Metals in the Low-redshift Universe:
From Galaxies to the Intergalactic Medium

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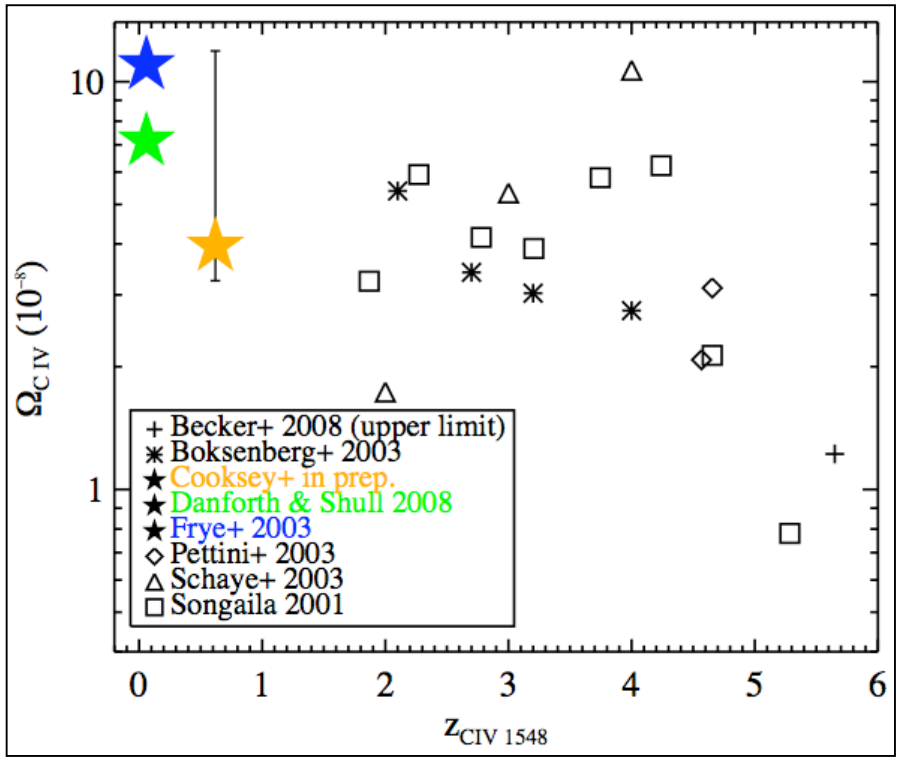
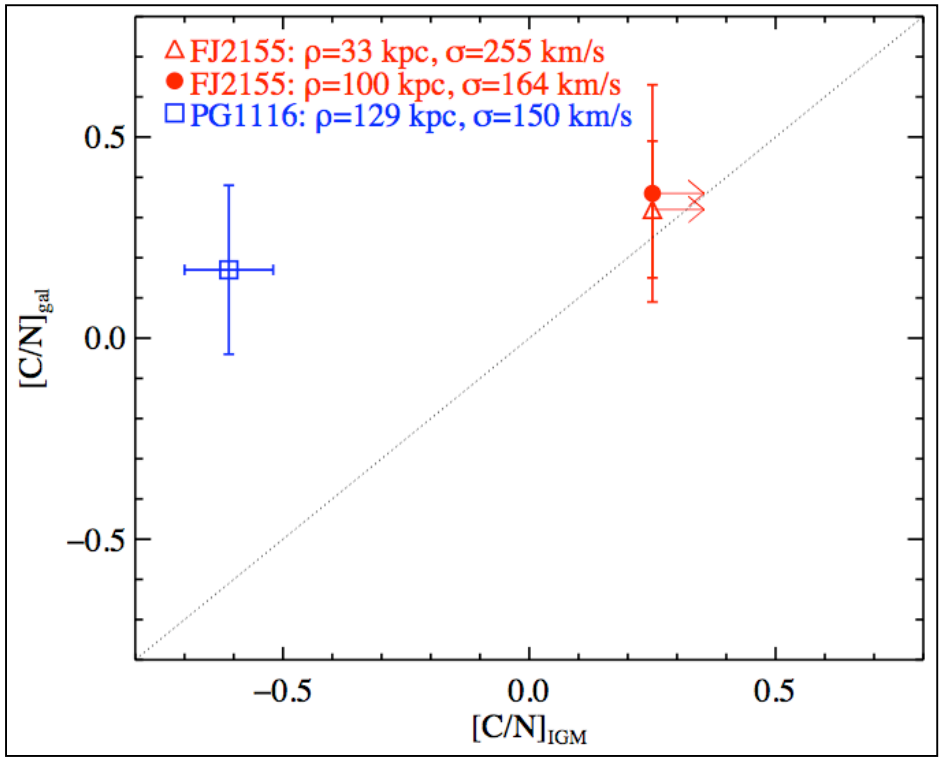
Science Driver: Enrichment of IGM

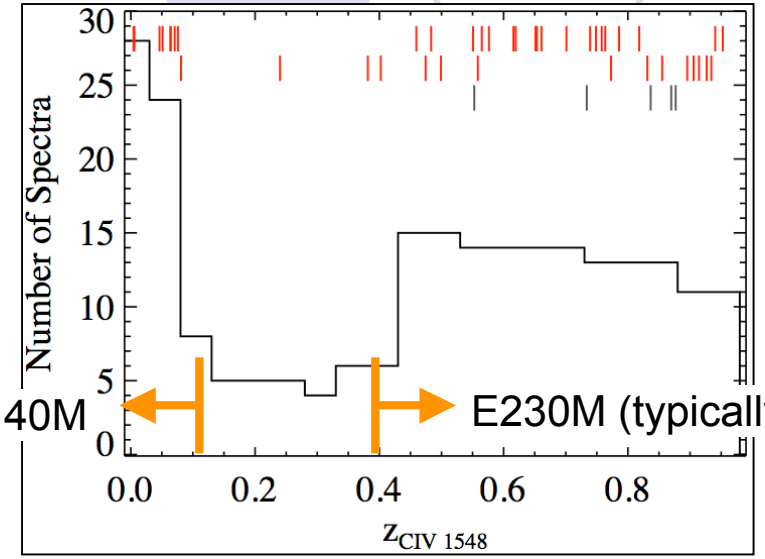
- CIV in z < 1 IGM
  - Measure Ω_{CIV}
- IGM-galaxy connection
  - Compare abundances

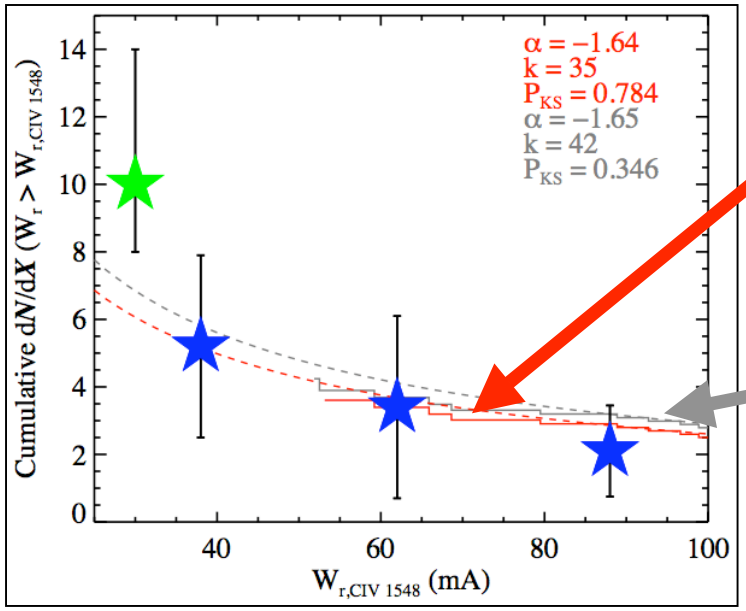




(Plotted points normalized to same H_o)

CIV Sample





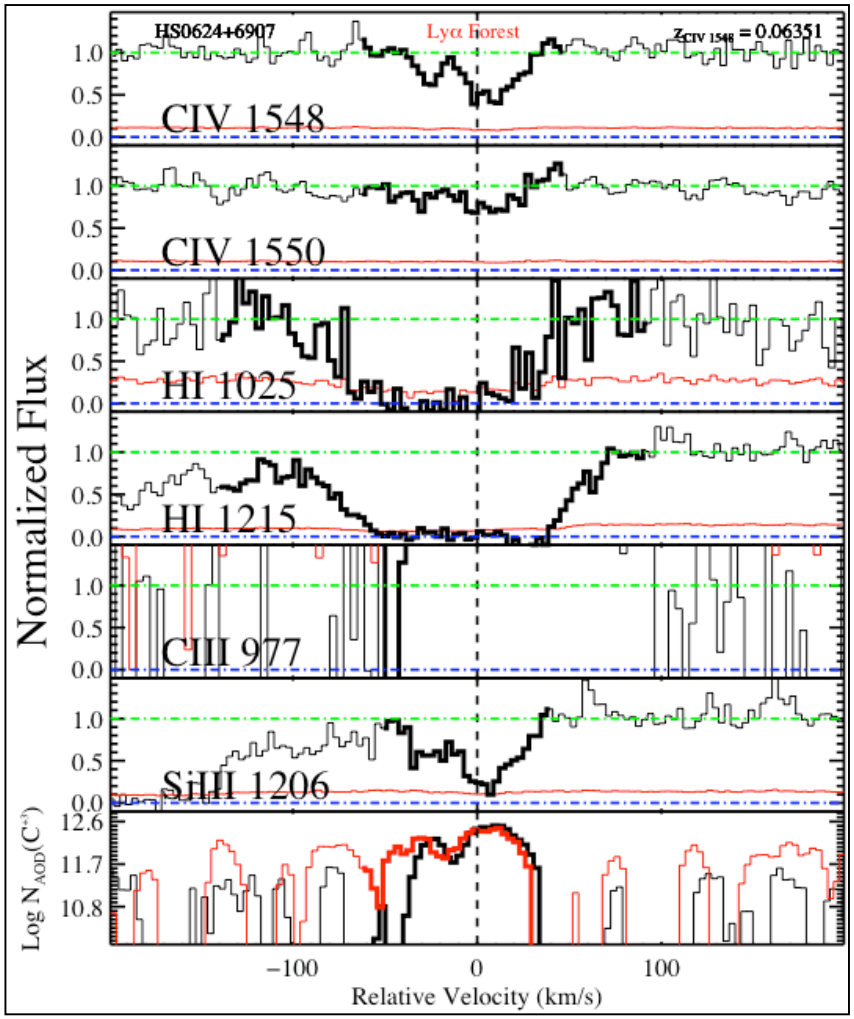
- 48 lines of sight
- Blind CIV search
  - Ultimately, $W_r \geq 3\sigma$ for both lines
- d*N*/d*X* = 4.2 ($W_{r,CIV\ 1548} \geq 52$ mÅ)

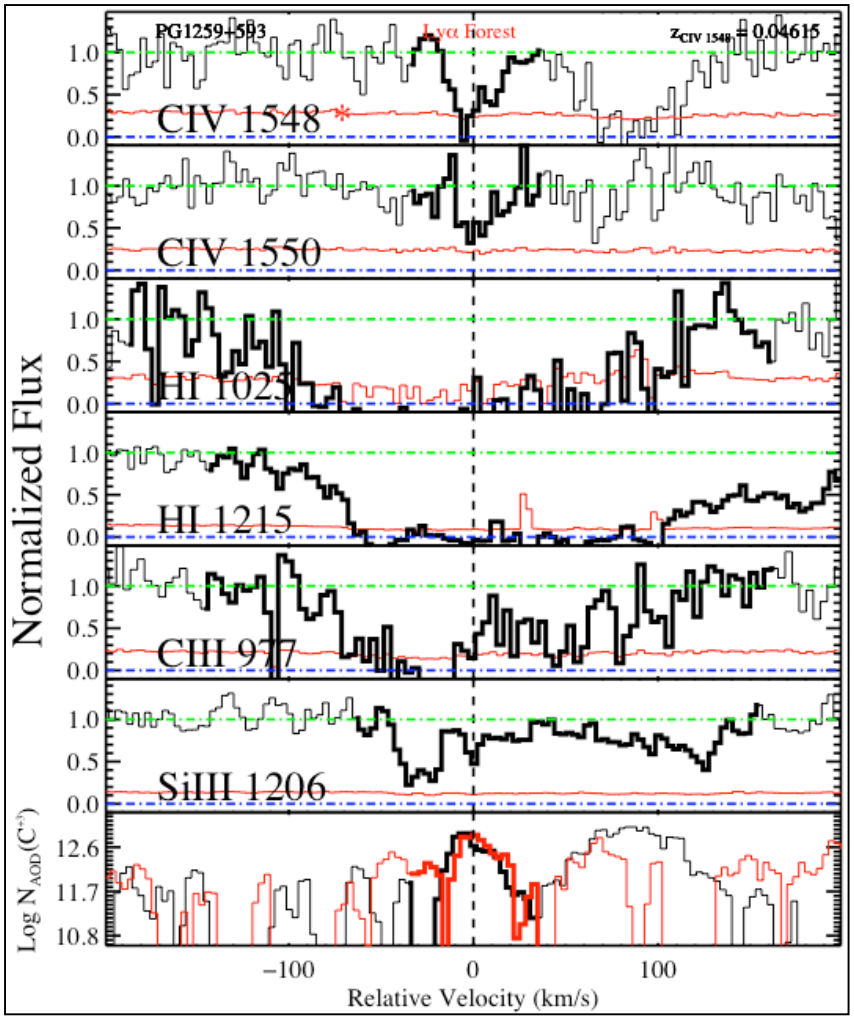
Group	*N*	$W_r \geq 3\sigma$	Unsat
Definite	49	42	27
Likely	19	5	5
Total	68	47	32

★ Danforth & Shull 2008
★ Frye+ 2003

Example CIV: Consensus at z ≤ 0.1

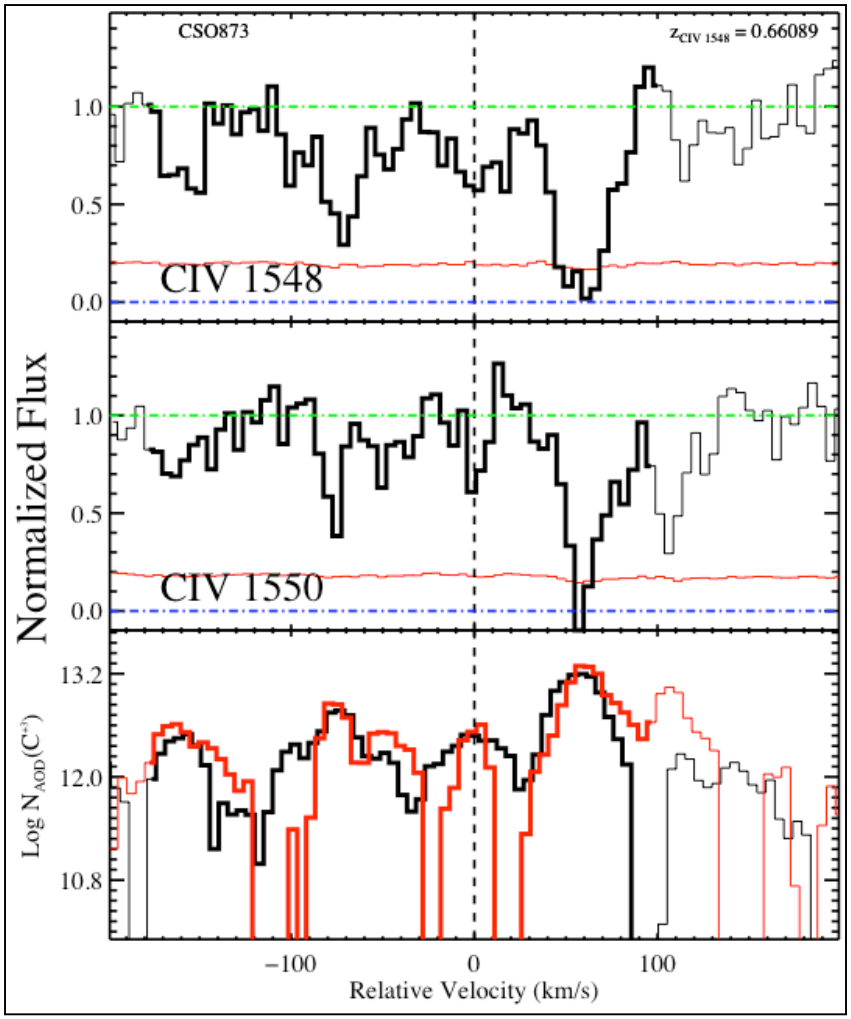
- Agree with Frye+ 2003 and Danforth & Shull 2008

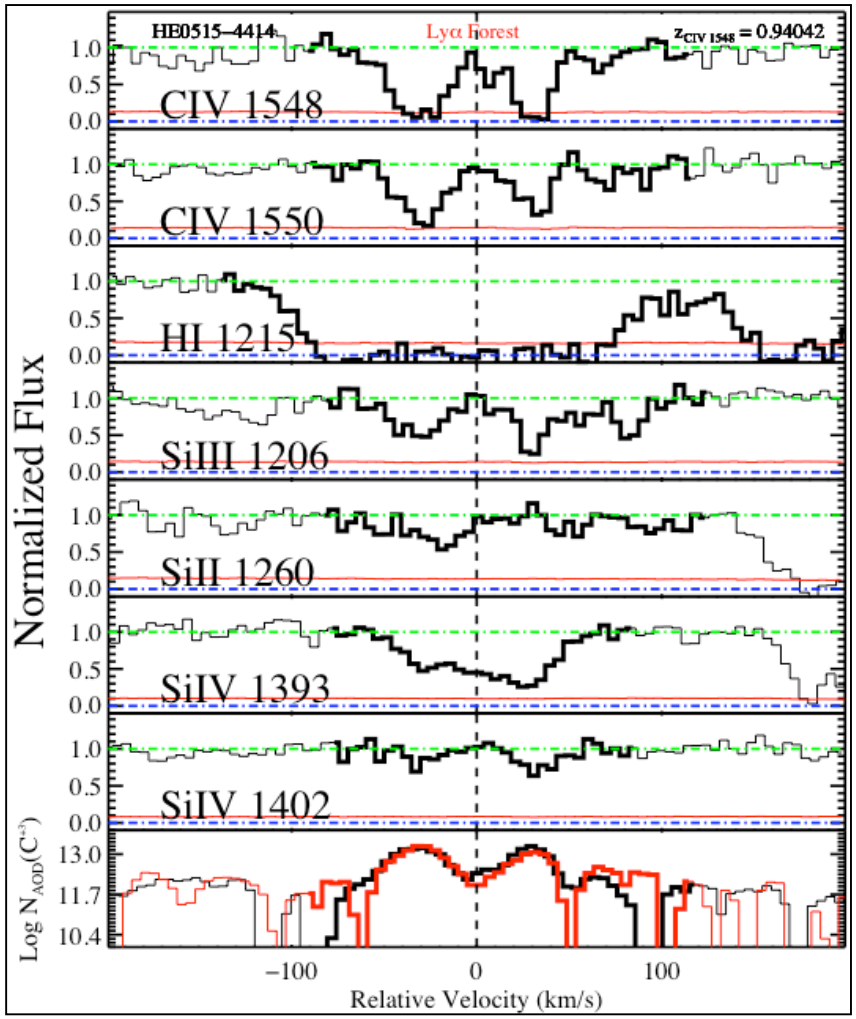




Example CIV: Consensus at z > 0.4

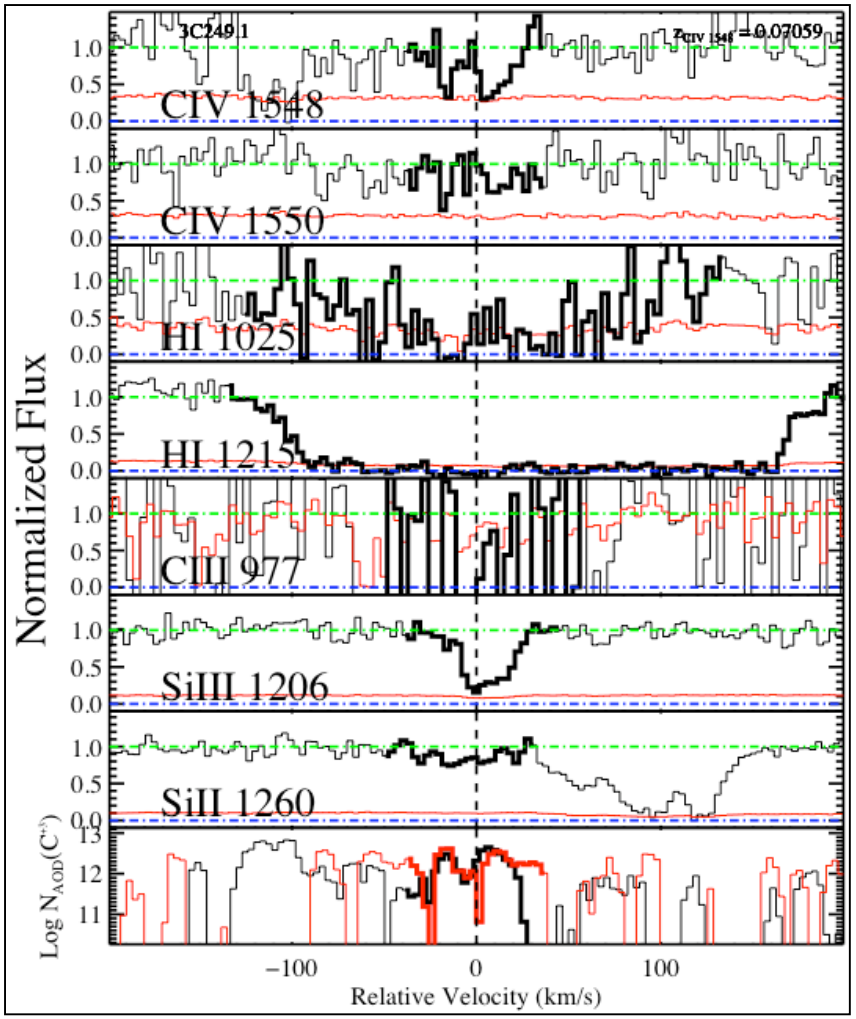
- Agree with Milutinovic+ 2007

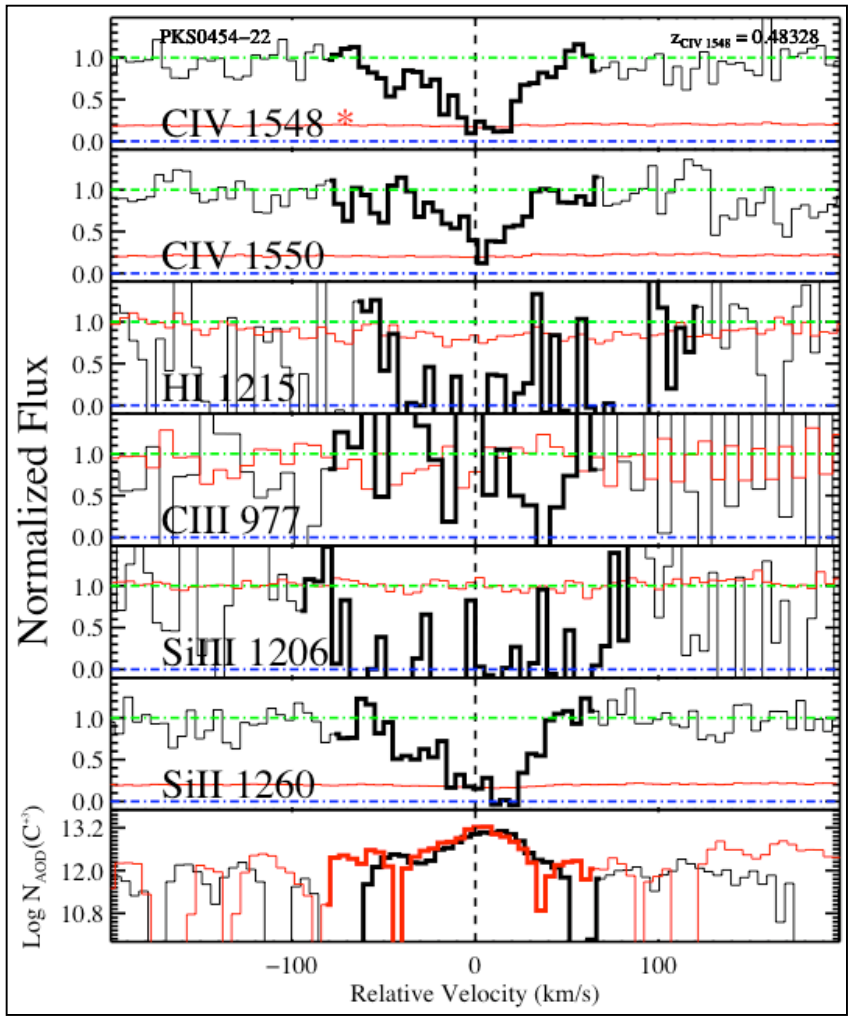




Example CIV: New at z < 1

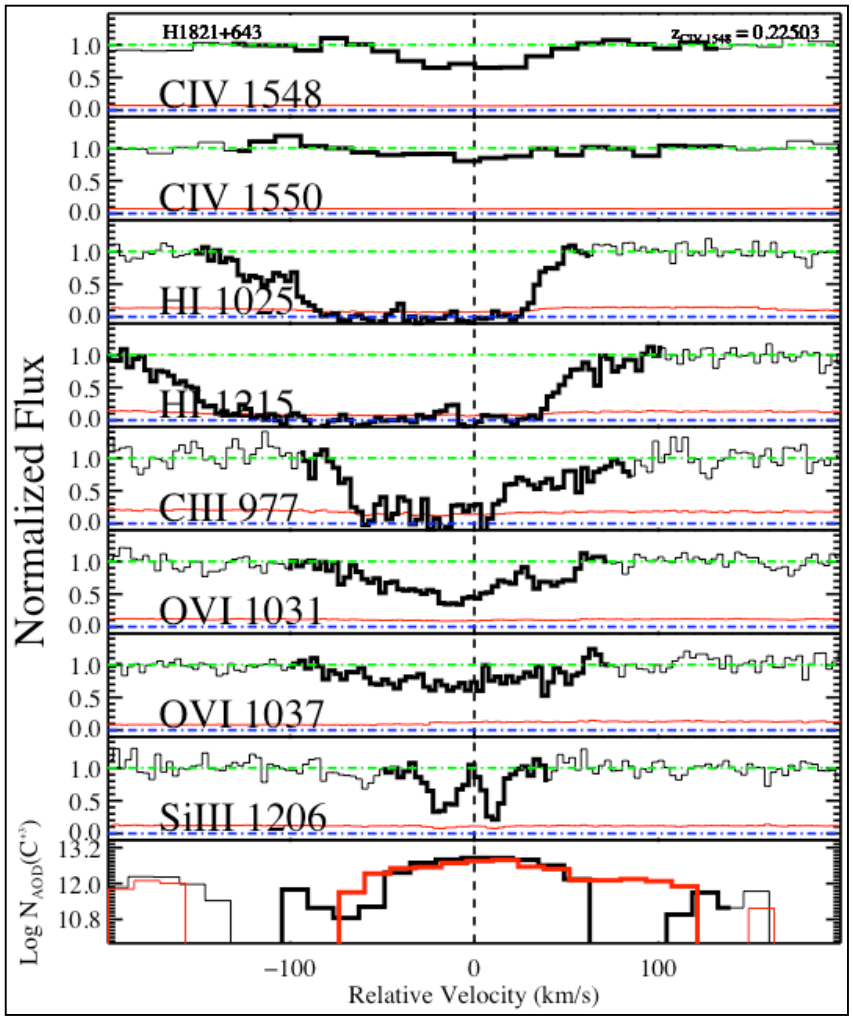
- Sightlines not in other studies at z < 1



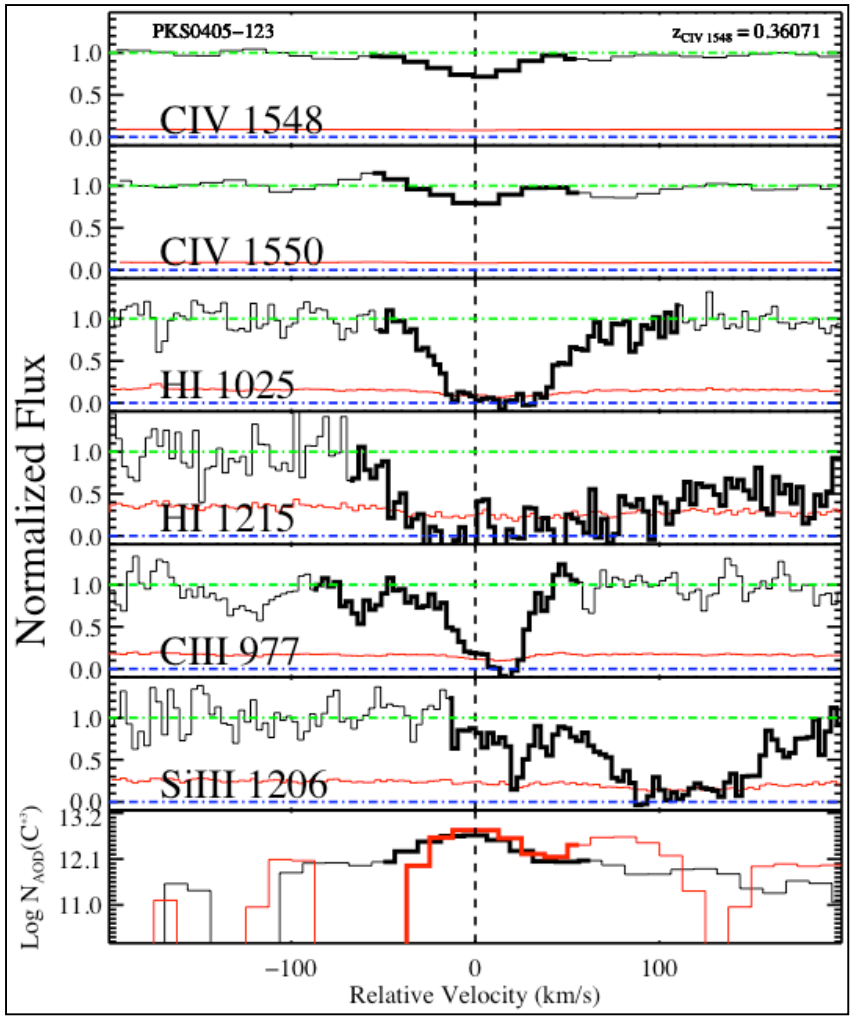


Example CIV: GHRS Detections

- However, CIV 1550 < 3σ



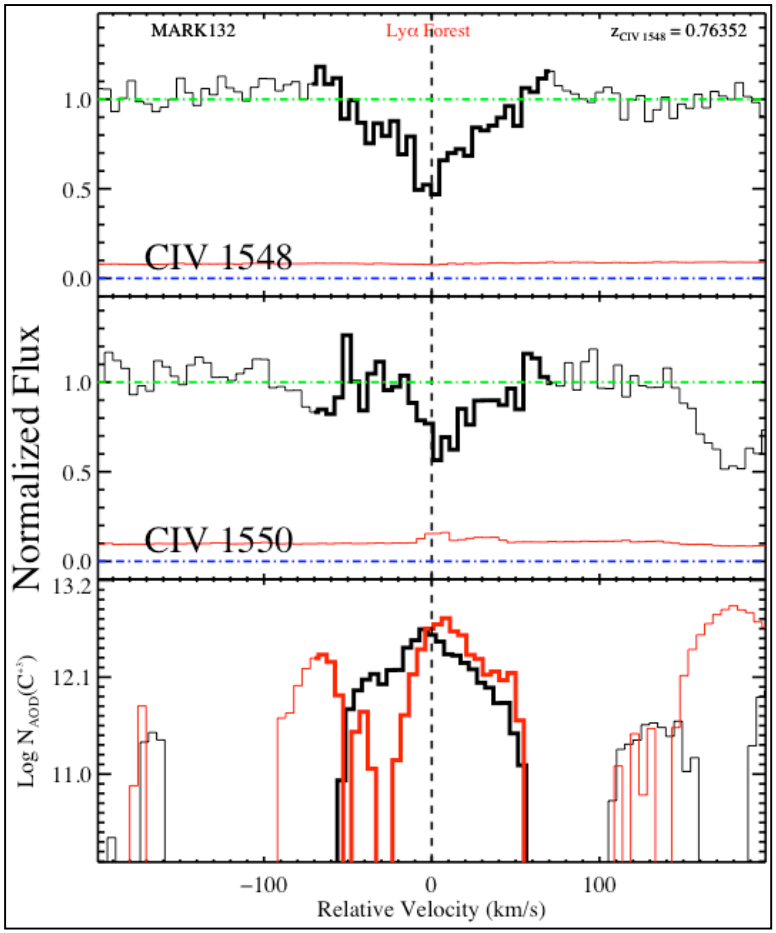
(See e.g., Thom & Chen 2006 or poster 482.07)

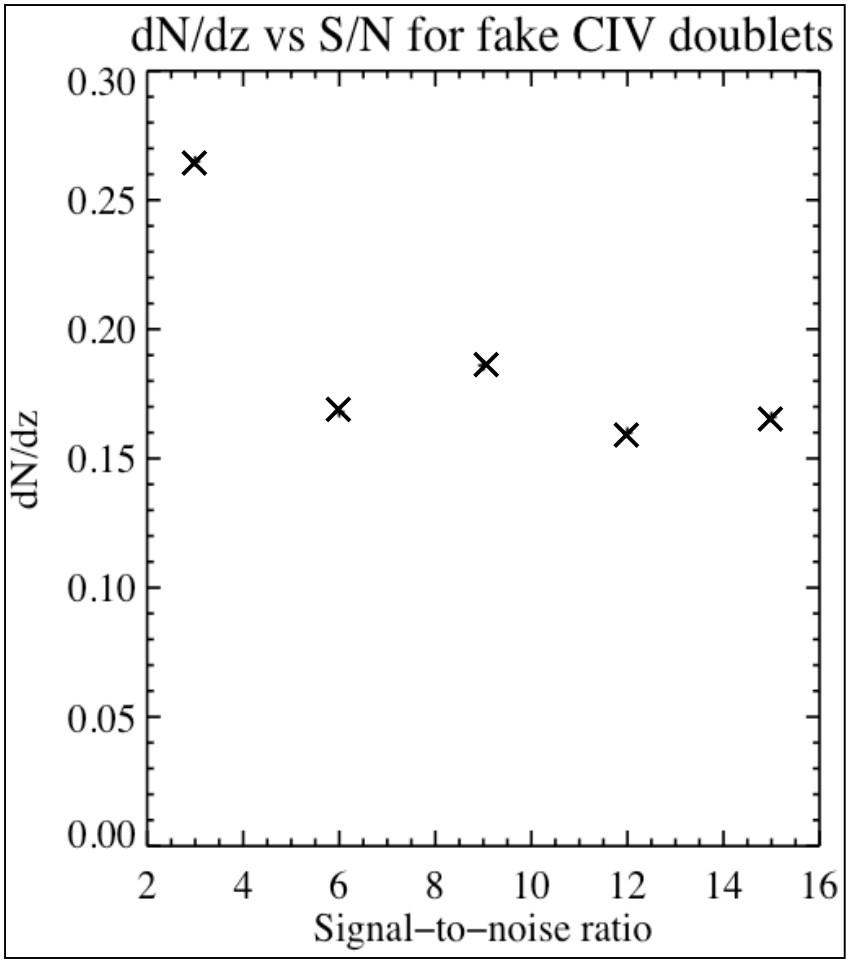


(See e.g., Prochaska+ 2004)

Lyα Contamination

- Fraction of CIV sample that are coincident Lyα forest lines

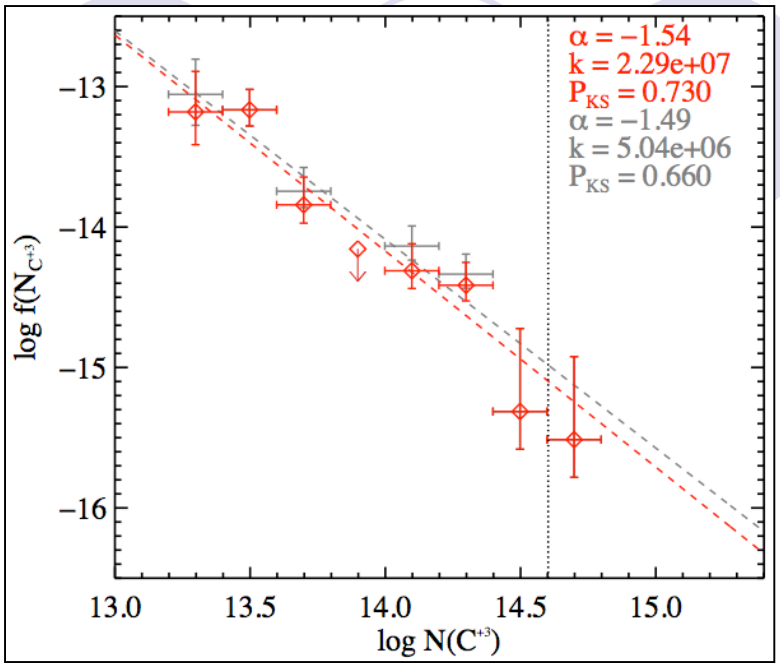




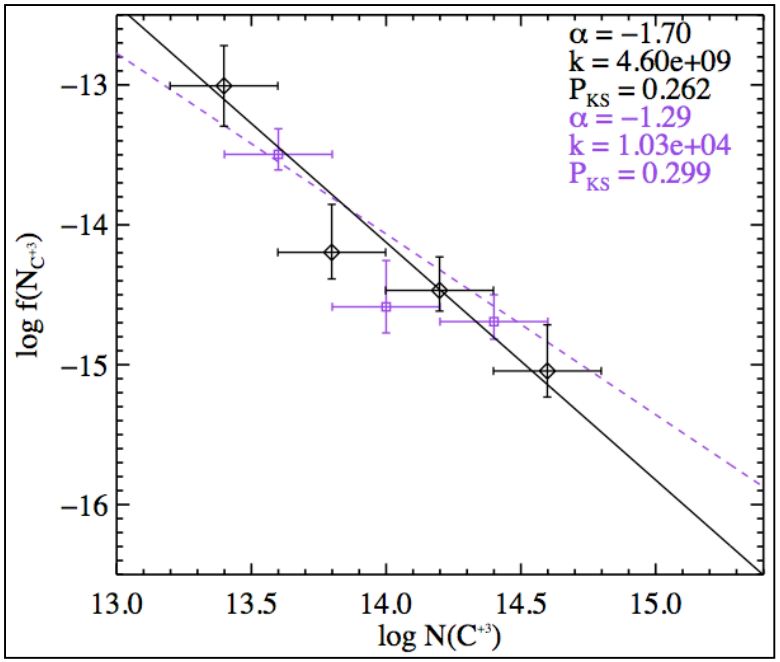
(Compliments of Chris & Hsiao-Wen)

Frequency Distribution

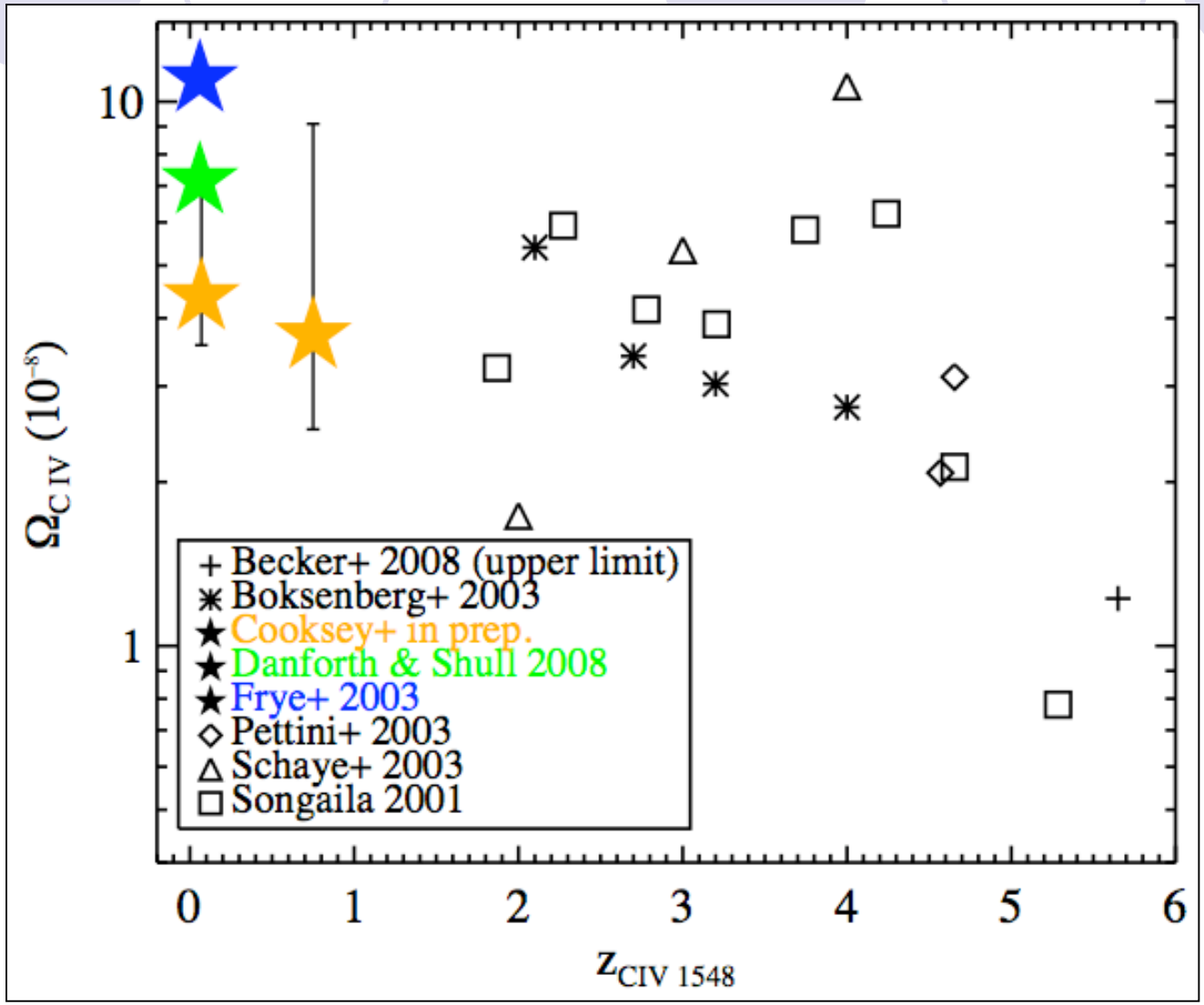
- $\alpha \approx -1.5$ for $z < 1$
  - Fit to 27 definite CIV (red) and 32 total (gray)



- $\alpha = -1.7$ for $z < 0.6$
  - Similar to Danforth & Shull 2008 ($\alpha = -1.79$)
- $\alpha = -1.3$ for $z \geq 0.6$
  - Lower than high-z studies ($\alpha \approx -1.44$)

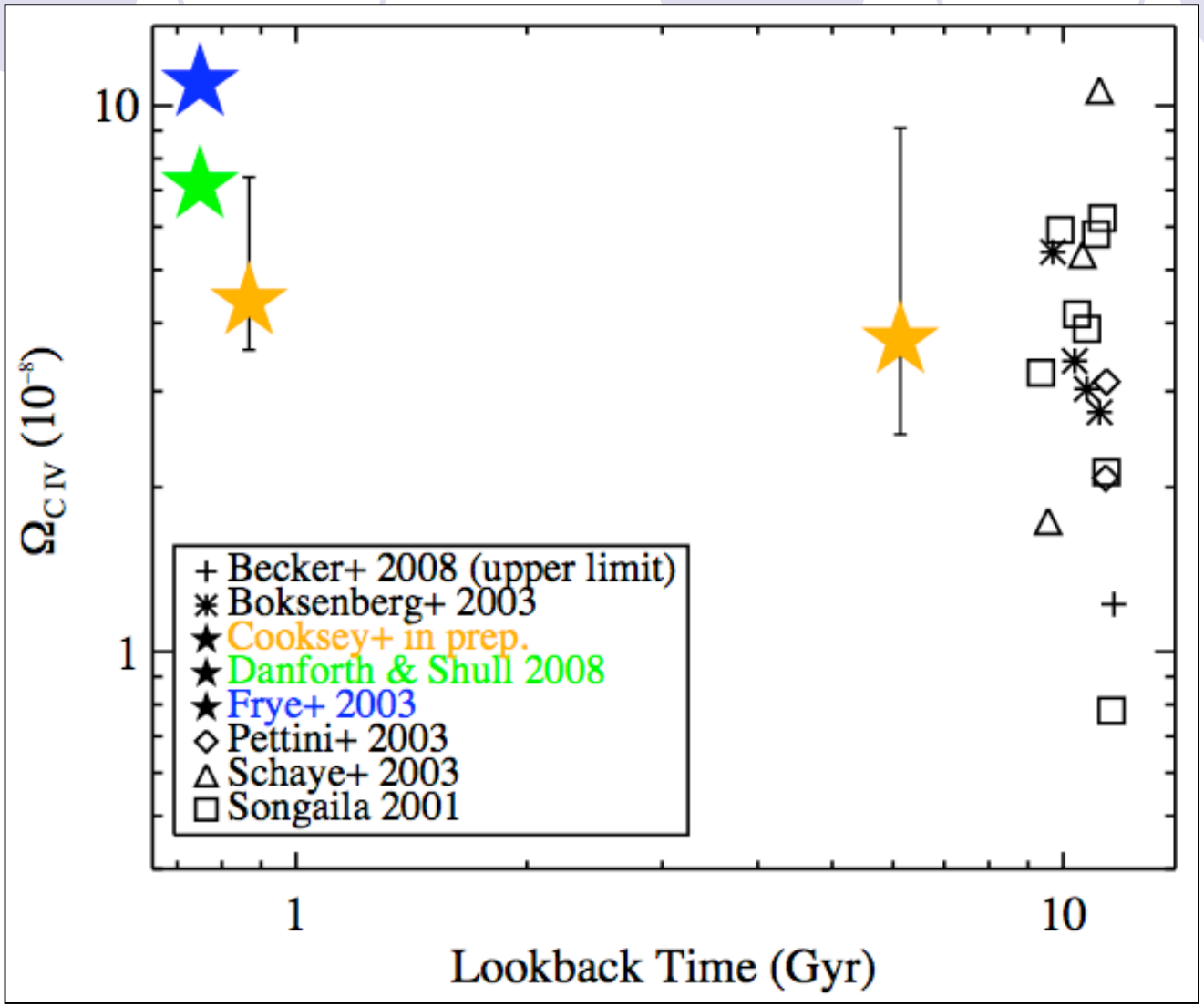


CIV Mass Density: Over Redshift



(Plotted points normalized to same H_o)

CIV Mass Density: Over Time

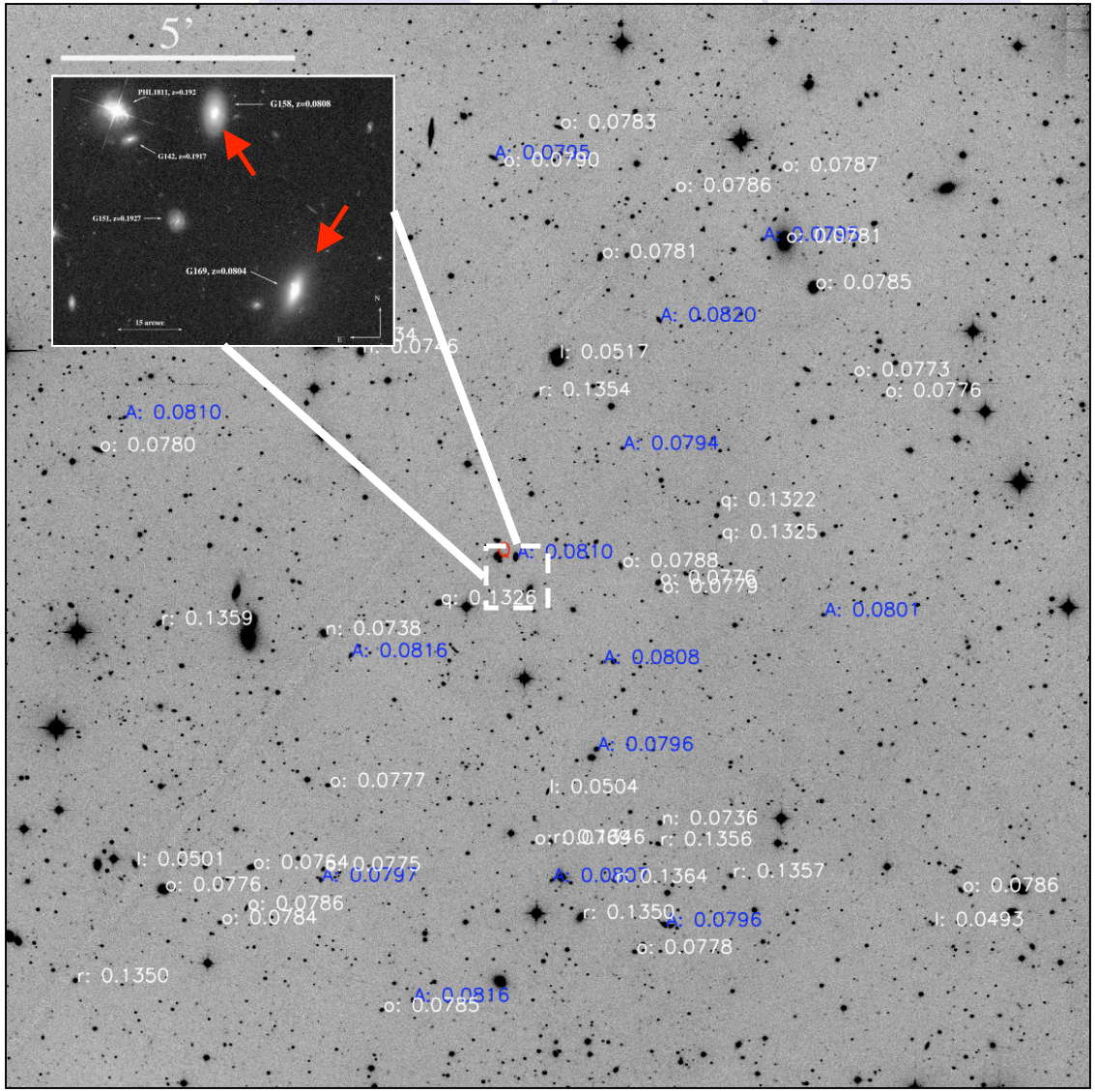


(Plotted points normalized to same H_o)

343.03: K. Cooksey

IGM-Galaxy Connection

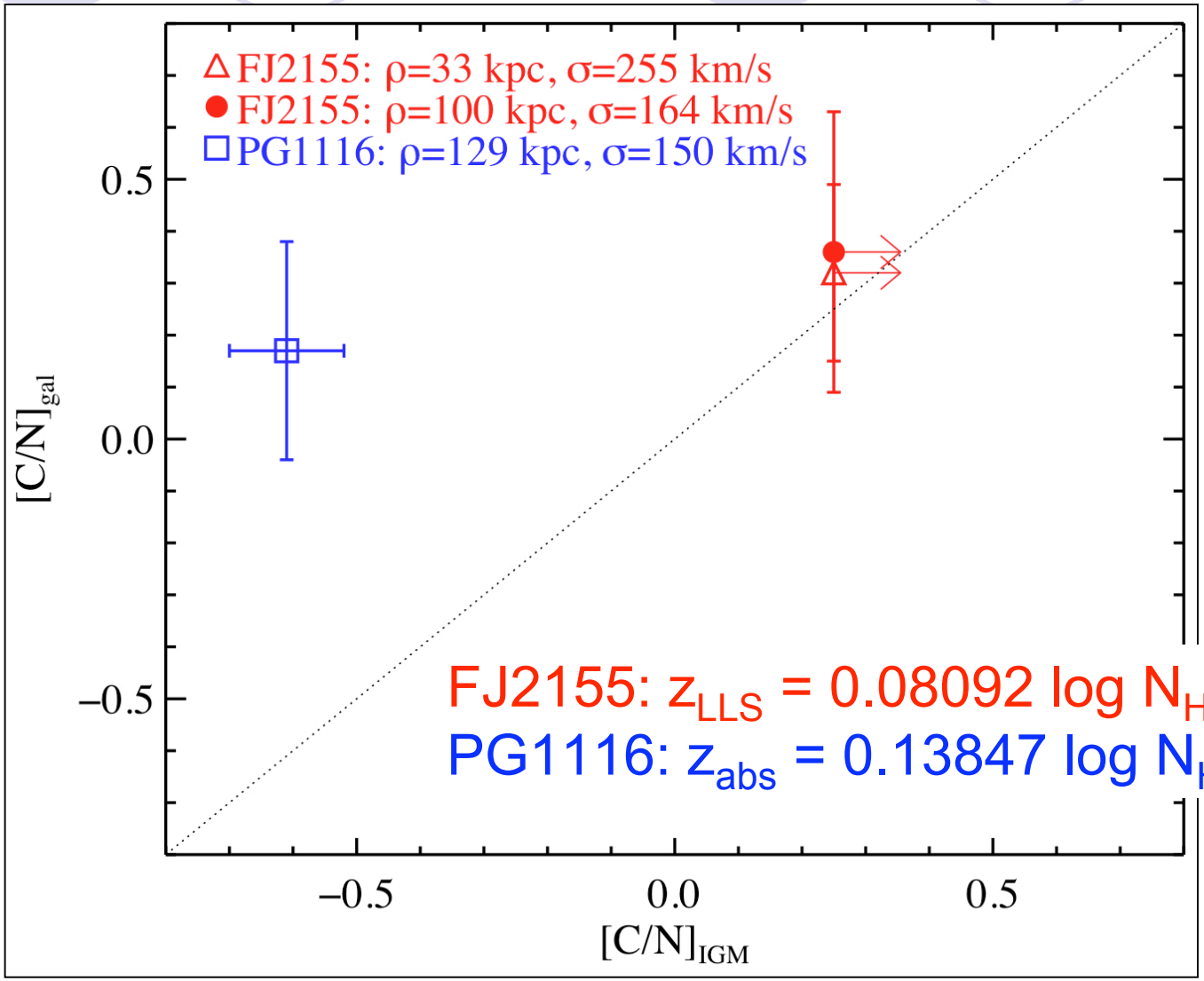
- Galaxies close to LOS
  - ρ < 150 kpc; $|\delta v|$ < 500 km/s
- Follow-up LRIS spectra
  - 3 galaxies close to 2 *published* log N_{HI} > 15 metal-line systems
- Measure IGM and galaxy abundances
  - IGM: CLOUDY
  - Galaxy: EZ_Ages



Blue: FJ2155-092: galaxies with $|\delta v|$ < 500 km/s of z_{LLS} = 0.08092

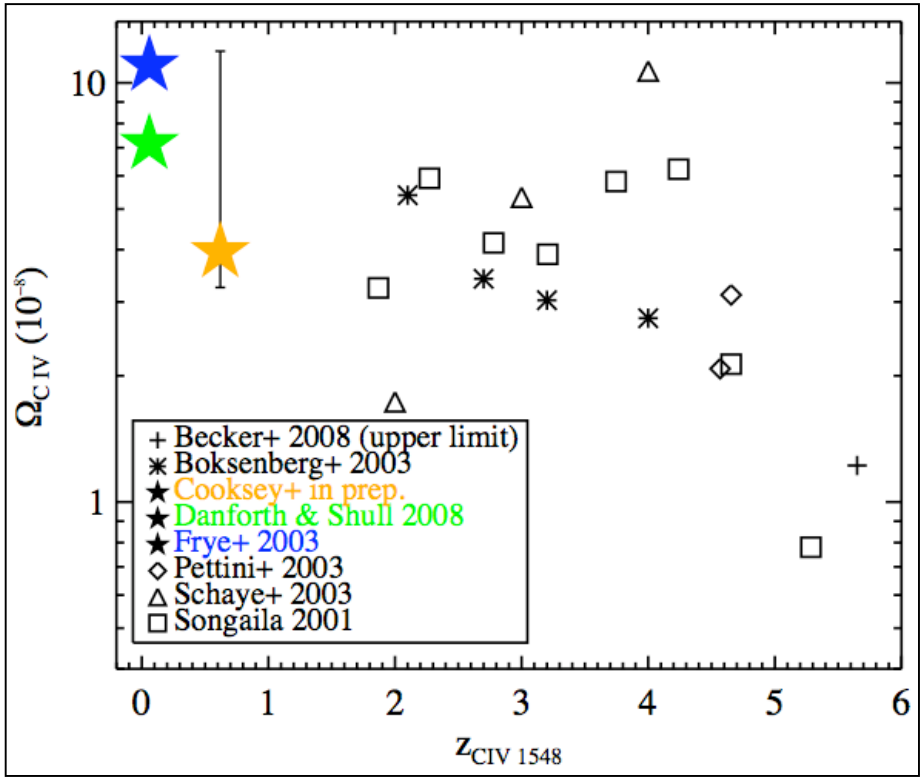
Inset: ACS image (Jenkins et al 2005)

IGM-Galaxy Metals Connection?



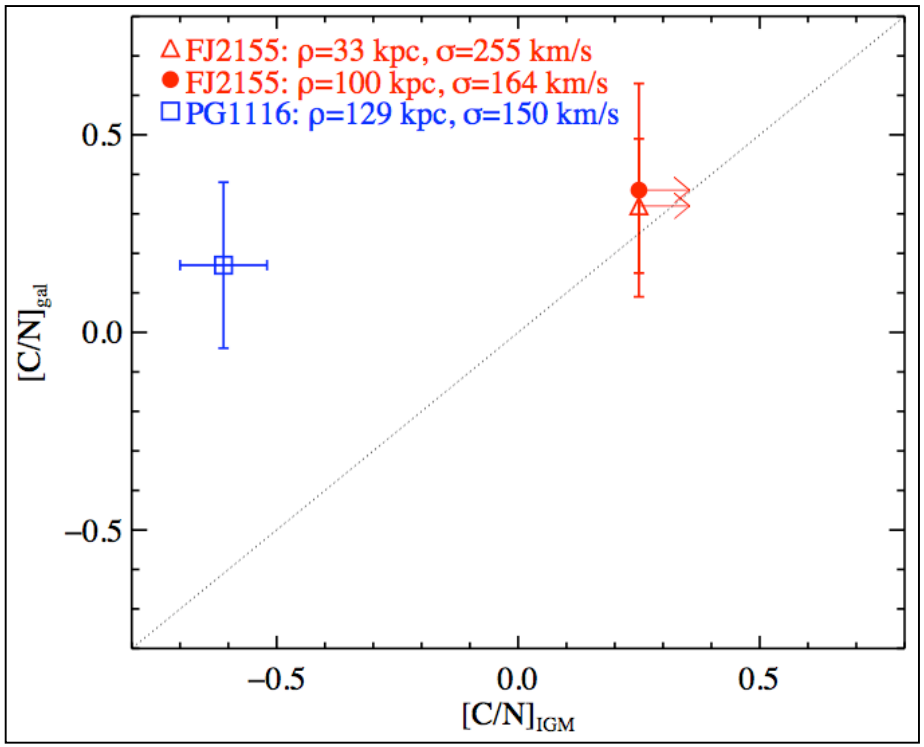
Summary

- Ω_{CIV} at z < 1 consistent with z > 1.5



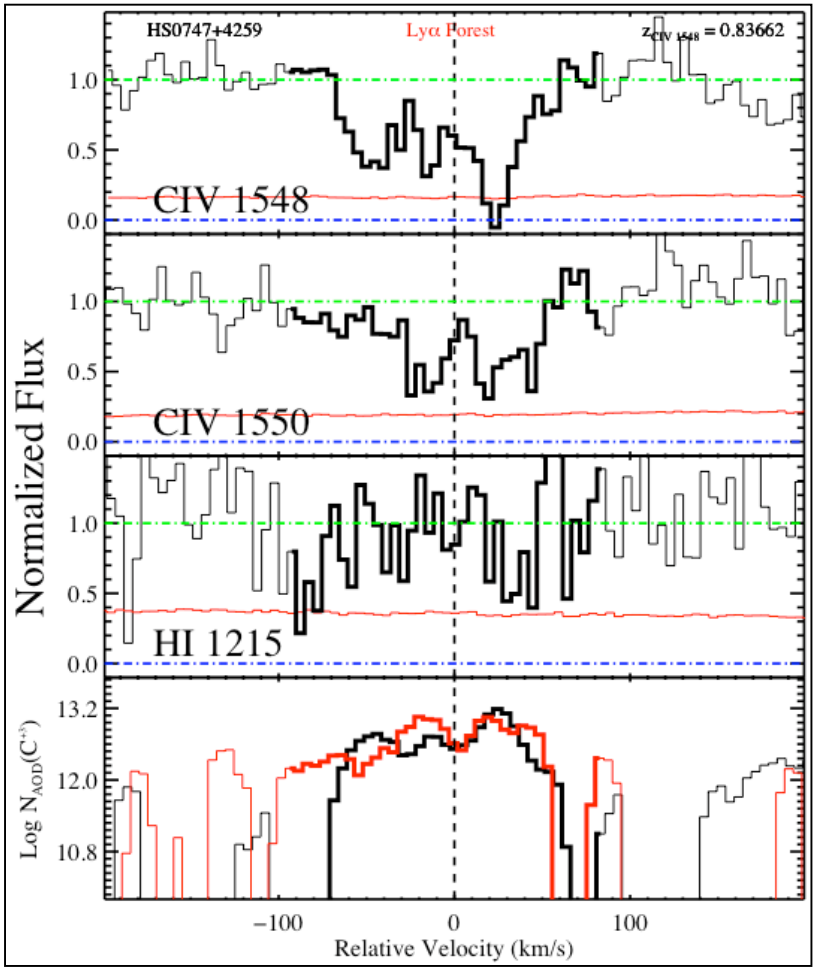
(Plotted points normalized to same H_o)

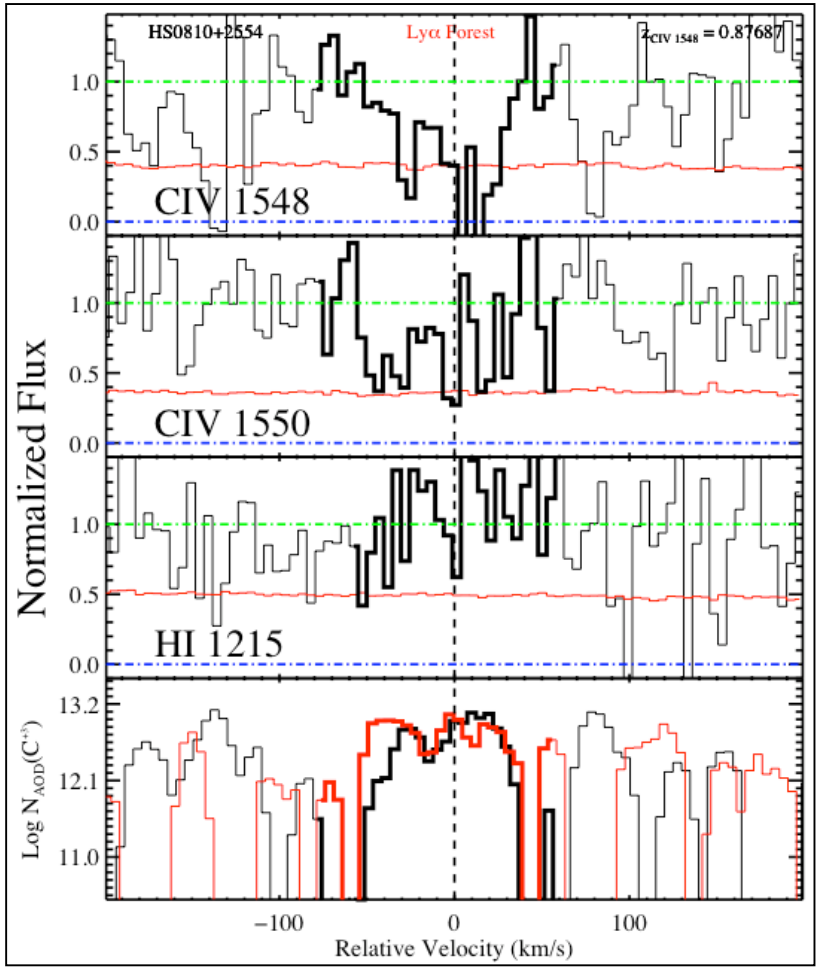
- $[C/N]_{gal}$ mimic $[C/N]_{IGM}$ in one system



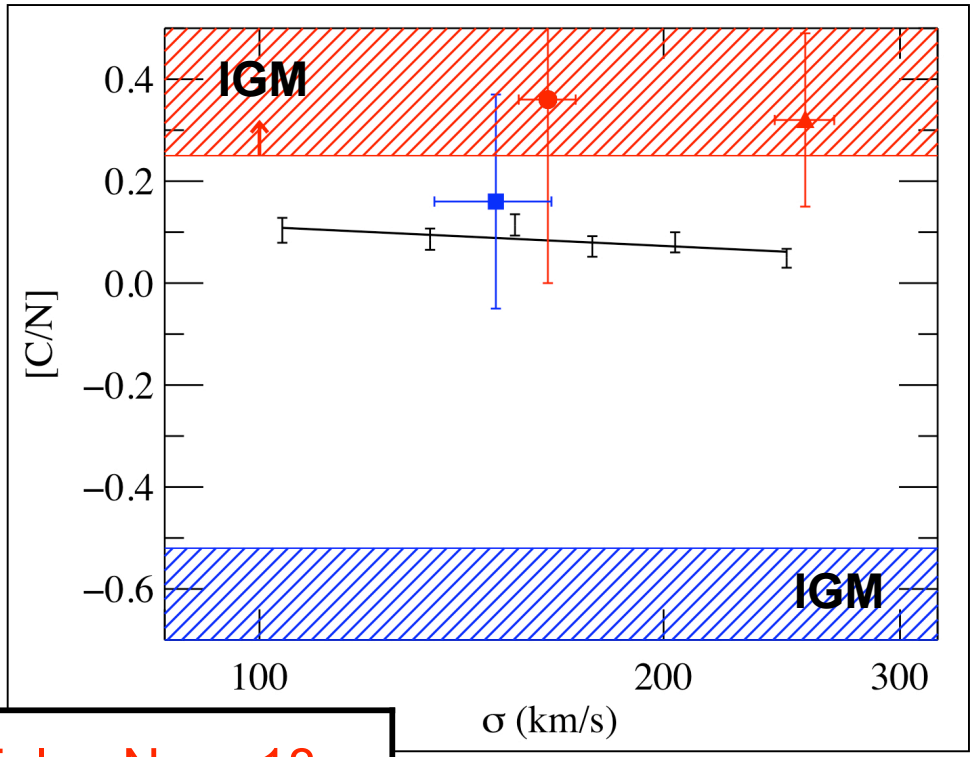
CIV without Lyα

- Purpose of blind survey
- Are these believable?





Galaxy Metallicities



	PG1116: log N_{HI} = 16.2	FJ2155: log N_{HI} = 18	
		z_{gal} = 0.0804	z_{gal} = 0.0808
ρ (kpc)	129 ■	100 ●	33 ▲
Age (Gyr)	8.8 ± 2.9	15.1 ± 3.4	13.2 ± 1.6
[Fe/H]	-0.03 ± 0.11	-0.31 ± 0.08	-0.68 ± 0.09
[C/N]	0.17 ± 0.21	0.36 ± 0.27	0.32 ± 0.17

(Beware: AGN!)

(σ thanks to Arjen van der Wel)