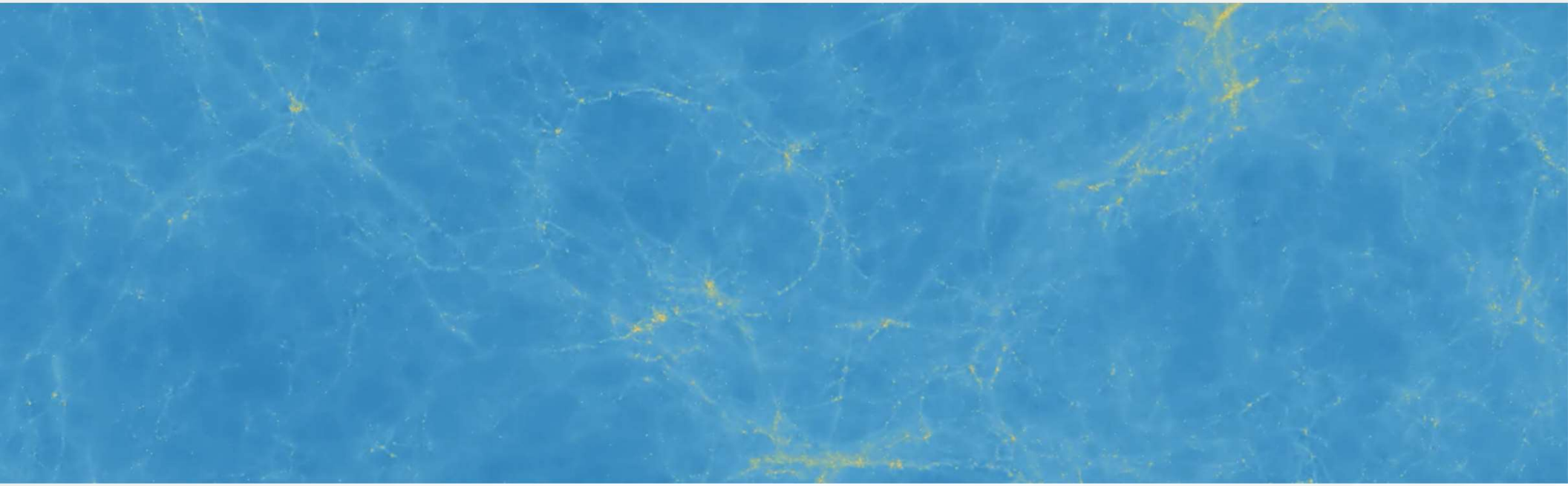
Metal Enrichment during Reionisation using the redshift 7 quasar

Sarah Bosman
University of Cambridge

PhD supervisors: George Becker (UCR) and Martin Haehnelt

Collaborators: Paul Hewett, Richard McMahon, Daniel Mortlock,
Chris Simpson, Bram Venemans

Measuring Metal Enrichment of the CGM using Absorption



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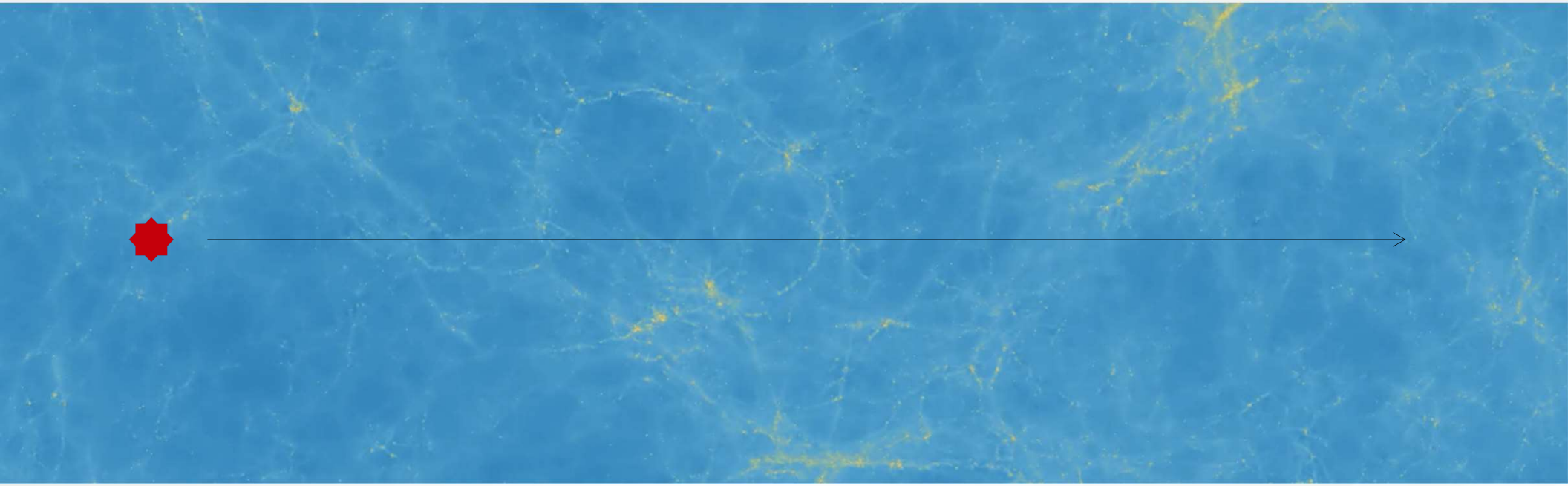

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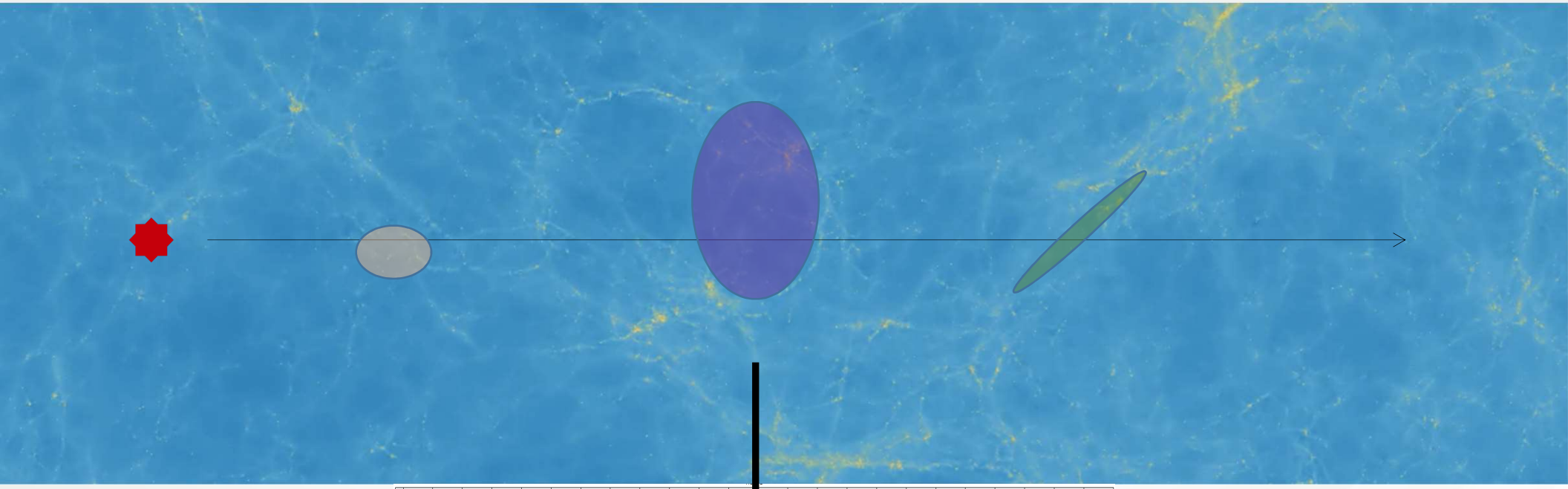
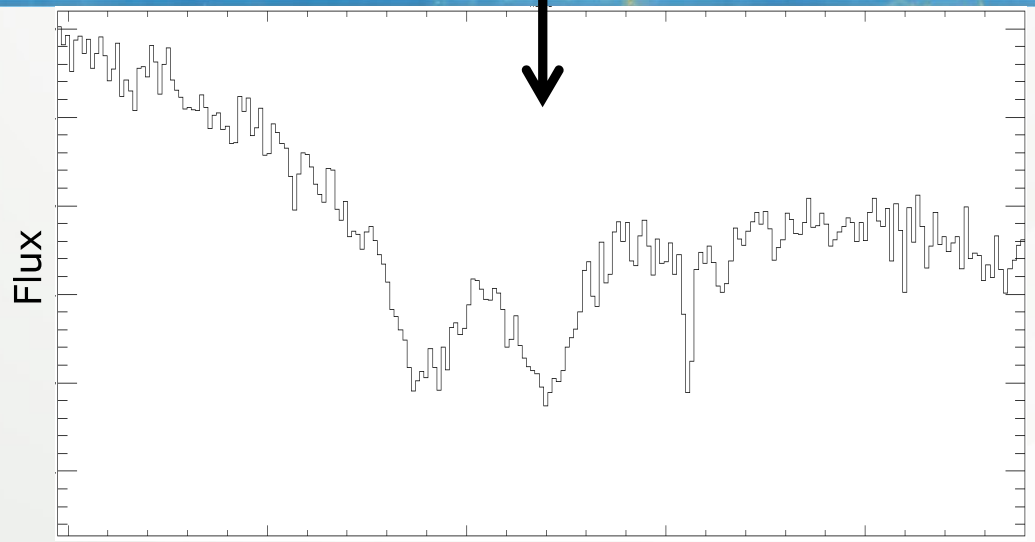
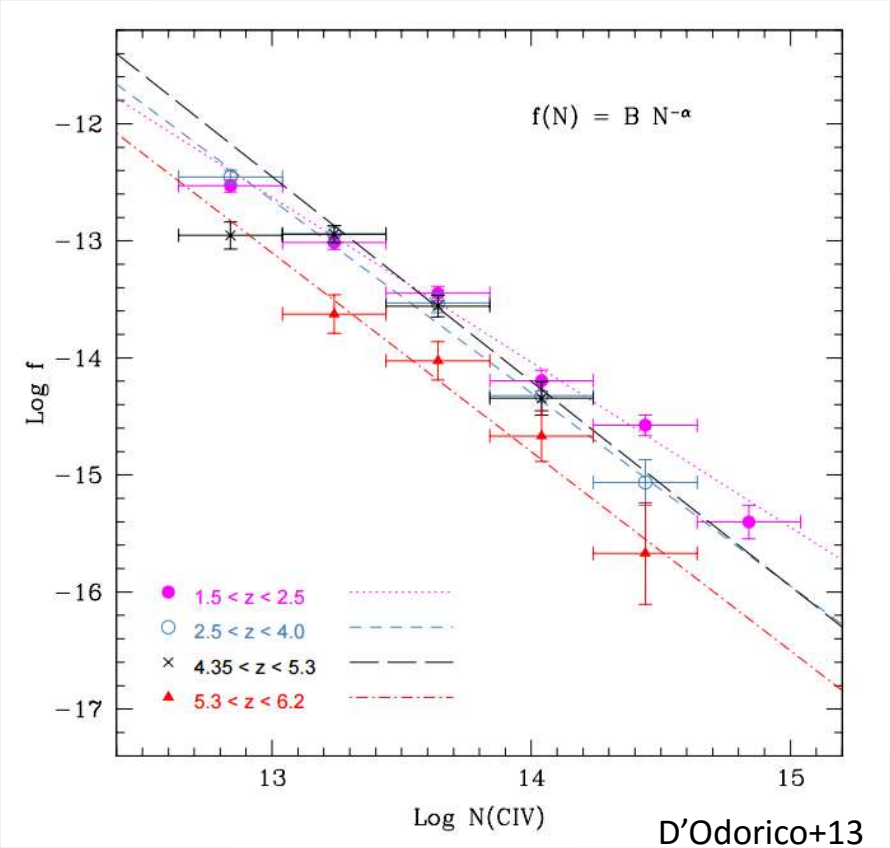
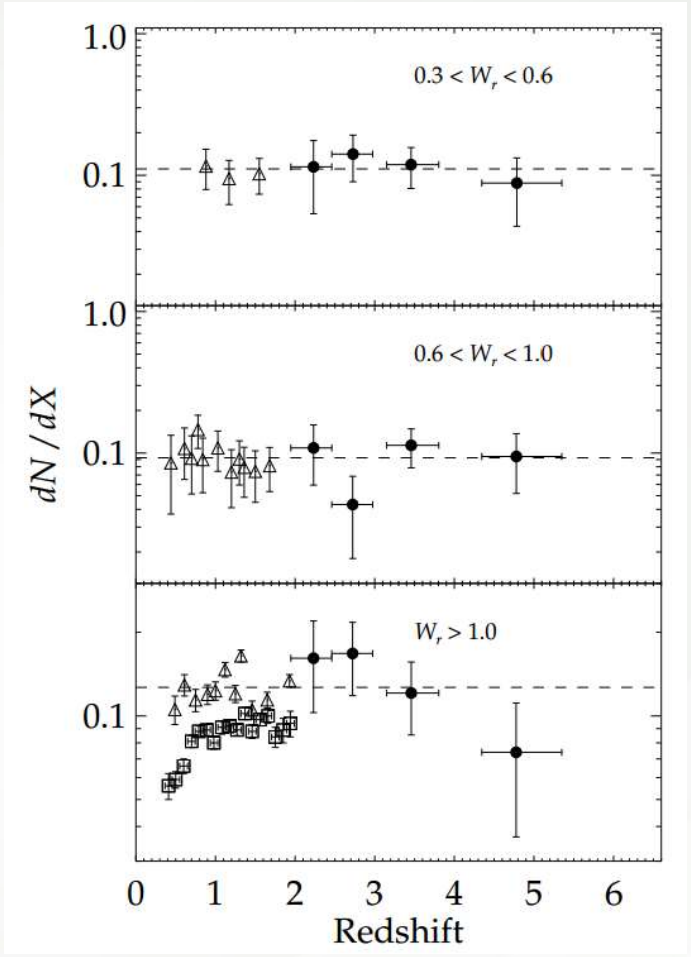




What we know so far



D'Odorico+13

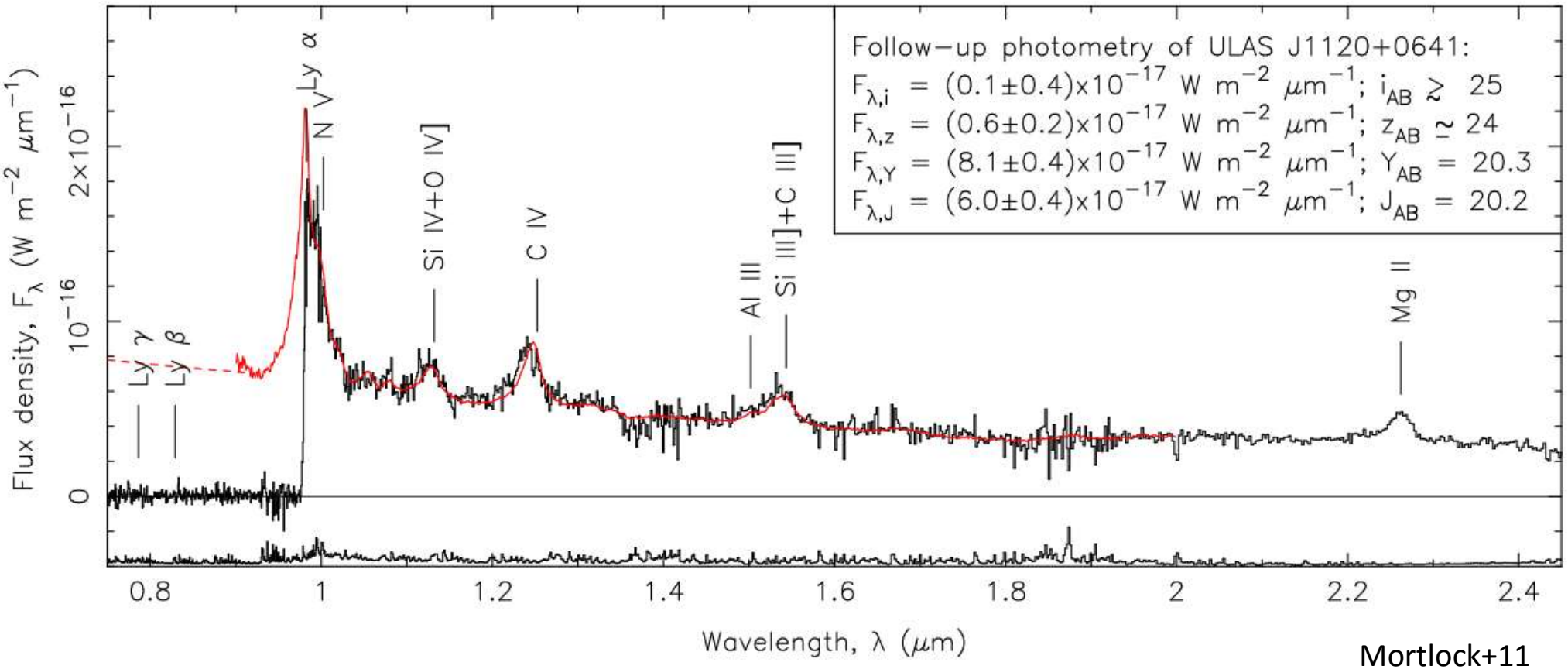


Matejek & Simcoe 11

Highly ionised absorbers (e.g. C IV) go missing with redshift at z > 5.3

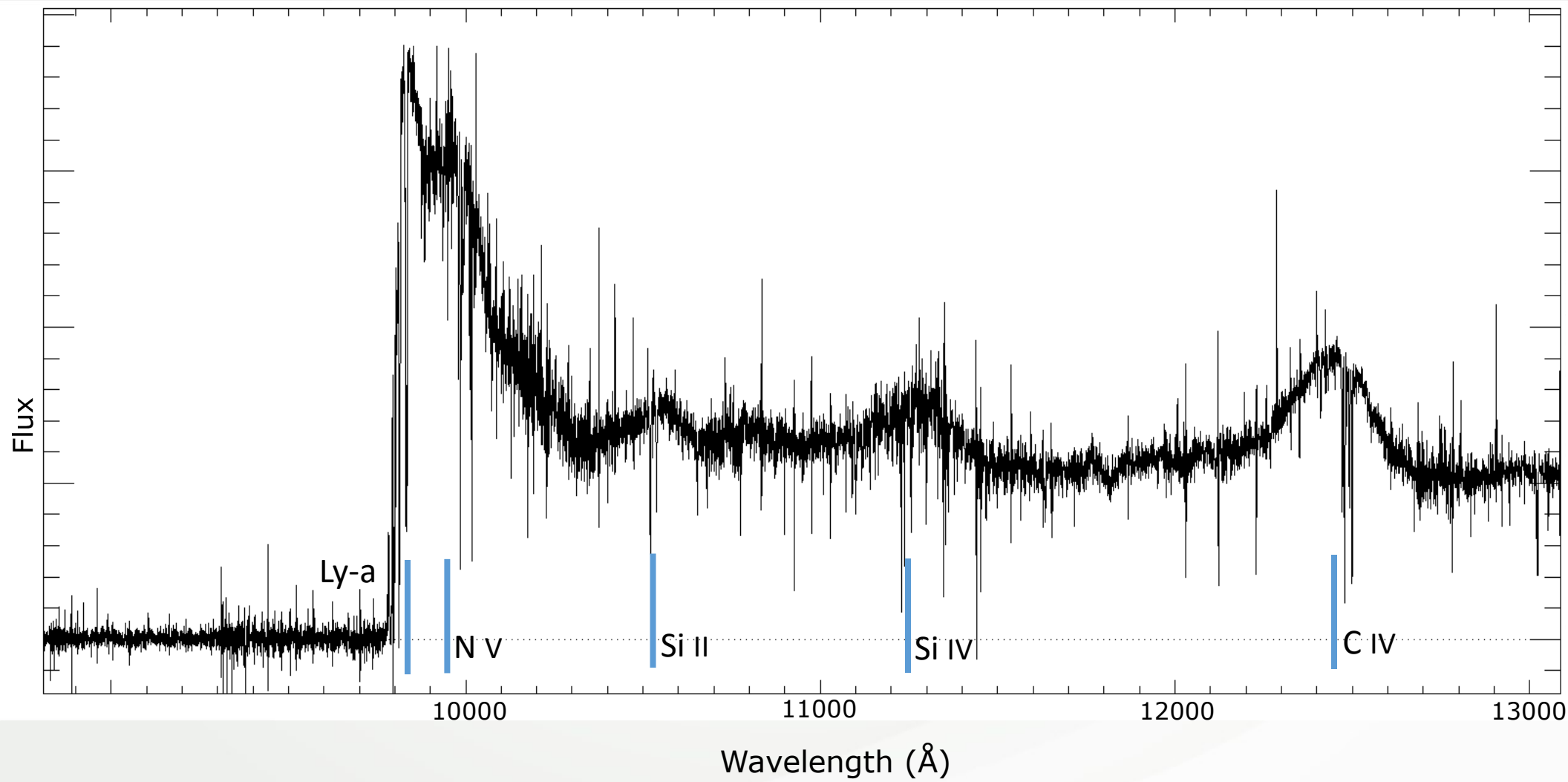
Weak Mg II systems remain constant with redshift – strong ones may track SFRs

Highest redshift line of sight: ULAS J1120+0641 at z = 7.0842



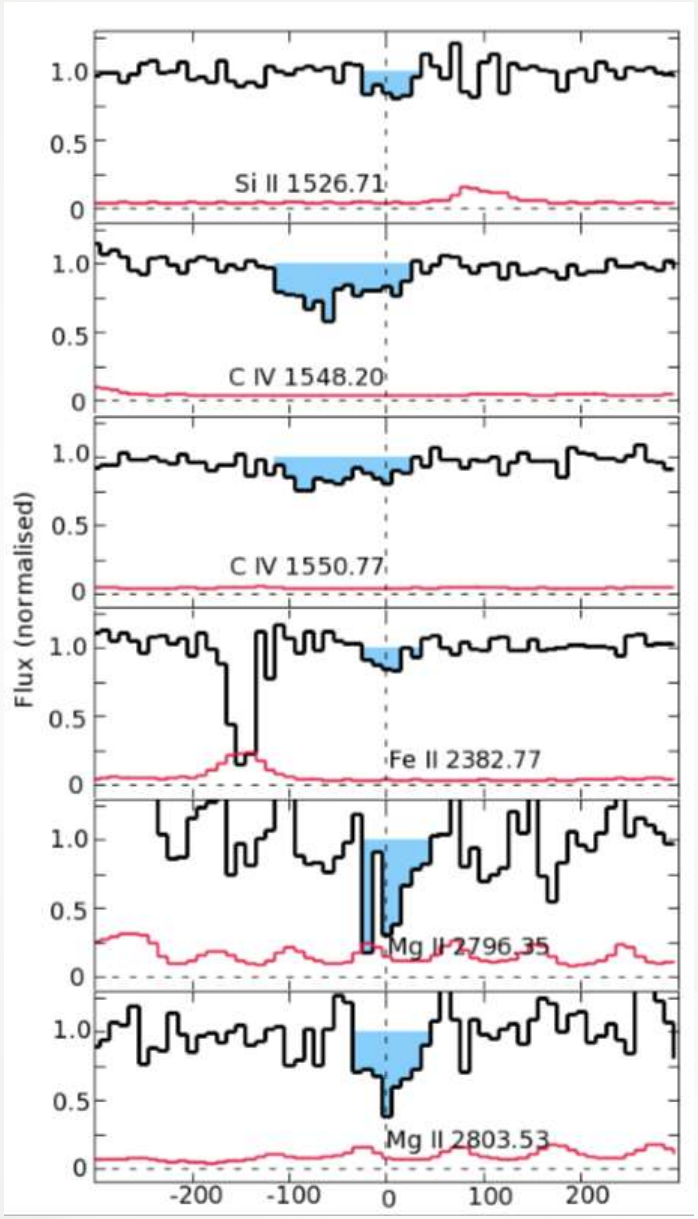
Mortlock+11

Highest redshift line of sight: ULAS J1120+0641 at z = 7.0842



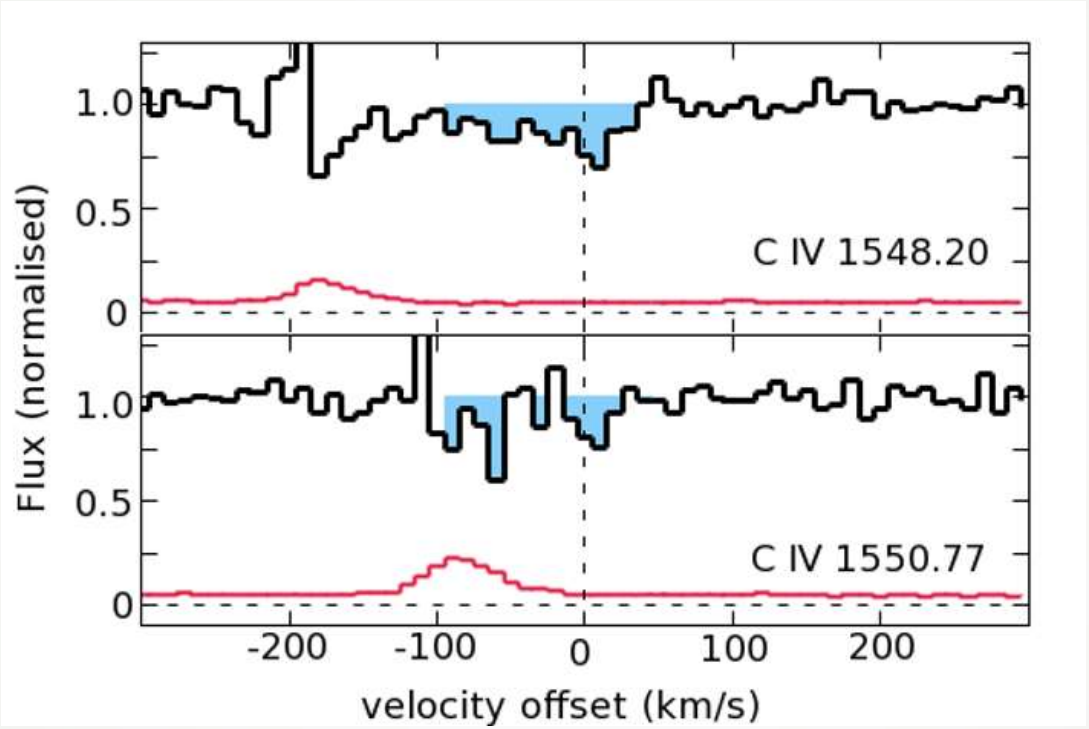
PI George Becker

Results



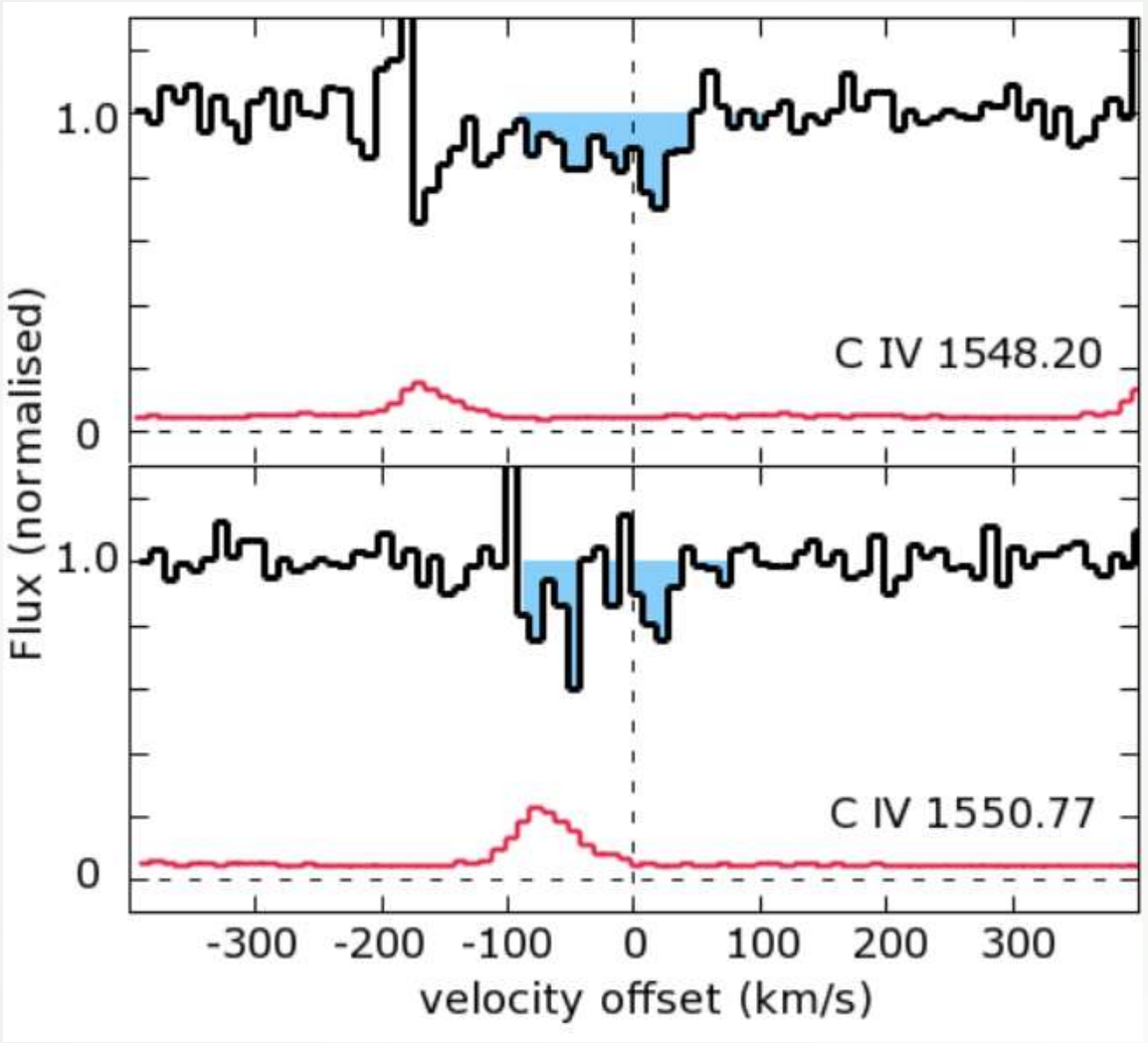
Example system found at z = 6.1711

Results



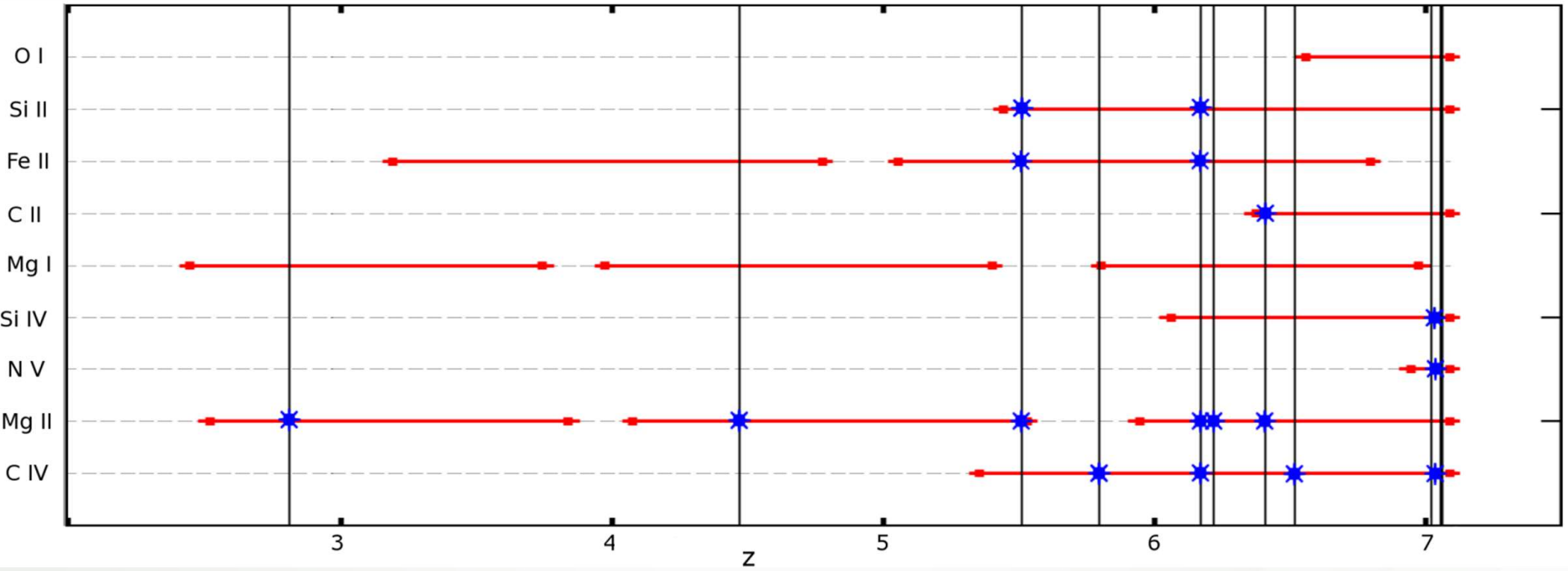
Highest redshift intervening system at z = 6.51511

Results



Highest redshift intervening system at z = 6.51511

Results

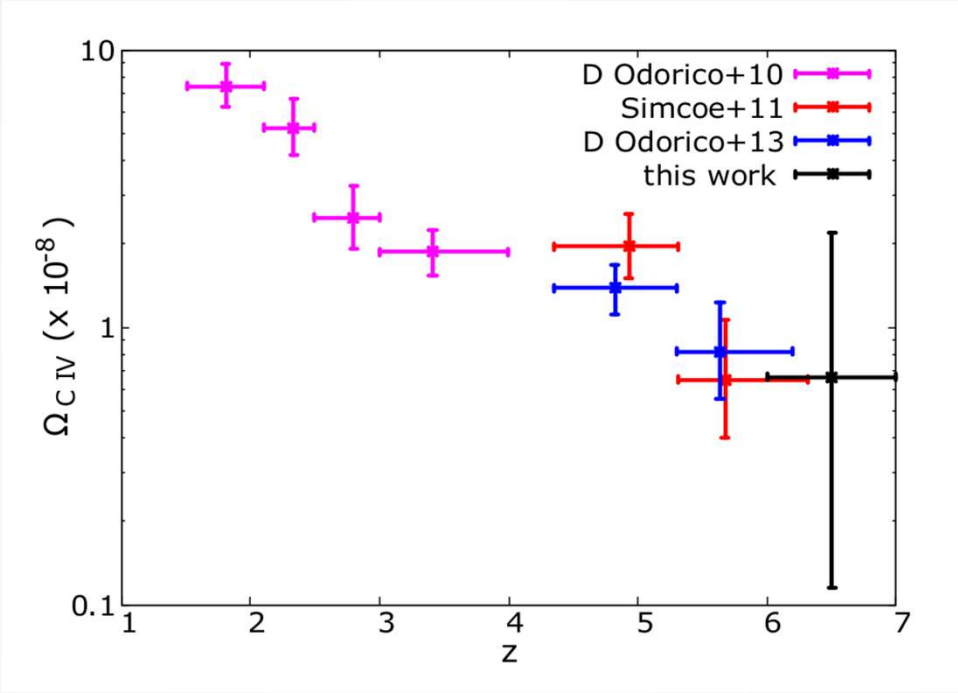


- 6 intervening z > 5.5 systems
- 3 associated z ~ 7 systems
- Highest-z system: C IV at z = 6.51

detection

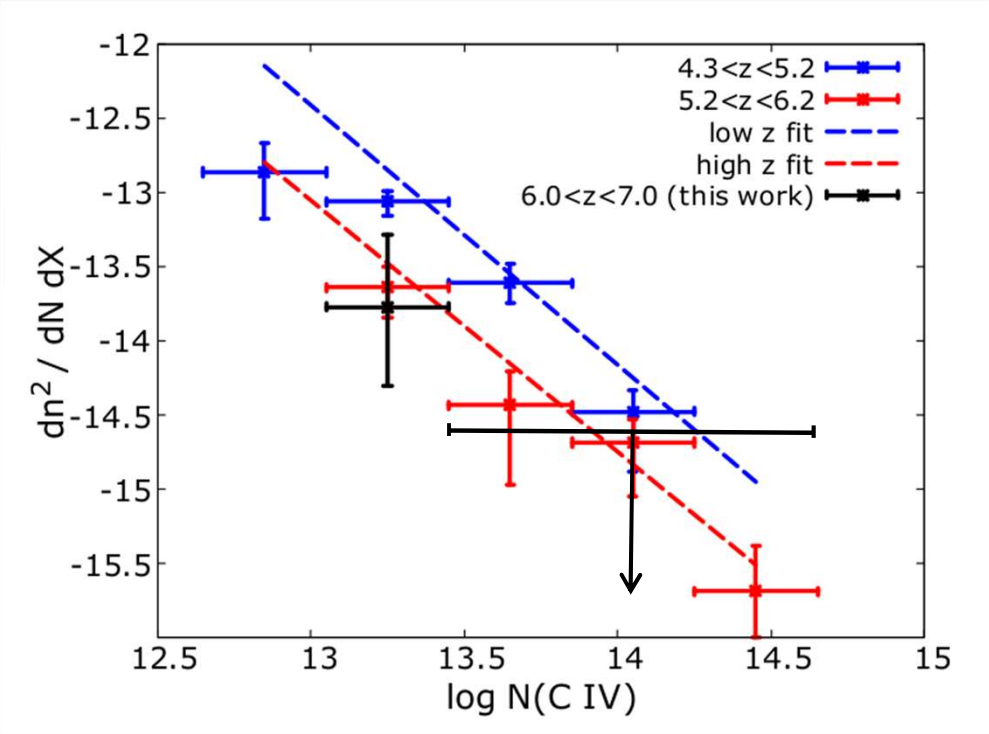
detectability range

C IV consistent with z ~ 5-6 ?



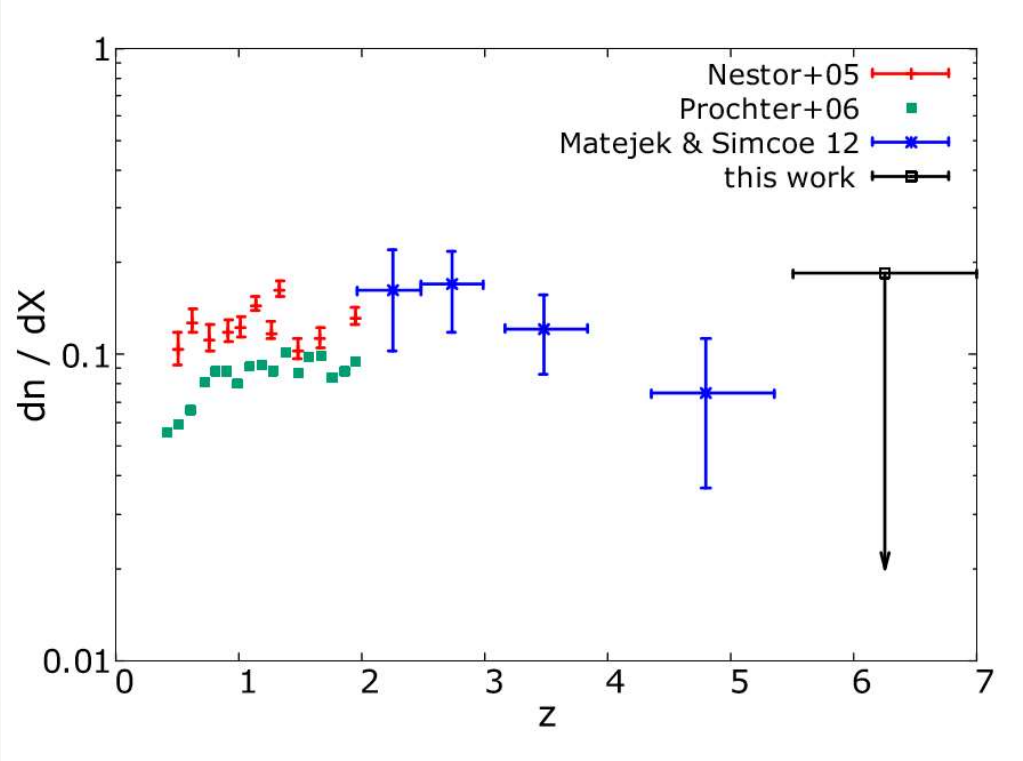
- Cosmic mass fraction of C IV contained in strongly absorbing systems is observed to decline from z = 1 to z = 5.5
- This trend continues or slows down up to z = 7

C IV consistent with z ~ 5-6 ?



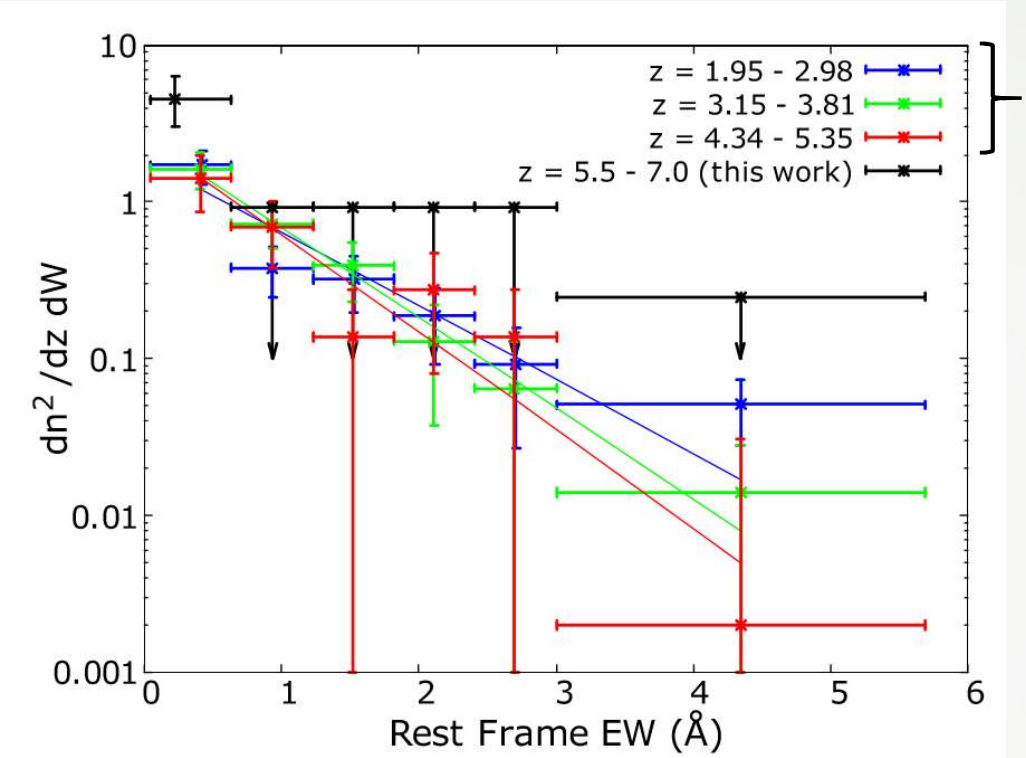
- We detect no strong systems, but expected number based on lower-z abundances was <~1

No strong Mg II observed



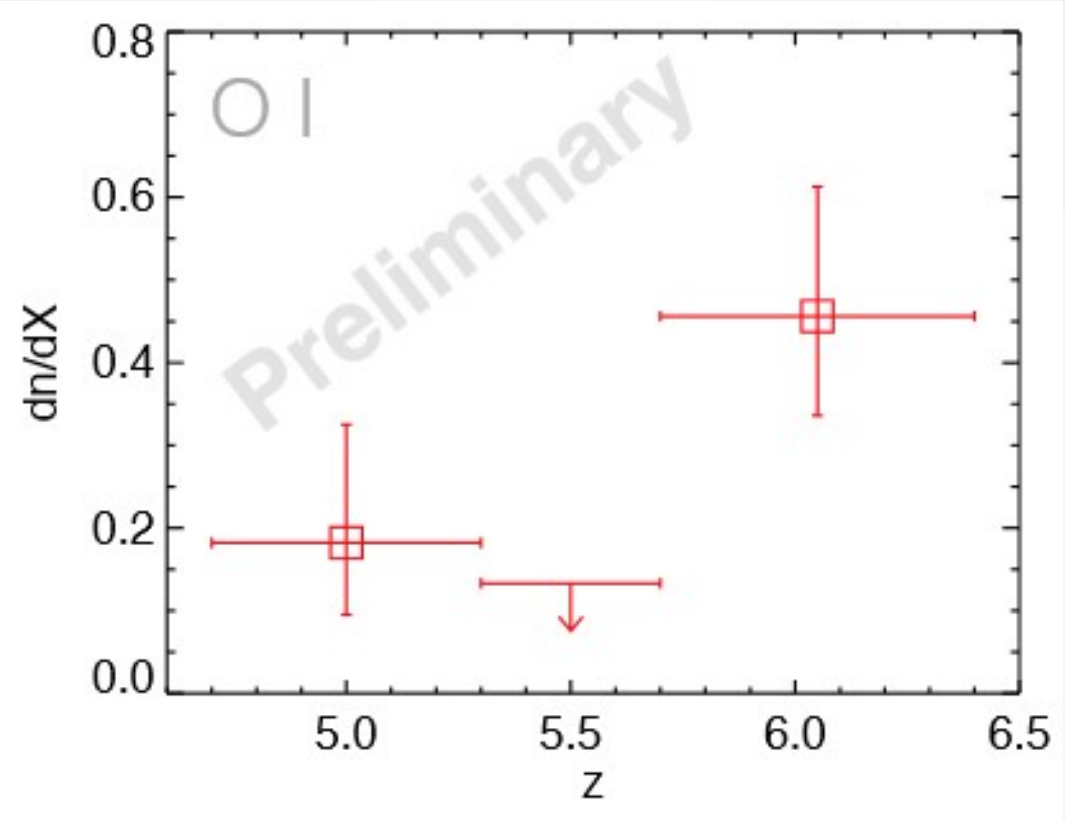
- We find no strong Mg II, but this gives a poor upper limit

Overabundance of weak Mg II



- We find 4 weak Mg II systems where ~1 was expected
- Significant disagreement with z < 5.4 distribution

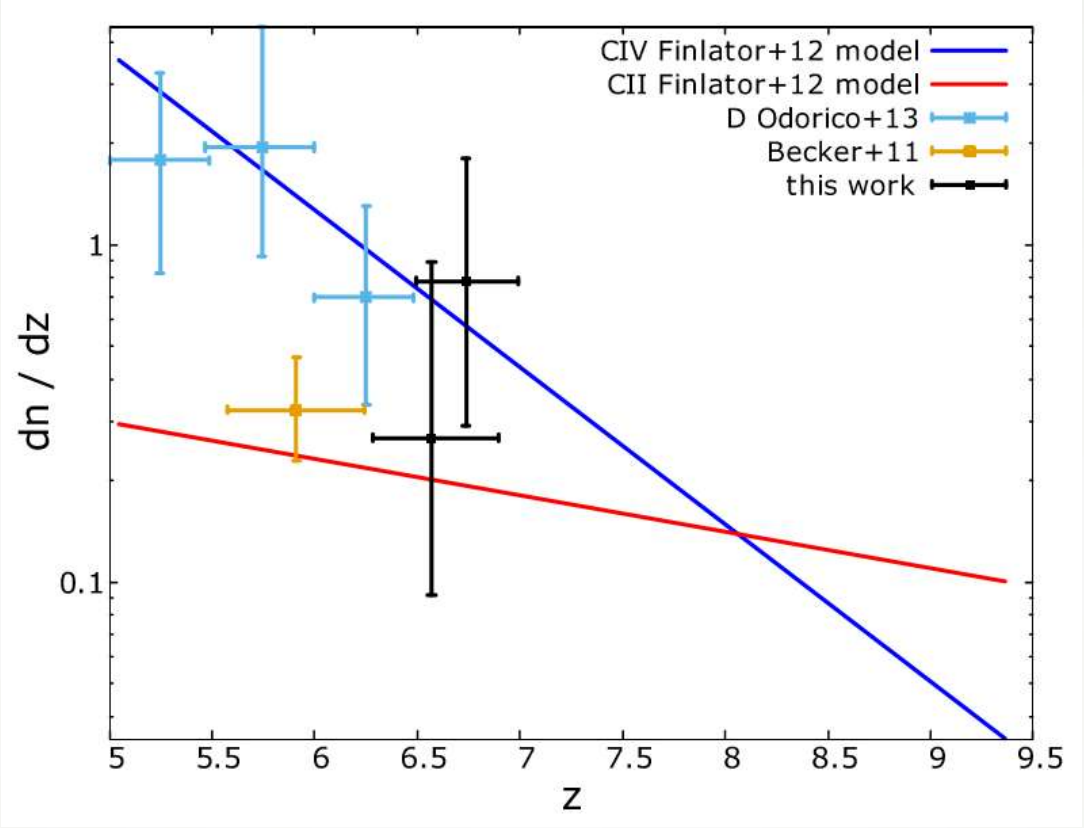
Weak O I more abundant too?



Courtesy of George Becker

- Based on 2 over-dense QSO lines of sigth

C II versus C IV



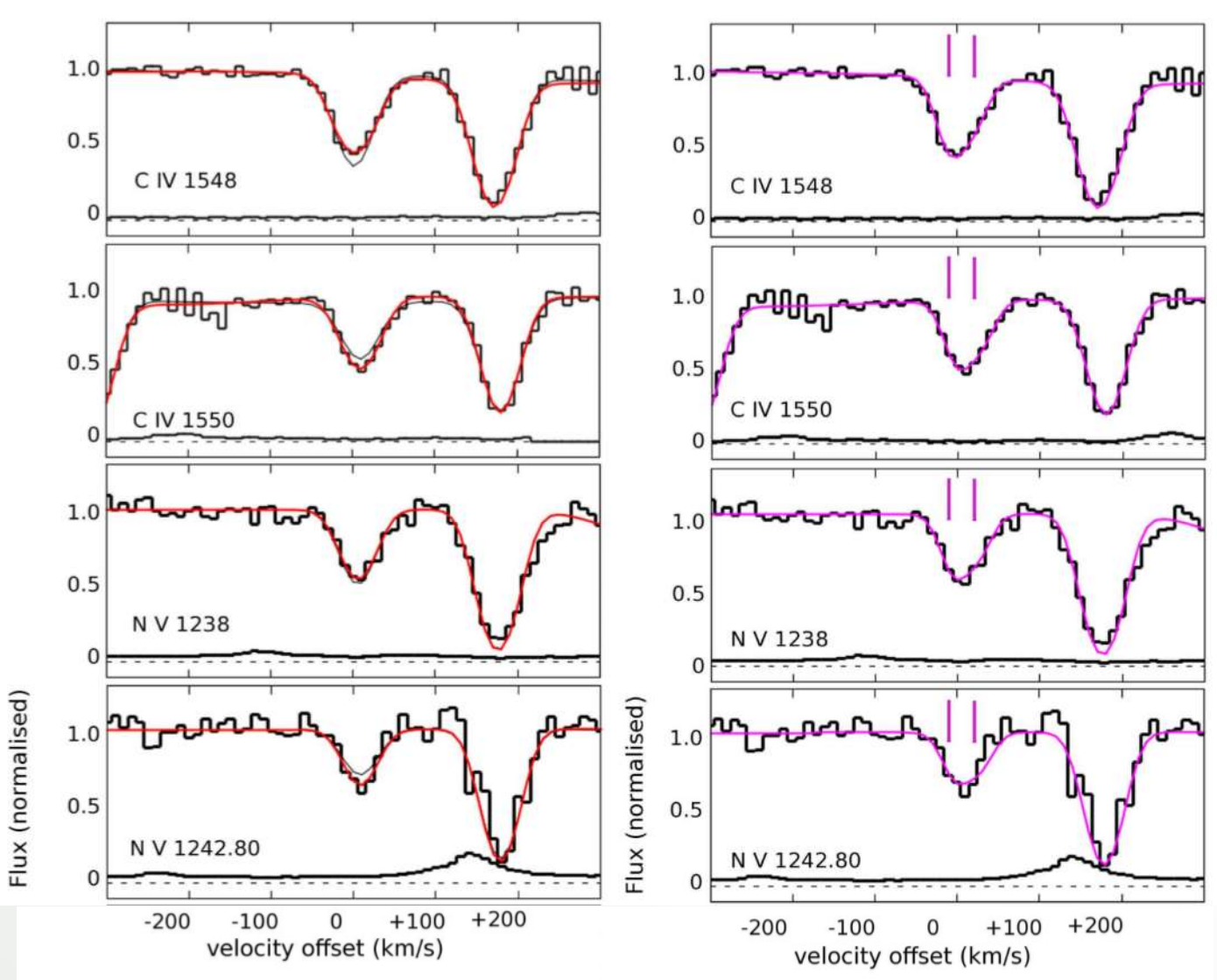
- Simulations (Finlator+15) predict crossover of C II and C IV occurence at z~8 – our detections of both ions are in agreement with this

Associated Absorbers

Partial Covering? →

42 +- 2 %
covering fraction?

(Possibly) rarely
seen in QSO spectra



← Multiple
Unresolved
Components?

b = 2.7 +- 1.6 ?

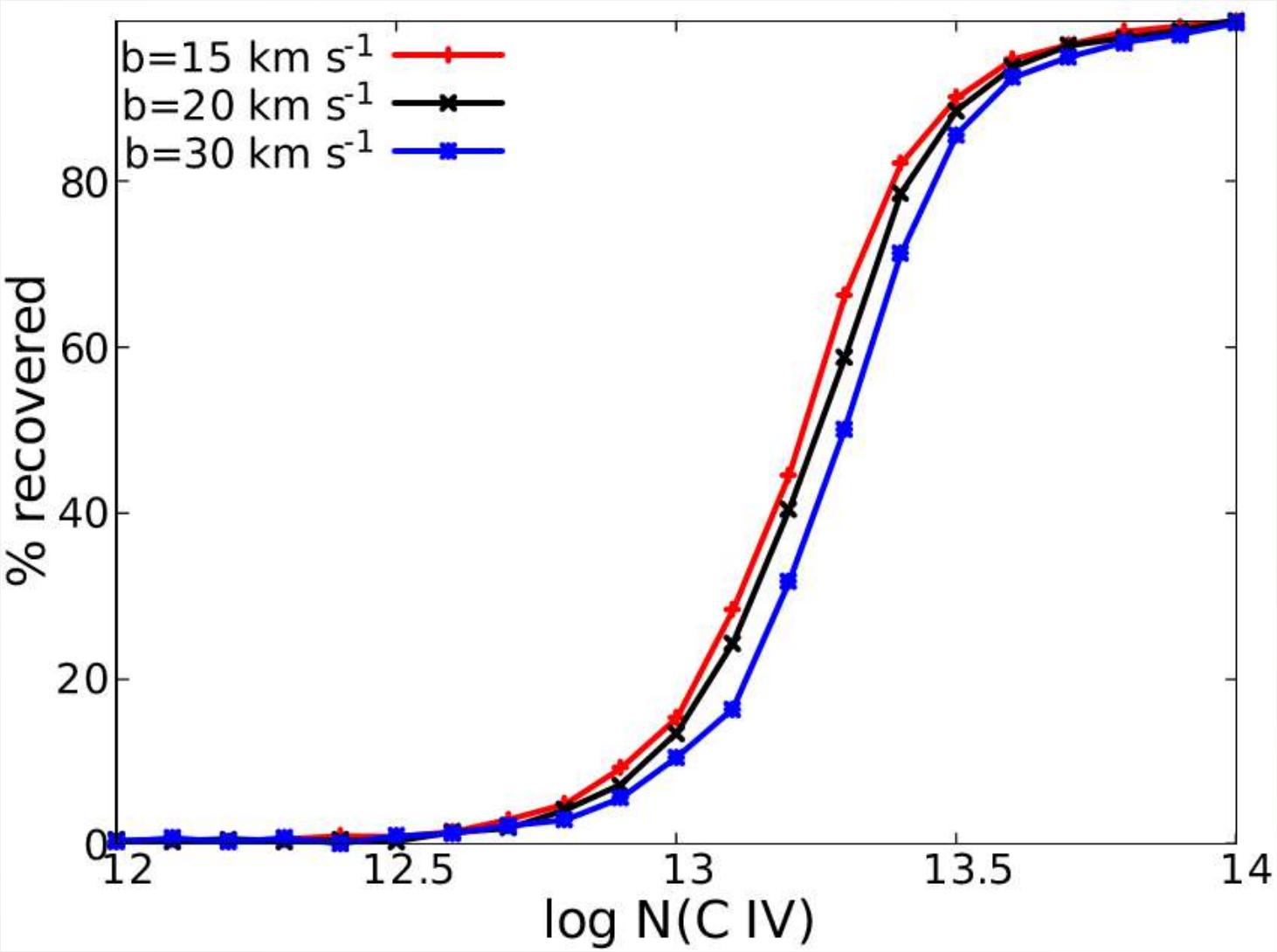
Would imply
cold gas
T = 5000K
(10 000 K)

Conclusions

- Occurence of highly ionised metals (C IV) up to z~7 appears to be consistent with z~5.
- Overabundance of weak Mg II found at z > 5.5 – could be linked to previously found increase of O I with redshift.
- Since metal enrichment increases with time, this points to evolution in the UVB at z > 5.5
- Peculiar associated absorption in the redshift 7 quasar

Additional Slides

C IV completeness study



Associated abs. best fit parameters

Partial Covering

	$z = 7.05542 \pm 0.00002$	$z = 7.060000 \pm 0.000013$
C IV	$\log N = 14.6 \pm 0.2$	$\log N = 14.44 \pm 0.04$
N V	$\log N = 14.37 \pm 0.11$	$\log N = 14.82 \pm 0.12$
Si IV	$\log N = 14.2 \pm 0.3$	$\log N = 11.9 \pm 0.5$
	$\mathrm{F_{cover}} = 42 \pm 2$ per cent	$\mathrm{F_{cover}} = 10 \pm 5$ per cent
	$b = 17.9 \pm 1.8$ km s^{-1}	$b = 18.8 \pm 1.1$ km s^{-1}
	$\chi^2/N_{\mathrm{dof}} = 2.641$	
	$\chi^2_{\mathrm{no\ Si\ IV}}/N_{\mathrm{dof}} = 1.736$	

Unresolved components

	$z = 7.05514 \pm 0.00004$	$z = 7.05596 \pm 0.00006$	$z = 7.060002 \pm 0.000013$
C IV	$\log N = 14.2 \pm 0.3$	$\log N = 14.3 \pm 1.4$	$\log N = 14.45 \pm 0.04$
N V	$\log N = 13.94 \pm 0.15$	$\log N = 14.1 \pm 1.0$	$\log N = 14.84 \pm 0.12$
Si IV	$\log N = 13.6 \pm 0.5$	$\log N = 14.5 \pm 1.6$	$\log N = 11.9 \pm 0.5$
	$b = 5.8 \pm 1.8$ km s^{-1}	$b = 2.7 \pm 1.6$ km s^{-1}	$b = 18.7 \pm 1.1$ km s^{-1}
	$\chi^2/N_{\mathrm{dof}} = 2.656$		
	$\chi^2_{\mathrm{no\ Si\ IV}}/N_{\mathrm{dof}} = 1.772$		

Si IV component & H