



Revisiting the Early Universe: A New Spectroscopic Analysis of $z \sim 6.4$ Quasar PSO J159-02

Christian Piscitelli, PhD Student @INAF OATs

Supervisors: Valentina d'Odorico, Stefano Borgani

Collaborators: Manuela Bischetti, Matilde Brazzini, Simona di
Stefano



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Rest-frame UV properties - BH mass and Eddington ratio

We derive the bolometric luminosity at 3000 Å (Richard+ 2006) obtaining
 $L_{bol} = 5.15 \times \lambda L_{\lambda}(3000 \text{ \AA}) \text{ erg/s} = (3.01 \pm 0.03) \times 10^{47} \text{ erg/s}$

Mg II BH mass

We use the **scaling relation** from Vestergaard & Osmer (2009):

$$M_{BH,MgII} = 10^{6.86} \left[\frac{FWHM_{MgII}}{10^3 \text{ km s}^{-1}} \right]^2 \left[\frac{\lambda L_{\lambda}(3000 \text{ \AA})}{10^{44} \text{ erg s}^{-1}} \right]^{0.5} M_{\odot}$$

$$\log \left(\frac{M_{BH,MgII}}{M_{\odot}} \right) = 9.53 \pm 0.04$$

C IV BH mass

We use the **scaling relation** from Vestergaard & Peterson (2006):

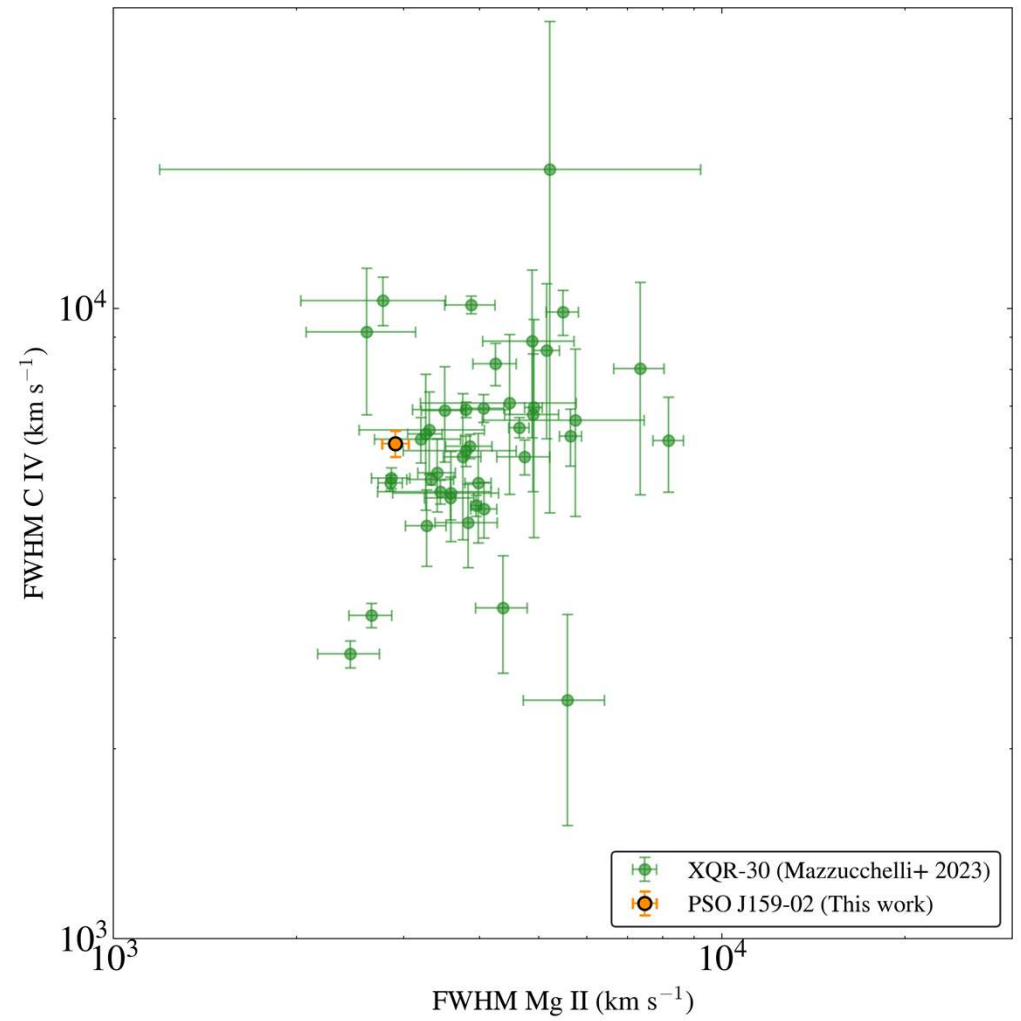
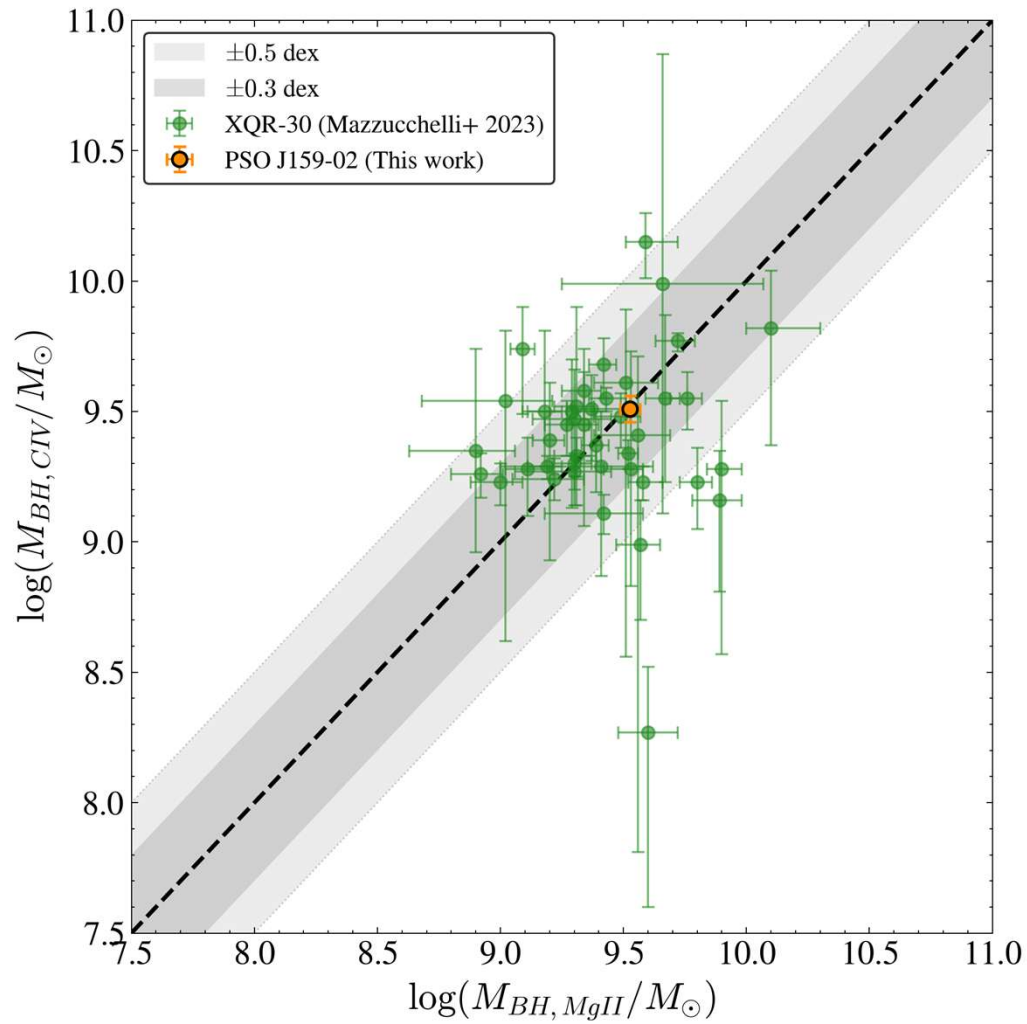
$$M_{BH,CIV} = 10^{6.66} \left[\frac{FWHM_{CIV,corr}}{10^3 \text{ km s}^{-1}} \right]^2 \left[\frac{\lambda L_{\lambda}(1350 \text{ \AA})}{10^{44} \text{ erg s}^{-1}} \right]^{0.53} M_{\odot}$$

$$\log \left(\frac{M_{BH,CIV}}{M_{\odot}} \right) = 9.51 \pm 0.05$$

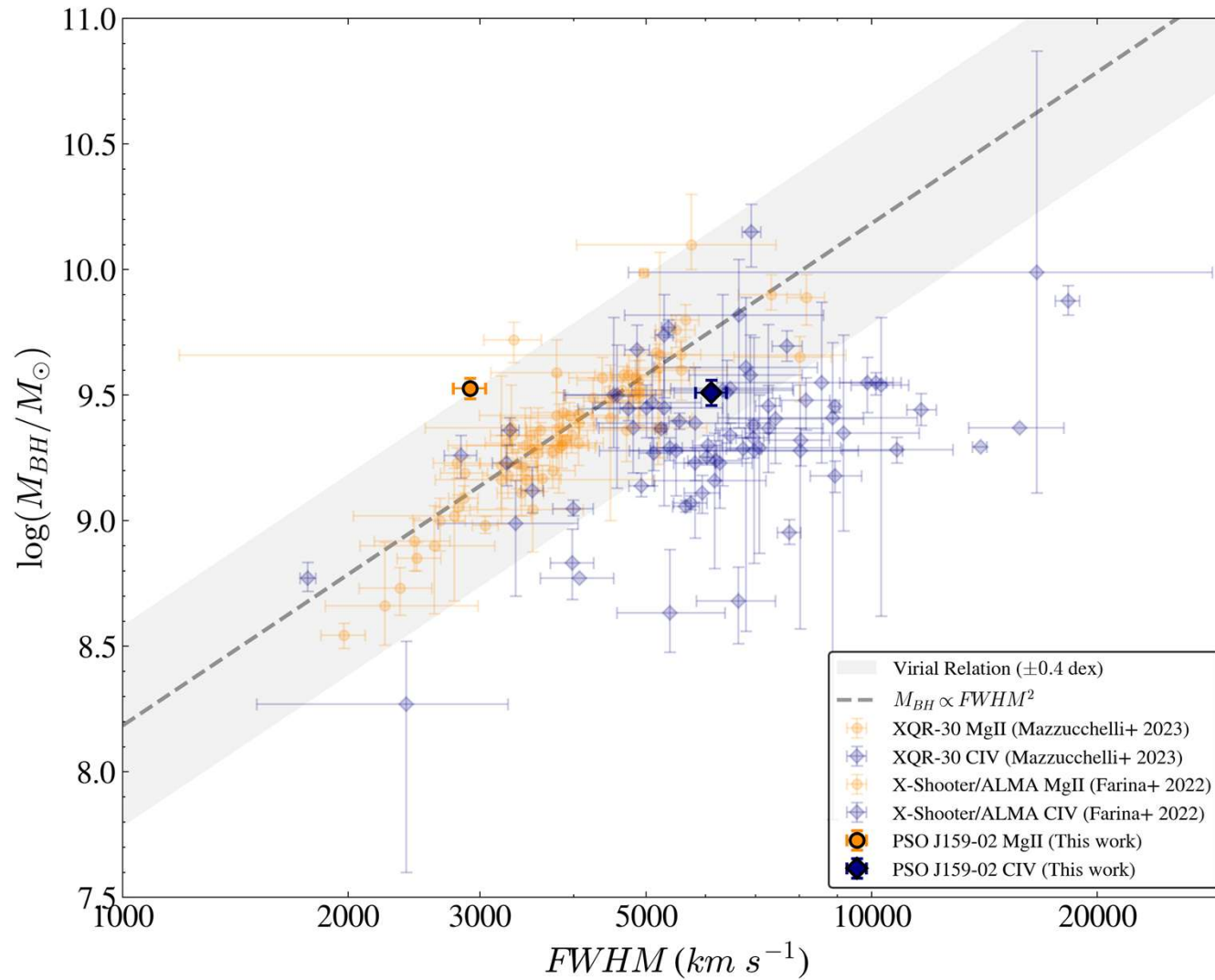
$$\lambda_{Edd,CIV} = 0.74 \pm 0.06$$
$$\lambda_{Edd,MgII} = 0.71 \pm 0.05$$

Excellent agreement!

Rest-frame UV properties – comparison with literature

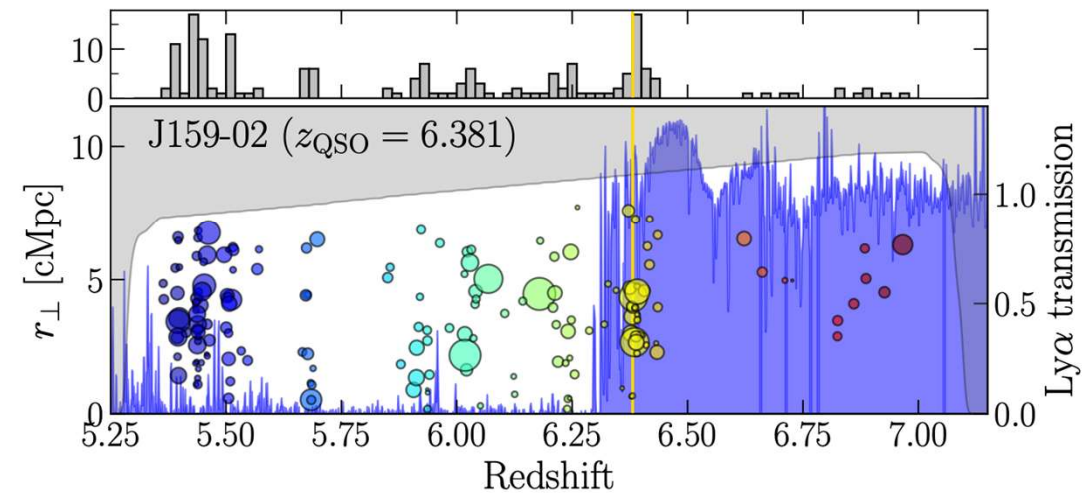
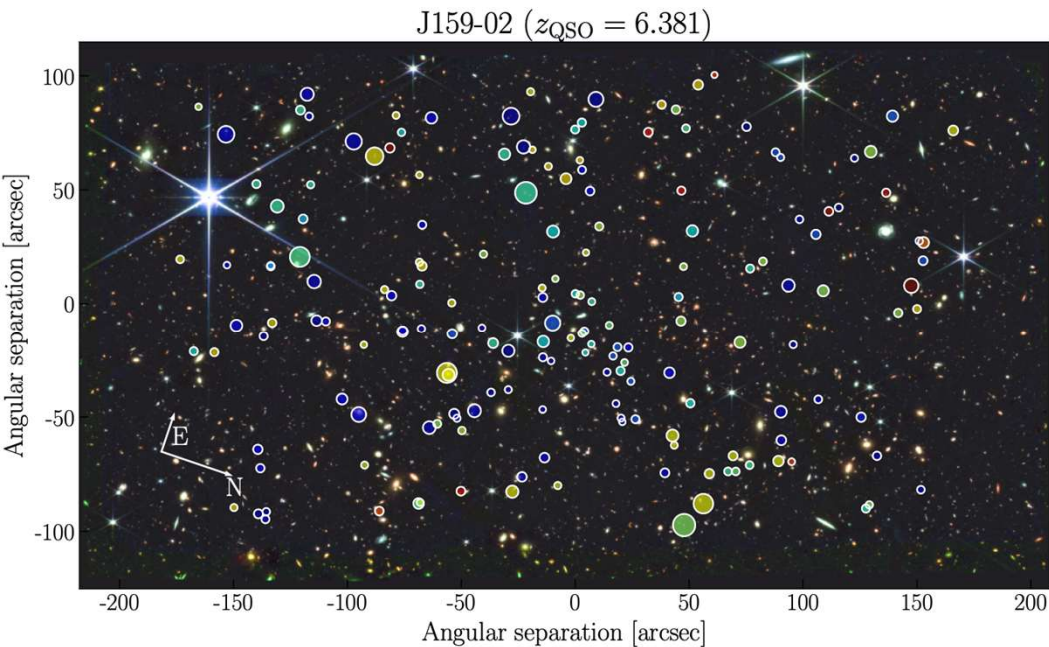


Rest-frame UV properties – comparison with literature



PSO J159-02 Field of View (EIGER)

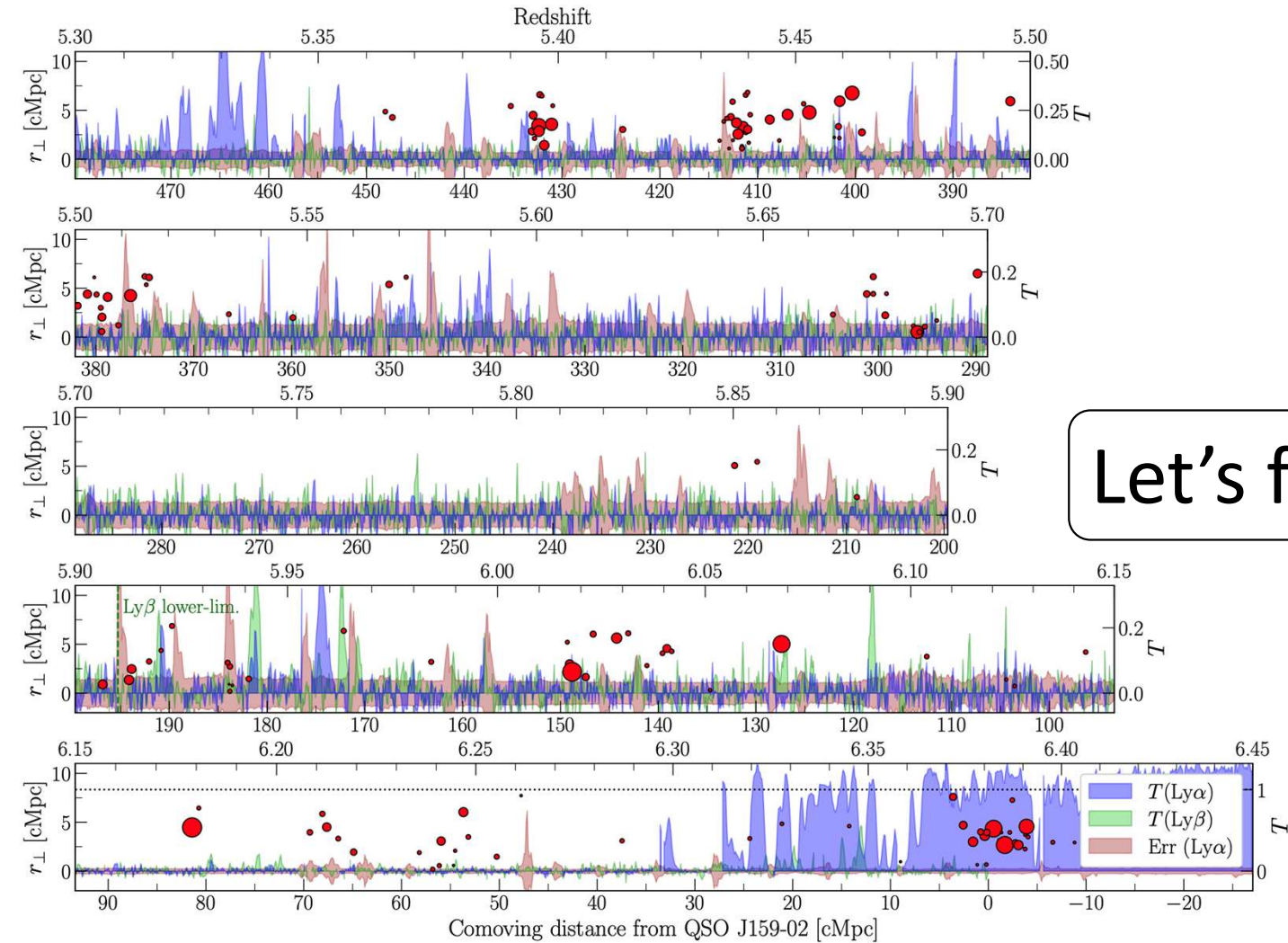
JWST/NIRCam observations with F115W, F200W, and F356W



The circles are [O III] emitters, and the shape indicates their luminosity

In addition to J159, we have other 5 quasar fields: J0100, J1030, J1148, J0148, J1120

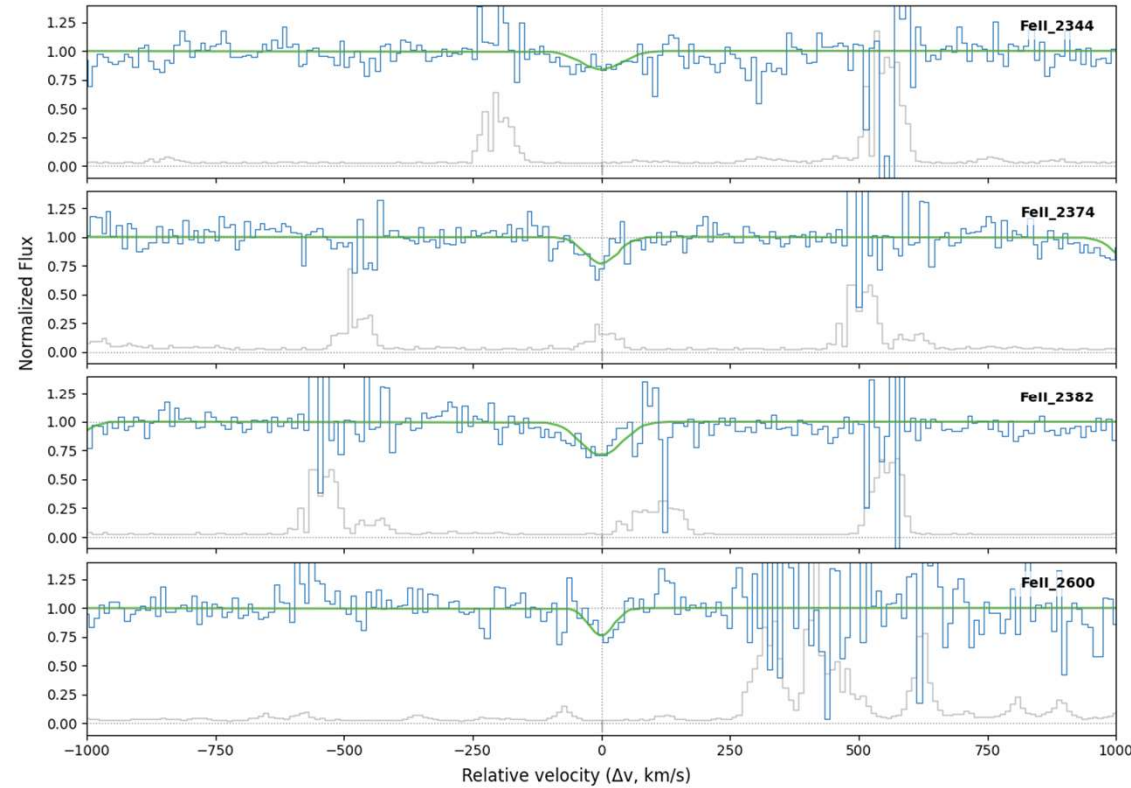
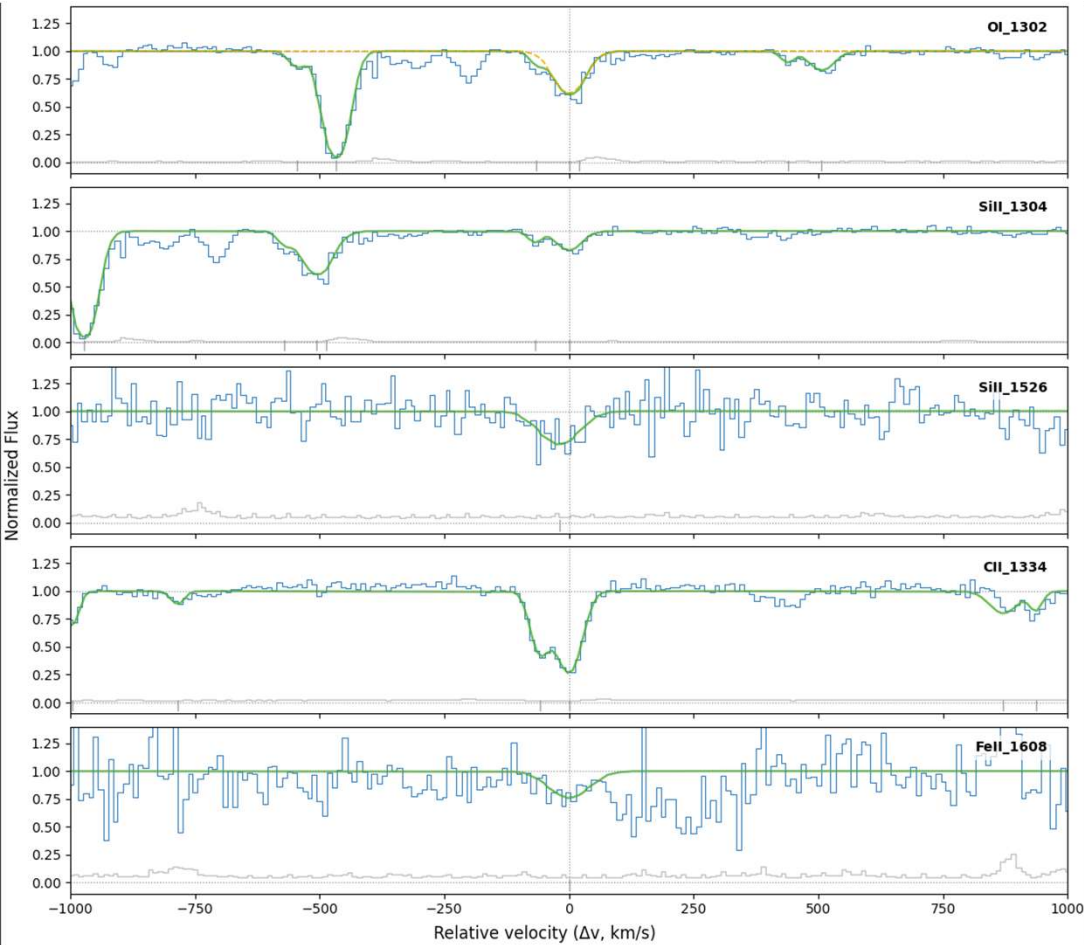
Intervening absorbers in J159-02 spectrum



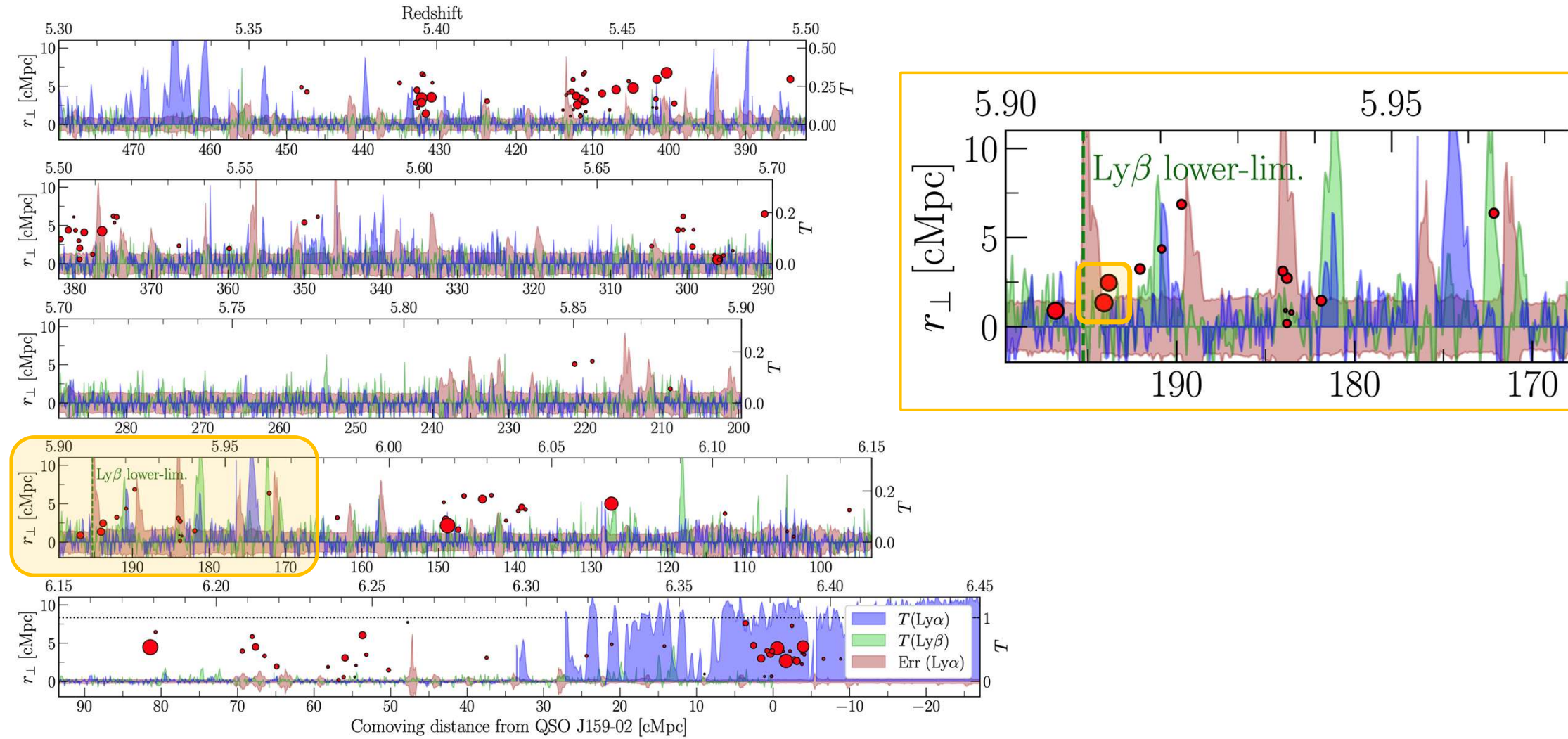
Let's find the absorbers!

Intervening absorbers in J159-02 spectrum (1)

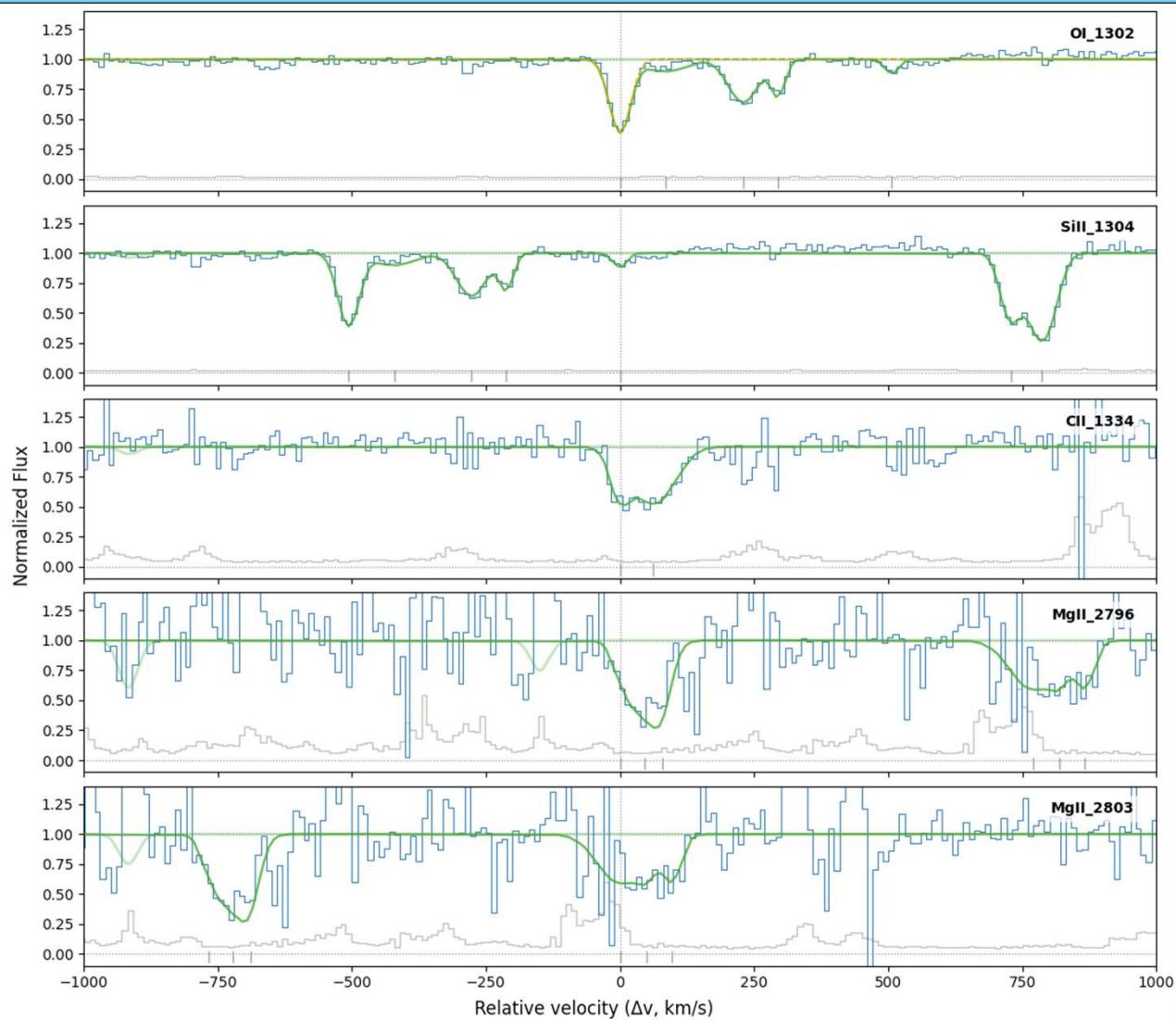
Absorption system at $z \sim 5.91309$



Intervening absorbers in J159-02 spectrum (1)

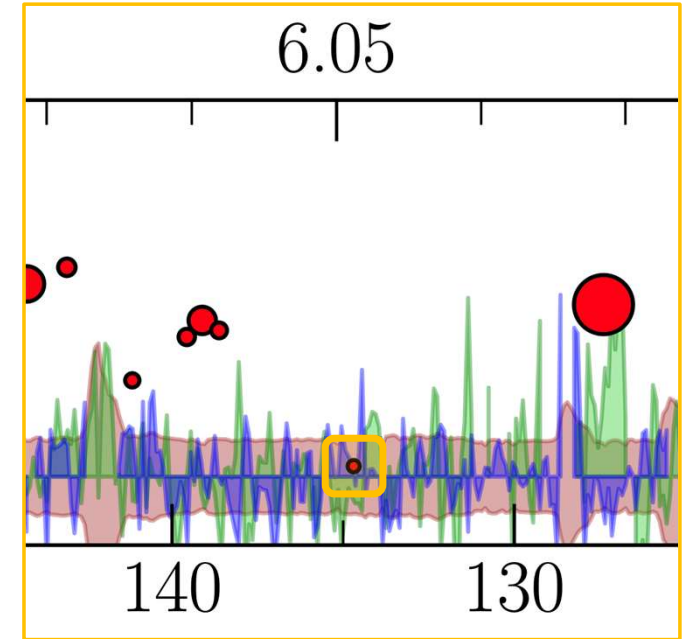
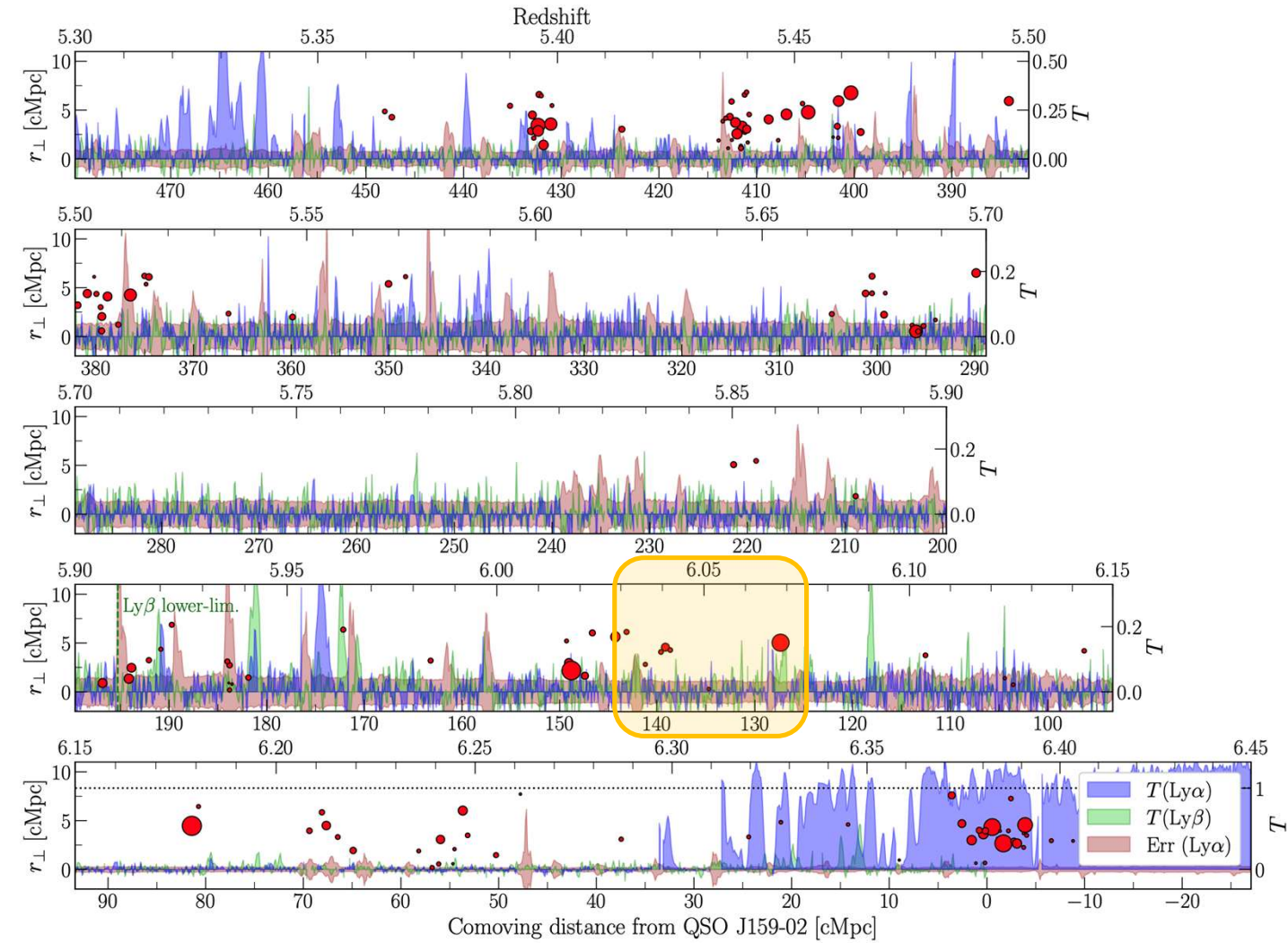


Intervening absorbers in J159-02 spectrum (2)

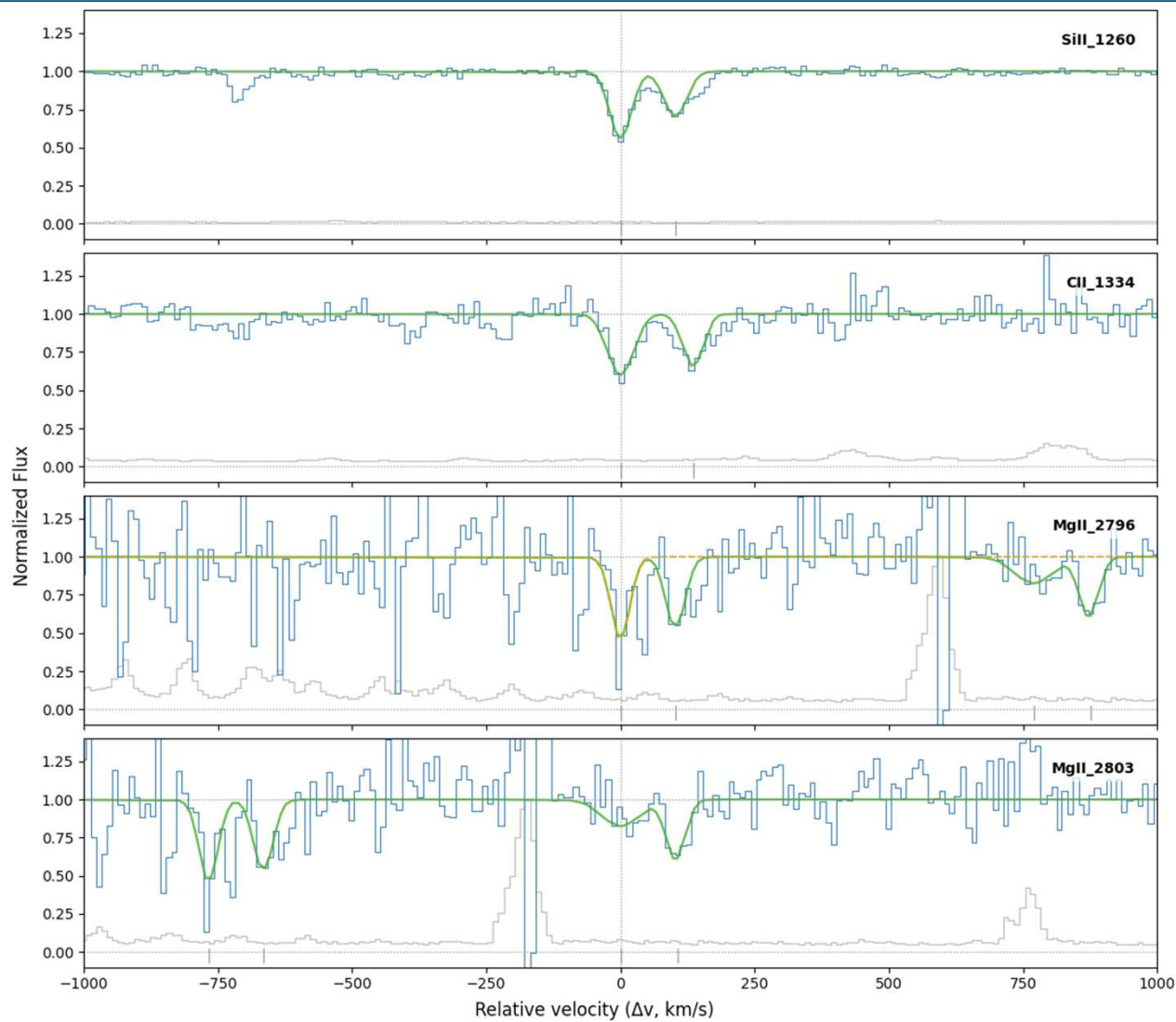


Absorption system at $z \sim 6.05443$

Intervening absorbers in J159-02 spectrum (2)

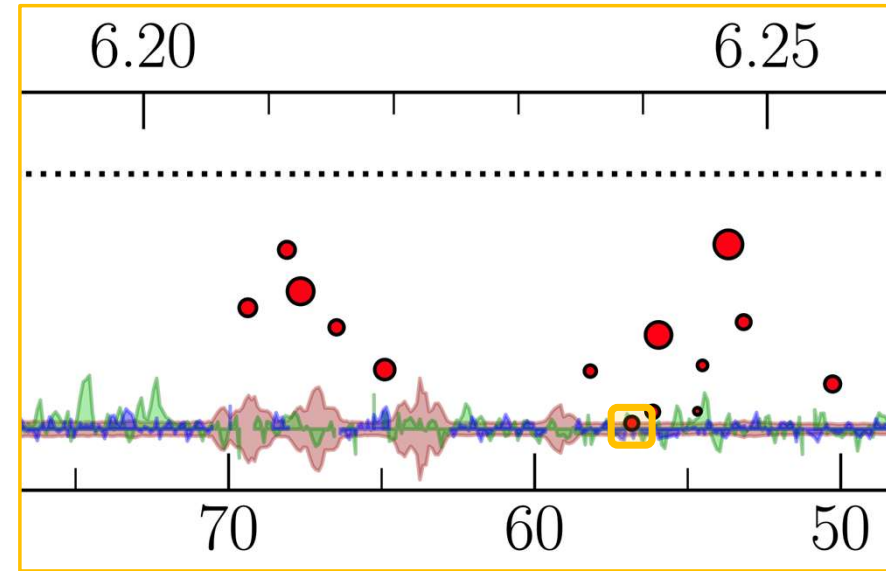
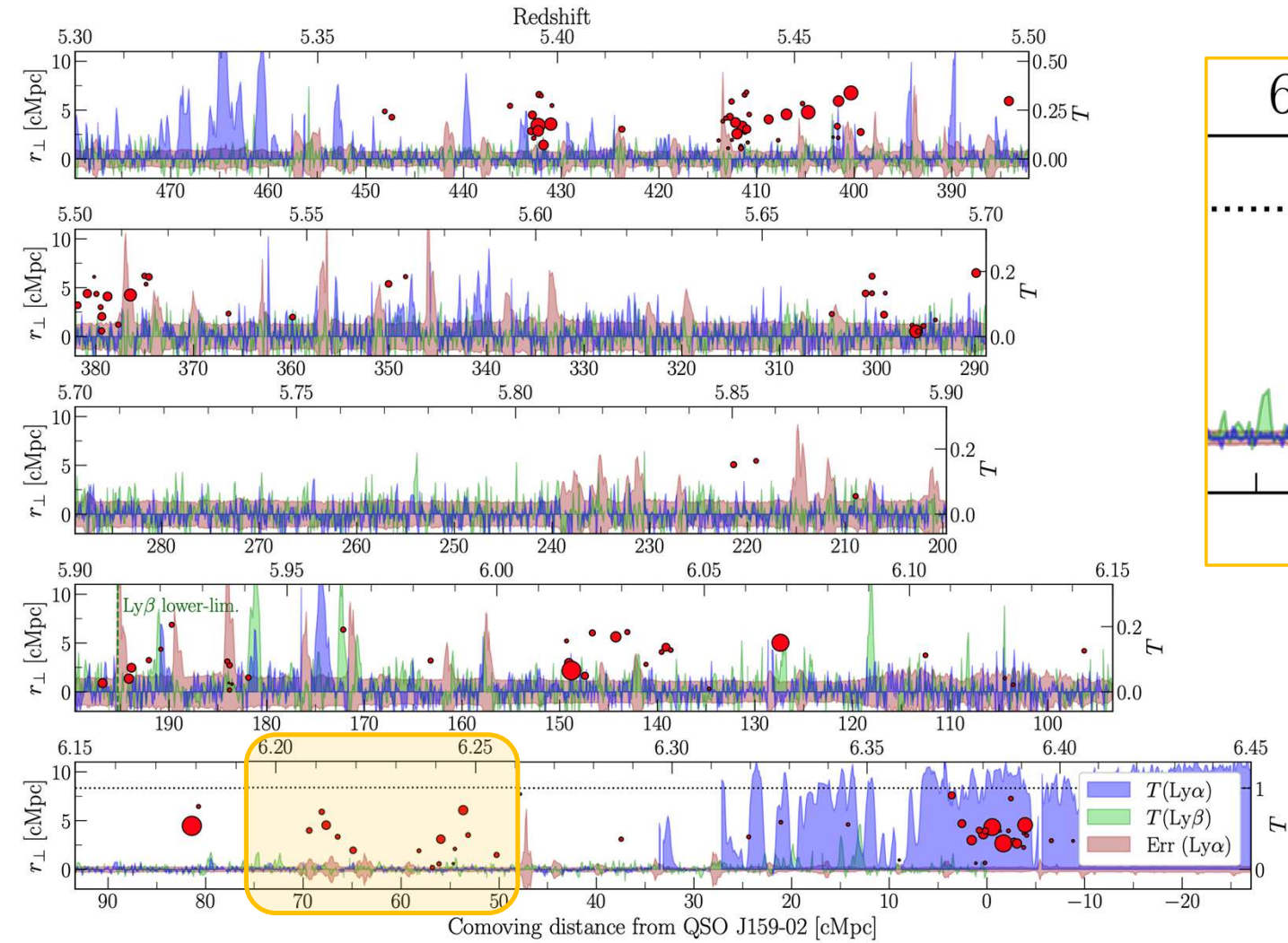


Intervening absorbers in J159-02 spectrum (3)

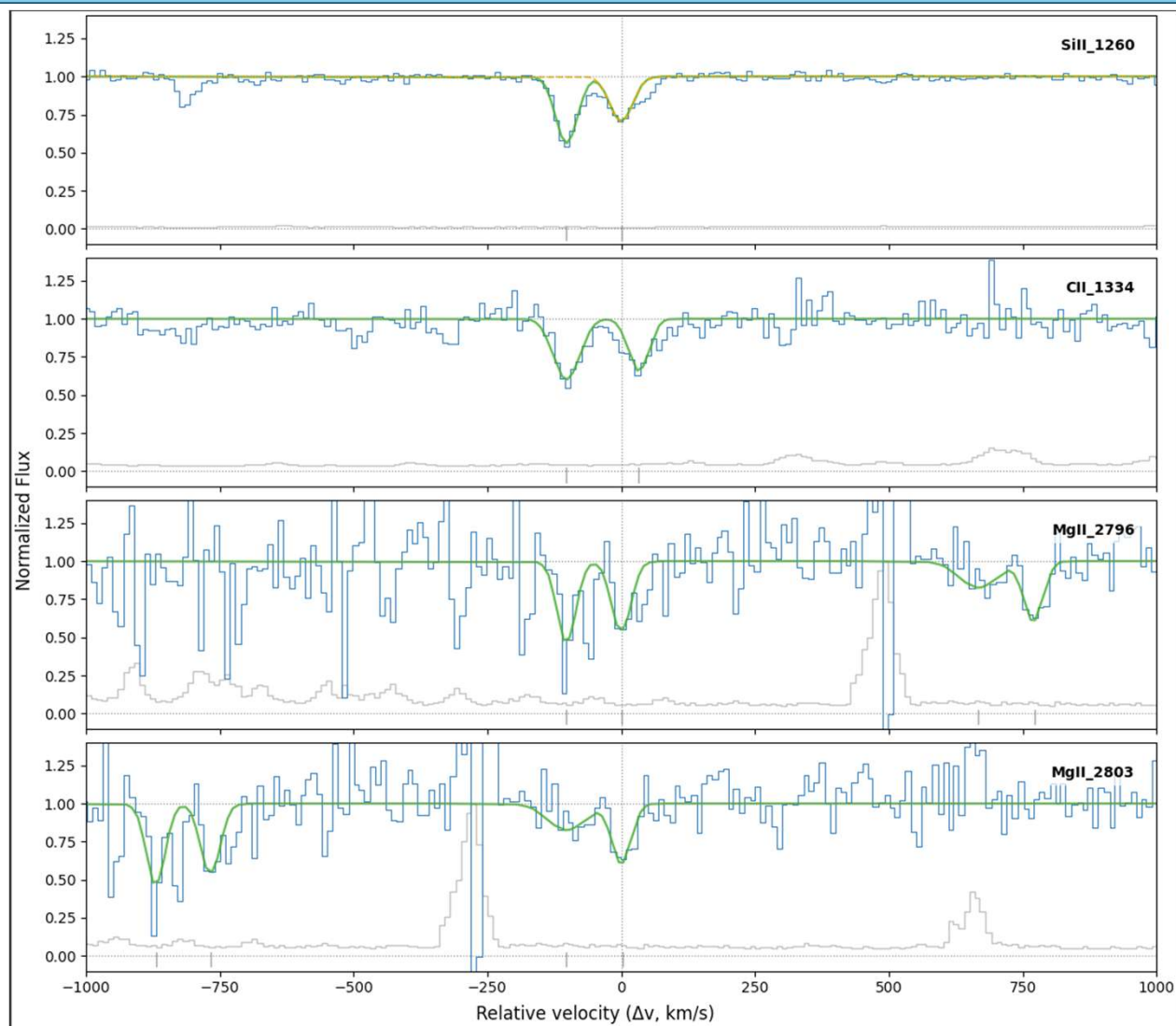


Absorption system at $z \sim 6.23694$

Intervening absorbers in J159-02 spectrum (3)

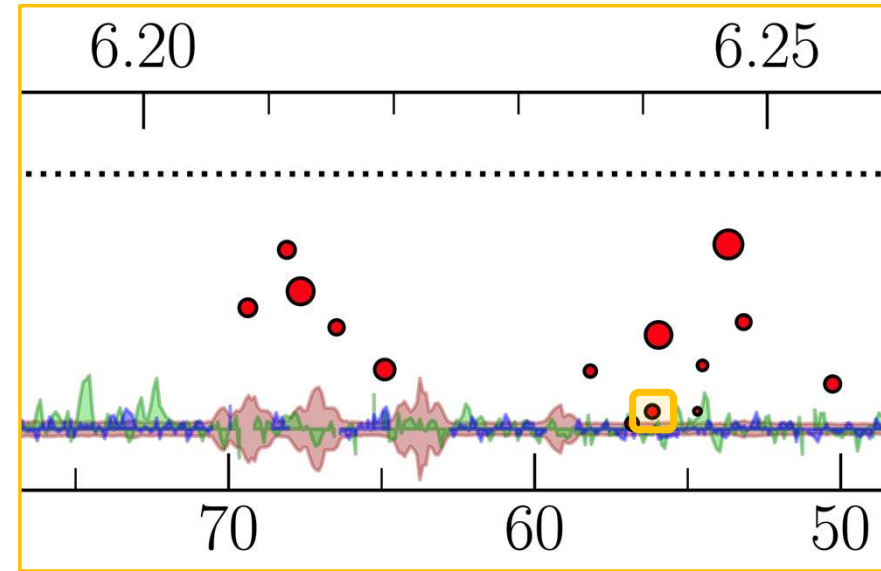
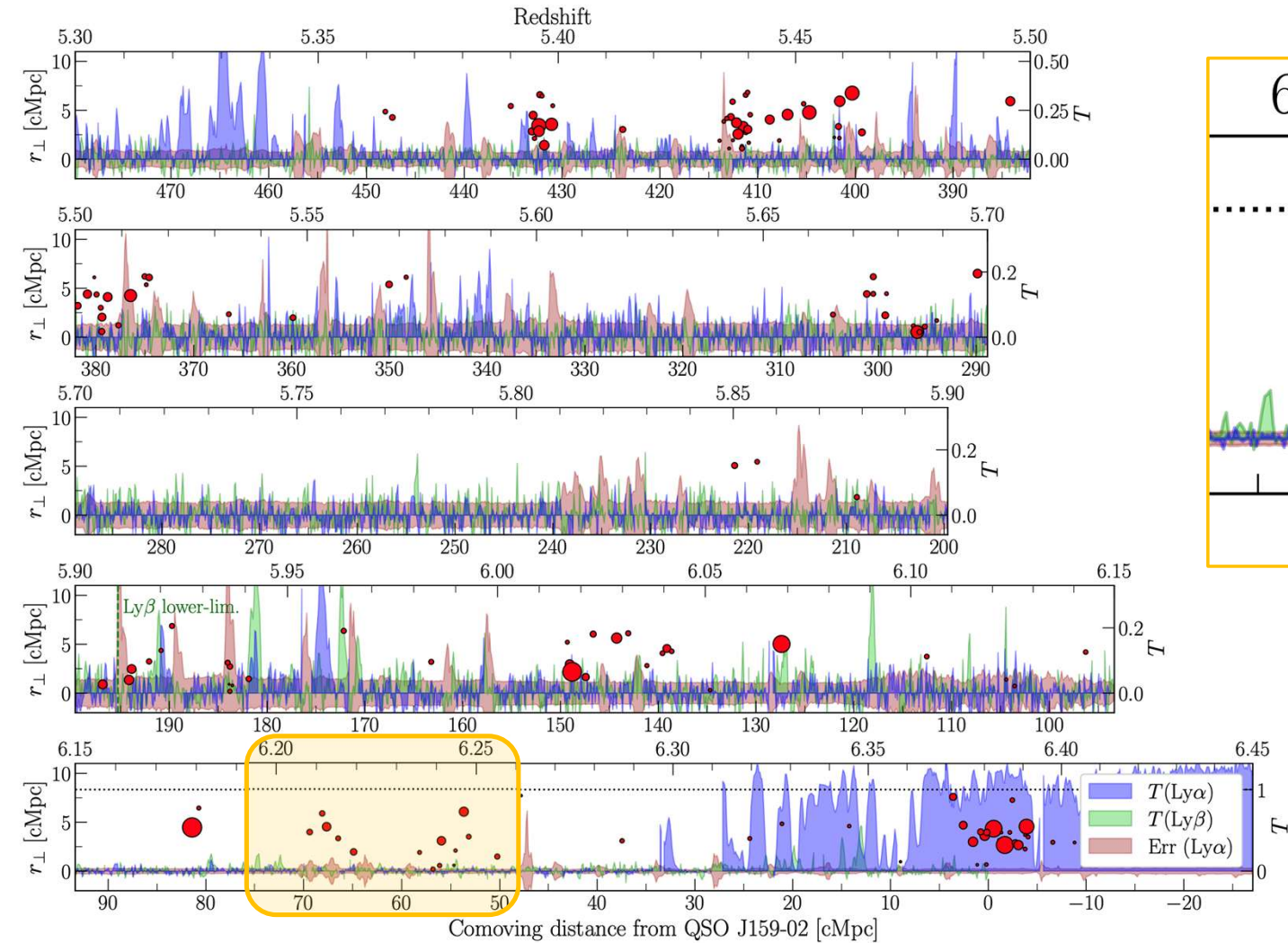


Intervening absorbers in J159-02 spectrum (4)



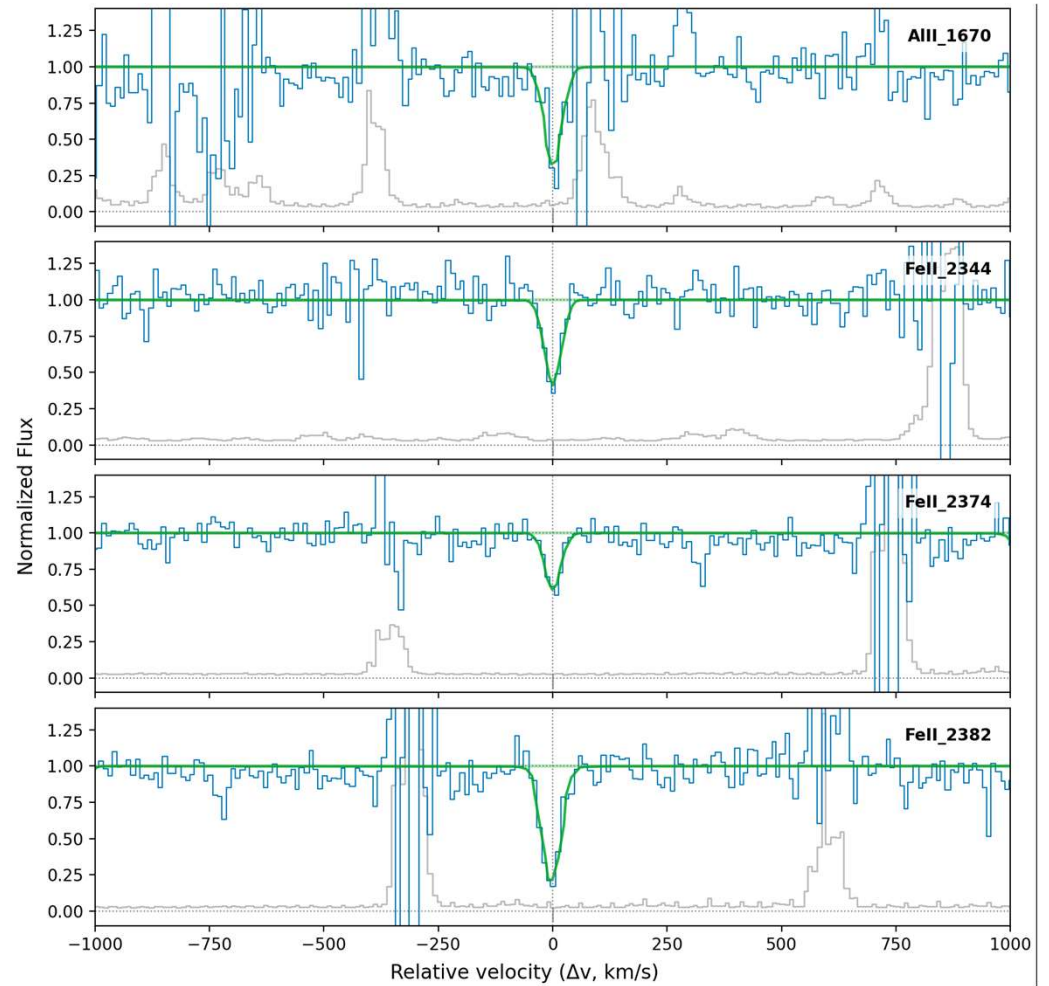
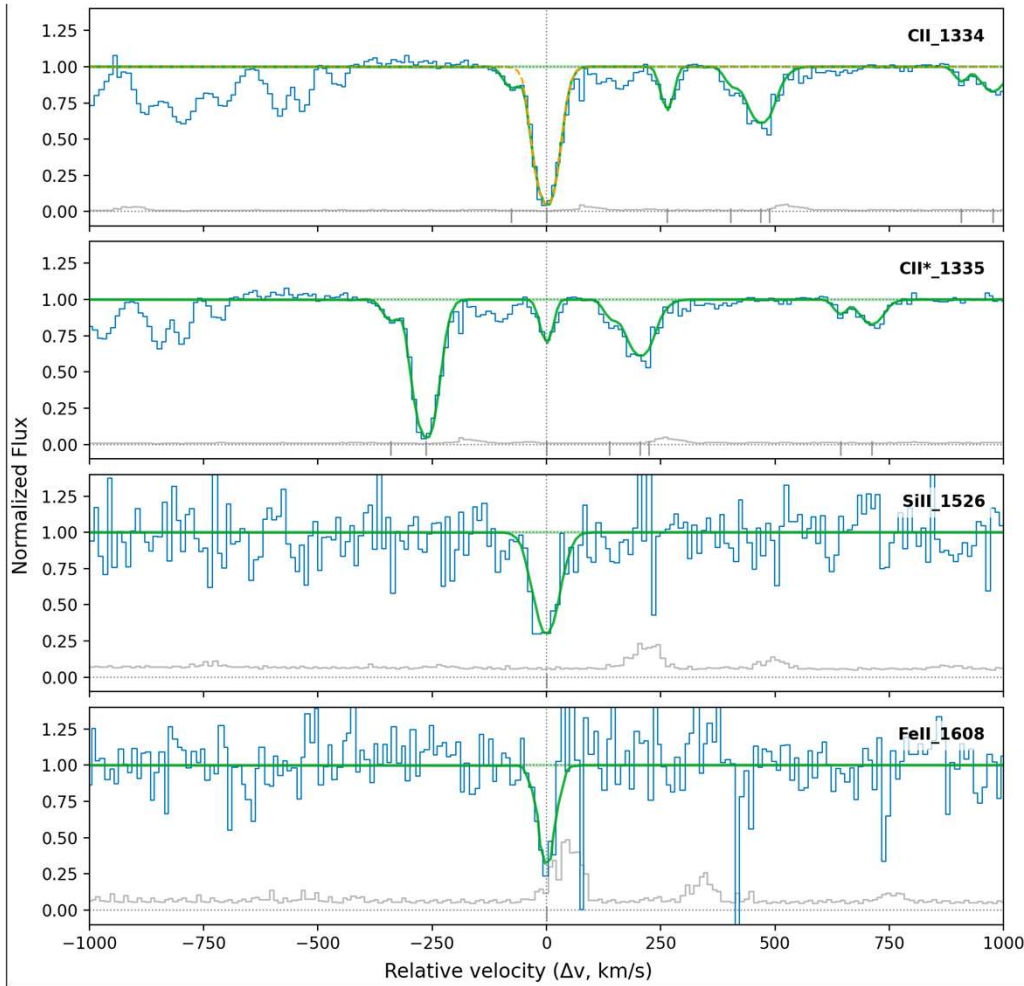
Absorption system at $z \sim 6.23941$

Intervening absorbers in J159-02 spectrum (4)

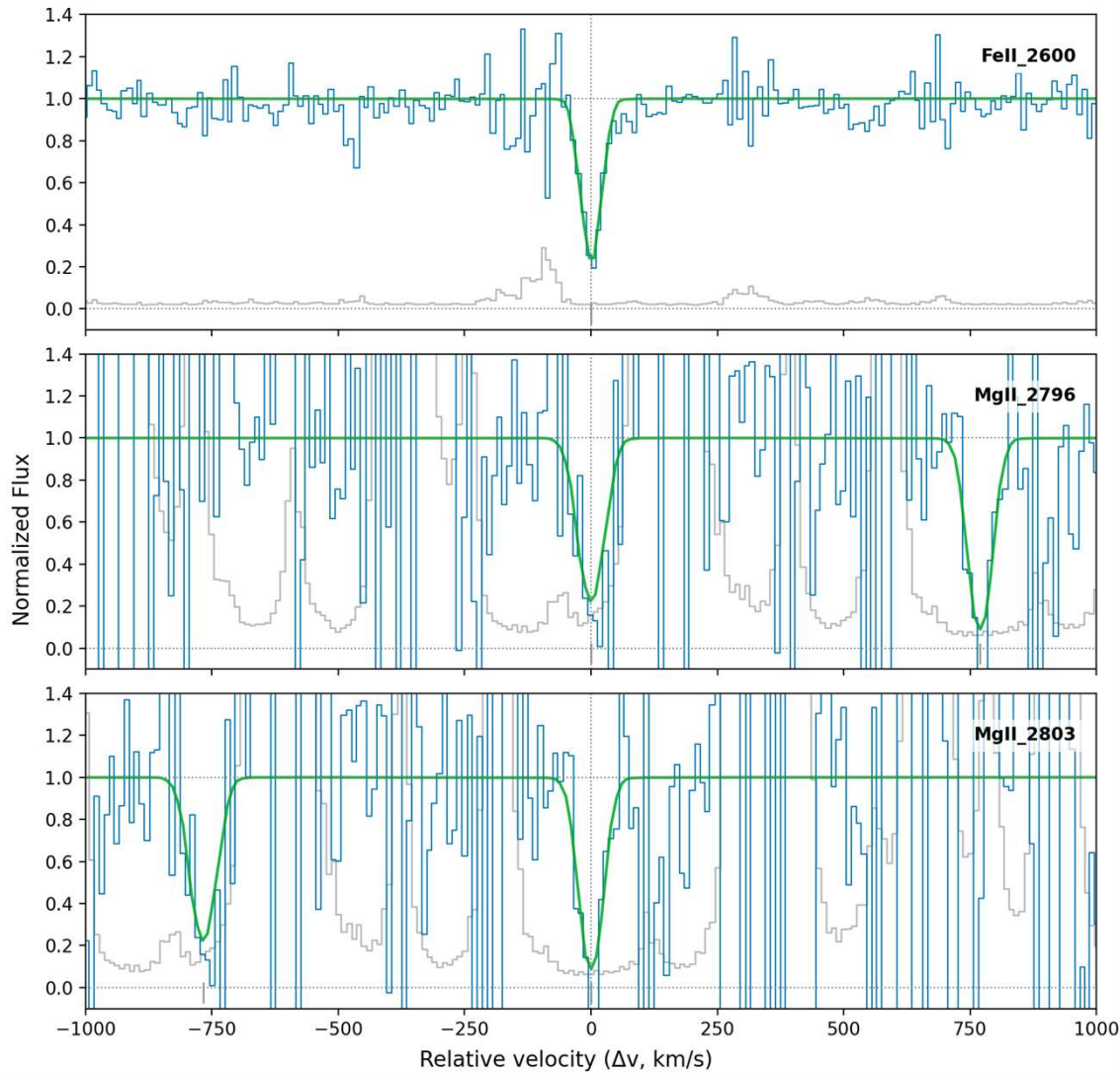


Intervening absorbers in J159-02 spectrum (5)

Absorption system at $z \sim 5.73491$

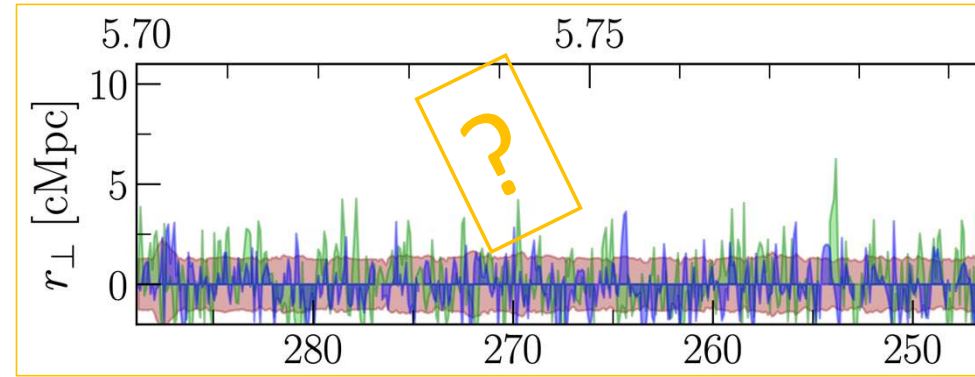
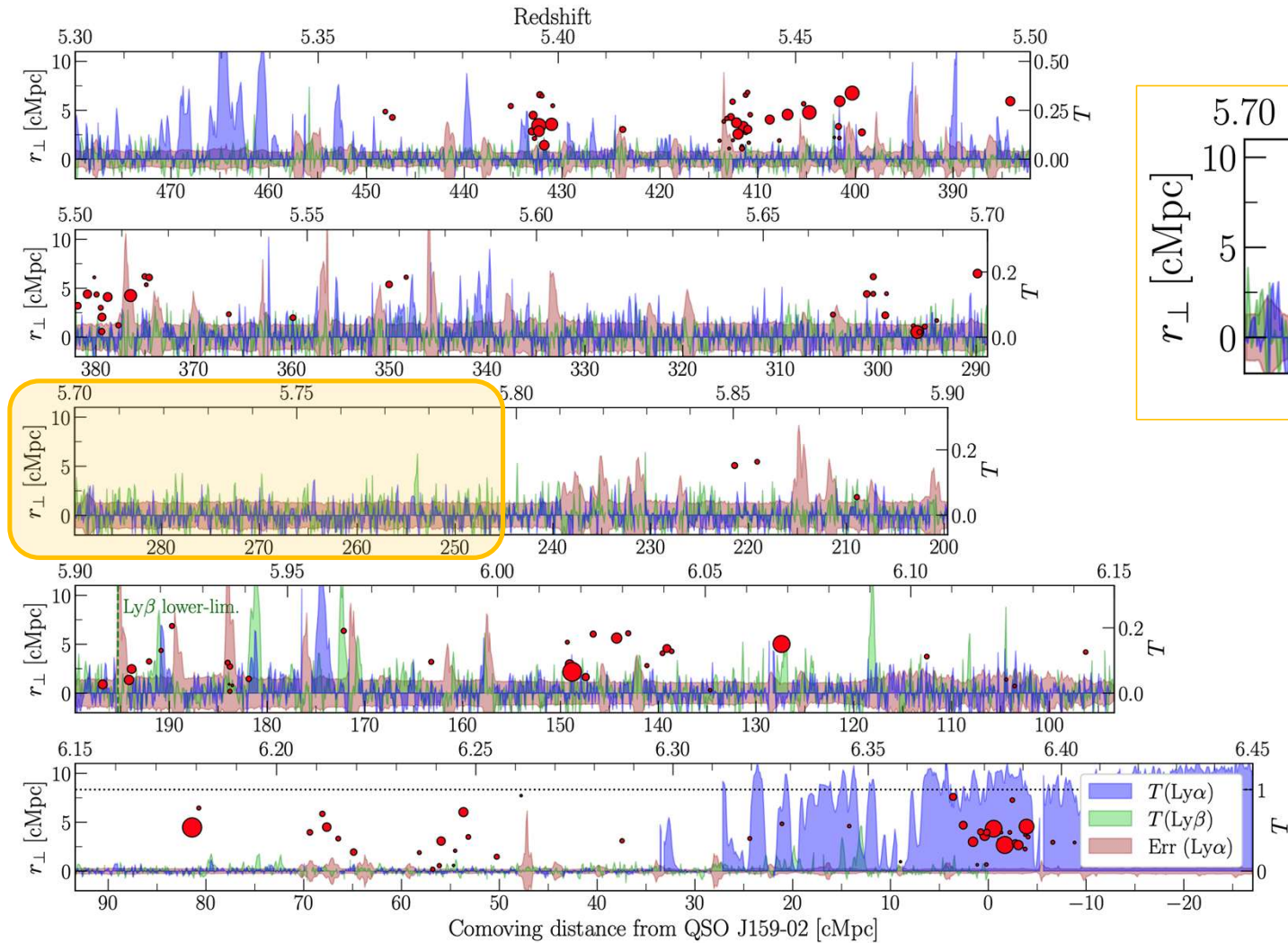


Intervening absorbers in J159-02 spectrum (5)



Absorption system at $z \sim 5.73491$

Intervening absorbers in J159-02 spectrum (5)



Low ionization absorption system without [O III] emitters counterpart!!!

Summary and Conclusion

- We reduced 2D raw spectroscopic data of the quasar PSOJ159-02 using *Pypelt* (Prochaska et al. 2020)
- Analysis of the continuum and emission lines, with a focus on C IV and Mg II
- BH mass and λ_{Edd} estimate, comparing their values with literature
- Identifying absorption systems in the spectrum at different redshifts
- Constraining the galaxy-absorbers cross correlation function