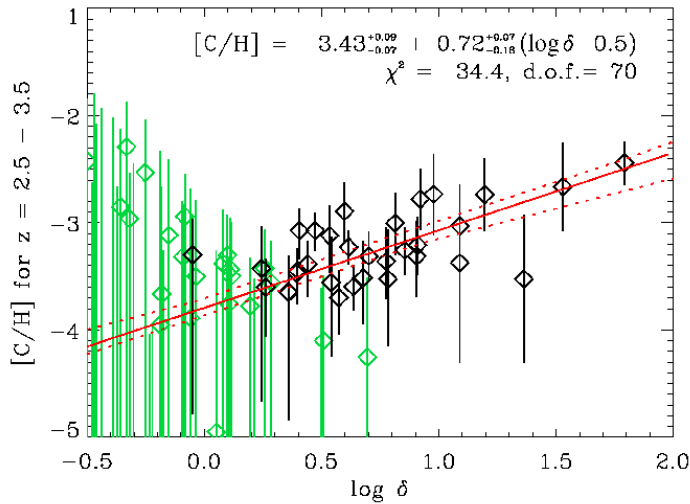
# Metallicity of overdense gas



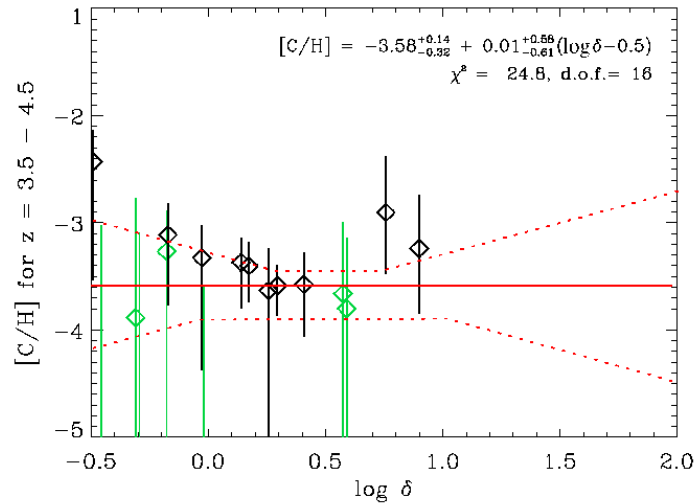
# Metallicity binned in redshift



$z = 2$

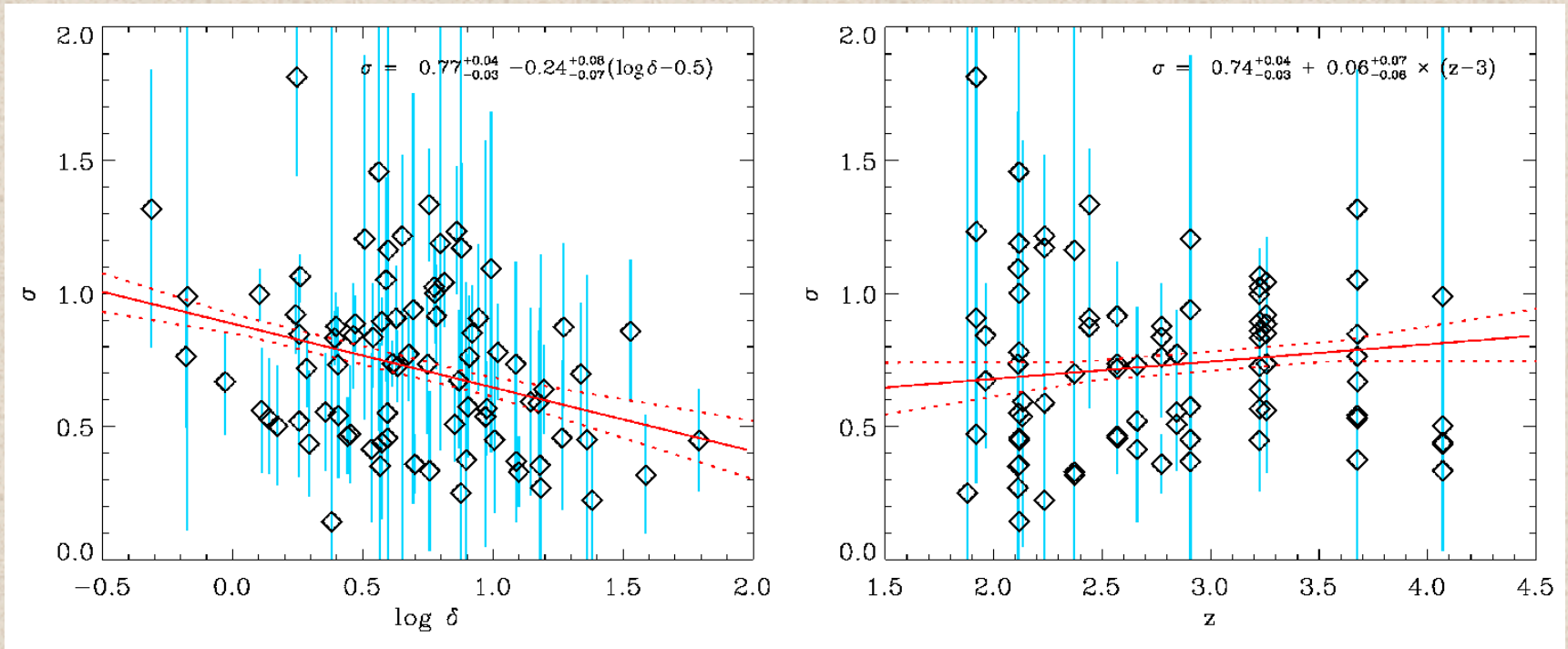


$z = 3$



$z = 4$

# Measuring the scatter

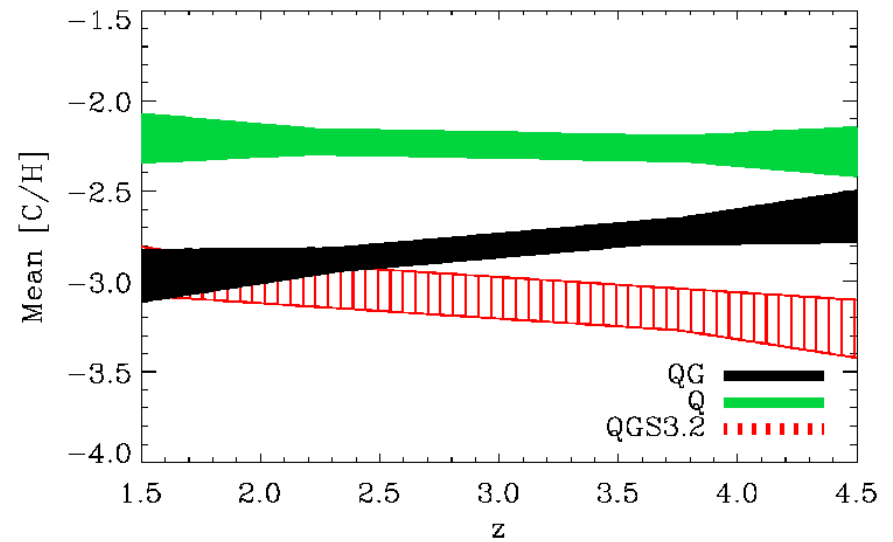
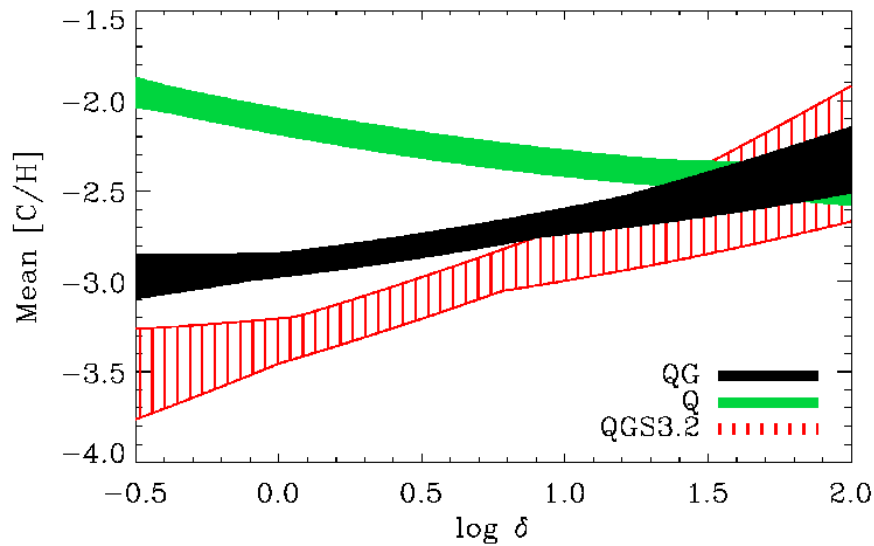


# Varying the UV background

## Mean metallicity

$z = 3$

$\log \delta = 0.5$



# Conclusions

- No evidence for evolution from  $z=4$  to  $z=2$ , except for  $\delta < 10$  if UV background was very soft at  $z > 3.2$
- Strong evidence for an increase of the median metallicity with overdensity
- Metallicity at  $\delta=1$ : Median  $\sim -3.5$ , mean  $\sim -2.9$  (higher if background is harder)
- Scatter (independent of UV background):
  - Metal distribution is lognormal for fixed density
  - $\sigma(\log Z) \sim 0.9$  dex at  $\delta=1$
  - strong evidence for a decrease in scatter with overdensity
  - no evidence for evolution
- Carbon is present in underdense gas (median abundance is nonzero at  $>99\%$  confidence)
- Pure quasar background is too hard
- CIII/CIV ratio implies CIV absorbers are warm (photoionization temperatures), but there could be additional metals in hot gas.