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STScI

wordle.net

ABSORPTION LINES PRODUCED BY GALACTIC HALOS

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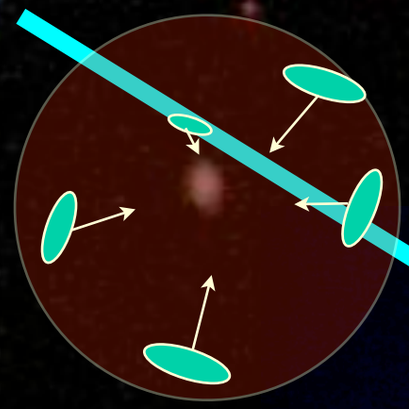
ABSTRACT

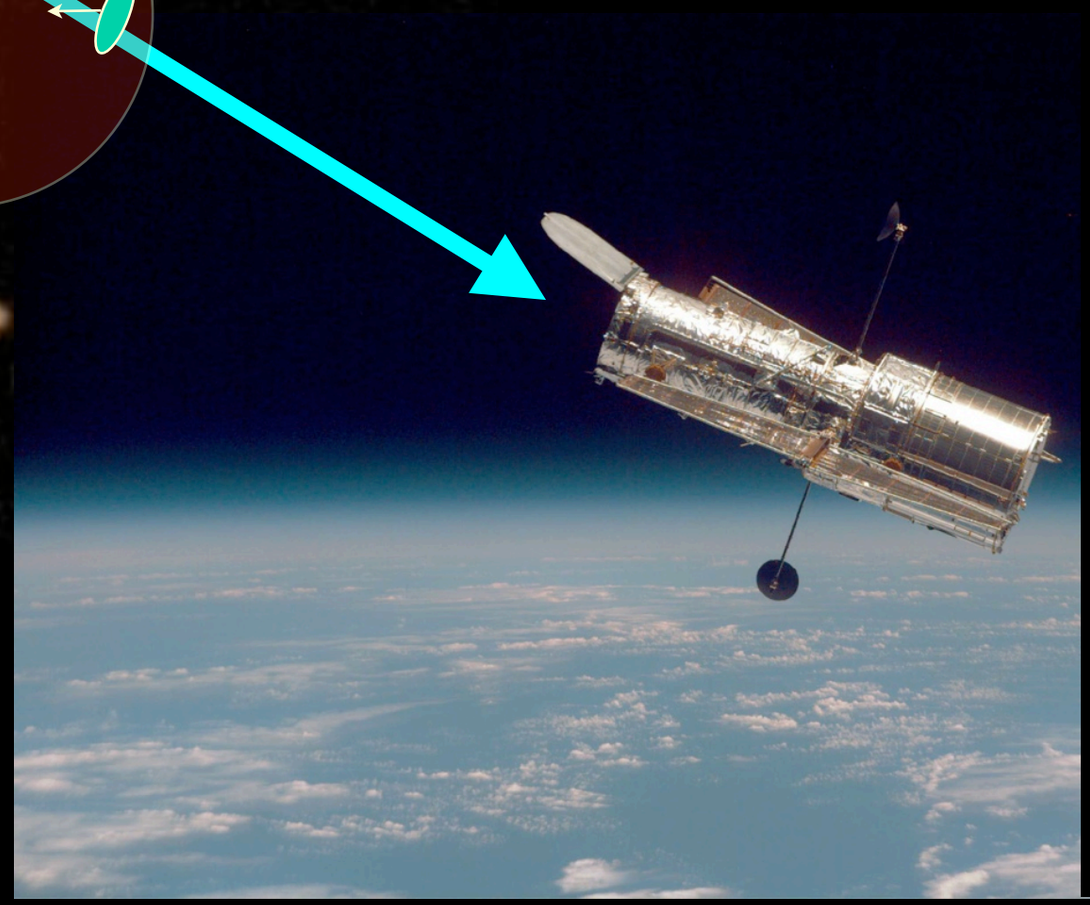
We propose that most of the absorption lines observed in quasi-stellar sources with multiple absorption redshifts are caused by gas in extended halos of normal galaxies.

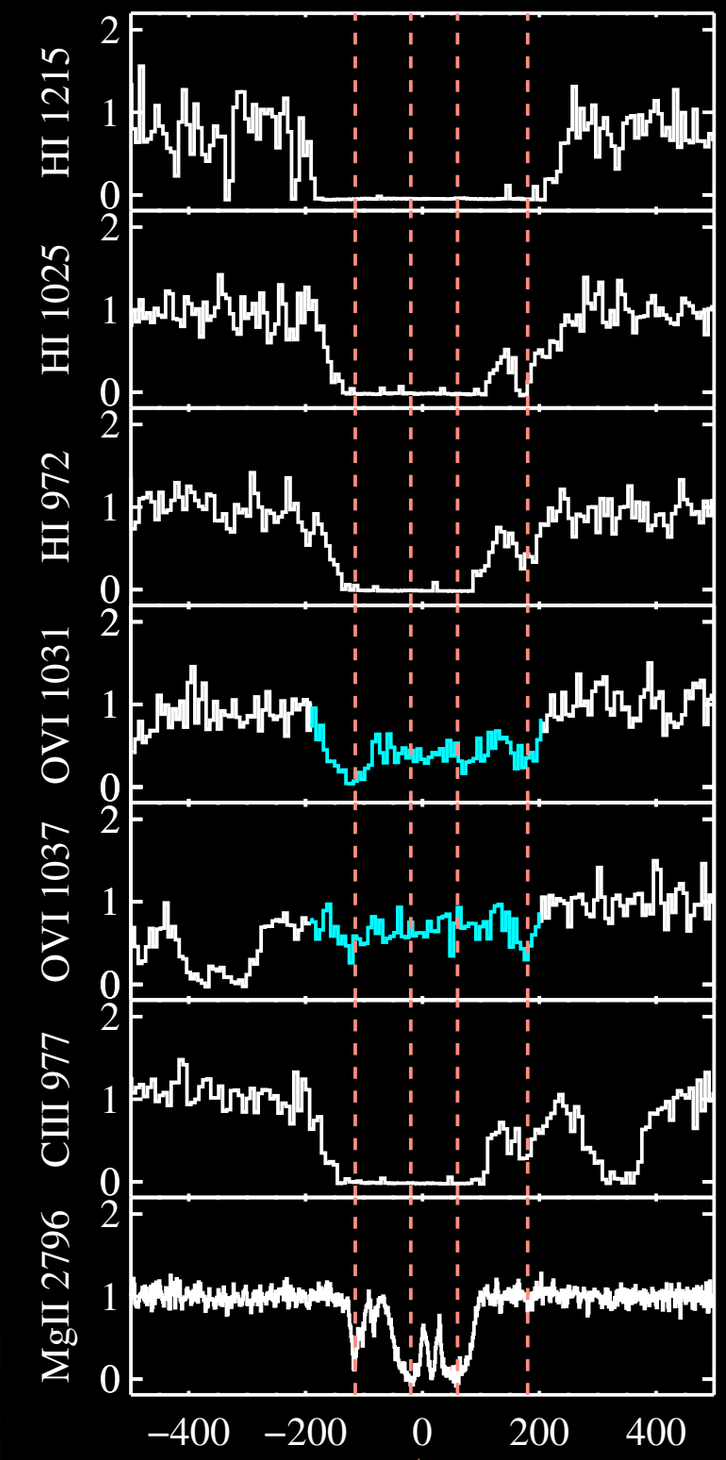
Recent work has established that some quasi-stellar sources have multiple redshift systems in absorption (Bahcall 1968; Bahcall, Greenstein, and Sargent 1968; Burbidge, Lynds, and Stockton 1968; Burbidge 1969; Bahcall, Osmer, and Schmidt 1969). A number of possible explanations have been suggested for this phenomenon (Bahcall *et al.* 1968; Burbidge *et al.* 1968; Peebles 1968), but none of the suggestions seem especially plausible when considered in the light of the observed features of the absorption systems. We propose that most of the absorption lines are caused by tenuous gas in extended halos of normal galaxies (see Spitzer 1956 for a review of some earlier work on galactic halos and for a preliminary discussion of the possibility of observing ultraviolet absorption lines formed in such halos).

COS-Halos Programme
"How Galaxies Acquire their Gas"

Background QSO



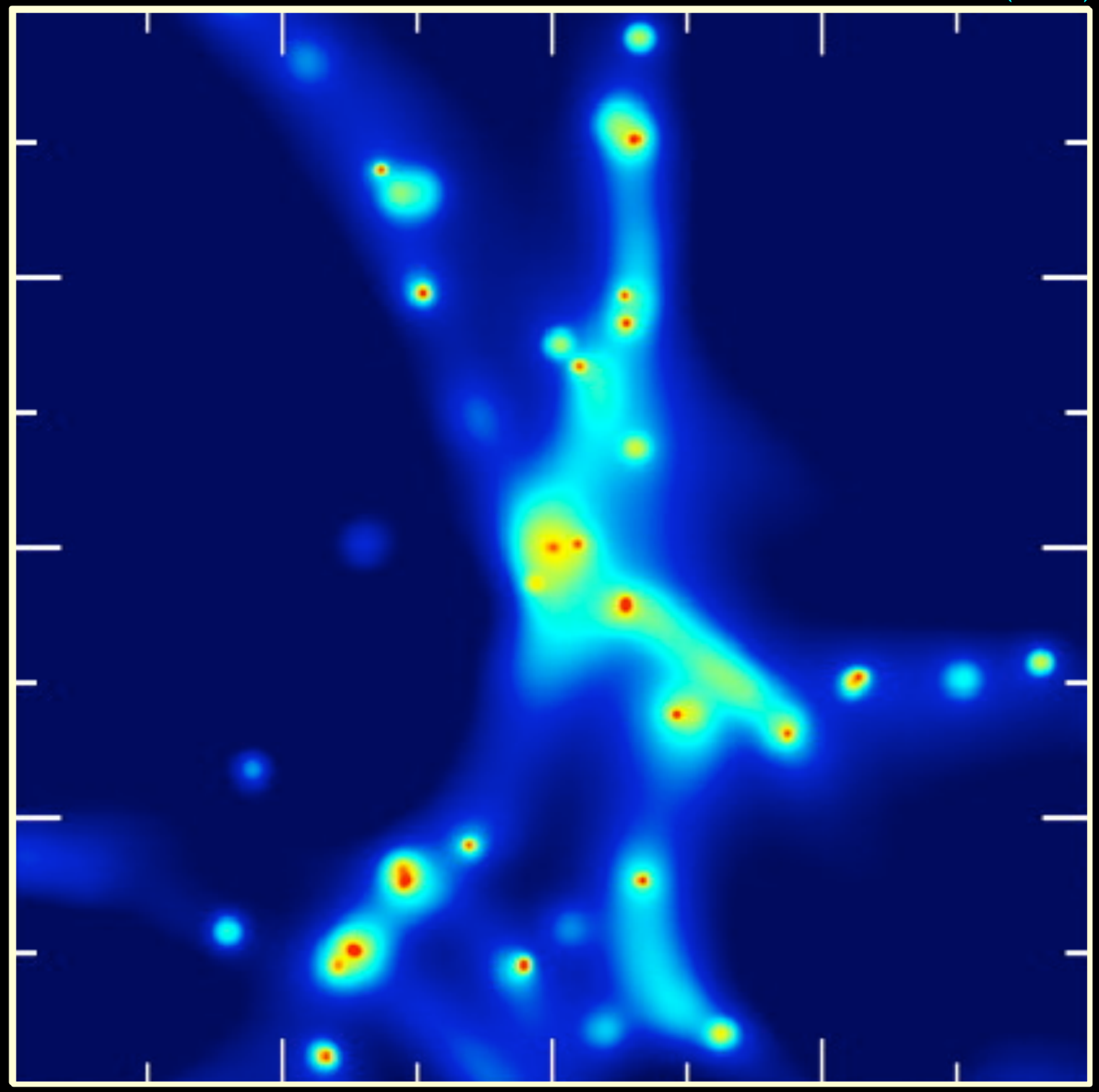


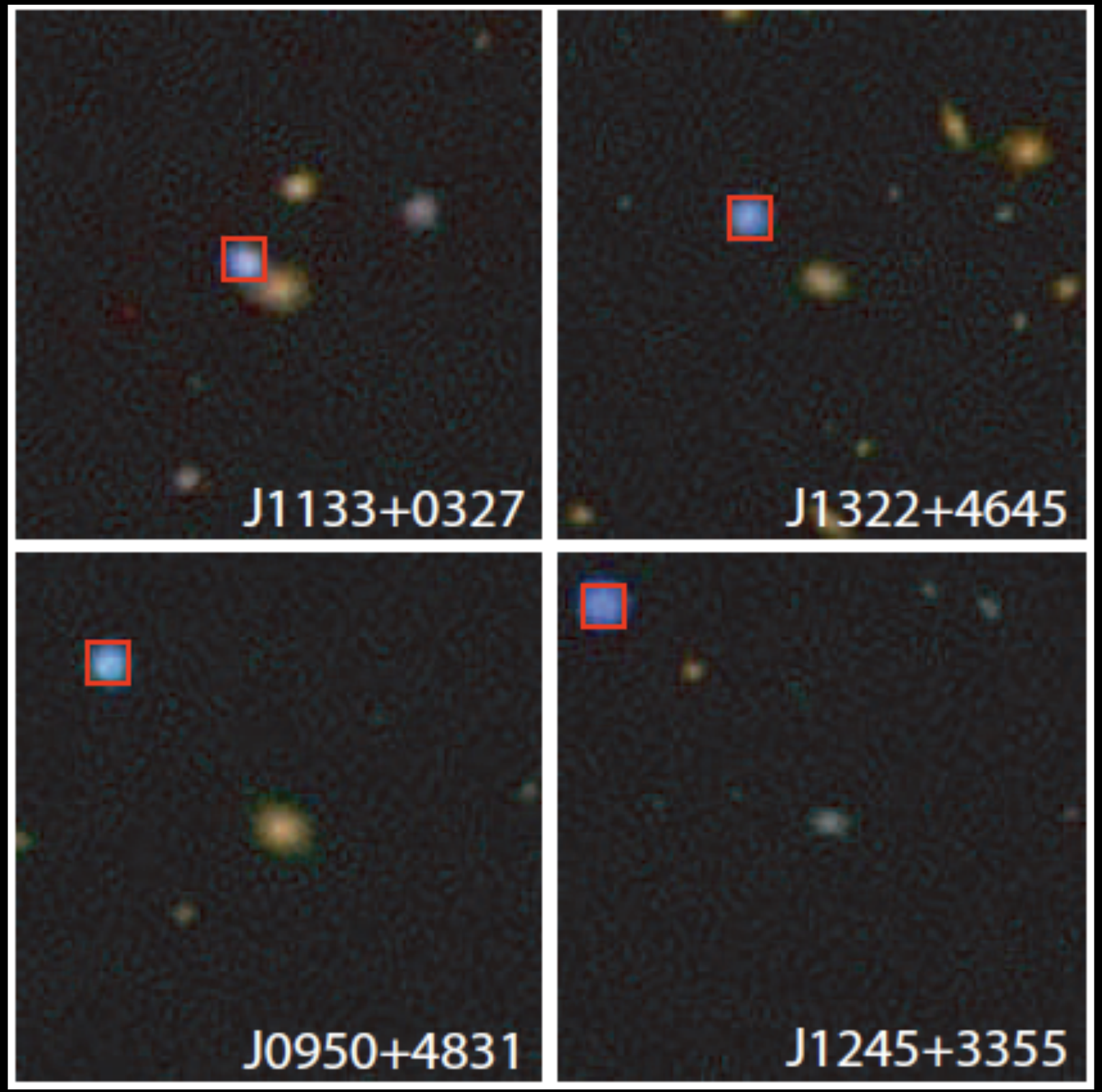


39 galaxies observed
with COS in 134 orbits

Absorption by galaxy halo gas

Kawata & Rauch (2007)




J1133+0327
J1322+4645
J0950+4831
J1245+3355

NYU VAGC: Blanton et al (2005)

Red sequence

"Blue Cloud"

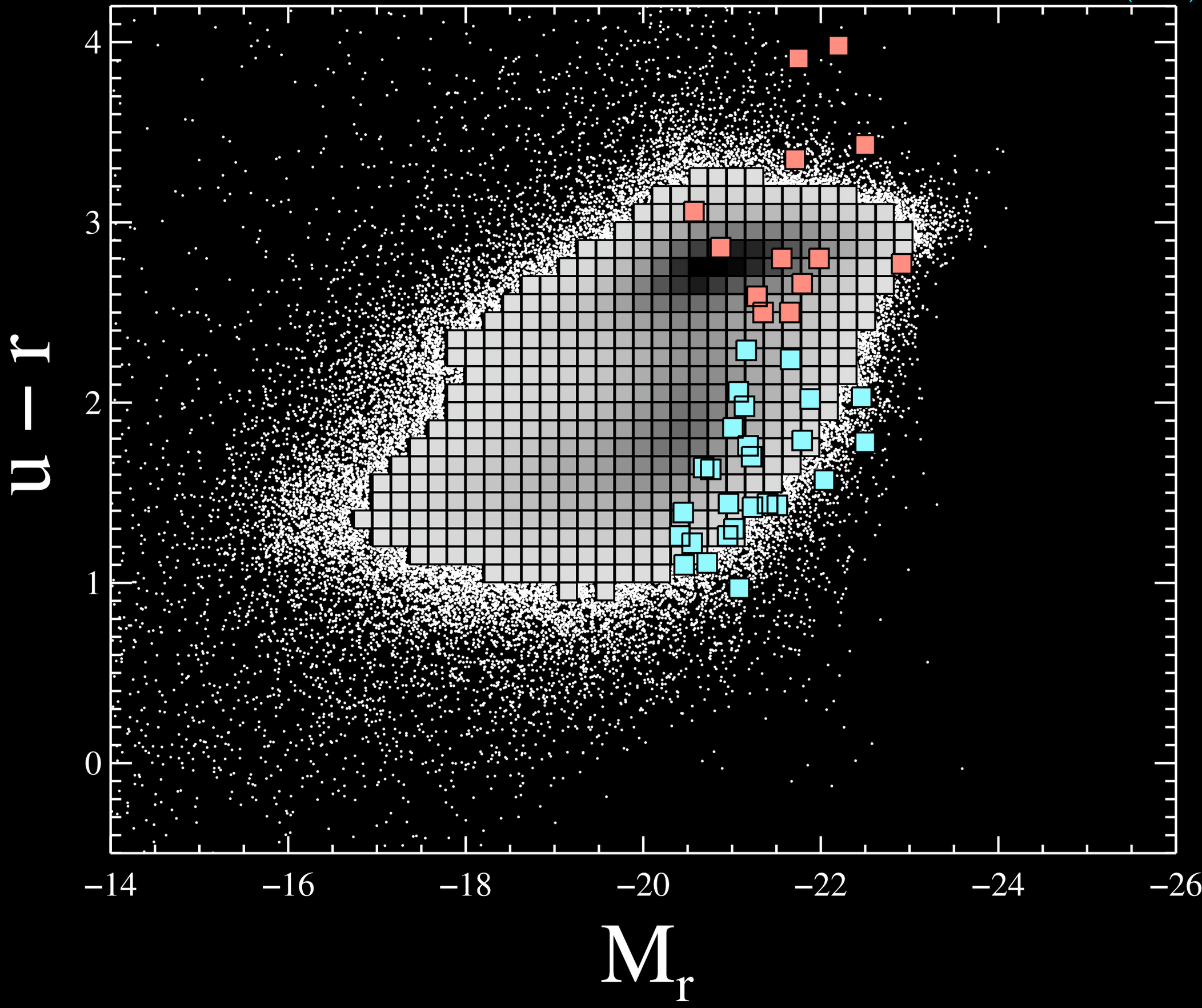
$u - r$

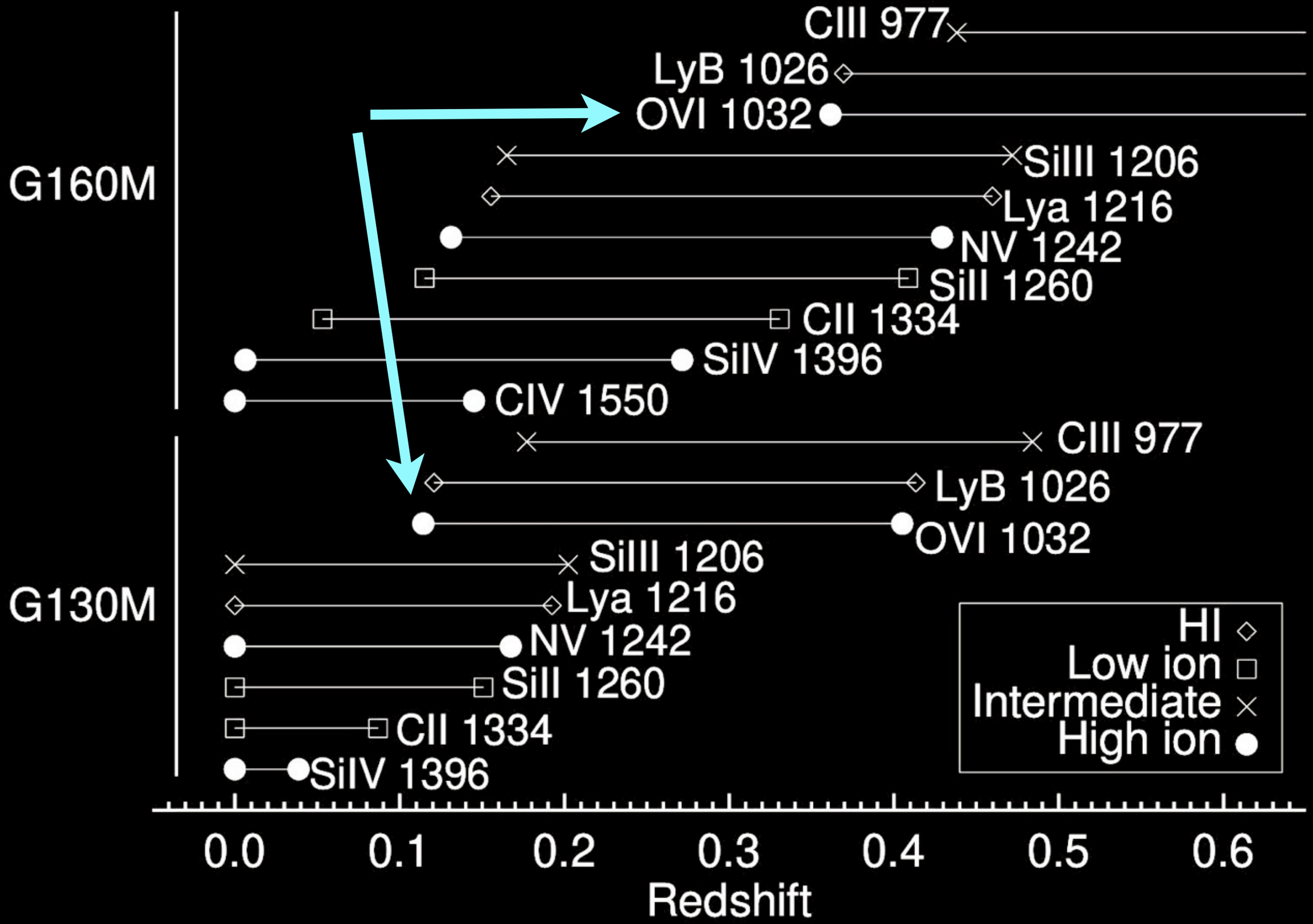
4
3
2
1
0

−14 −16 −18 −20 −22 −24 −26

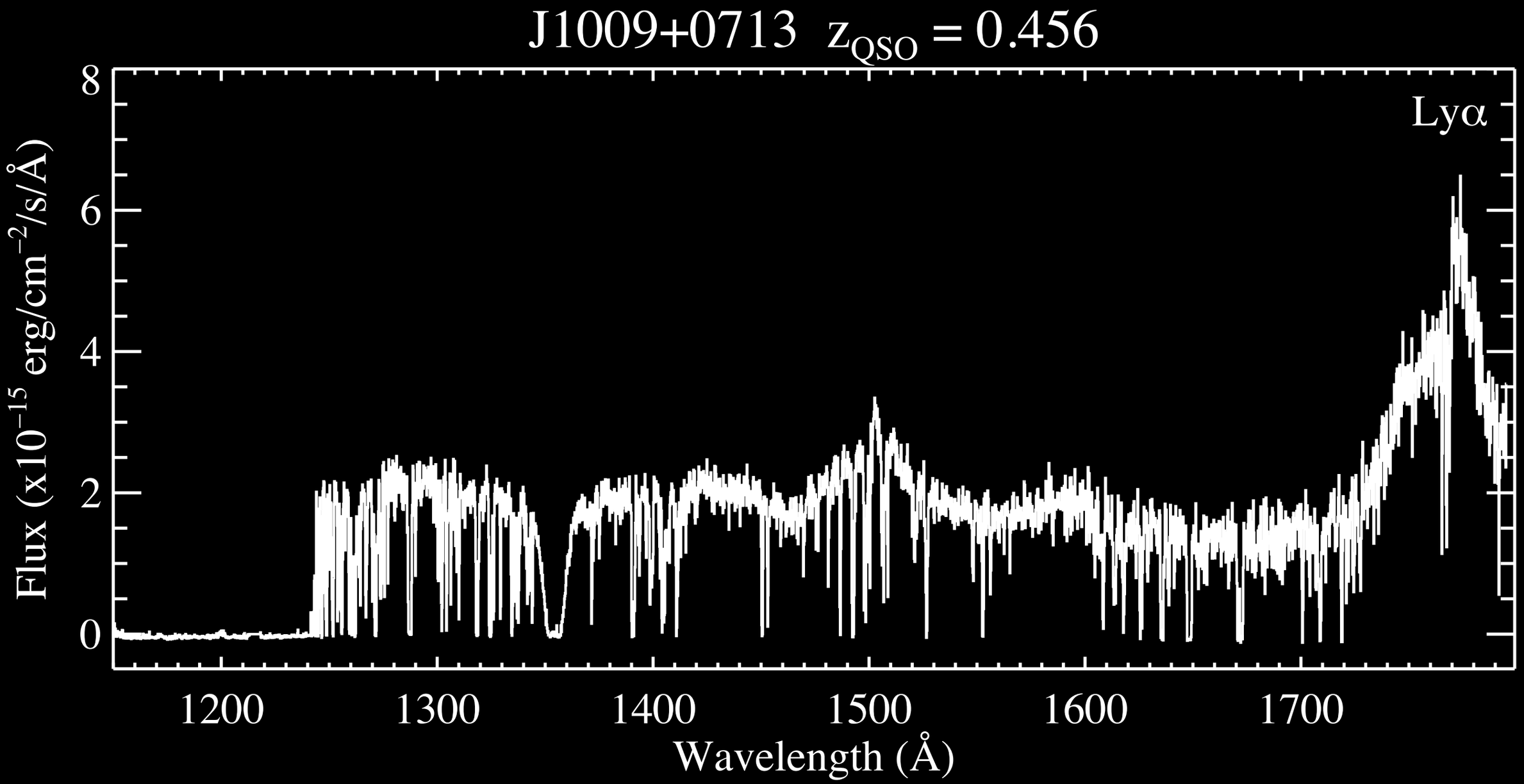
M_r

NYU VAGC: Blanton et al (2005)

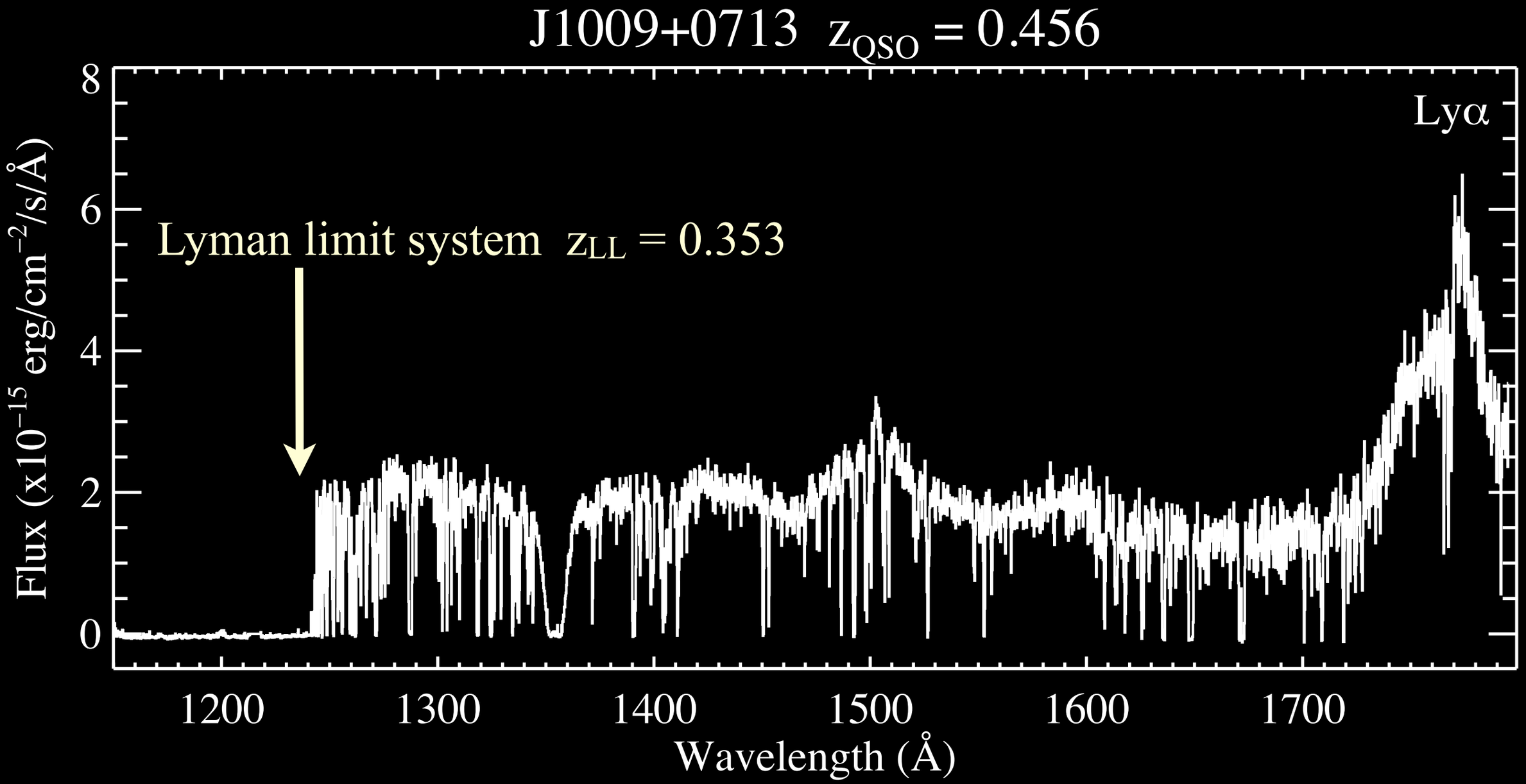



G160M
CIII 977
LyB 1026
OVI 1032
SiIII 1206
Lya 1216
NV 1242
SiII 1260
CII 1334
SiIV 1396
CIV 1550
G130M
CIII 977
LyB 1026
OVI 1032
SiIII 1206
Lya 1216
NV 1242
SiII 1260
CII 1334
SiIV 1396
HI
Low ion
Intermediate
High ion
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Redshift

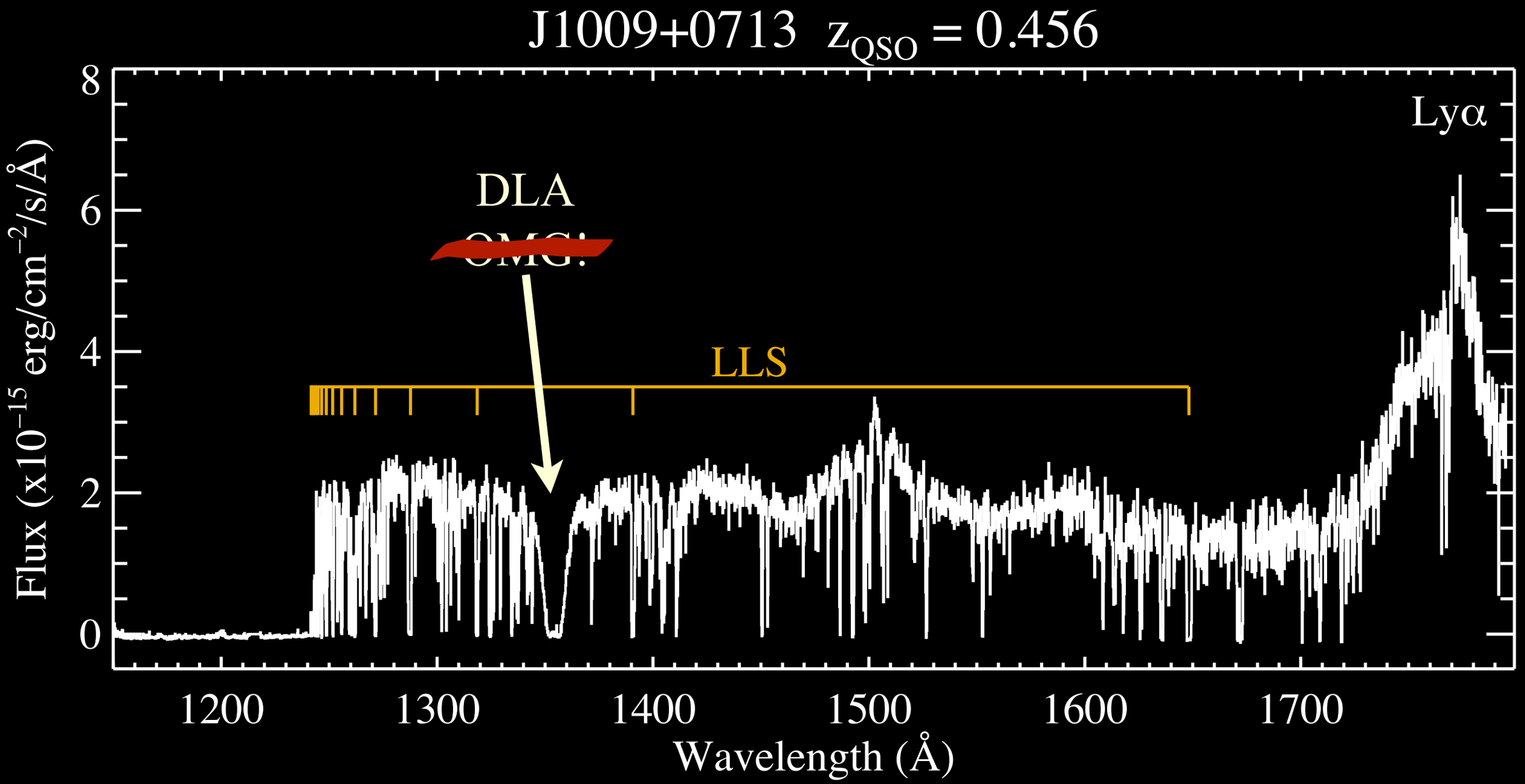
COS Spectra


J1009+0713 $z_{QSO} = 0.456$
Lyα
Flux (x10^{-15} erg/cm^{-2}/s/Å)
0
2
4
6
8
1200
1300
1400
1500
1600
1700
Wavelength (Å)

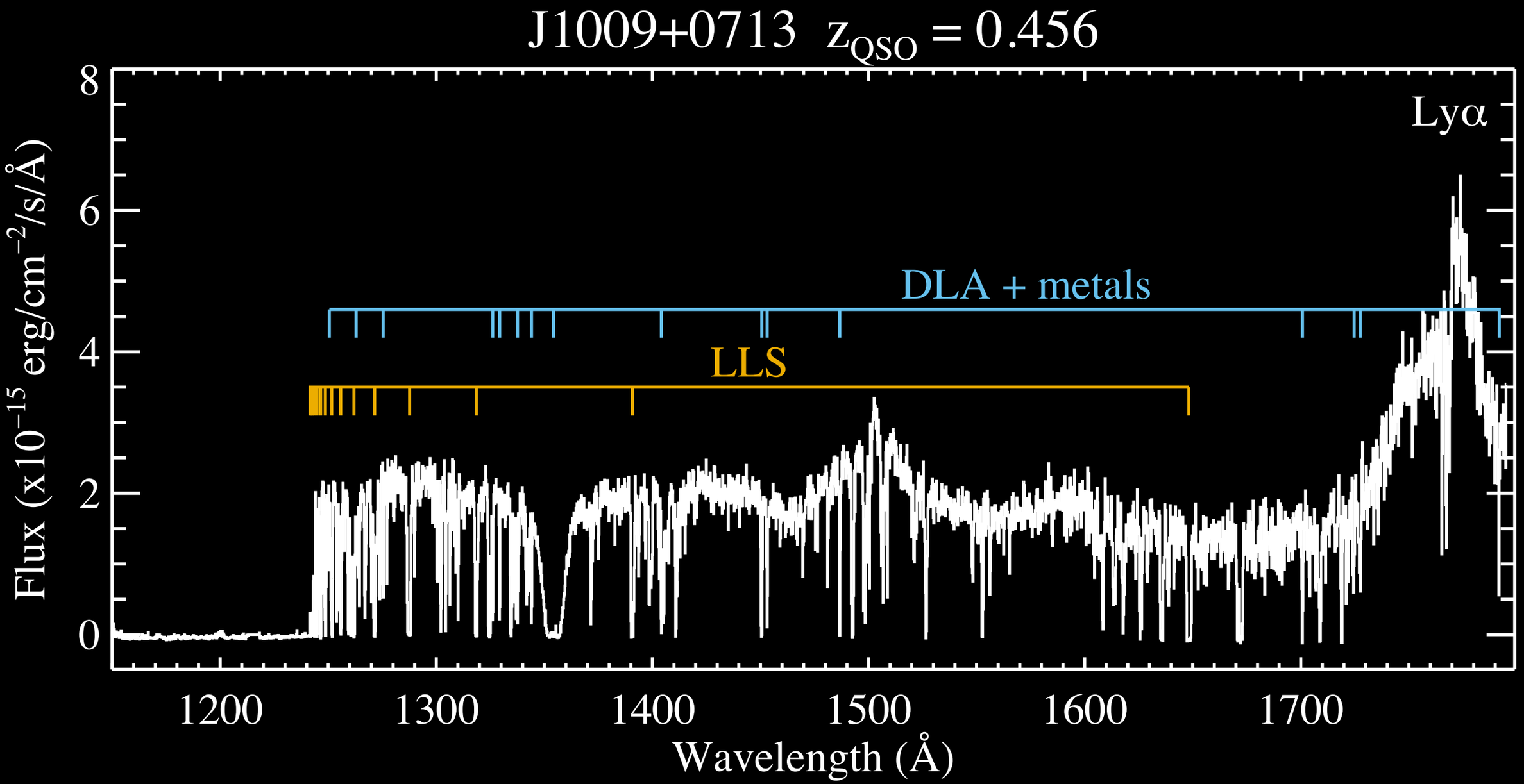
COS Spectra


J1009+0713 $z_{QSO} = 0.456$
Lyα
Lyman limit system $z_{LL} = 0.353$
Flux (x10^{-15} erg/cm^{-2}/s/Å)
0
2
4
6
8
1200
1300
1400
1500
1600
1700
Wavelength (Å)

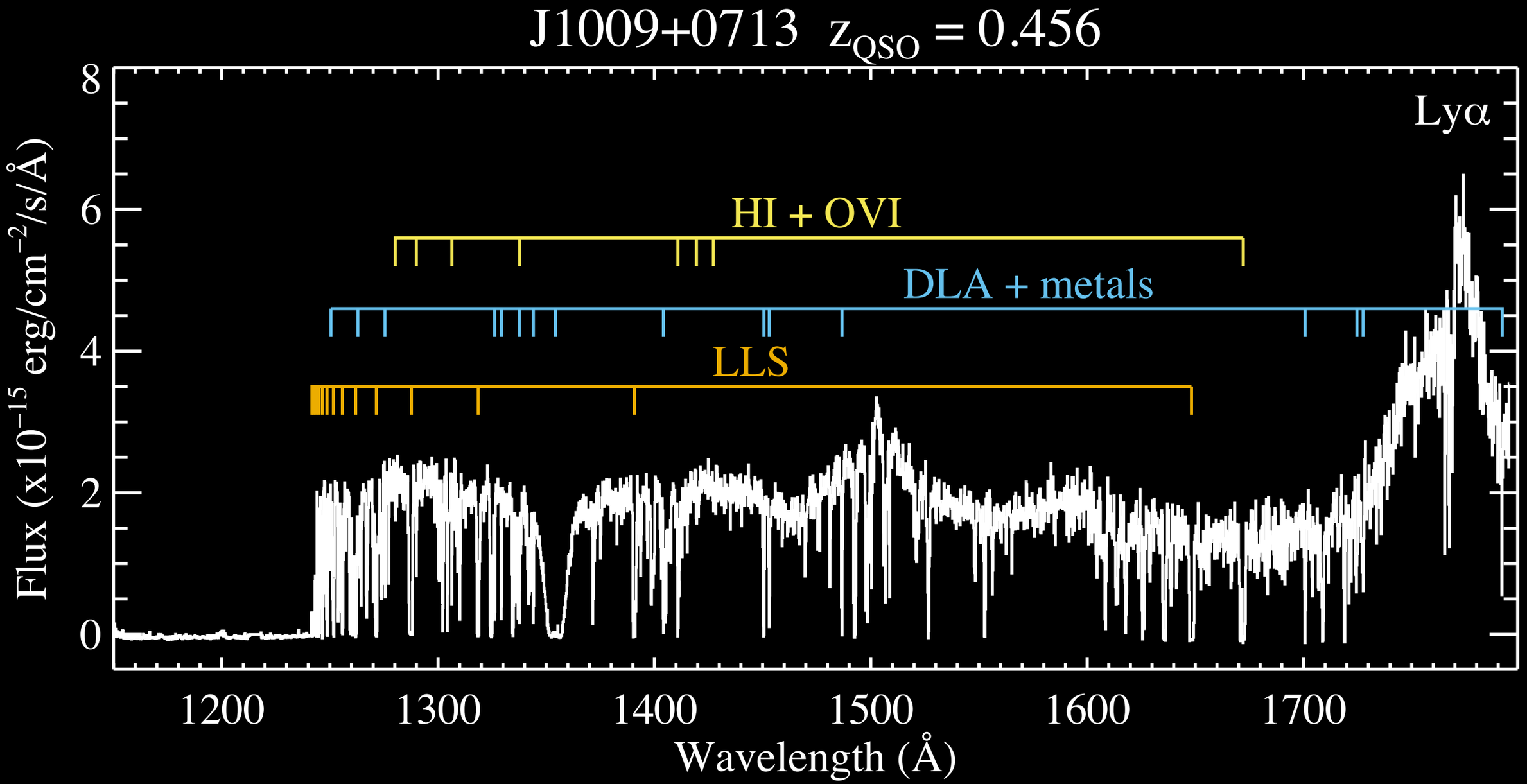
COS Spectra


J1009+0713 $z_{QSO} = 0.456$
DLA
OMG!
LLS
Lyα
Flux (x10^{-15} erg/cm^{-2}/s/Å)
0
2
4
6
8
1200
1300
1400
1500
1600
1700
Wavelength (Å)

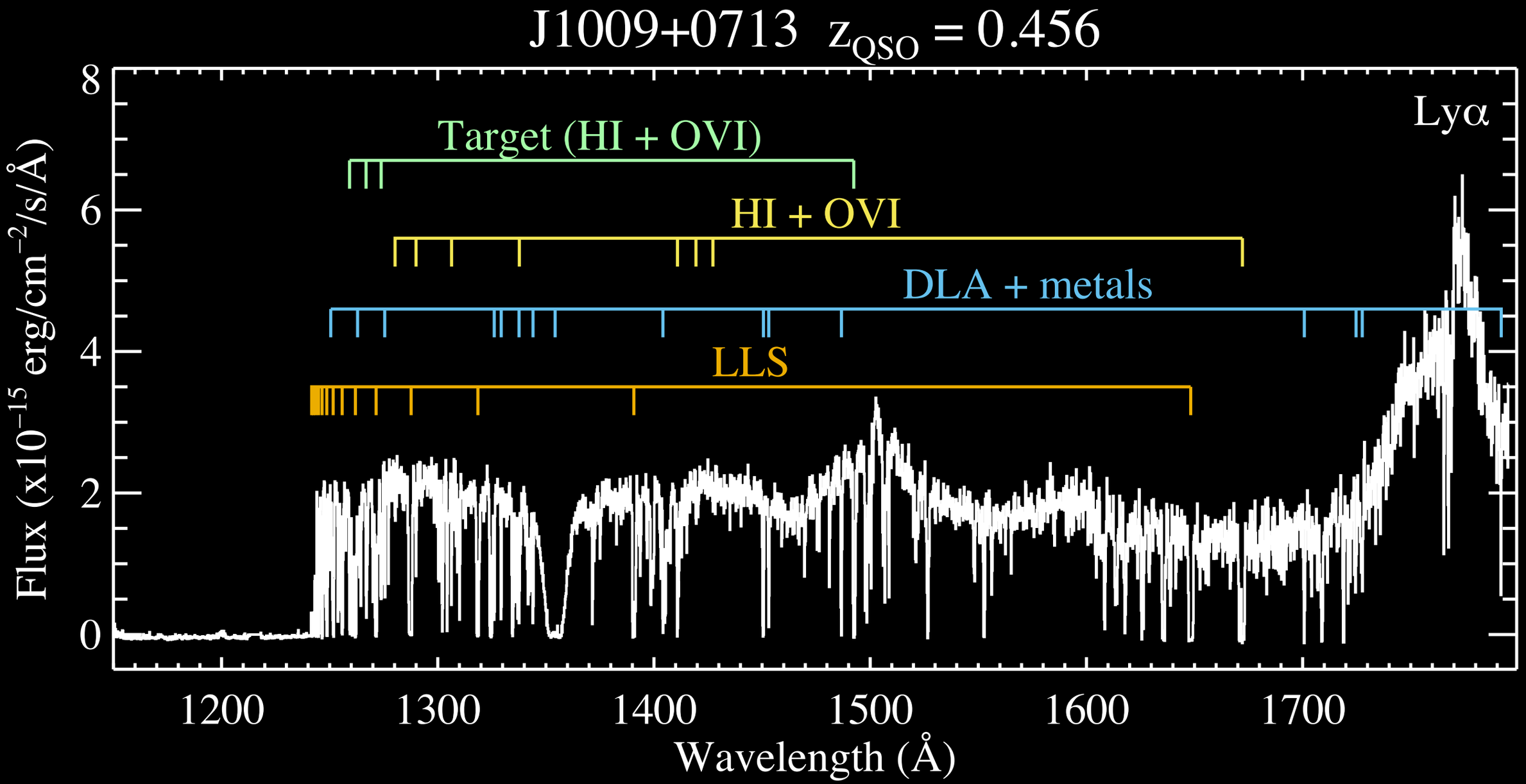
COS Spectra


J1009+0713 $z_{QSO} = 0.456$
Lyα
DLA + metals
LLS
Flux (x10^{-15} erg/cm^{-2}/s/Å)
Wavelength (Å)
0
2
4
6
8
1200
1300
1400
1500
1600
1700

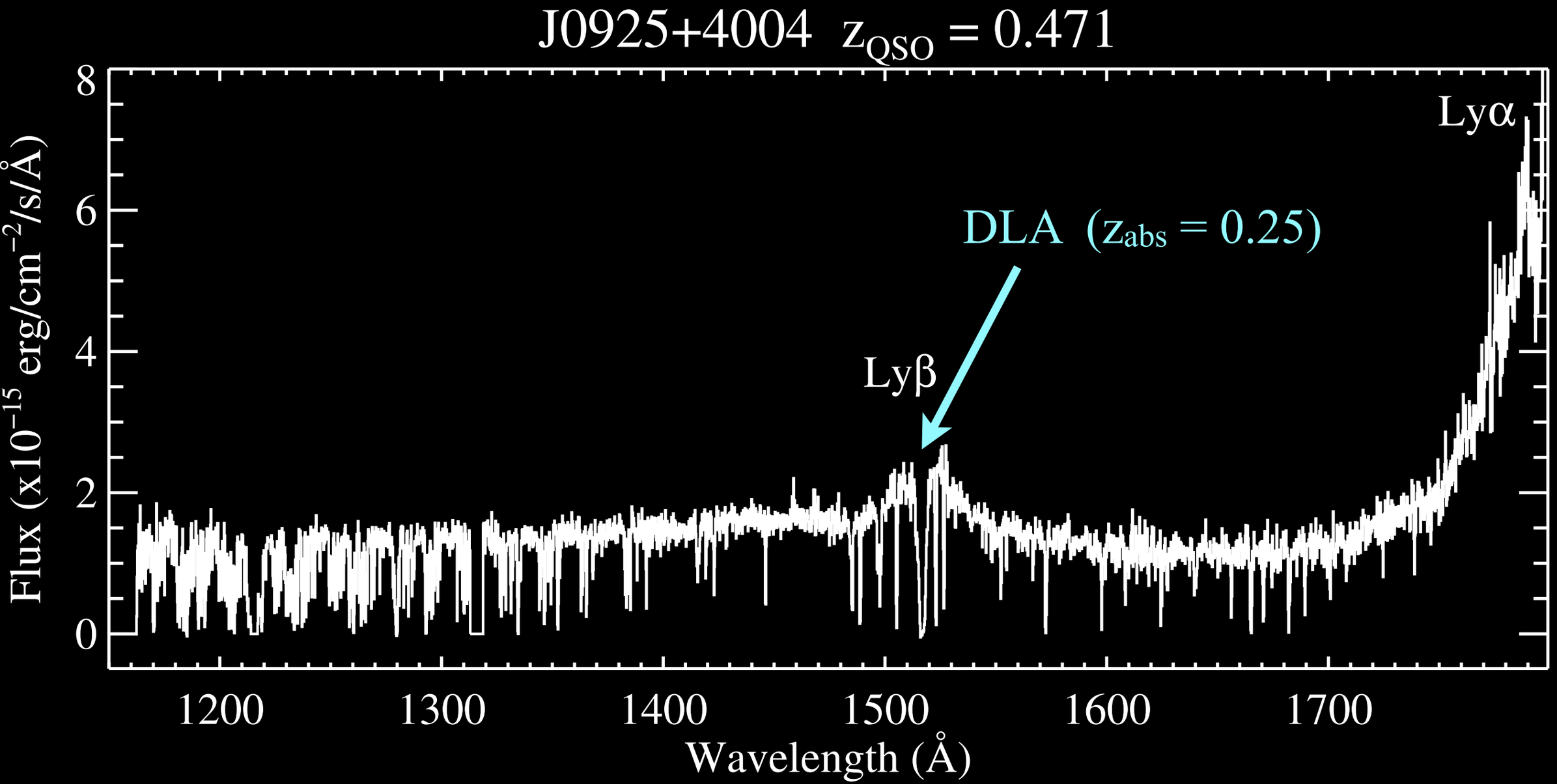
COS Spectra


J1009+0713 $z_{QSO} = 0.456$
Lyα
HI + OVI
DLA + metals
LLS
Flux (x10^{-15} erg/cm^{-2}/s/Å)
Wavelength (Å)
0
2
4
6
8
1200
1300
1400
1500
1600
1700

Awesome!

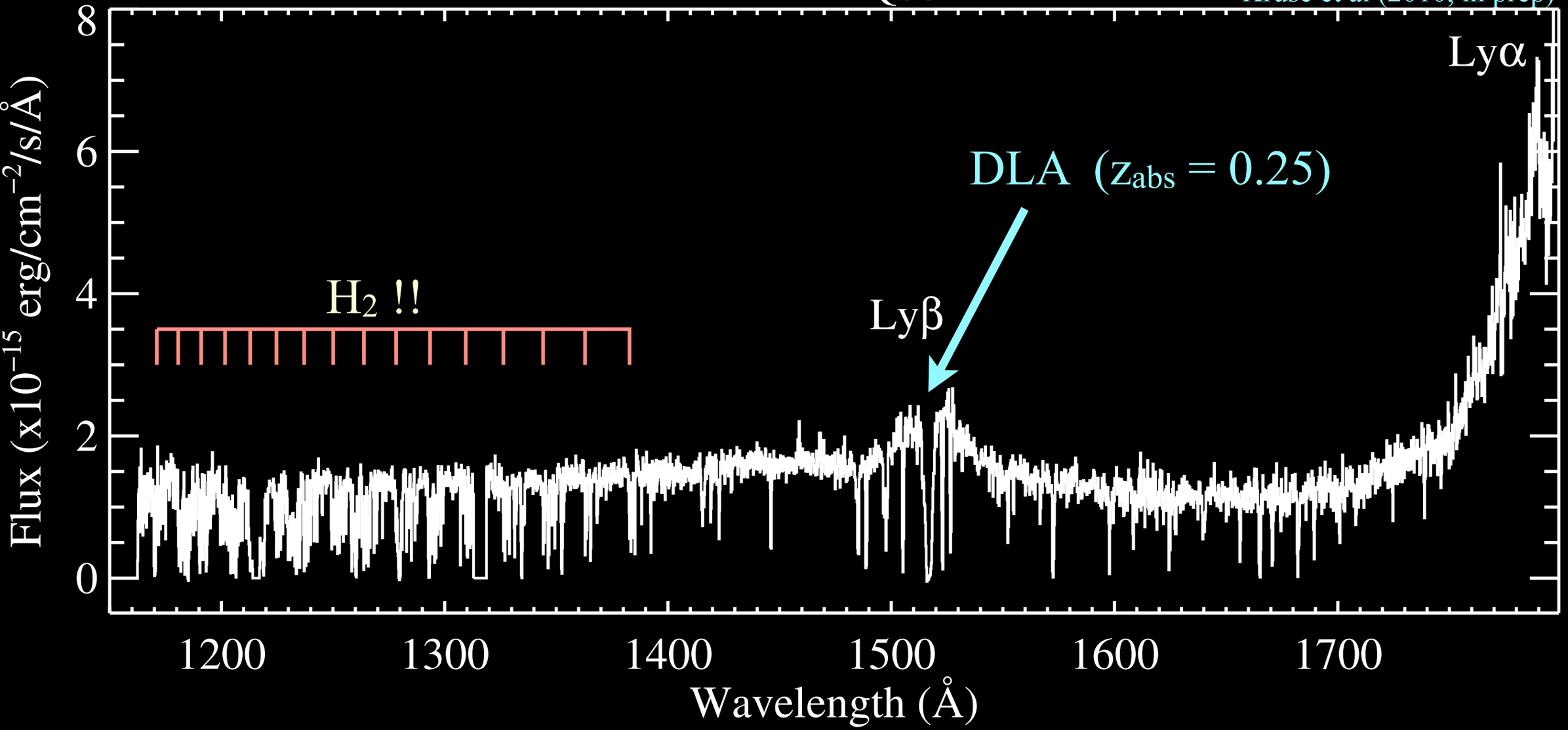


LLS: Tumlinson et al. (2010, in prep)
DLA: Meiring et al. (2010, in prep)


J0925+4004 z_{QSO} = 0.471
Lyα
DLA (z_{abs} = 0.25)
Lyβ
Flux (x10^{-15} erg/cm^{-2}/s/Å)
0
2
4
6
8
1200
1300
1400
1500
1600
1700
Wavelength (Å)

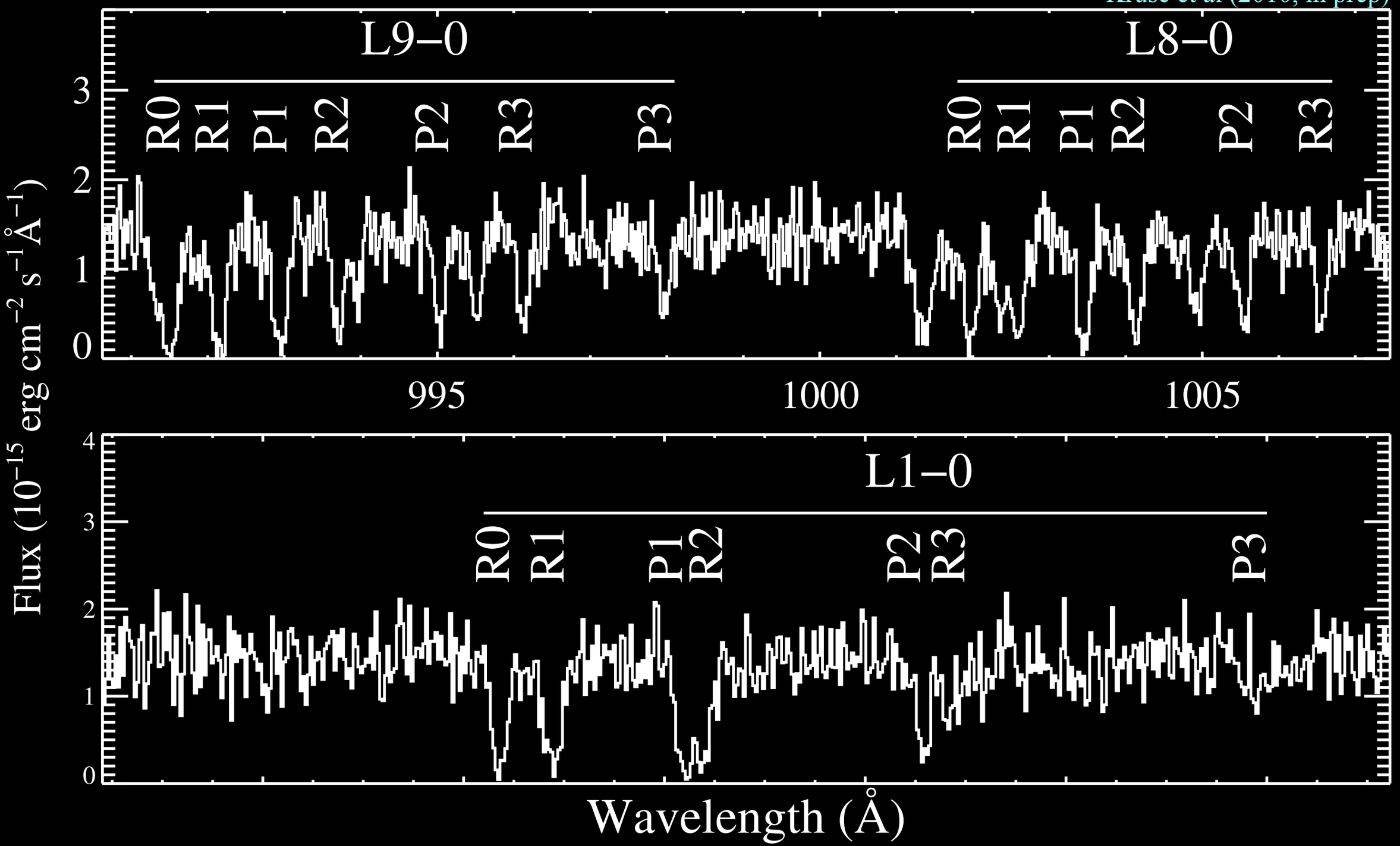
J0925+4004 $z_{QSO} = 0.471$

Kruse et al (2010, in prep)



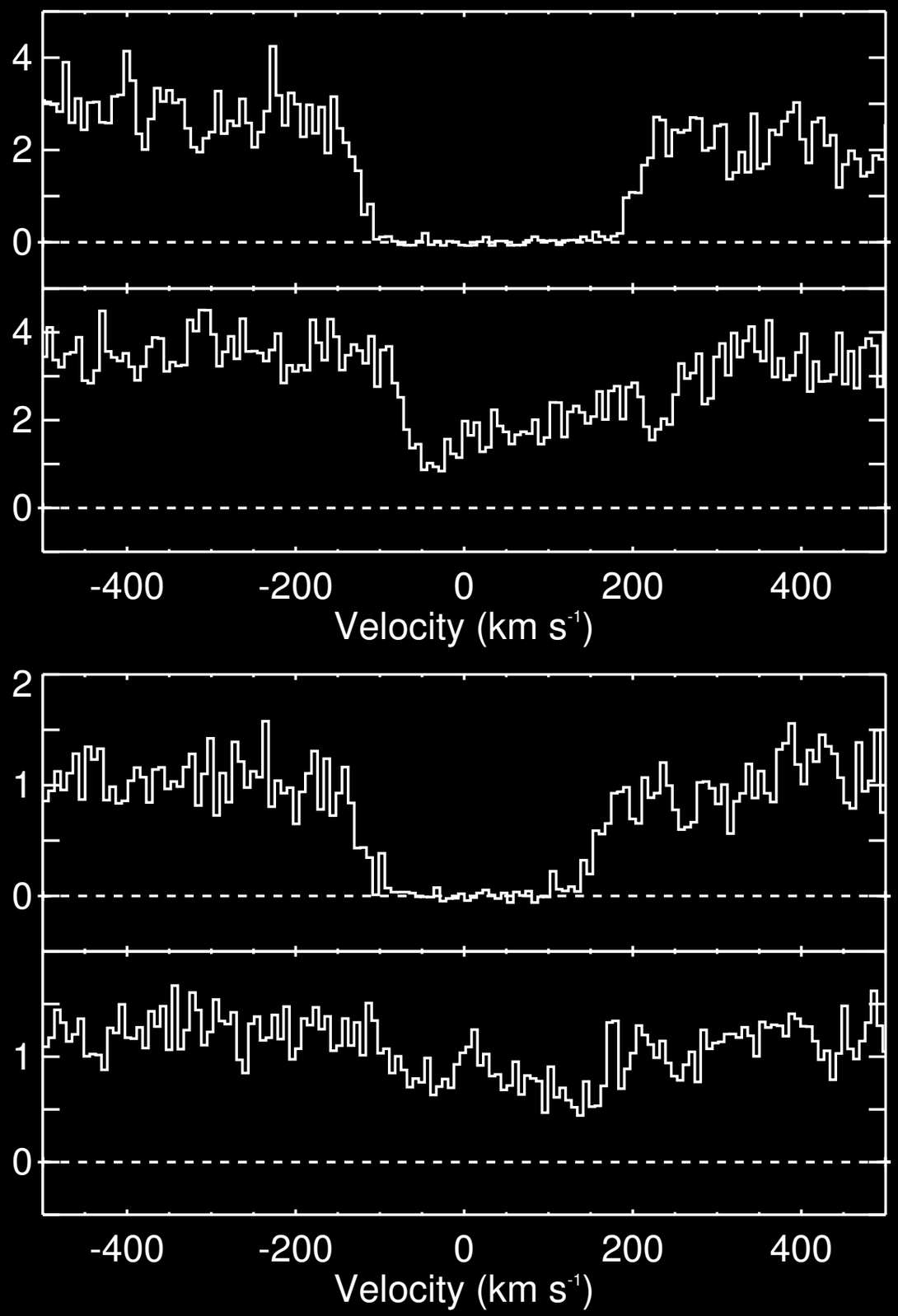
J0925+4004 H_2 lines!

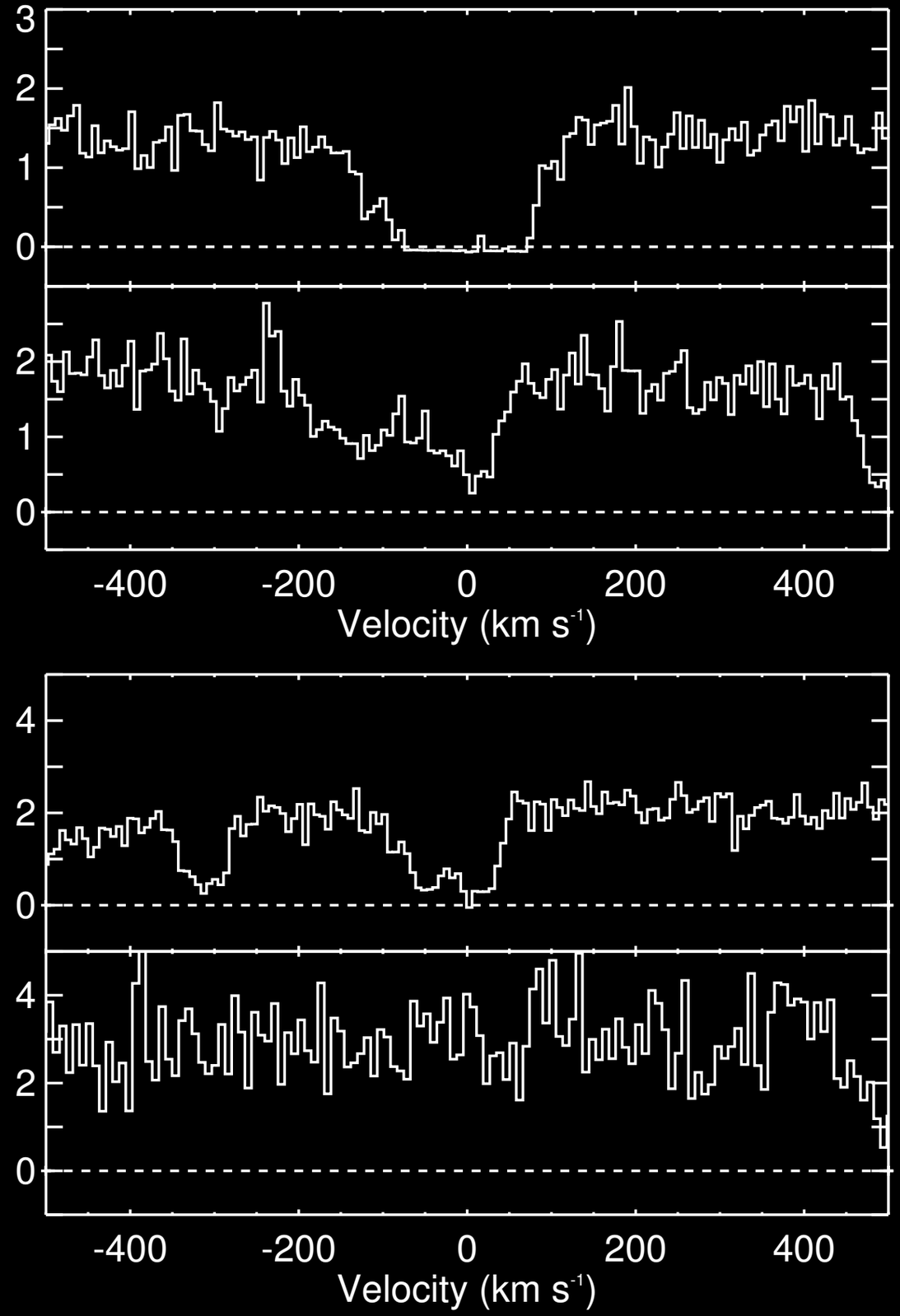
Kruse et al (2010, in prep)



Lyα

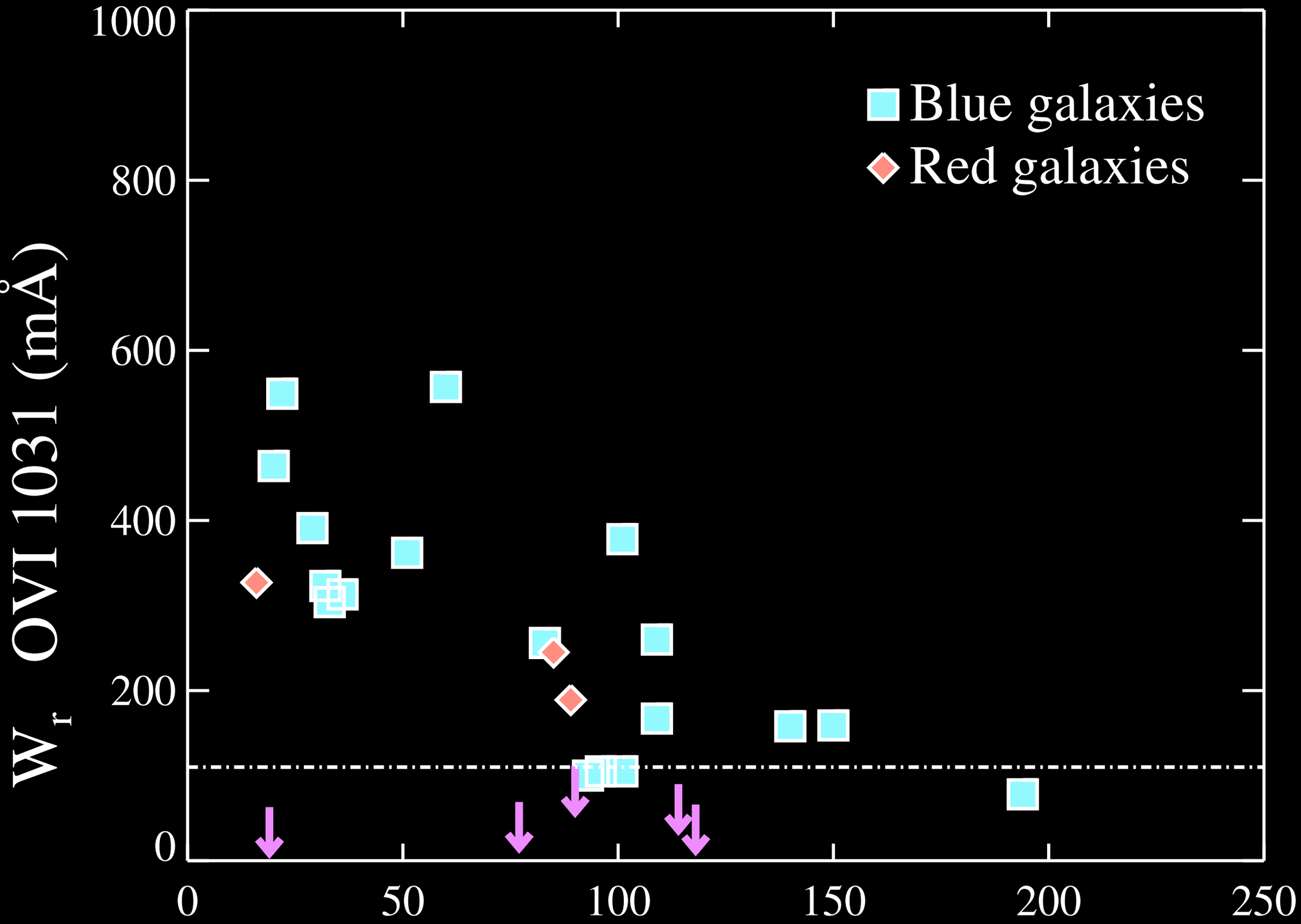
OVI

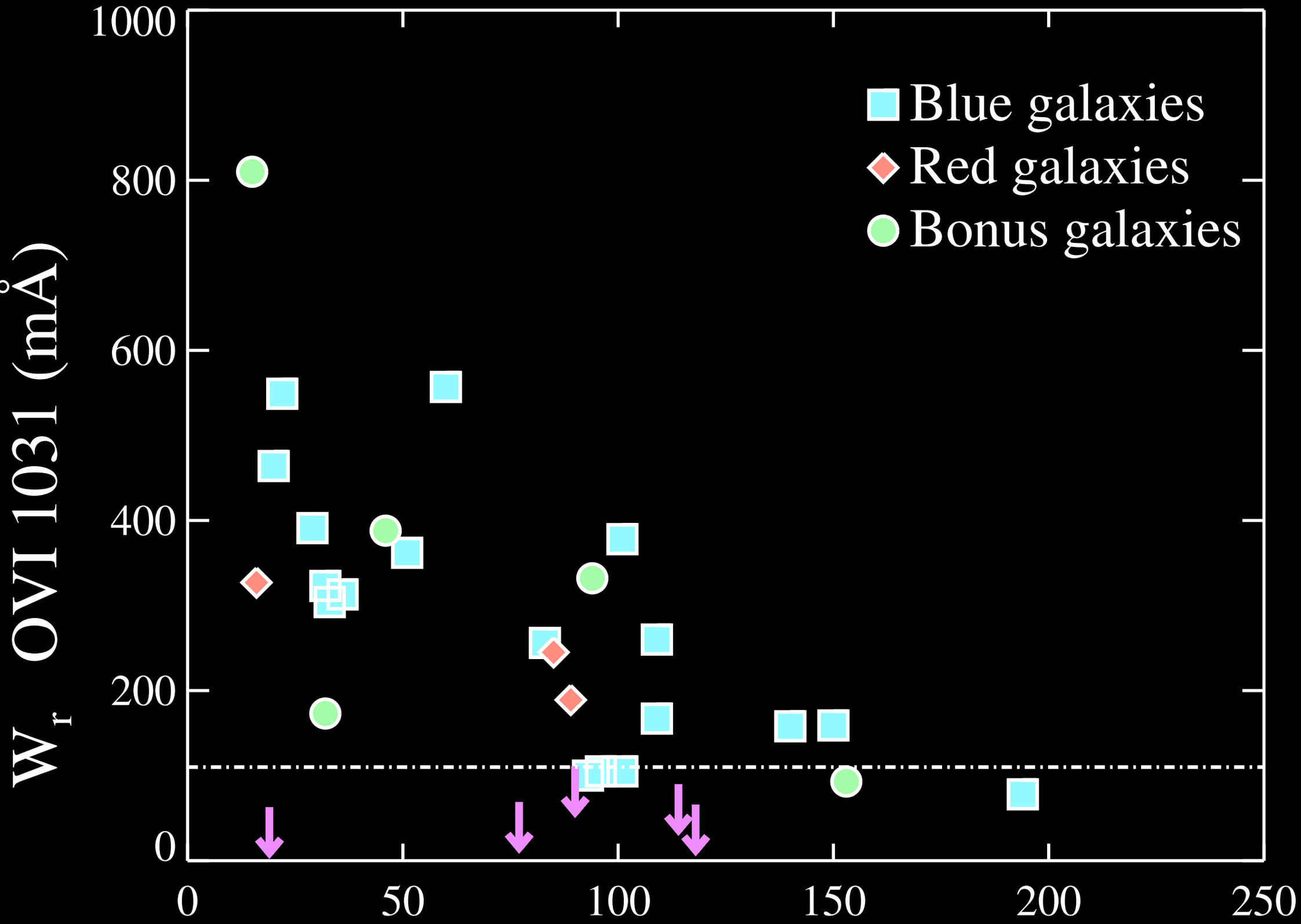




Lyα

OVI


Blue galaxies
Red galaxies
W_r OVI 1031 (mÅ)
1000
800
600
400
200
0
0
50
100
150
200
250
Impact parameter (kpc)


Blue galaxies
Red galaxies
Bonus galaxies
W_r OVI 1031 (mÅ)
1000
800
600
400
200
0
0
50
100
150
200
250
Impact parameter (kpc)

	Hits	Misses	No Coverage
N = 36	23	5	8

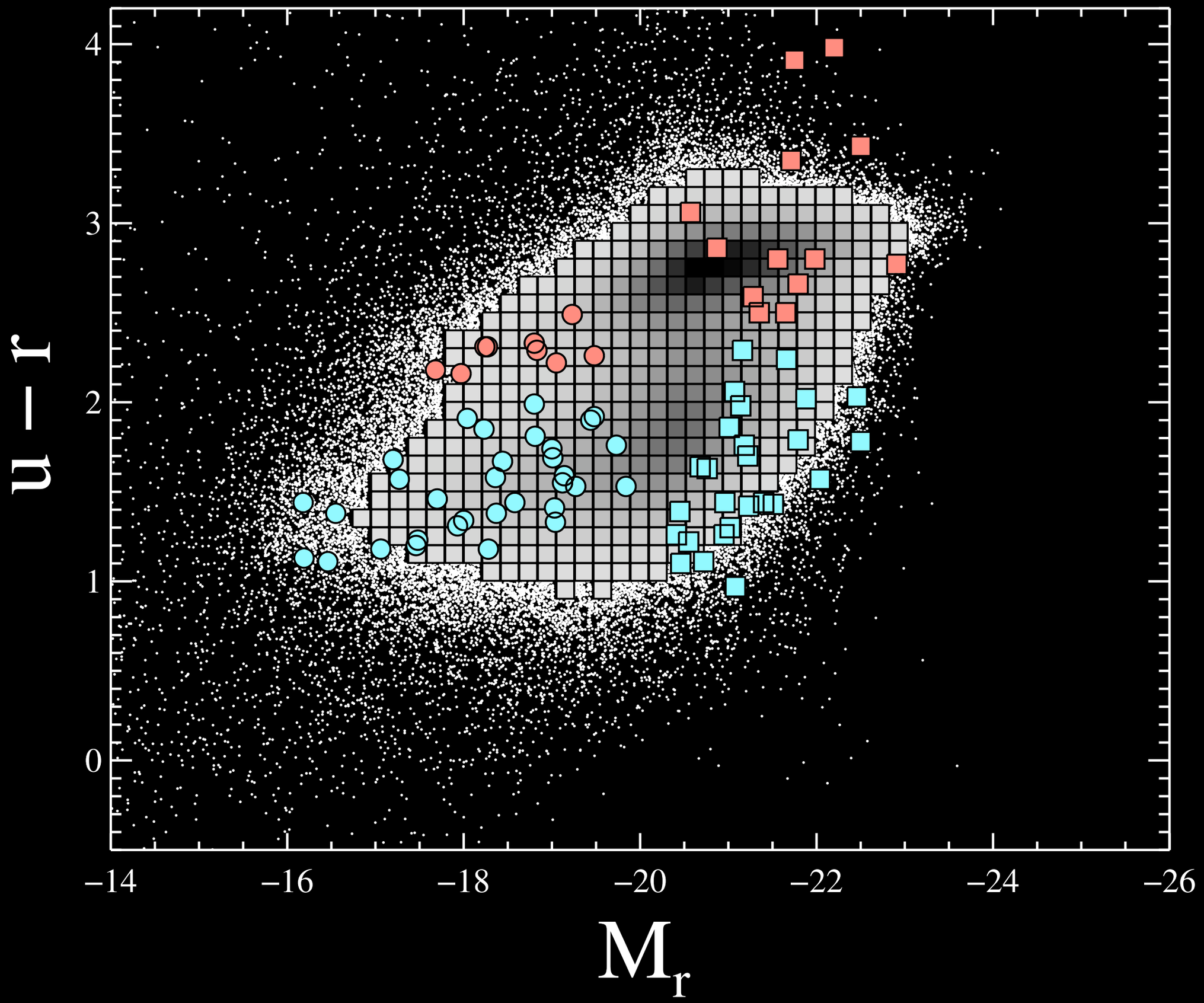
$$C_{\mathrm{OVI}} = \frac{N_{Hit}}{N_{Hit} + N_{Miss}} \pm \frac{\sqrt{N_{hit}}}{N_{hit} + N_{miss}}$$

$$\boxed{C_{\mathrm{OVI}} = 82 \pm 17\%}$$

Scorecard of Awesomeness!

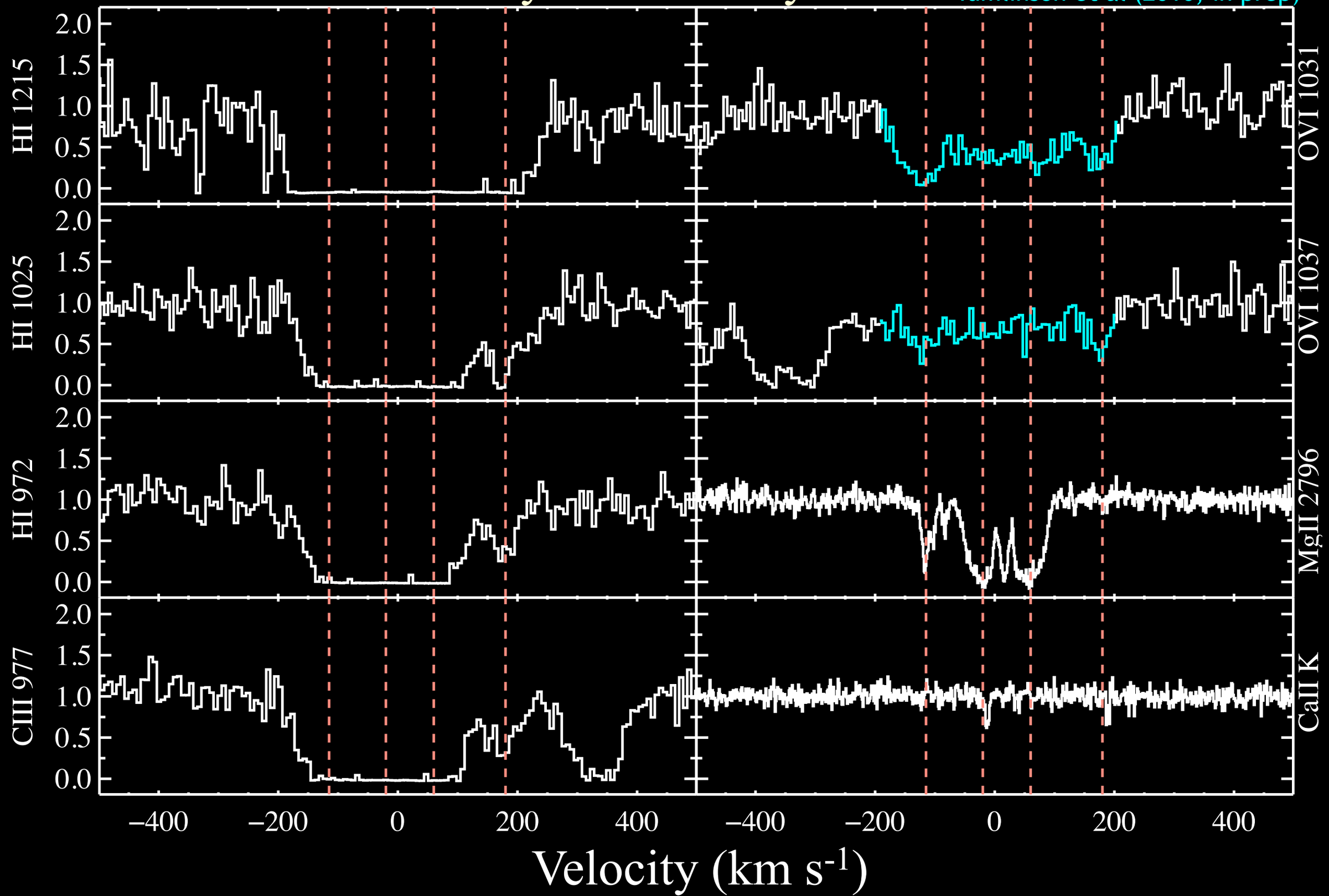
- 36 / 39 QSOs observed
- 6 DLAs; 14 LLS; 3 H_2 detections
- 17 “Bonus” galaxies
- 9+ HVCs
- 1 “miss” at 24kpc
- 1 dead laptop

To be continued…



Lyman-limit System

Tumlinson et al (2010, in prep)



Damped Lyα Absorber

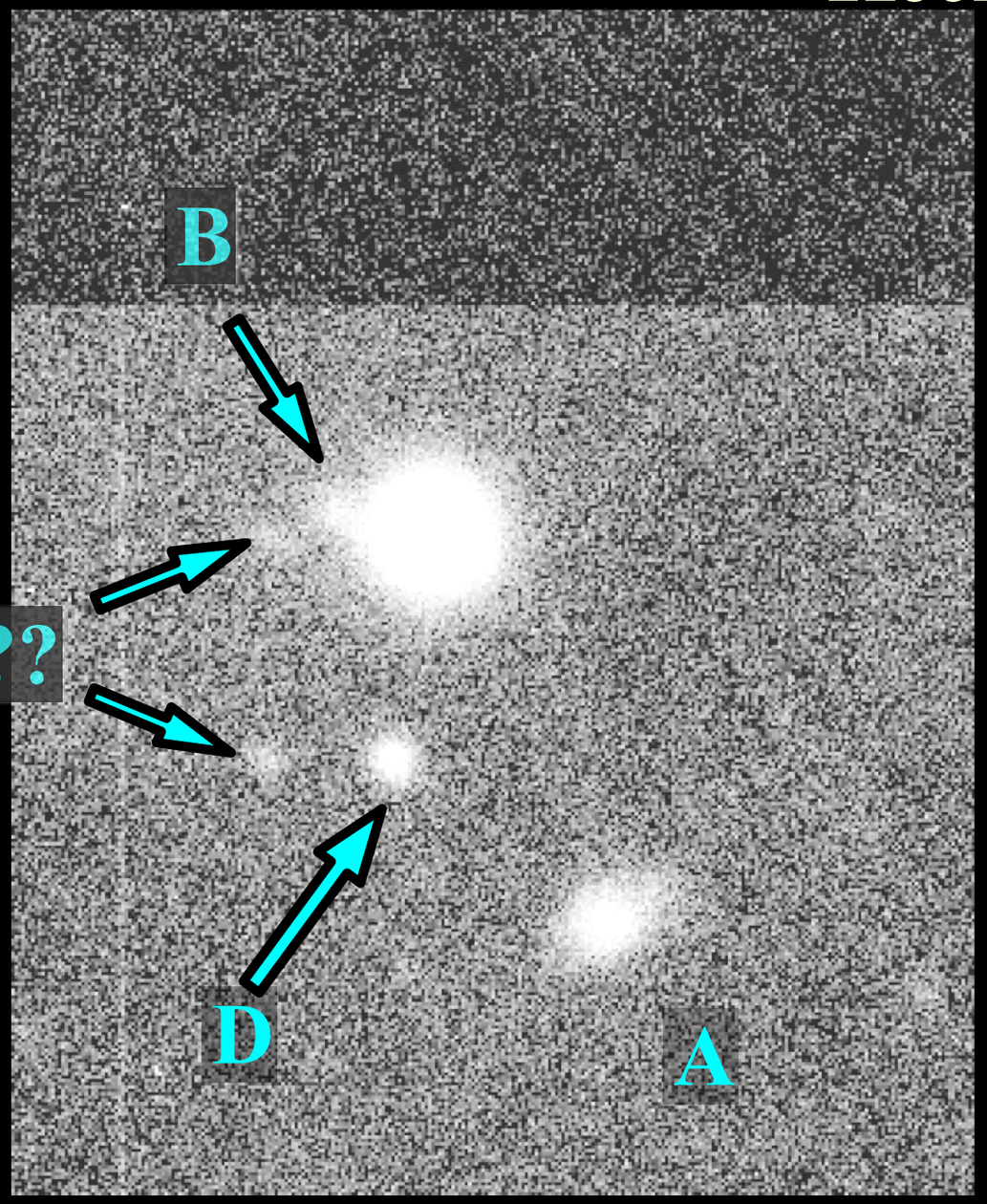
HI 1215
SII 1253
CII 1334
SII 1259
SiII 1260
MgII 2796
SiII 1264
CaII K

2.0
1.5
1.0
0.5
0.0

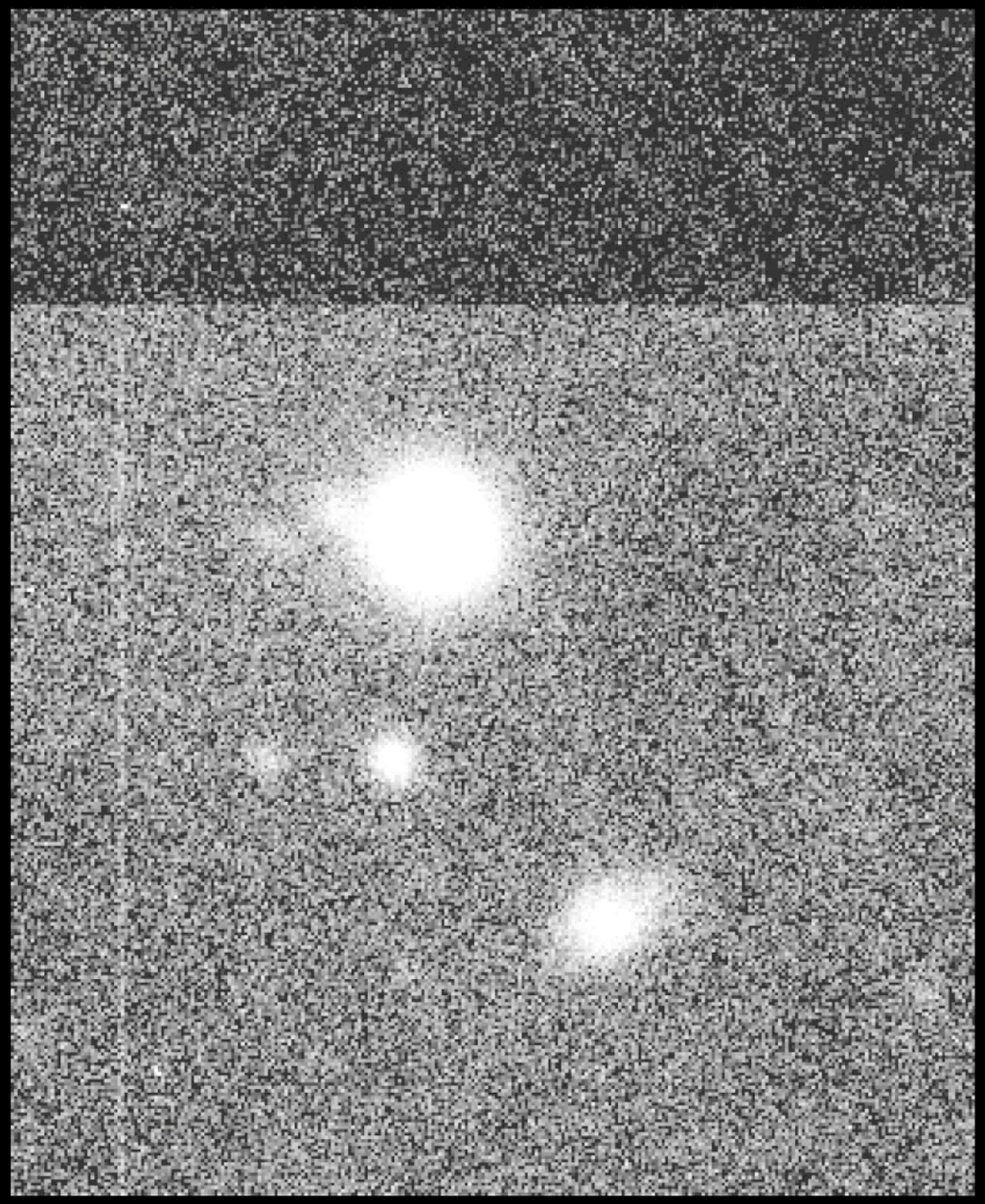
−400
−200
0
200
400

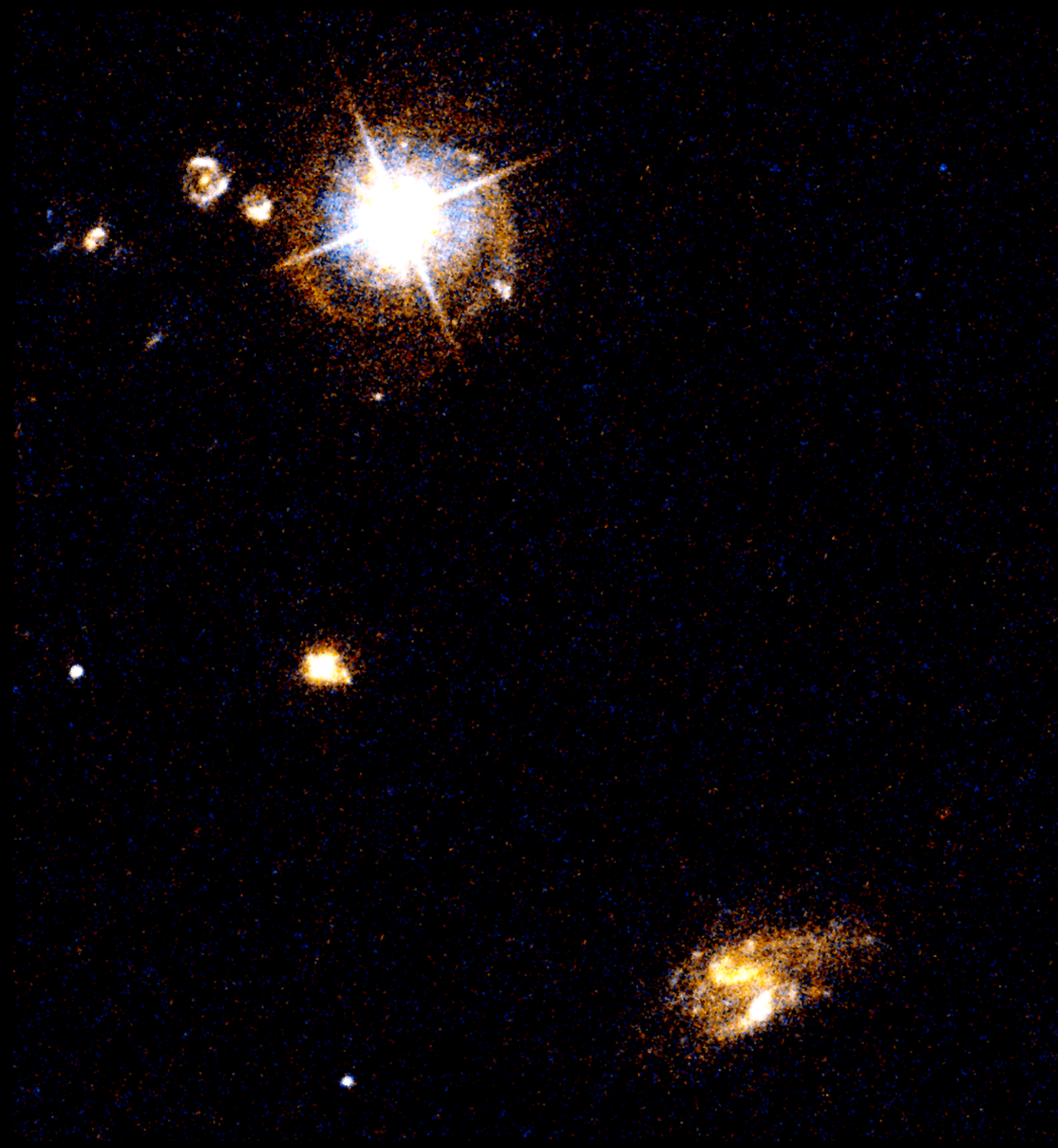
Velocity (km s^{-1})

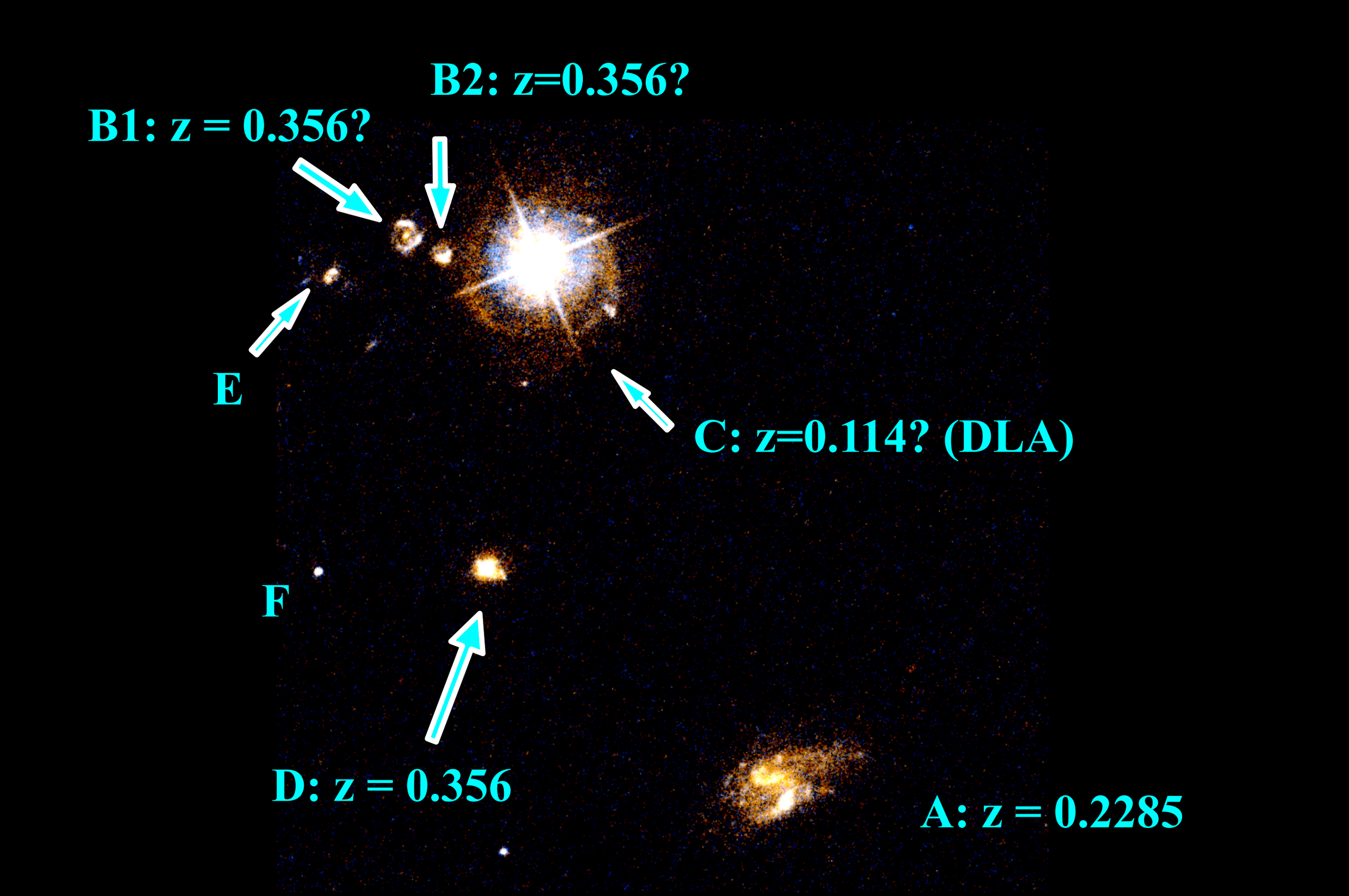
SDSS

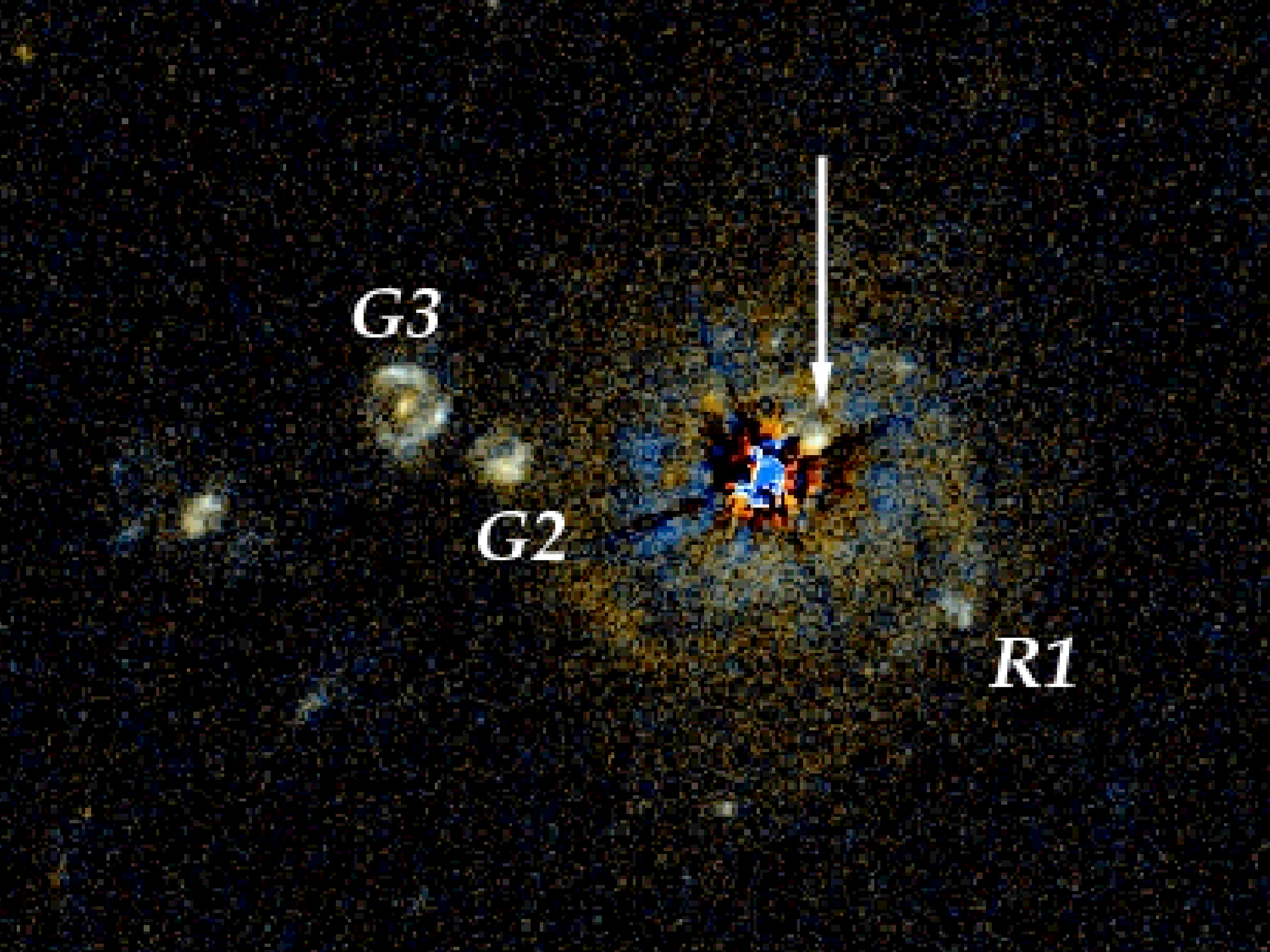


Keck






B2: z=0.356?
B1: z = 0.356?
E
C: z=0.114? (DLA)
F
D: z = 0.356
A: z = 0.2285


G3
G2
R1

Rest Wavelength [Å]
4000
4500
5000
[OII]
Balmer
Ca H K
Hβ
[OIII]
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flux [10^{-17} erg/s/cm^2/Å]
5000
5500
6000
6500
Observed Wavelength [Å]

10"

10”

N

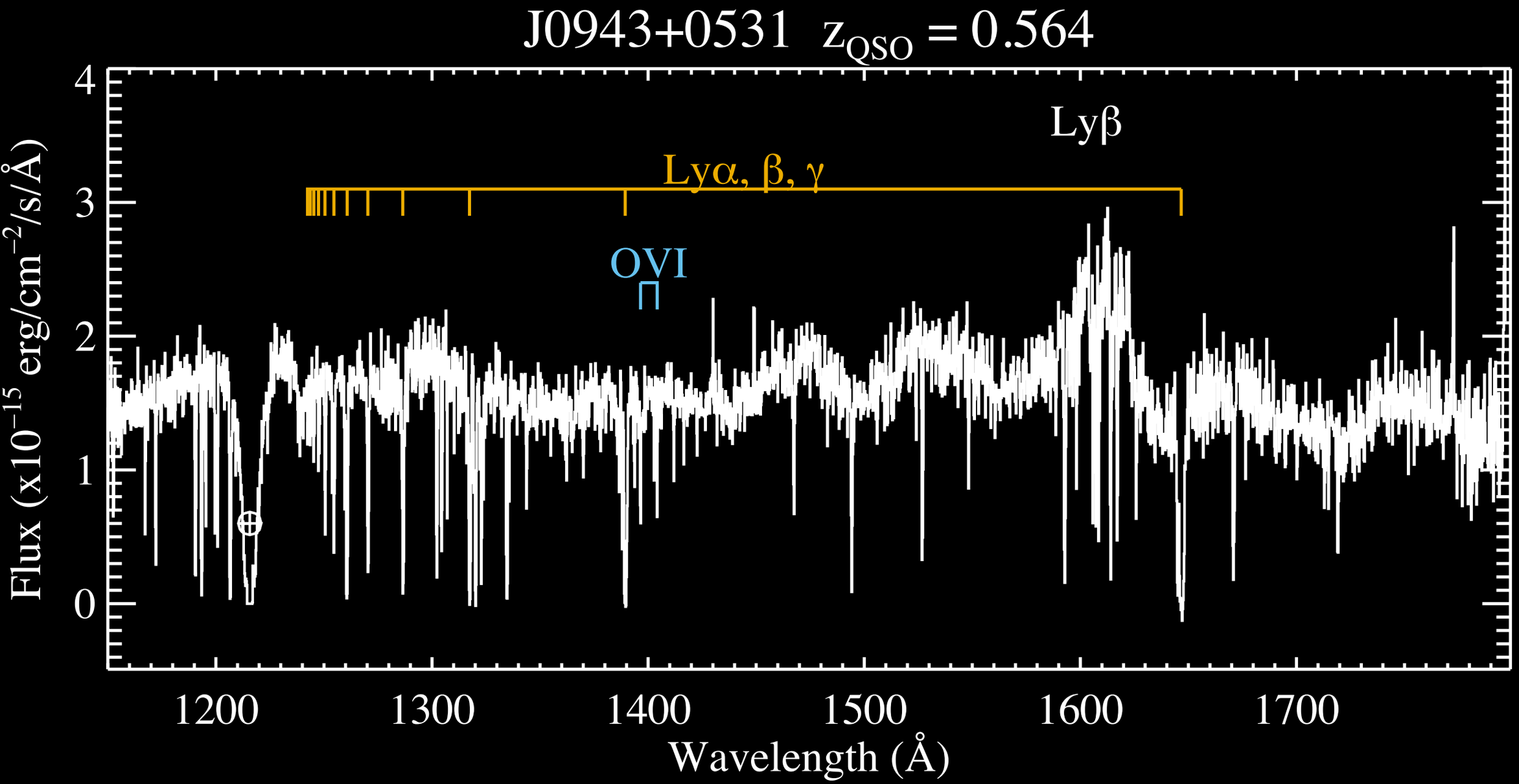
E

W

S

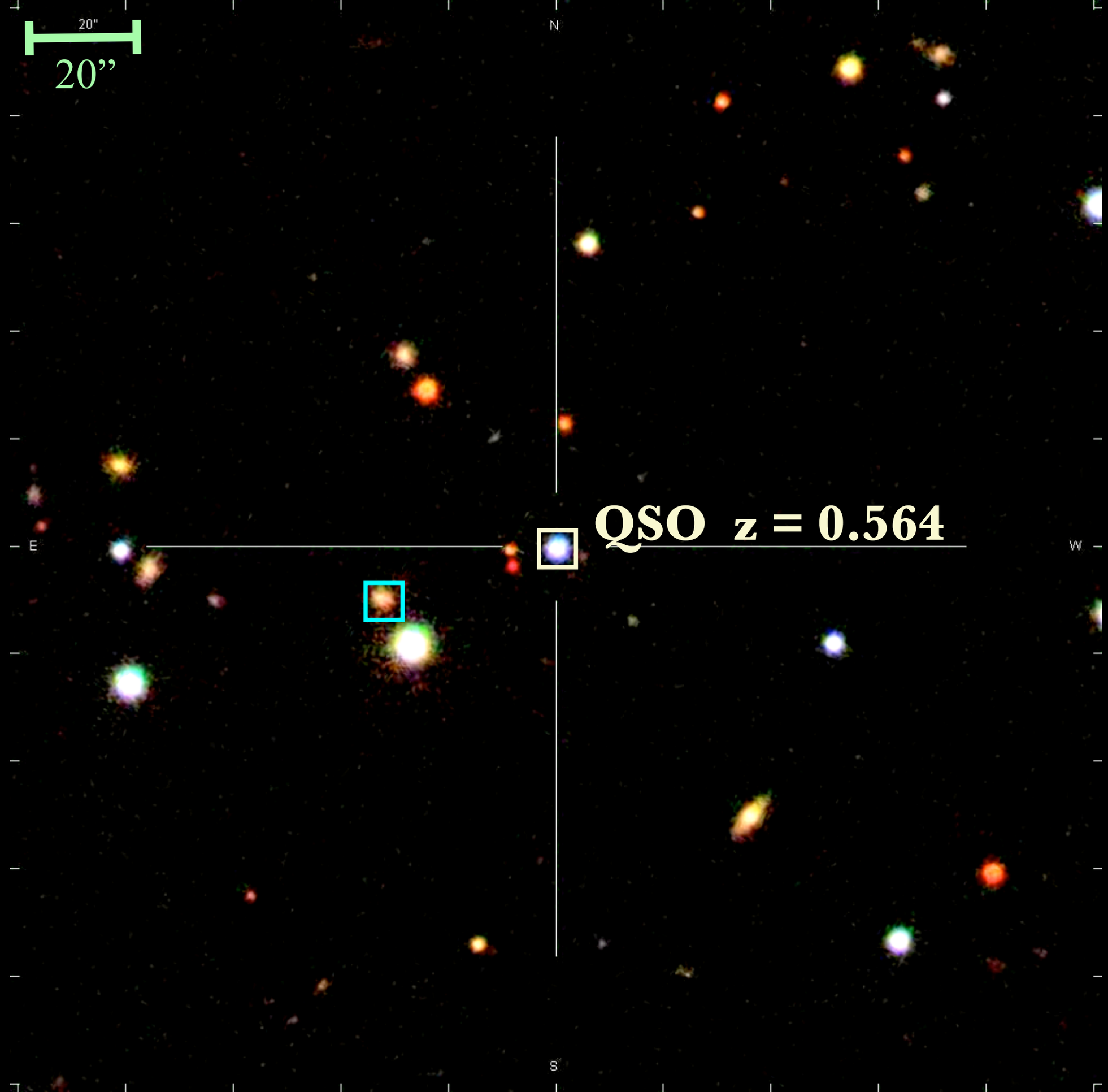
B: z = 0.252

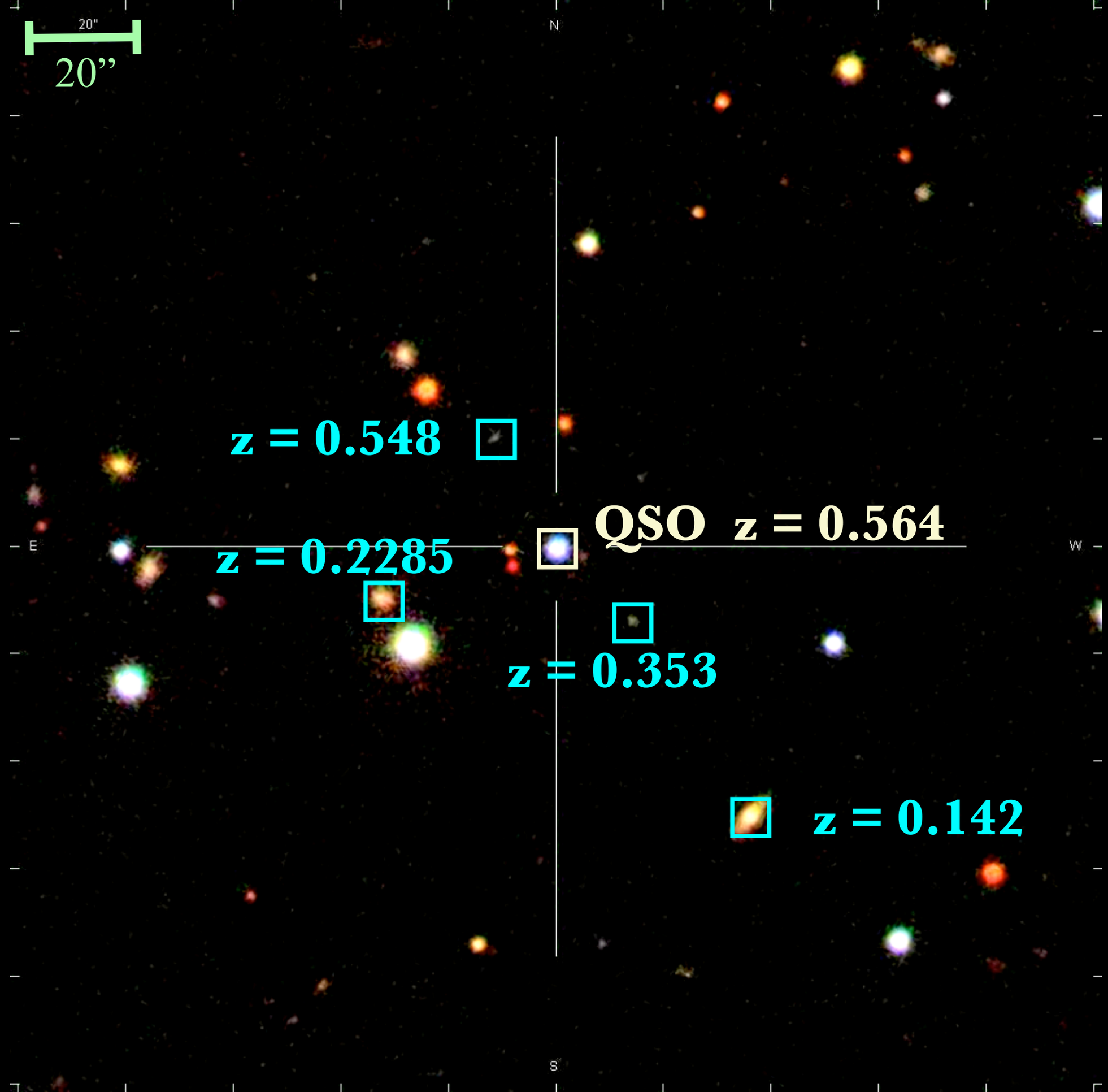
A: z = 0.252

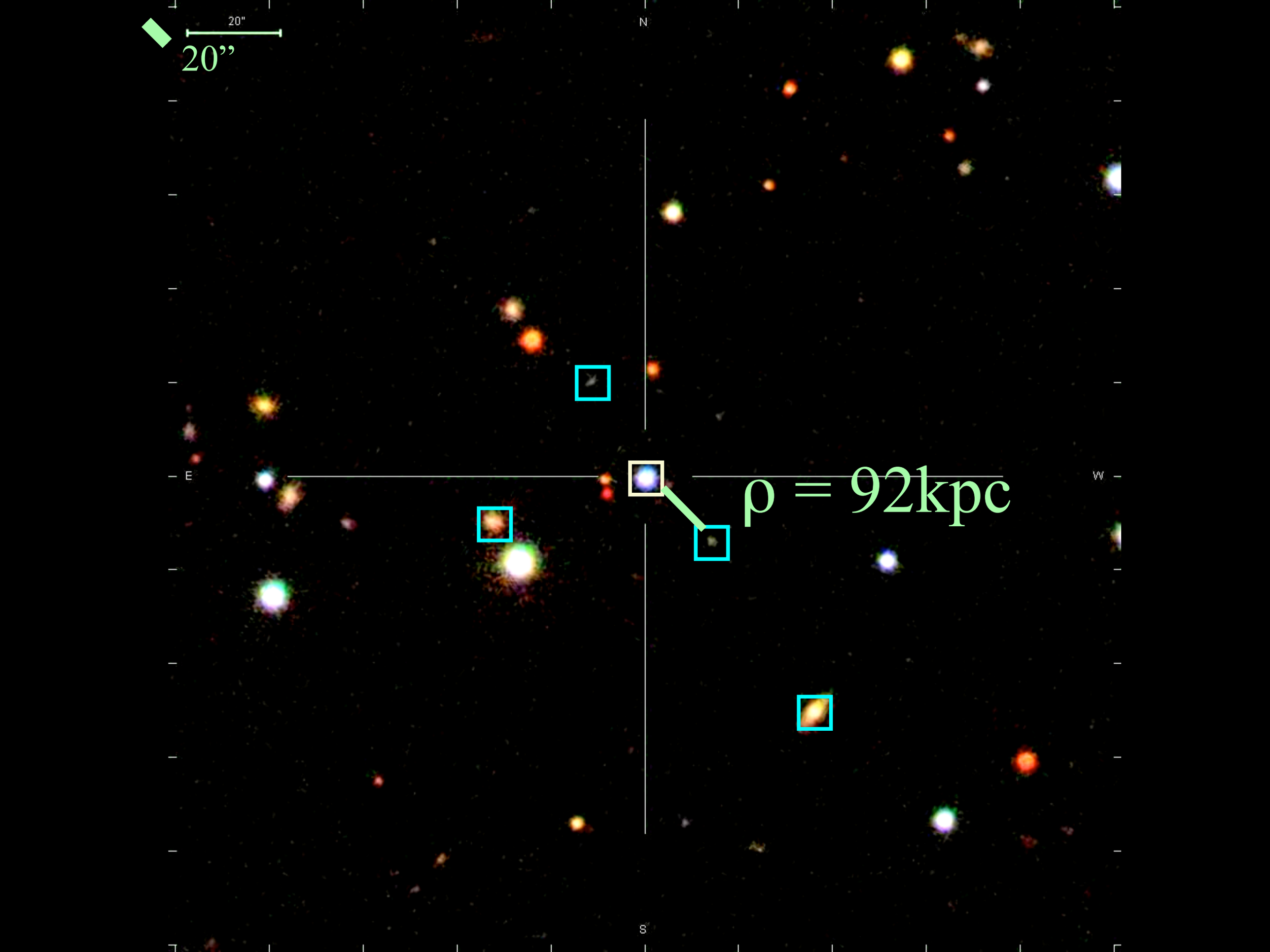

J0943+0531 $z_{QSO} = 0.564$
Lyβ
Lyα, β, γ
OVI
⊓
⊕
Flux (x10^{-15} erg/cm^{-2}/s/Å)
0
1
2
3
4
1200
1300
1400
1500
1600
1700
Wavelength (Å)

J0943+0531 $z_{abs} = 0.35328$

HI 1215
HI 920
HI 1025
CIII 977
HI 972
OVI 1031
HI 923
OVI 1037
1.0
0.0
−400
−200
0
200
Velocity (km s^{-1})


20"
20”
N
QSO z = 0.564
E
W
S


20"
20”
N
z = 0.548
QSO z = 0.564
z = 0.2285
z = 0.353
z = 0.142
E
W
S


20"
20”
N
E
W
S
ρ = 92kpc