Double peaked Lyman-Alpha Emitters

— starbursts or hidden AGN? —

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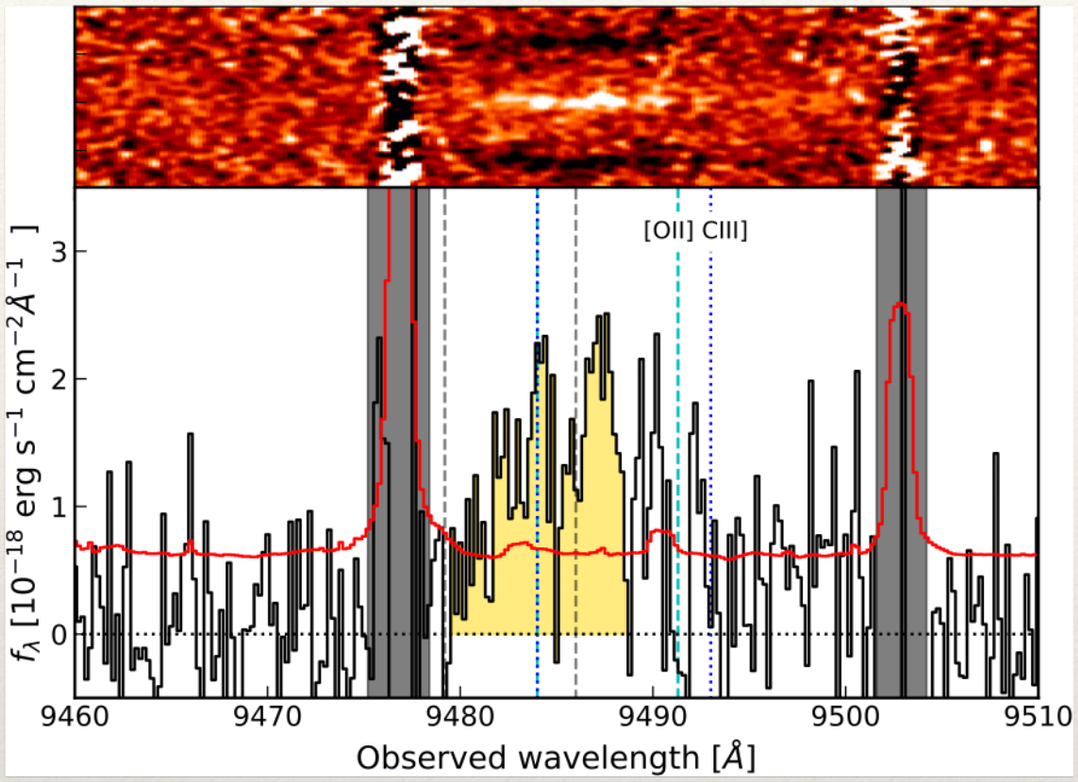
Based on: Hamsa Padmanabhan and Abraham Loeb (2021), *A&A Letters, 646, L10*

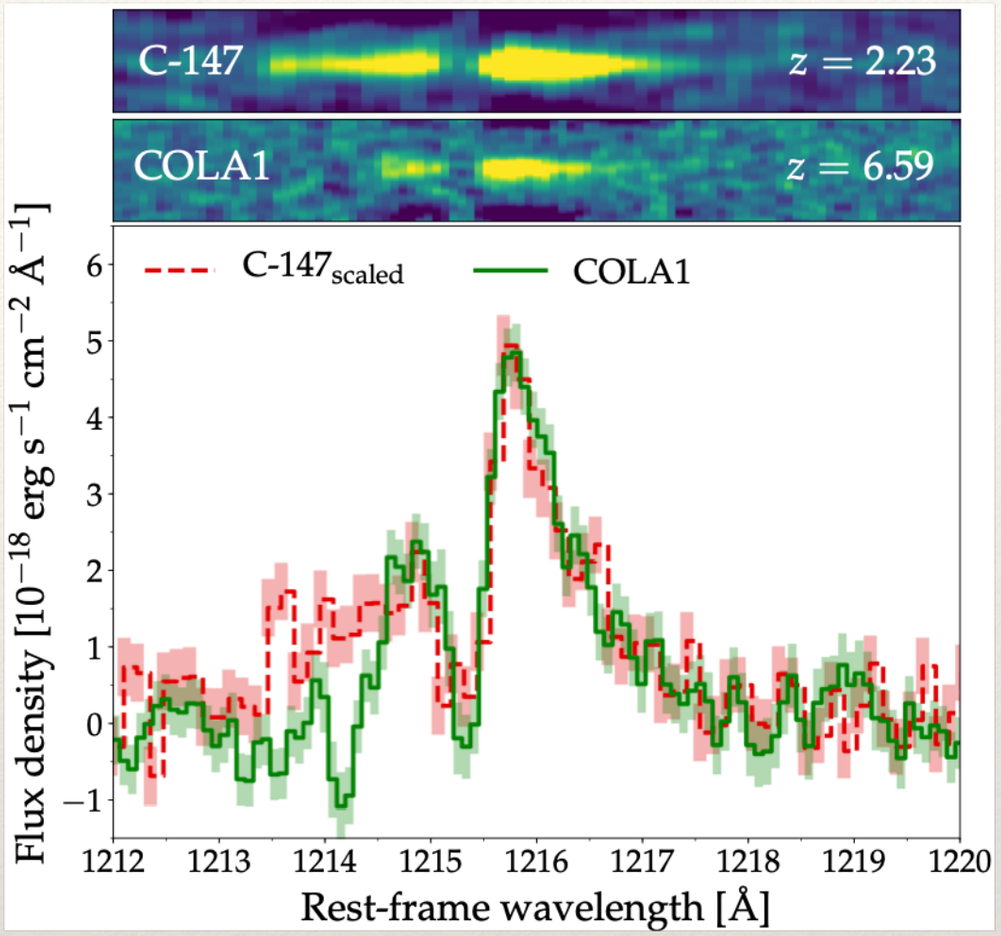
UNIVERSITÉ DE GENÈVE

Swiss National Science Foundation

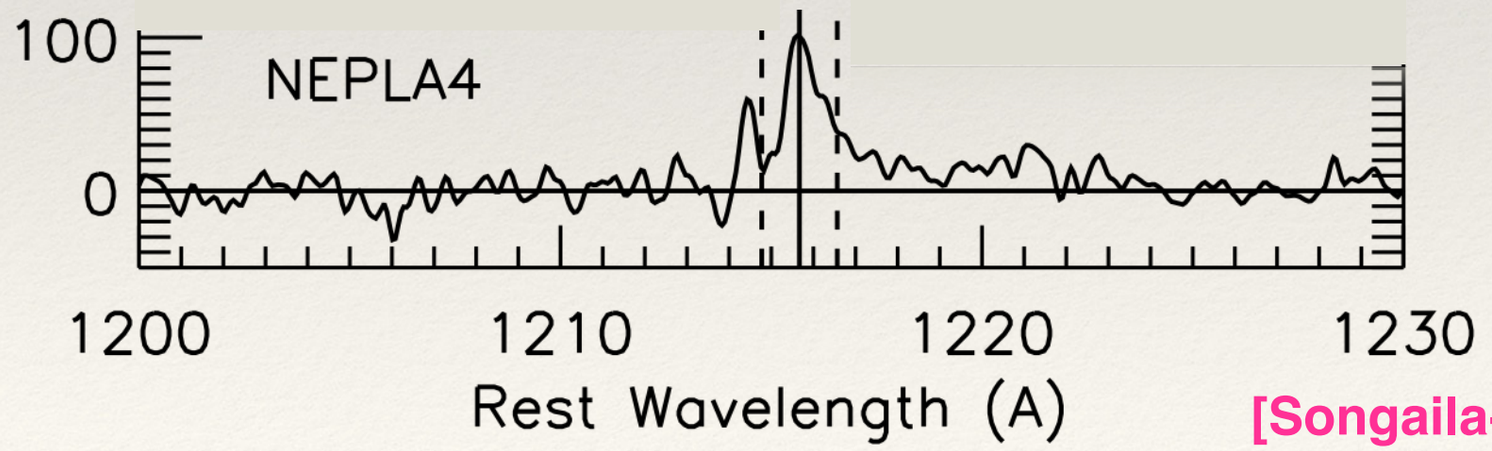
Double-peaked Lyman-alpha emitters



A370p_z1 [Meyer+ (2020)]



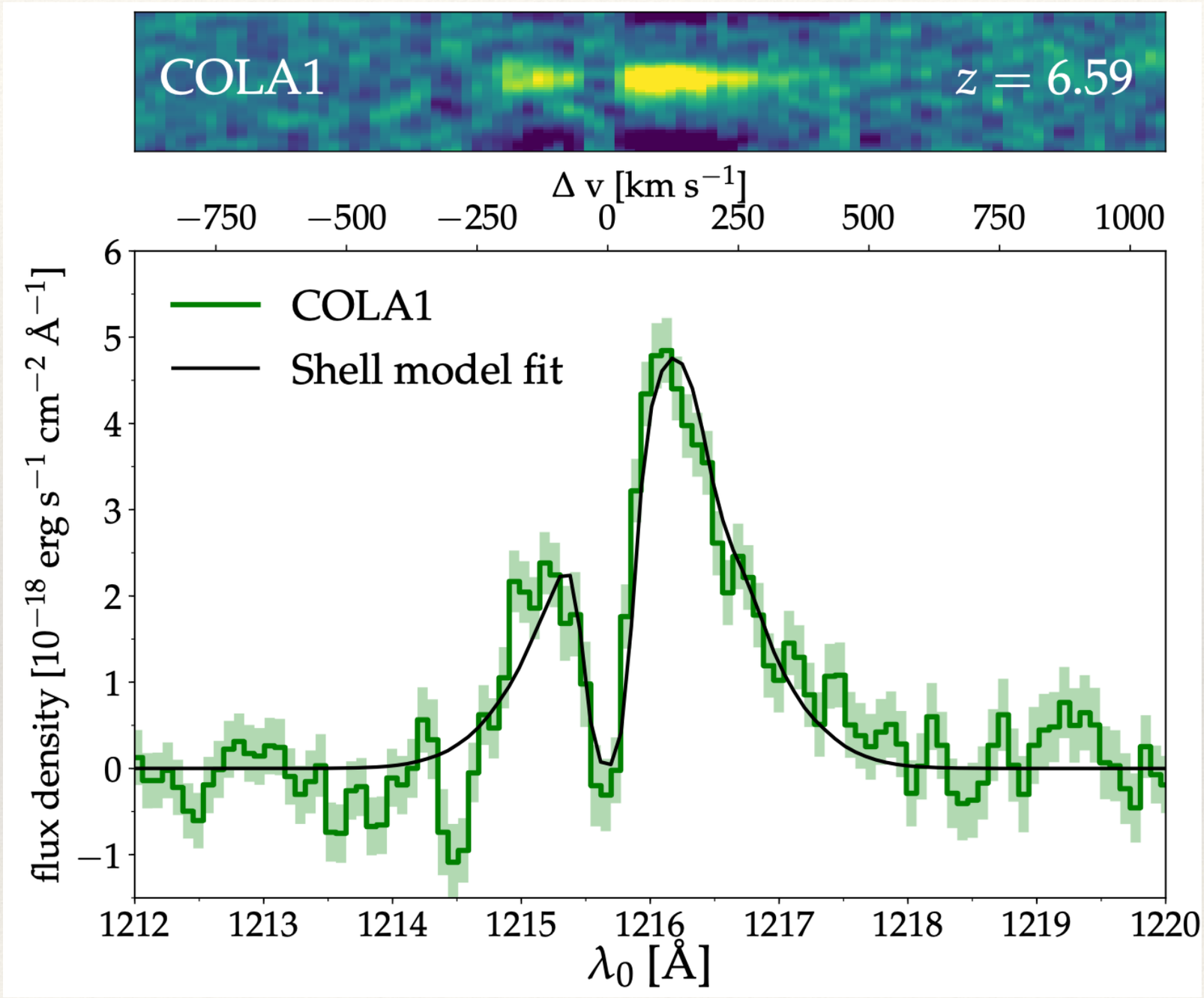
[Matthee + (2018)]



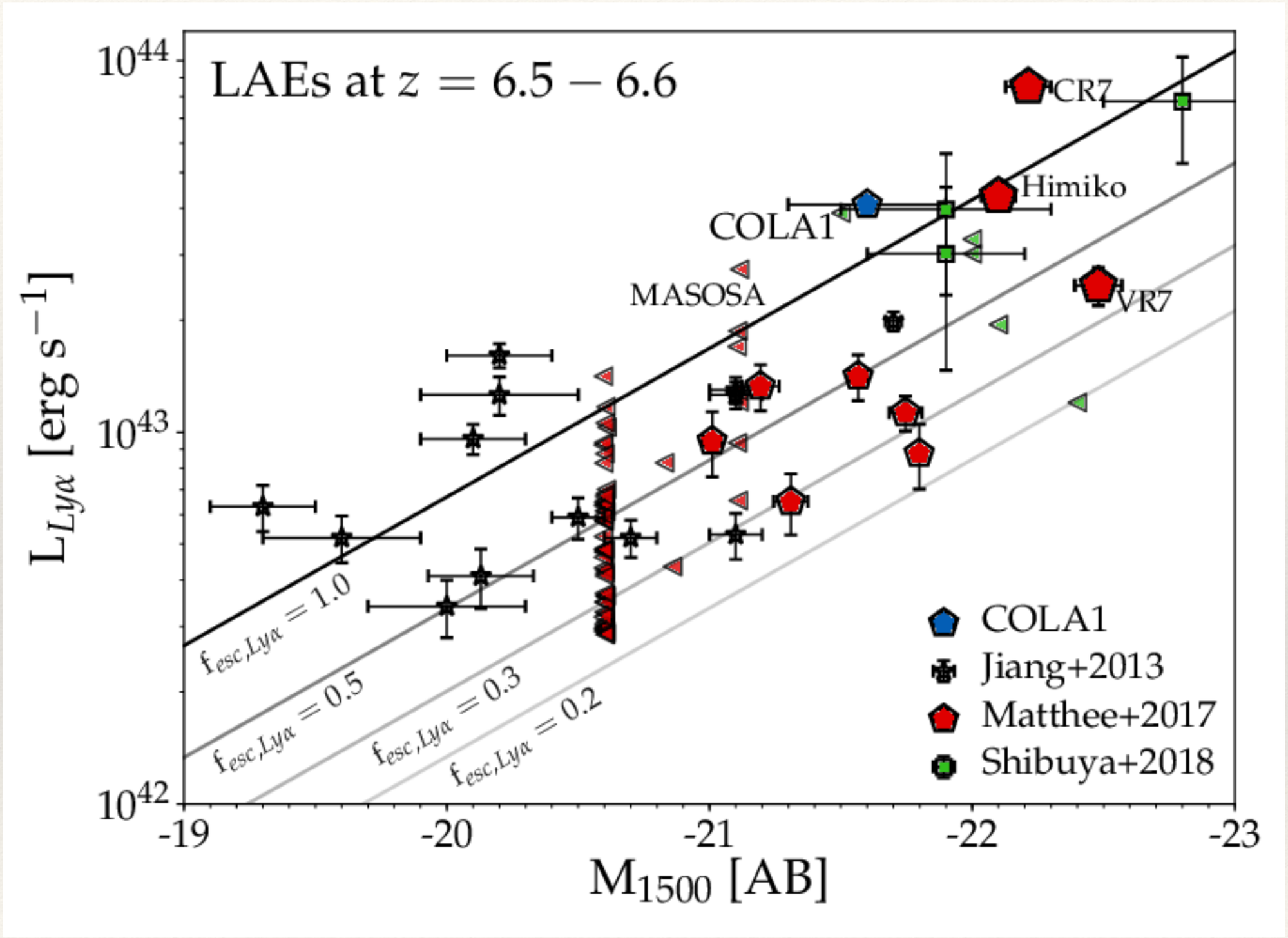
[Songaila+ (2018)]

… can constrain the minimum size of the ionized region in which the galaxy resides

The case of COLA-1



[Hu+ (2016), Matthee+ (2018), Songaila+ (2018), Meyer+ (2020)]



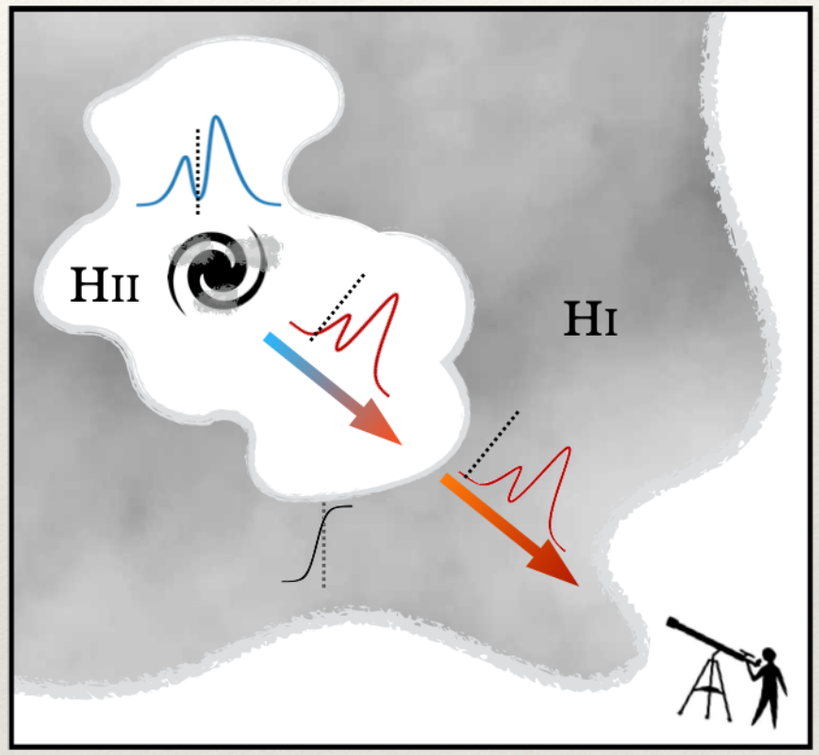
[Matthee+ (2018), Meyer+ (2020)]

Could this be an obscured quasar?

$$R_\alpha = 3.14 \left(\frac{N_{\rm ion}}{2 \times 10^{57} s^{-1}} \right)^{1/2} \left[\frac{(\alpha_\nu)^{-1}(\alpha_\nu + 3)}{3} \right]^{-1/2} \times \left(\frac{1+z_\alpha}{7} \right)^{-9/4} {\rm Mpc}$$

[Bolton+ (2007)]

Equate to



$$R_{\alpha,{\rm COLA-1}} \equiv \Delta v / H(z) = 0.13 {\rm Mpc}$$

[Matthee+ (2018)]

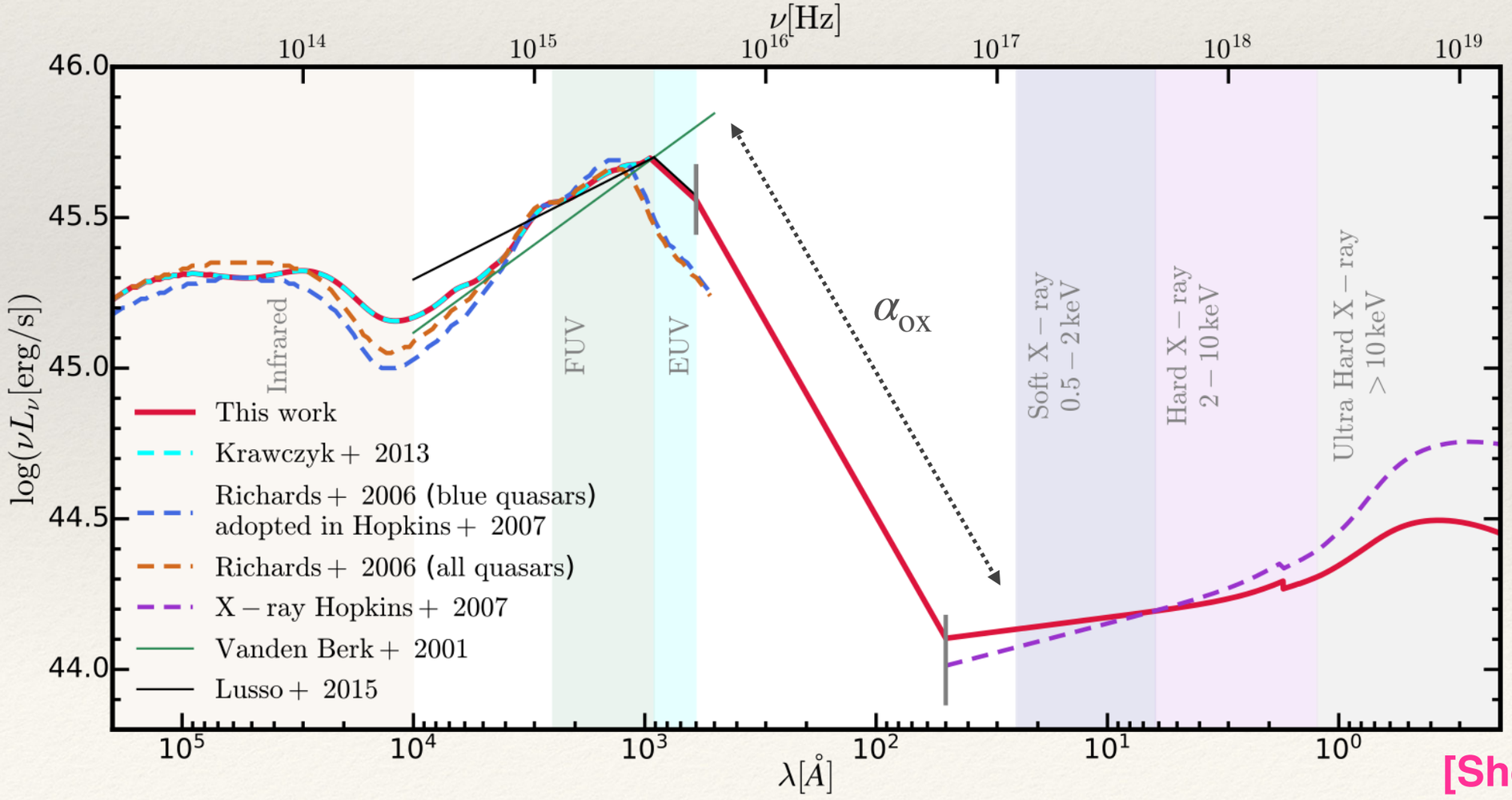
$$\Rightarrow \quad N_{\rm ion,COLA-1} = 2.60 \times 10^{55}\ s^{-1}$$

[HP & Loeb, A&A Letters, arXiv:2012.00014 (2021)]

Could this be an obscured quasar?

$$N_{\rm ion} = \int_{\nu_{\rm H}}^{\infty} \frac{L_\nu}{h\nu} d\nu$$; normalize spectral shape

$\log L_{\nu,4500} = 45.08 \mathrm{ergs/s/Hz}, M_{1500} = -23.2 > M_{\rm UV,COLA-1}$



[Shen+ (2020)]

Could this be an obscured quasar?

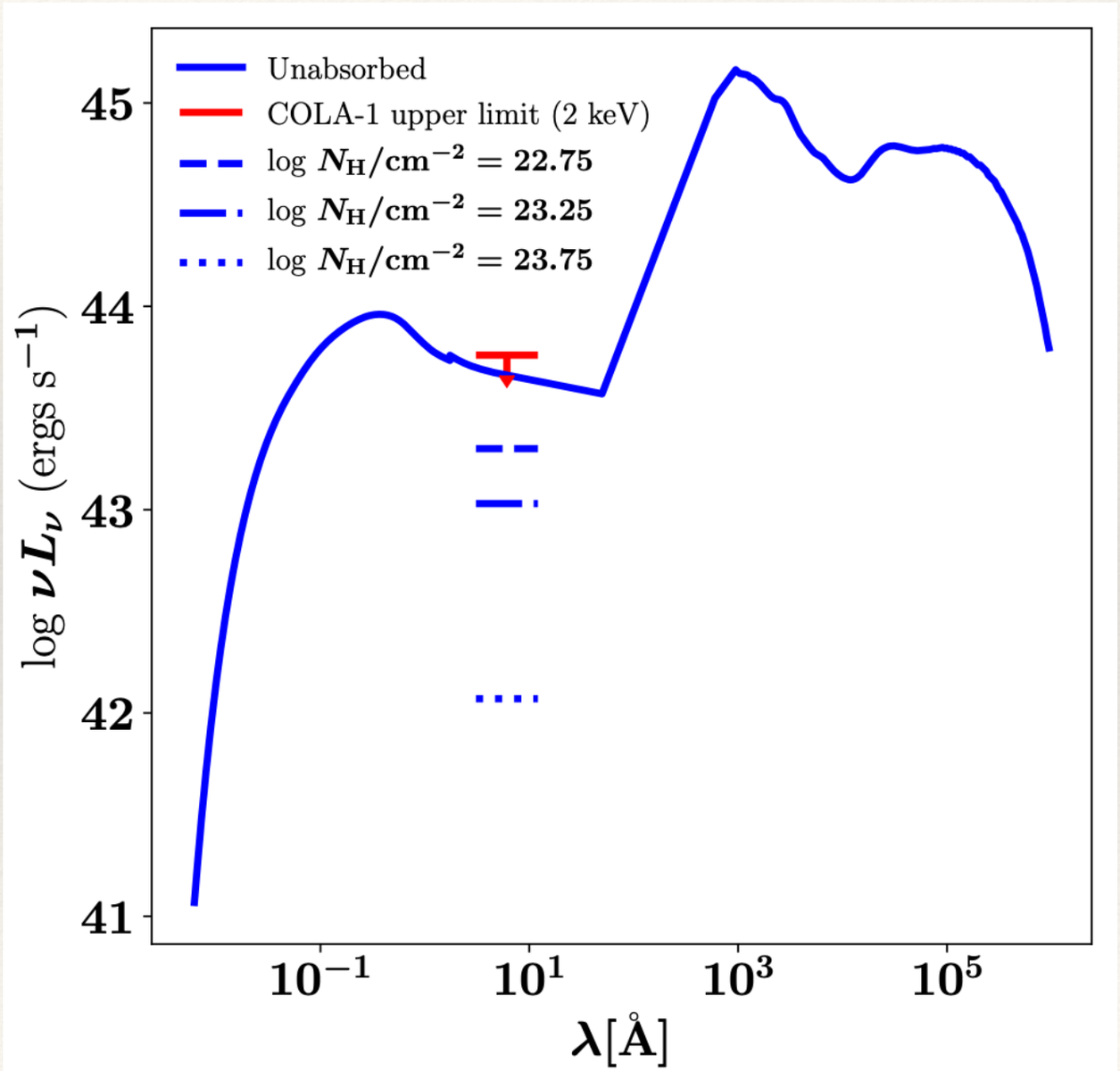
Predicted X-ray flux:

$$L_{0.5-7\mathrm{keV}} = 10^{44.17}\mathrm{ergs/s}$$

Measured upper limit:

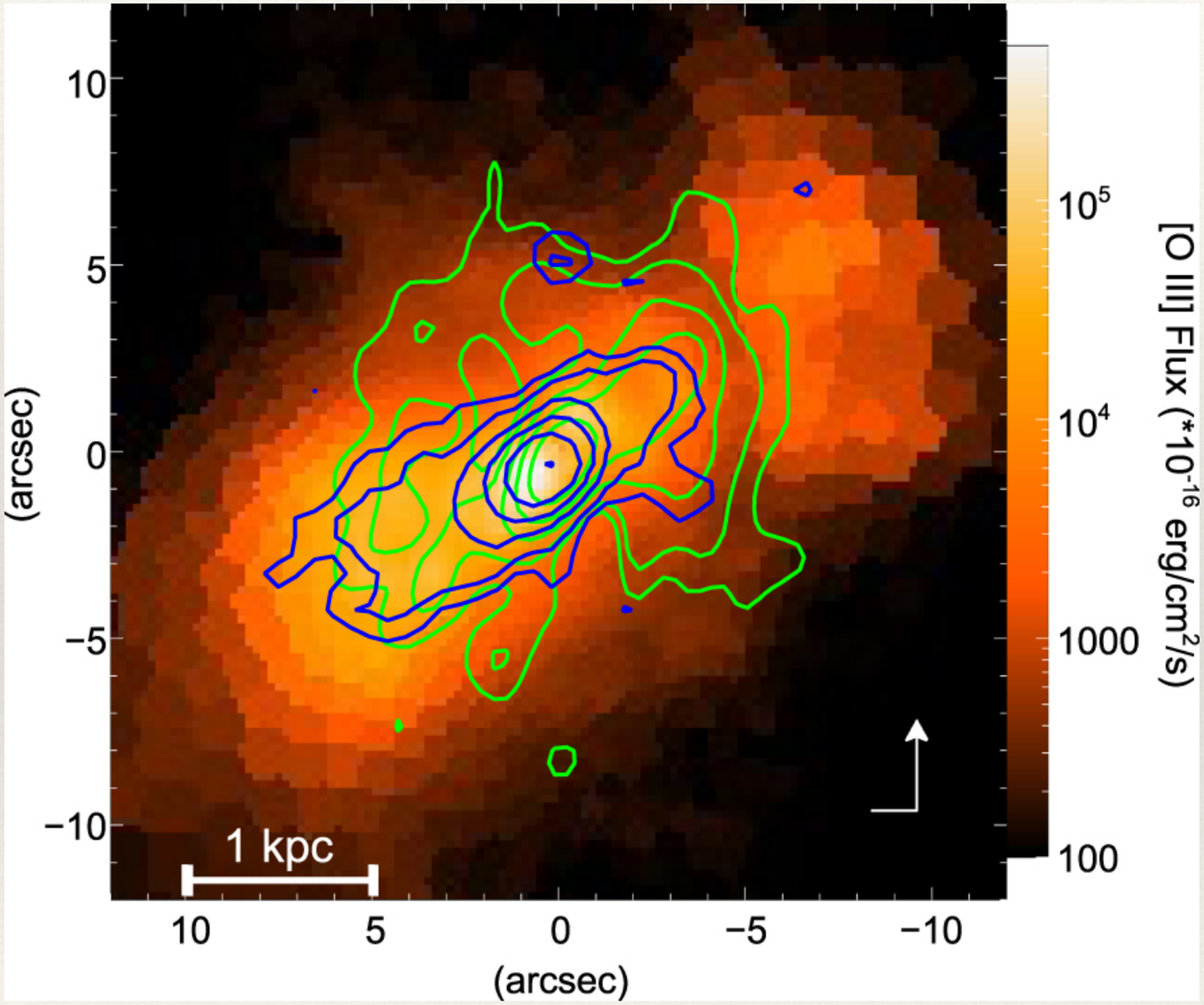
$$L_{0.5-7\mathrm{keV}} = 10^{44.3}\mathrm{ergs/s}$$

Flux can be suppressed by obscuring column

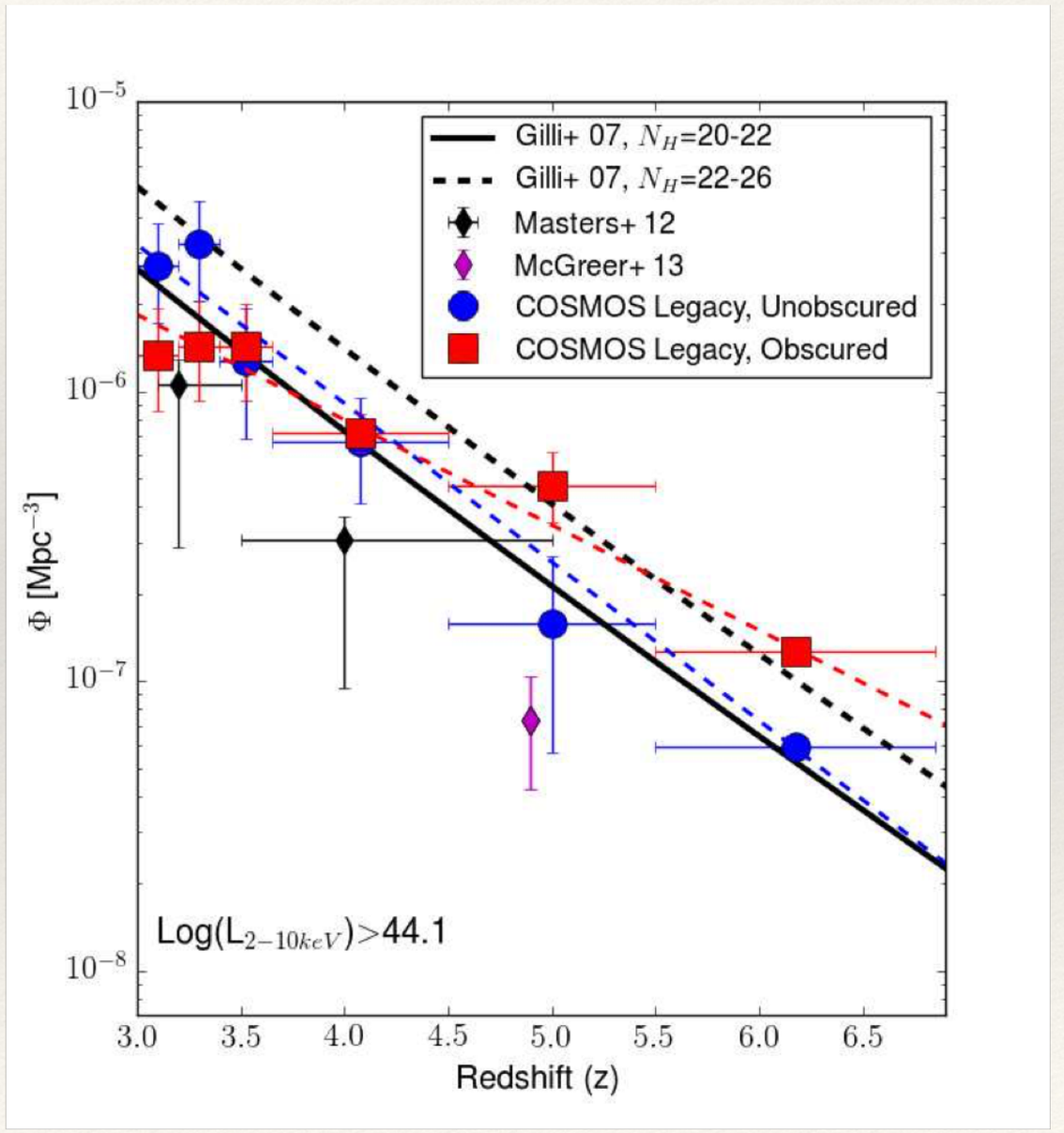


[HP & Loeb, A & A Letters, arXiv:2012.00014 (2020)]

Observational prospects



[Durré+ (2018)]



[Marchesi+ (2016)]

Contributions to reionization …

The Astrophysical Journal Letters, 813:L8 (6pp), 2015 November 1 doi:10.1088/2041-8205/813/1/L8

COSMIC REIONIZATION AFTER PLANCK: COULD QUASARS DO IT ALL?

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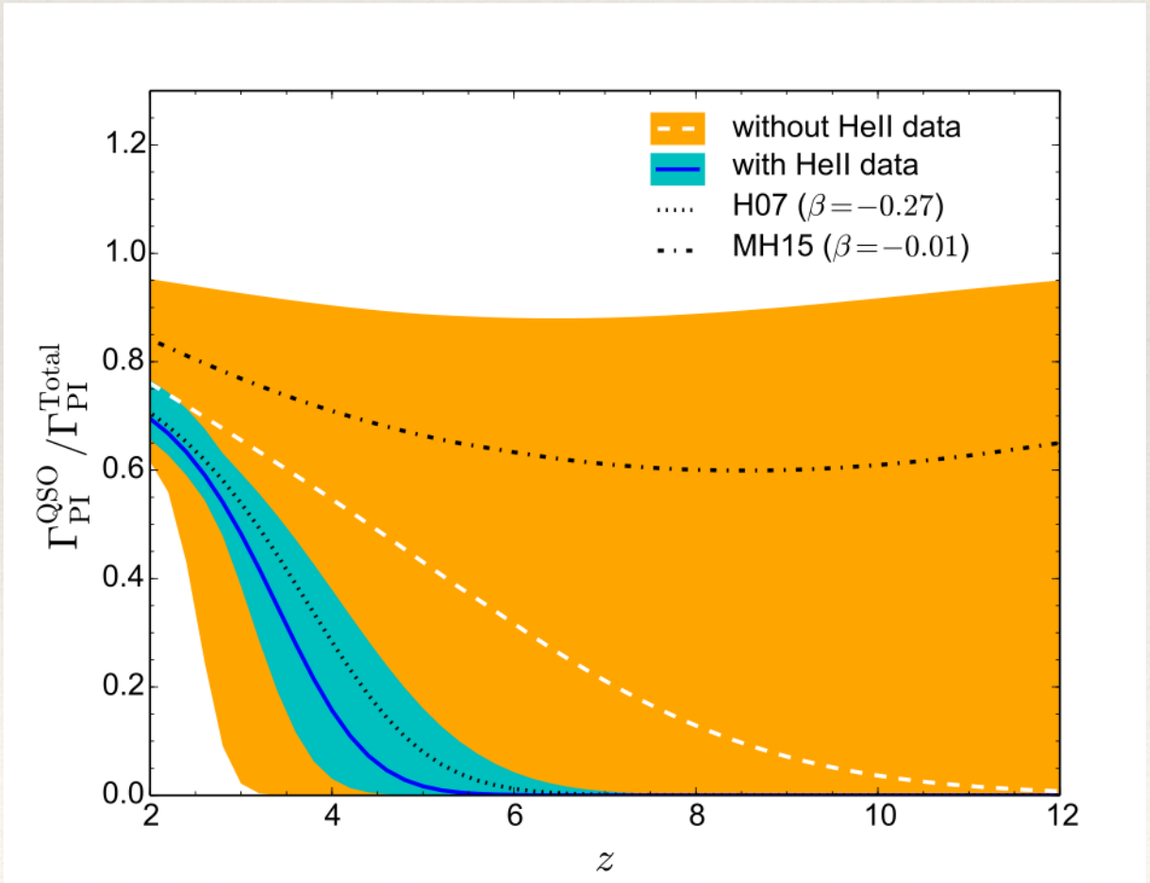
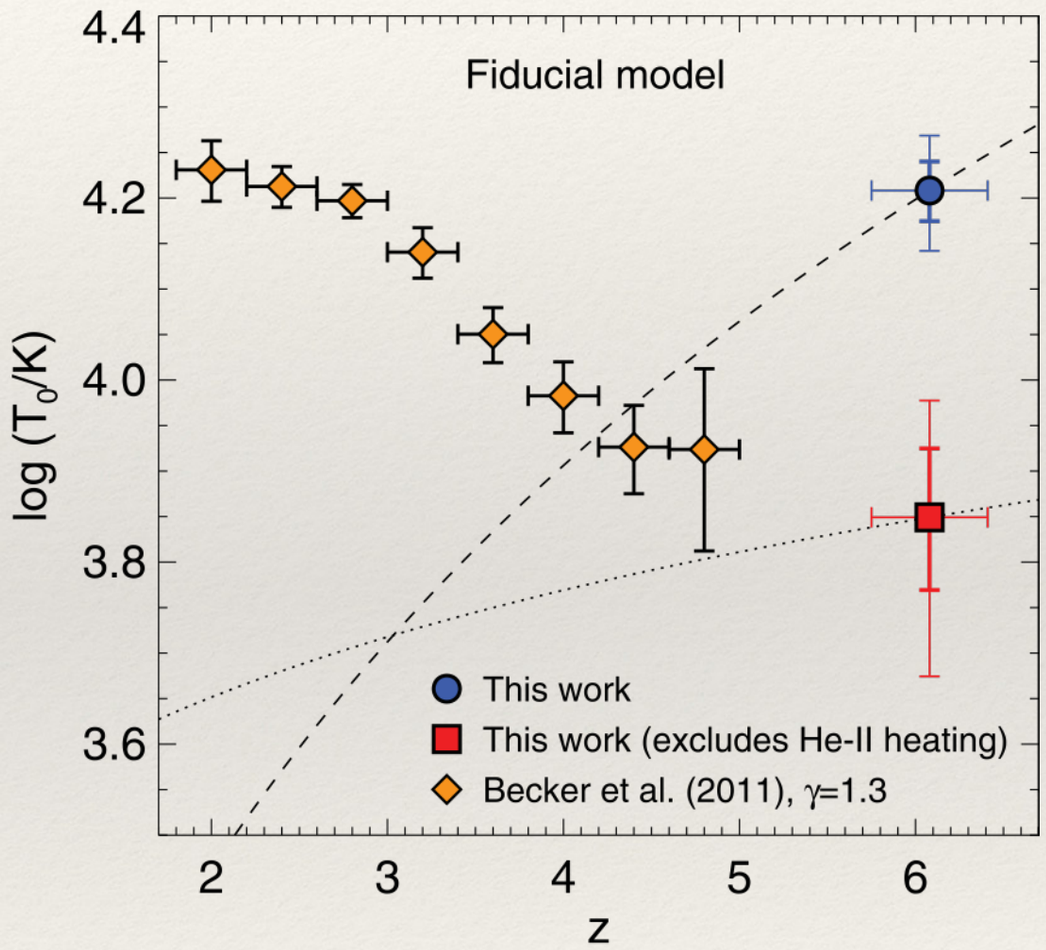
ABSTRACT

[Mitra, Choudhury & Ferrara (2018)]





Heating effects in QSO near-zones

[Bolton+ (2012), HP, Choudhury, Srianand (2014)]

Summary

- Double peaked Lyman-alpha emitters indicate large ionization zones, signs of (obscured) AGN activity
- Can explain the observations without additional faint sources
- At least three times higher obscured quasars at $z > 6$
- Consequences for reionization

[HP & Loeb (A & A Letters, 2021), HP, Choudhury, Srianand (MNRAS, 2014)]

In the future …

- Quantifying the obscured population
- Ionization cones with JWST
- Sub - mm (OIII/CII) searches

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Thank you!