LyC Escape and IGM Tomography Using the 600-900Å Continuum of the Sunburst Arc

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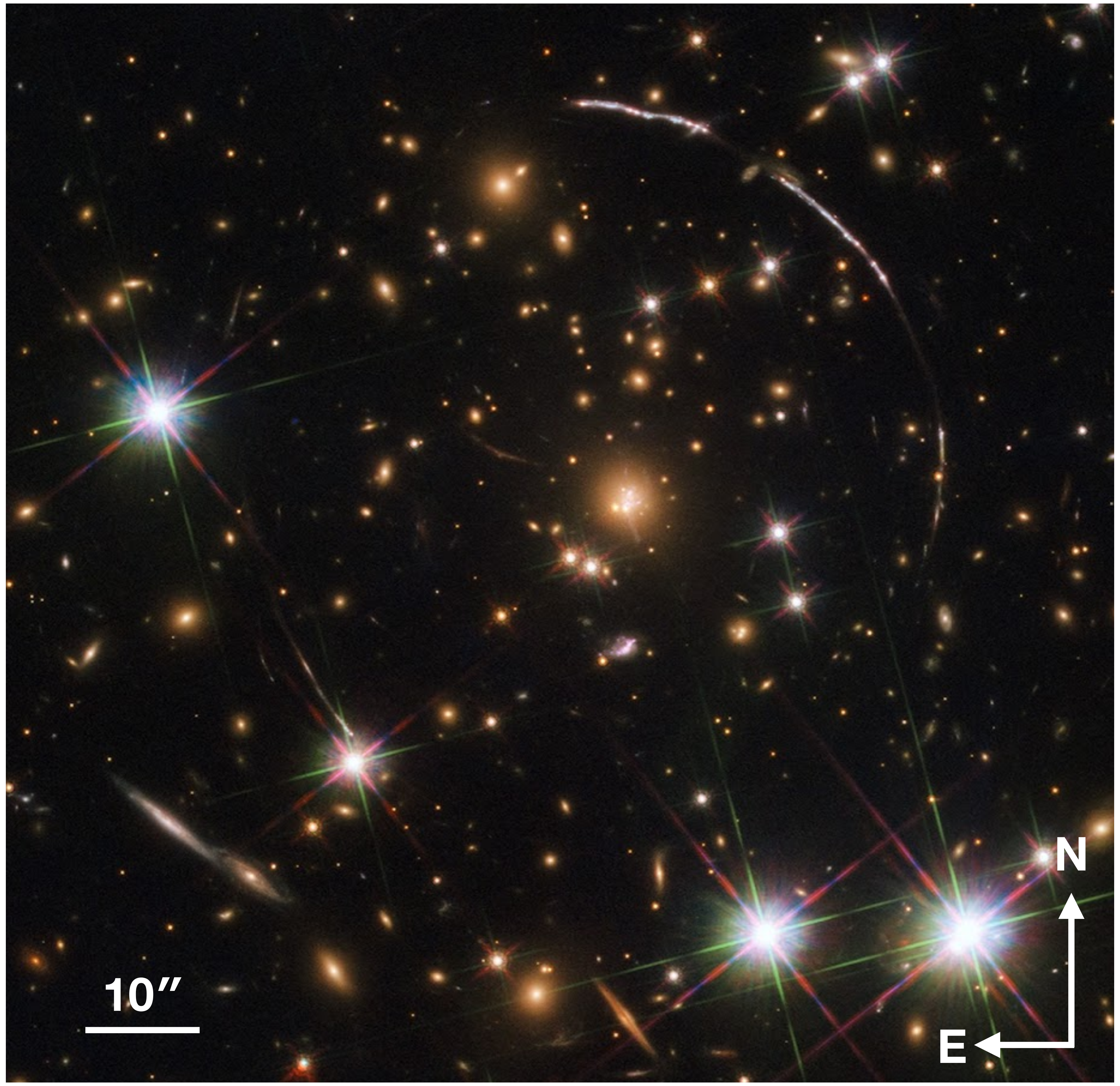
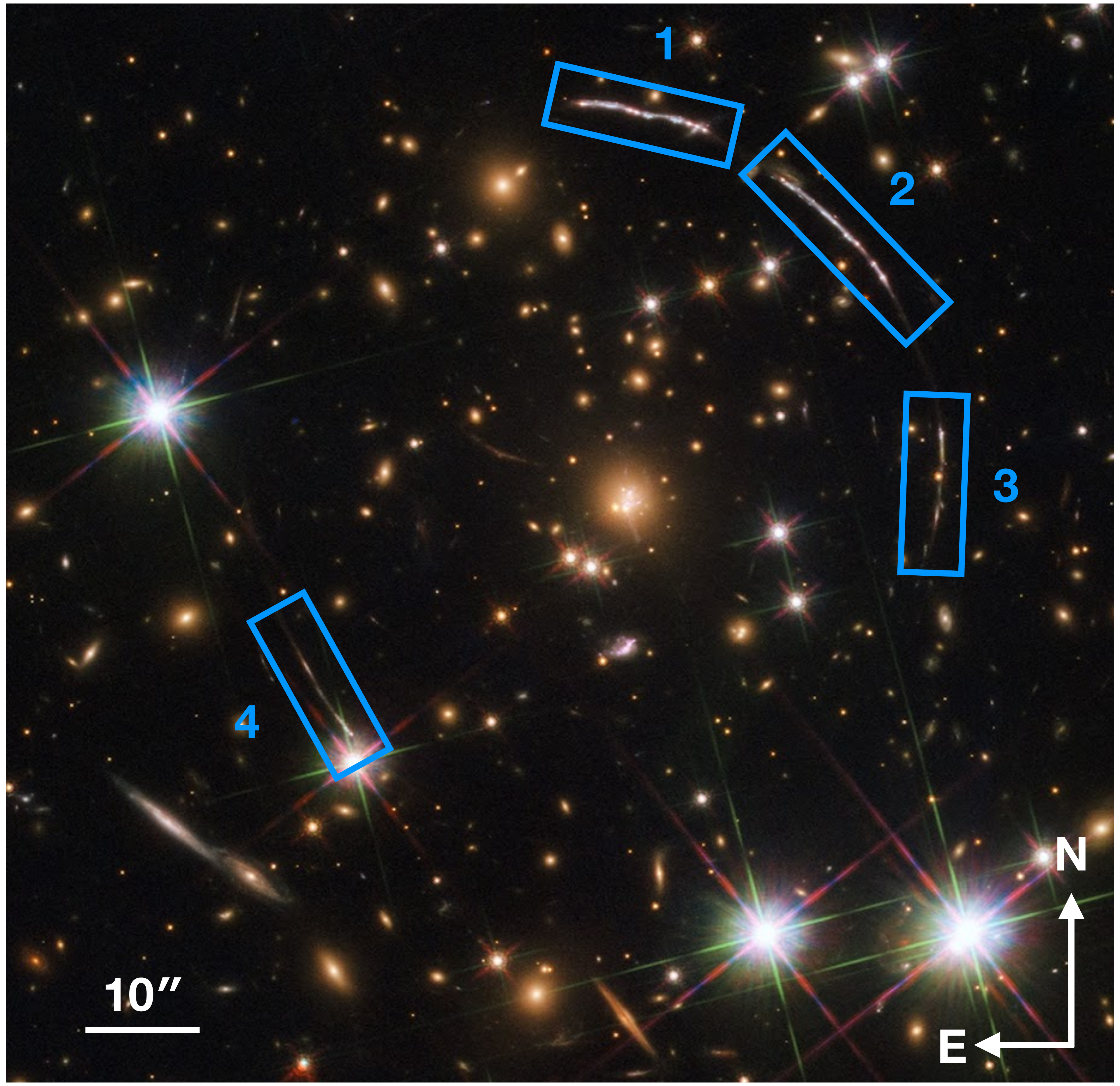
Sunburst Arc



The Sunburst Arc is the brightest lensed galaxy to ever be discovered at R=17.8 mag.

Dahle et al. 2016
Rivera-Thorsen et al. 2019
NASA, ESA and E. Rivera-Thorsen

Sunburst Arc



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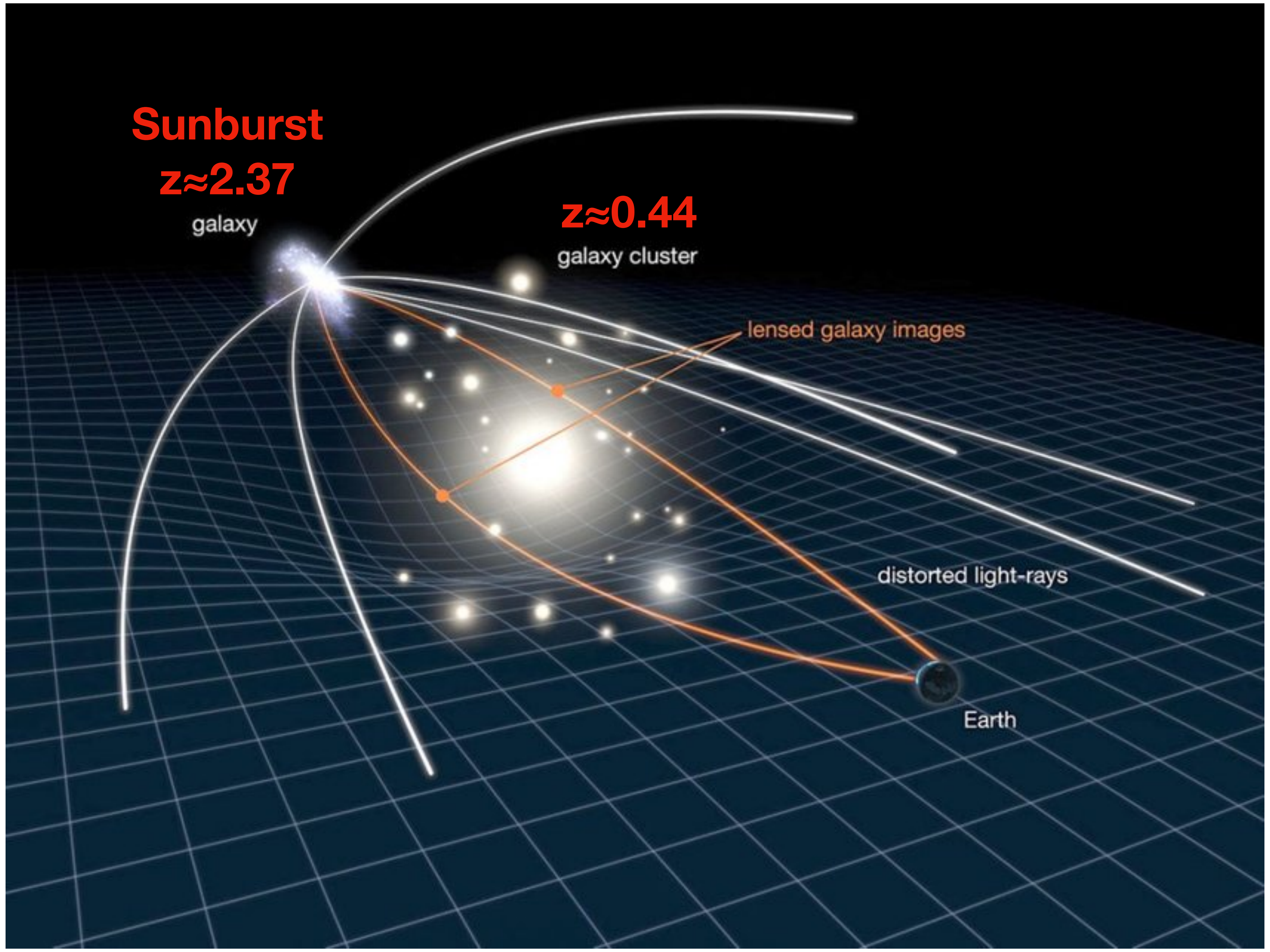
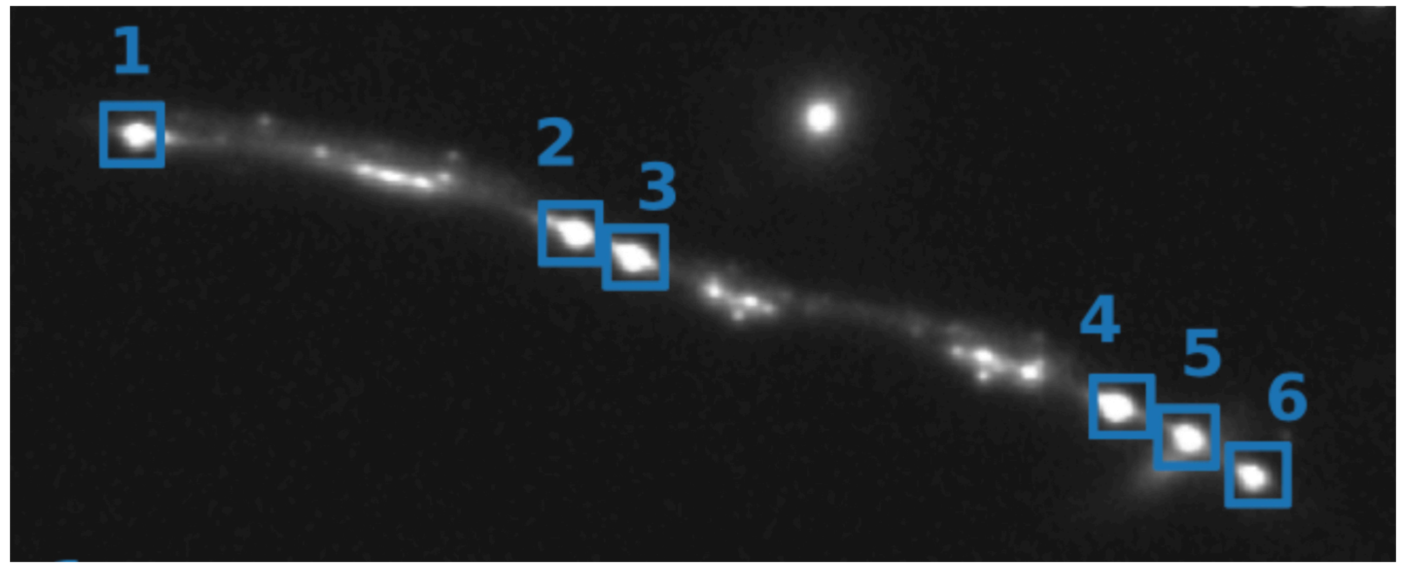
Gravitational Lensing



Light from a distant object is bent around a foreground massive object.

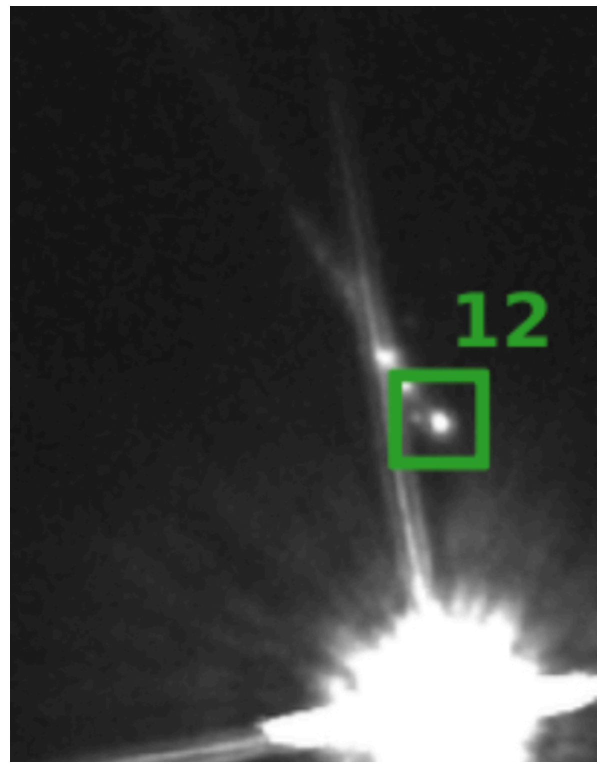
NASA, ESA and L. Calçada

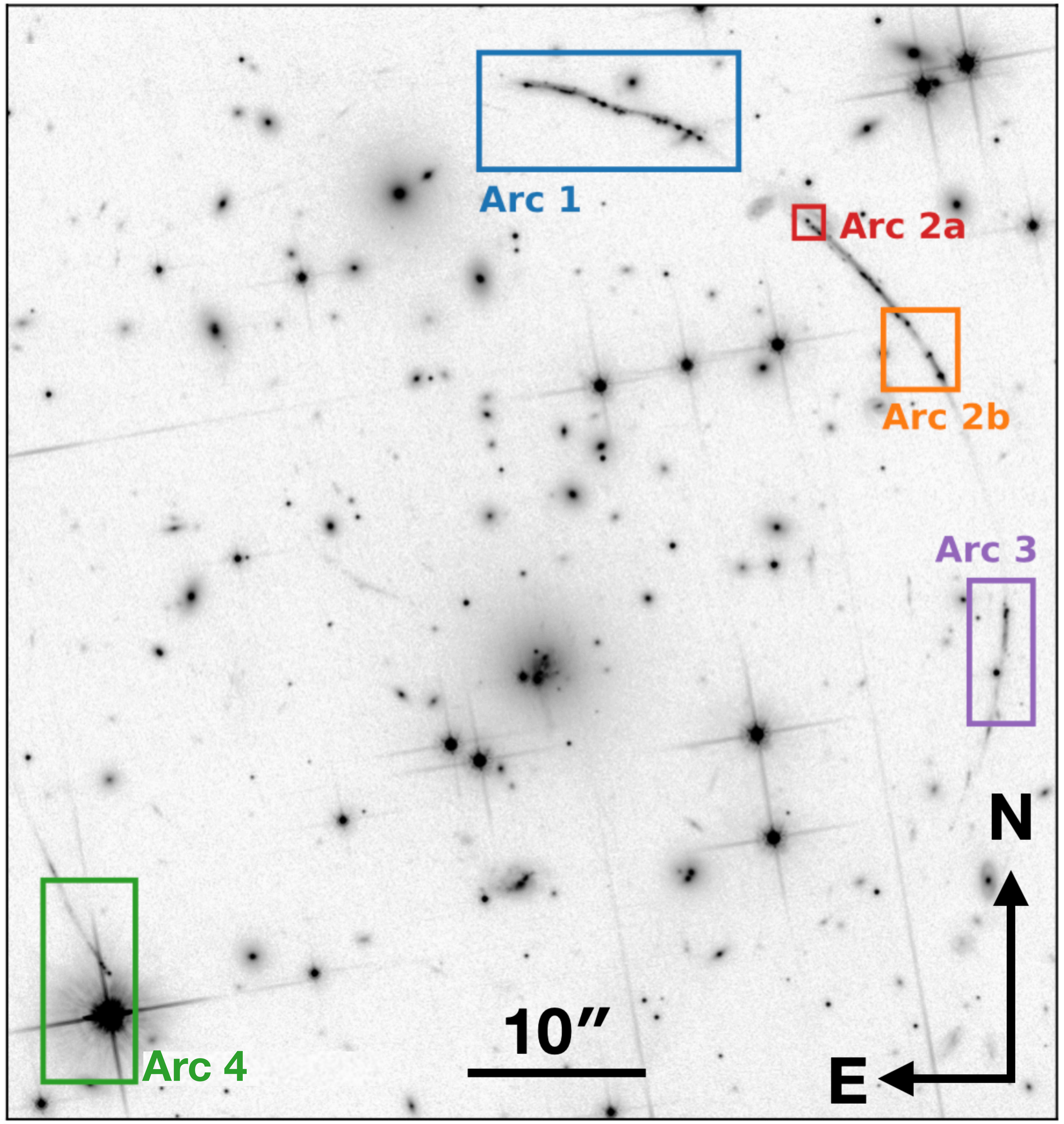
A LyC Leaker

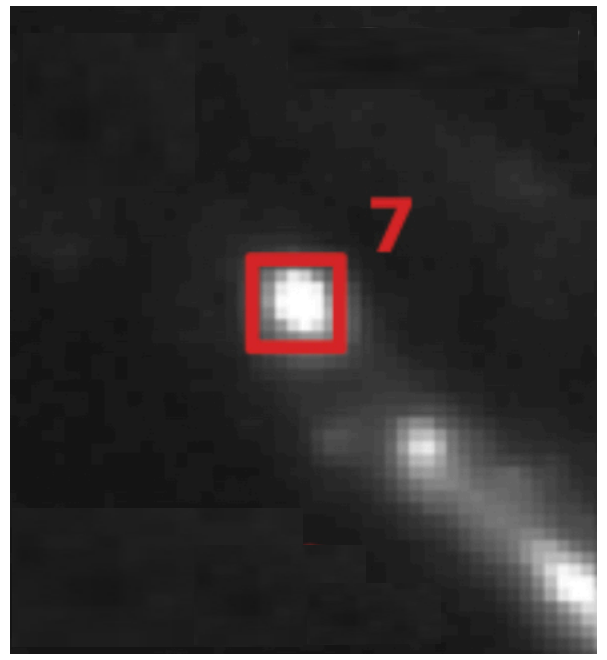


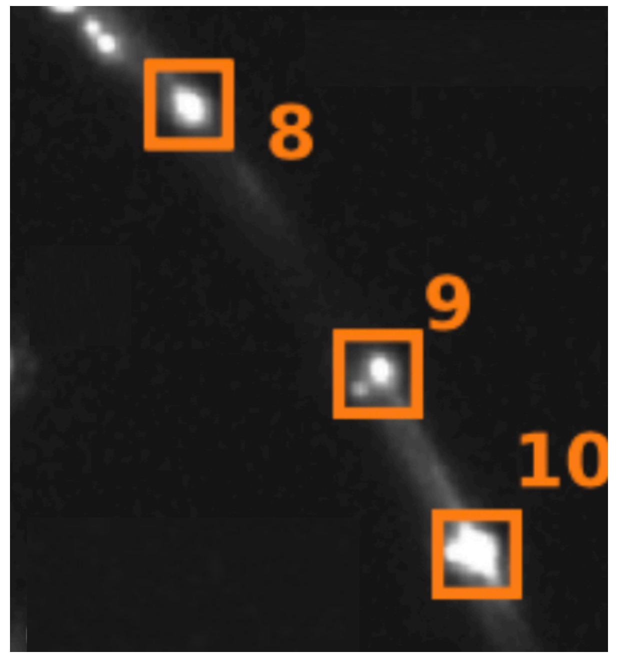
The leaking region is imaged
12 times over the 4 arcs.

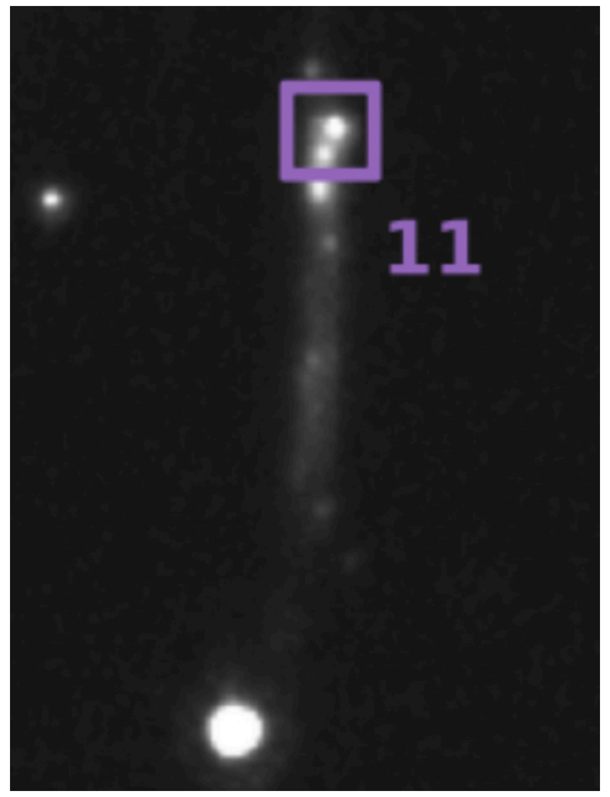
Best chance of observing the ionizing
stellar continuum for the first time!





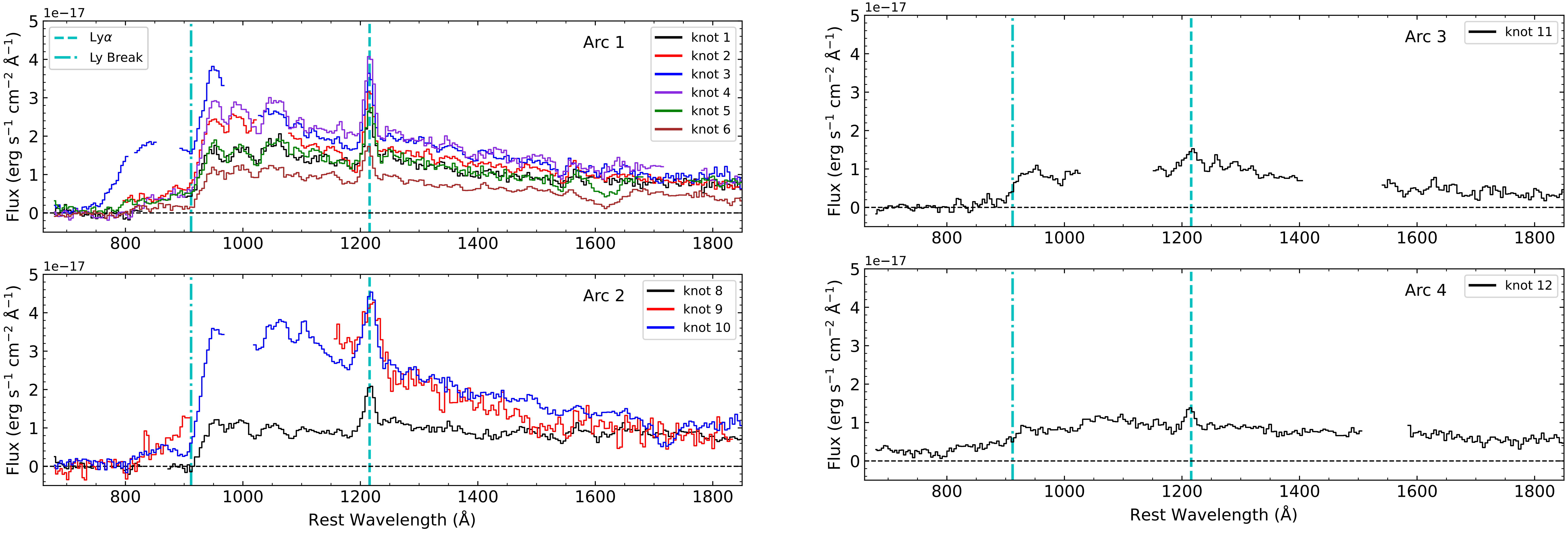






Rivera-Thorsen et al. 2019

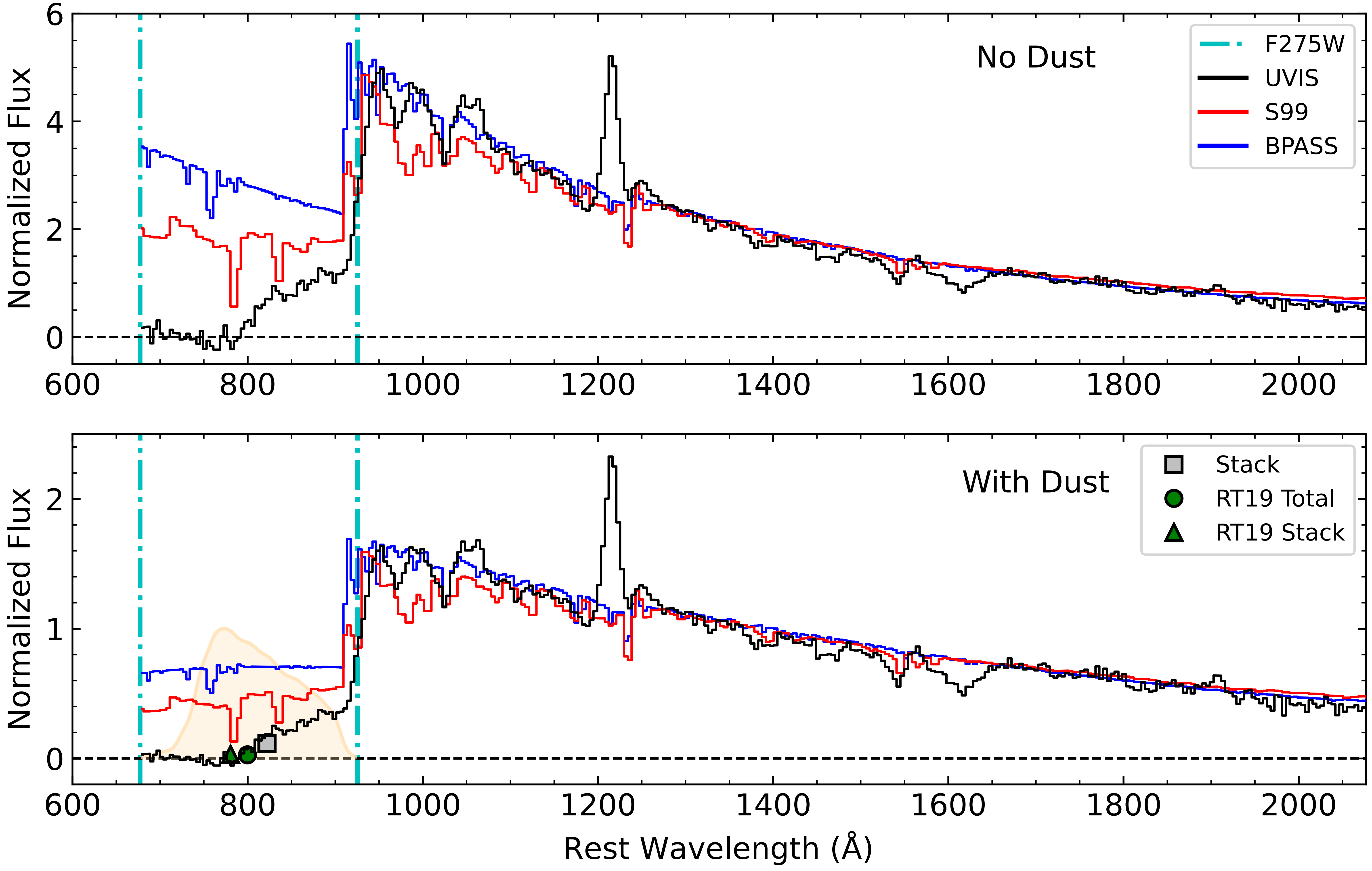
Leaking Images Spectra



The spectral shapes are consistent between the images.
We can measure the ionizing flux from ~800-900Å.

Berg et al. 2024a in prep

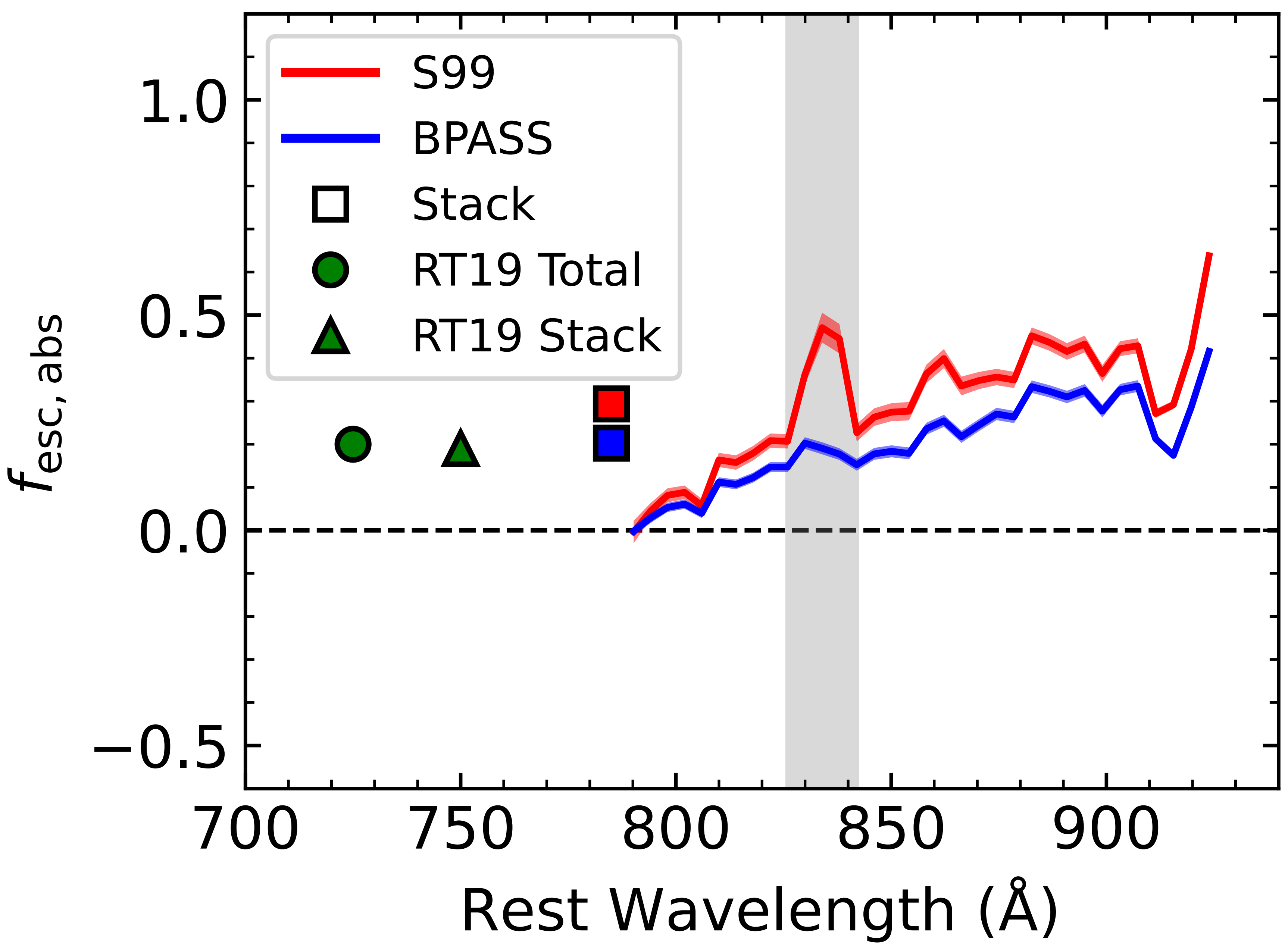
Comparison to Models

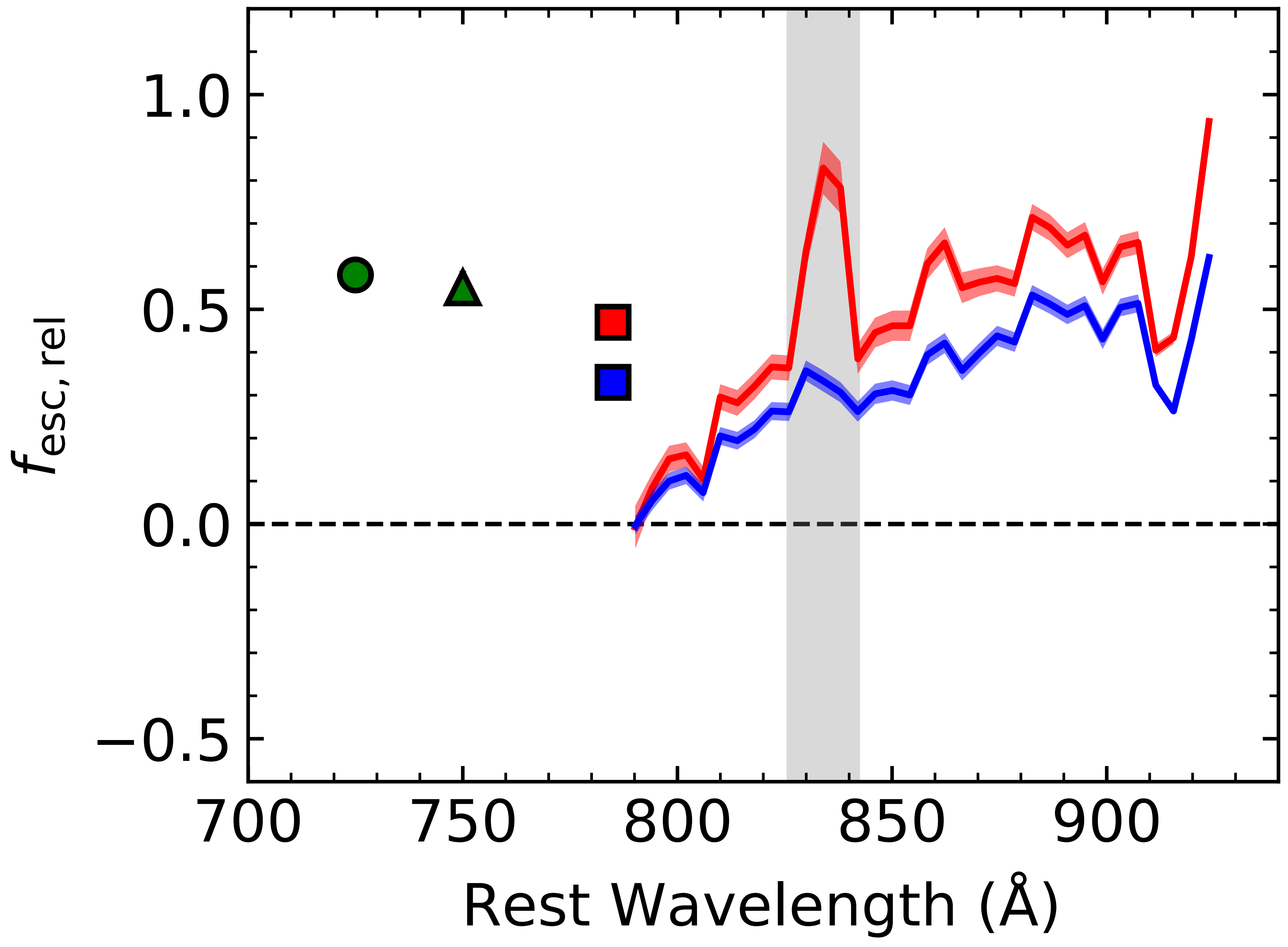


We cannot tell how well the models fit the observations in the ionizing continuum.

Leitherer et al. 1999, 2010
Eldridge et al. 2017
Chisholm et al. 2019
Rivera-Thorsen et al. 2019
Berg et al. 2024b in prep

Escape Fractions





S99 $f_{\mathrm{ecs,abs}}$ = 29.4 ± 0.3%
BPASS $f_{\mathrm{ecs,abs}}$ = 20.2 ± 0.2%

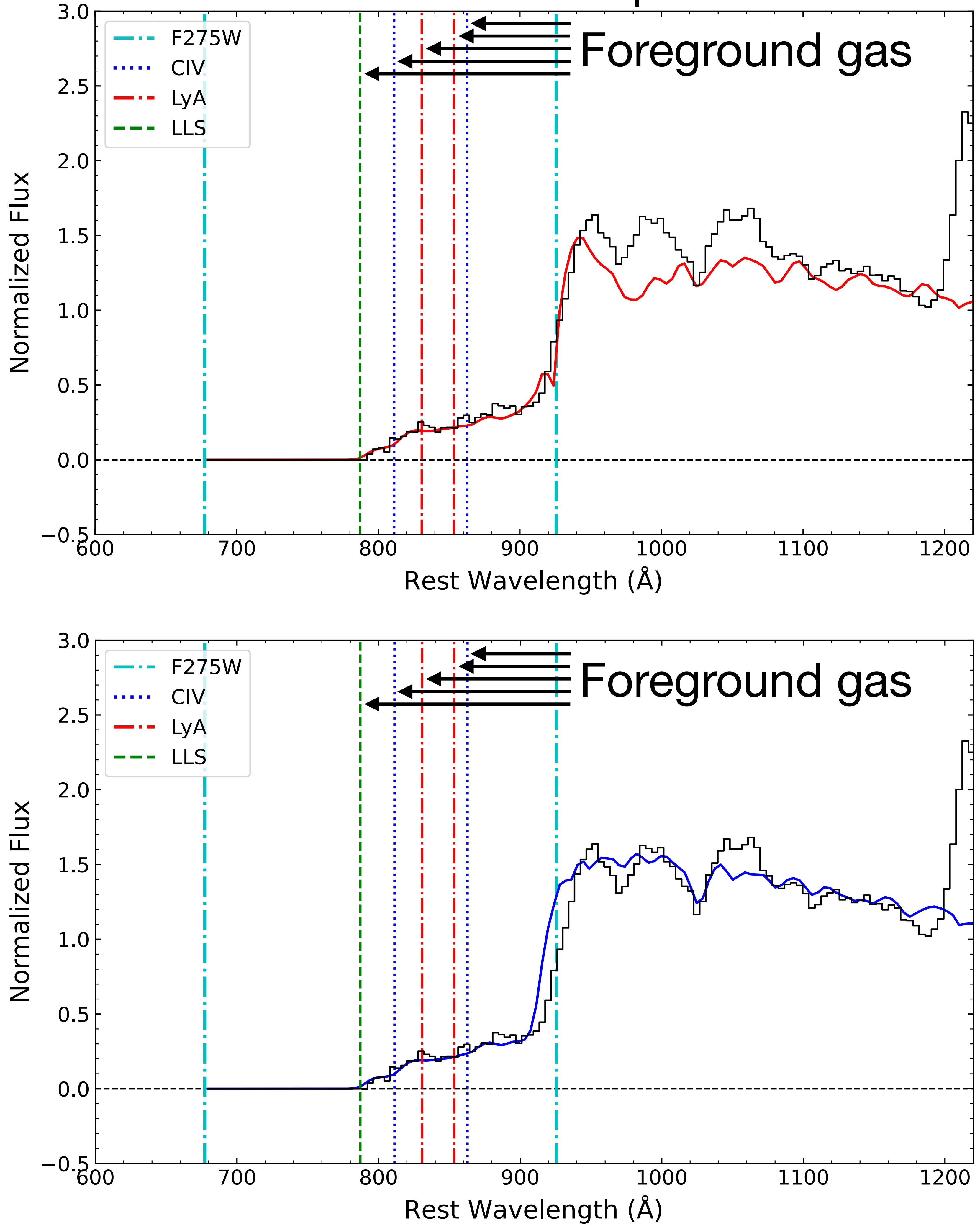
S99 $f_{\mathrm{ecs,rel}}$ = 47.0 ± 0.5%
BPASS $f_{\mathrm{ecs,rel}}$ = 33.0 ± 0.3%

The Sunburst Arc has a high escape fraction with either model.

Rivera-Thorsen et al. 2019
Berg et al. 2024b in prep

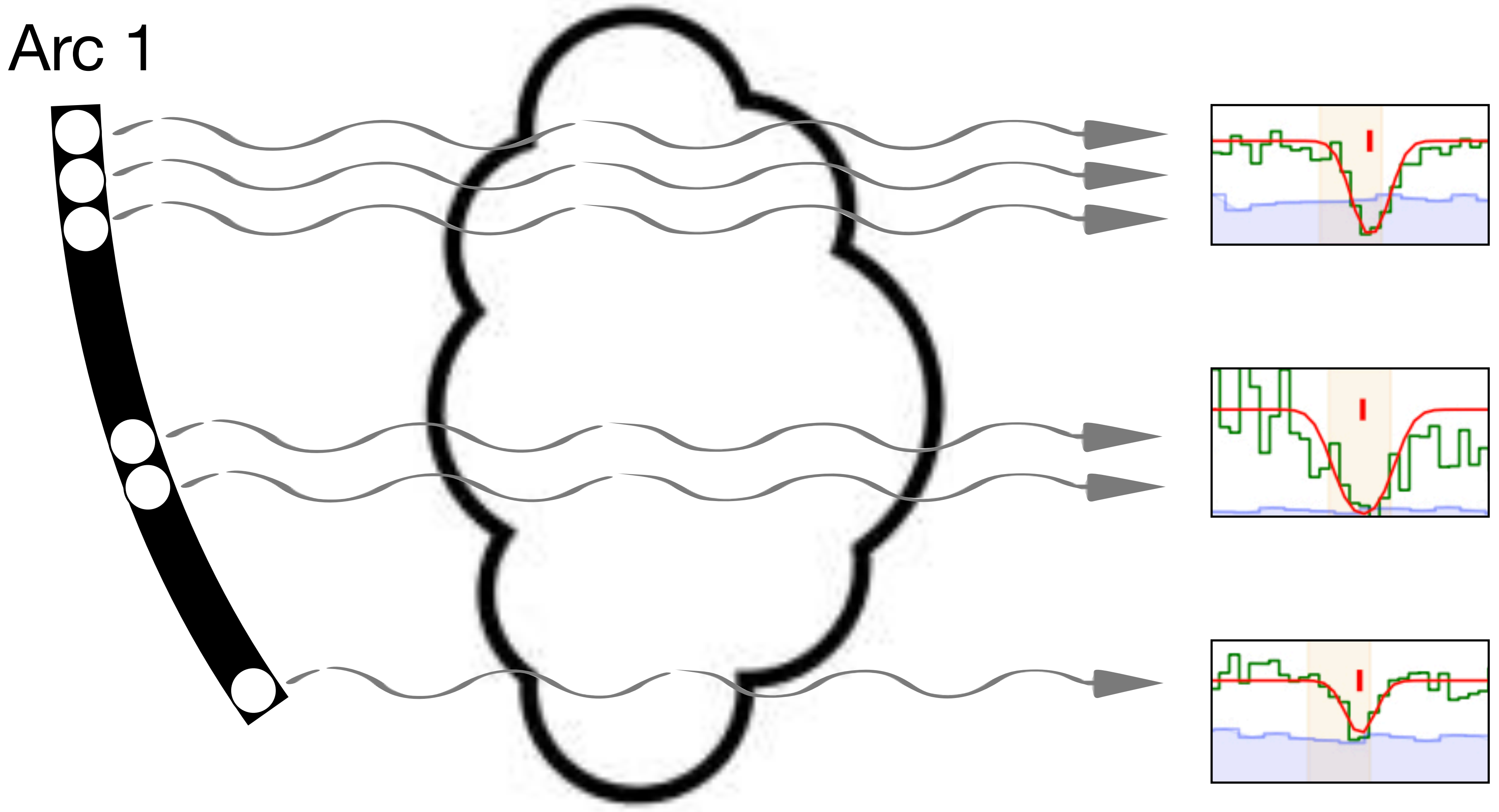
Models with IGM + Galaxy Absorption

Models with absorption



Add galaxy and absorber Lyman limit breaks

1. CIV at z=2.18916✱
2. Lyα at z=2.15420✱
3. Lyα at z=2.07030
4. CIV at z=1.99850✱
5. LLS at z=1.90930

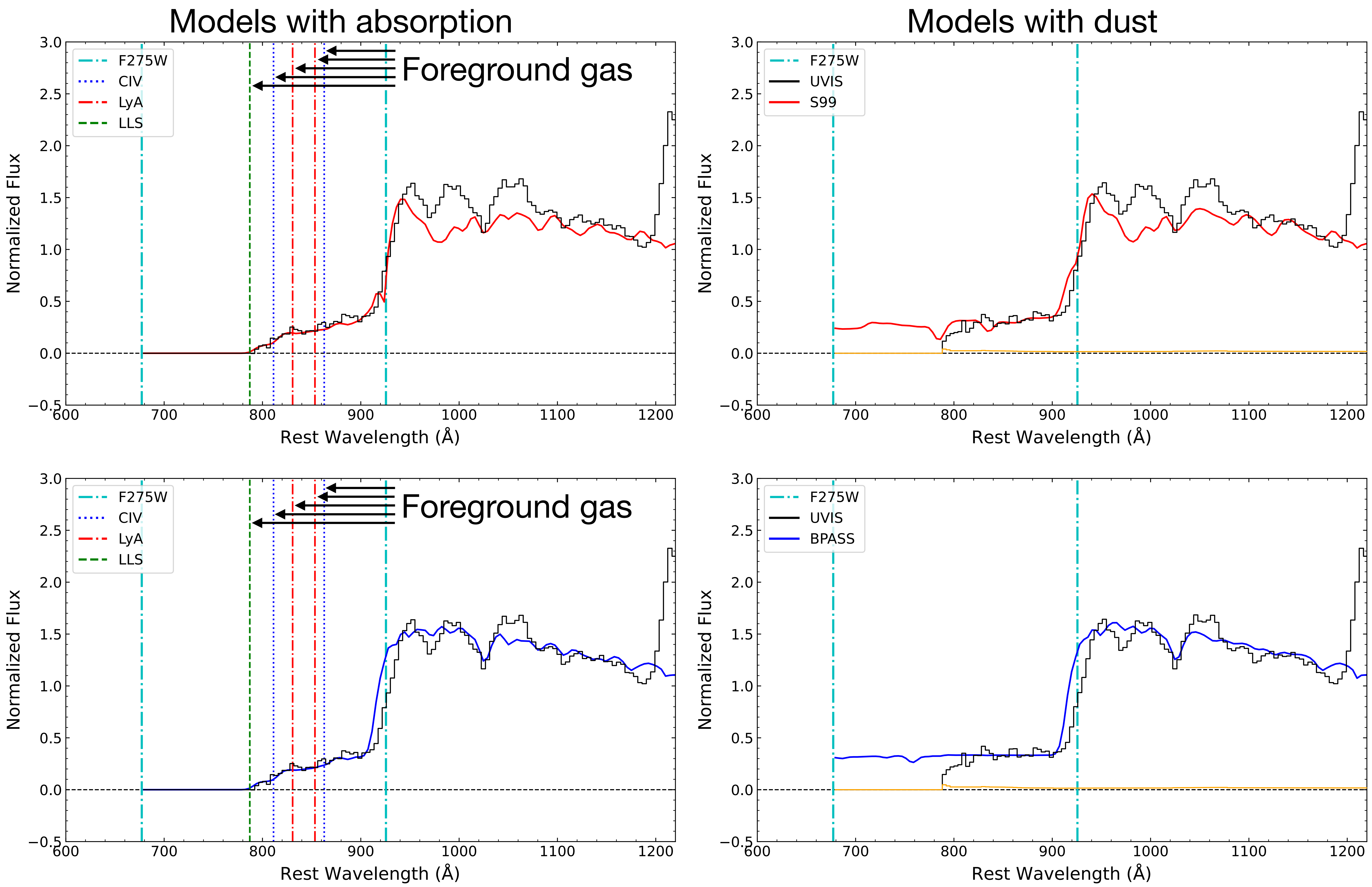


Foreground IGM can be substantially neutral and lower LyC estimates.

T_{ISM} c_f(S99)=36%, c_f(BPASS)=53%

Berg et al. 2024a,b in prep
Rigby et al. 2024 in prep

Models with IGM + Galaxy Absorption



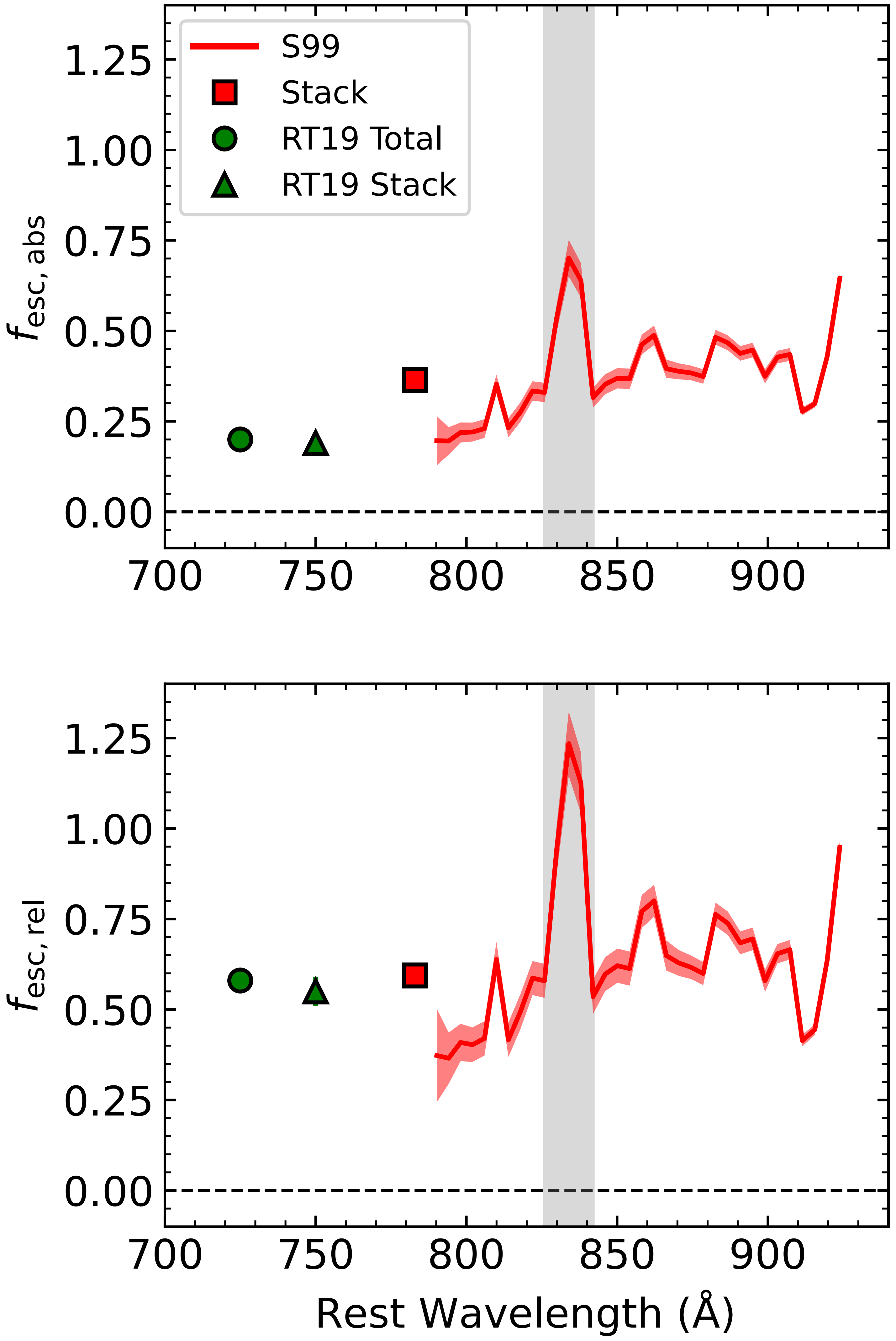
Berg et al. 2024a,b in prep

Models with IGM + Galaxy Absorption

Models with dust fit the observations the best from 790-912Å.

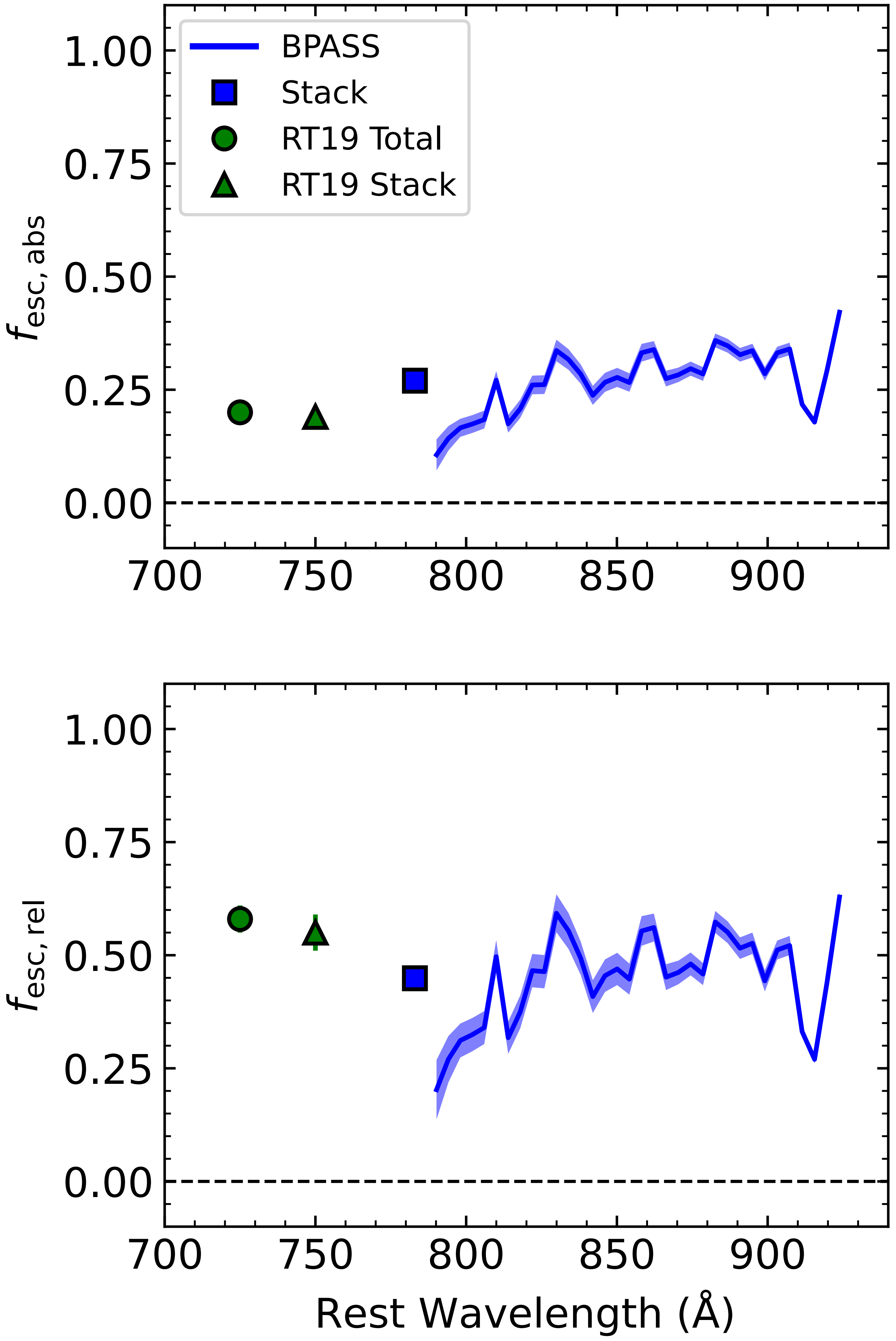
Berg et al. 2024a,b in prep

Updated Escape Fractions



S99 $f_{ecs,abs}$ = 36.4 ± 0.4%
BPASS $f_{ecs,abs}$ = 27.0 ± 0.3%

S99 $f_{ecs,rel}$ = 59.4 ± 0.7%
BPASS $f_{ecs,rel}$ = 45.0 ± 0.5%

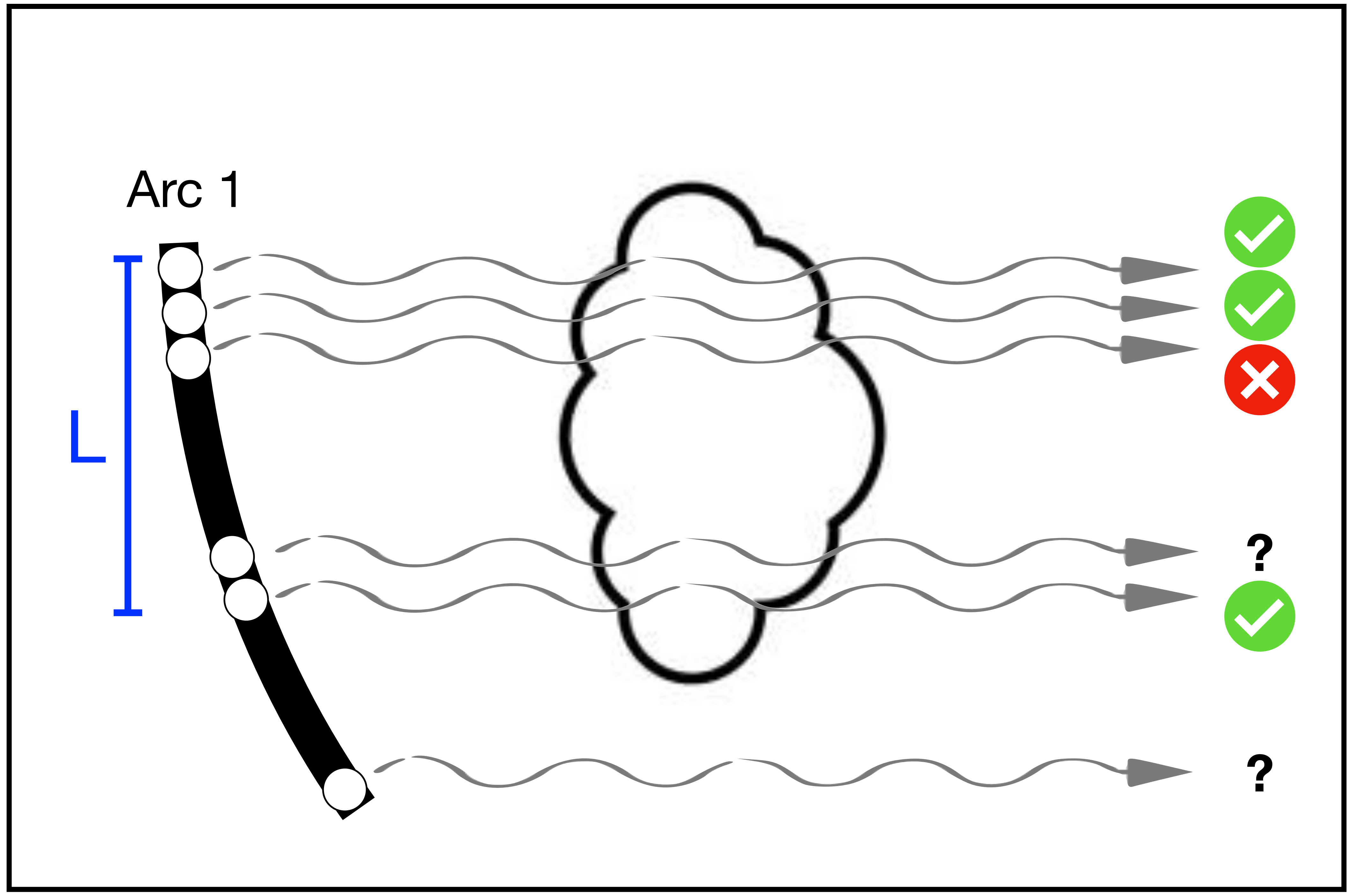


The escape fractions increased by 5-10%.

Berg et al. 2024b in prep

IGM Tomography

Lyα at z=2.15420



We can estimate the size of the foreground absorbers in 2D and the HI mass.

Berg et al. 2024a in prep

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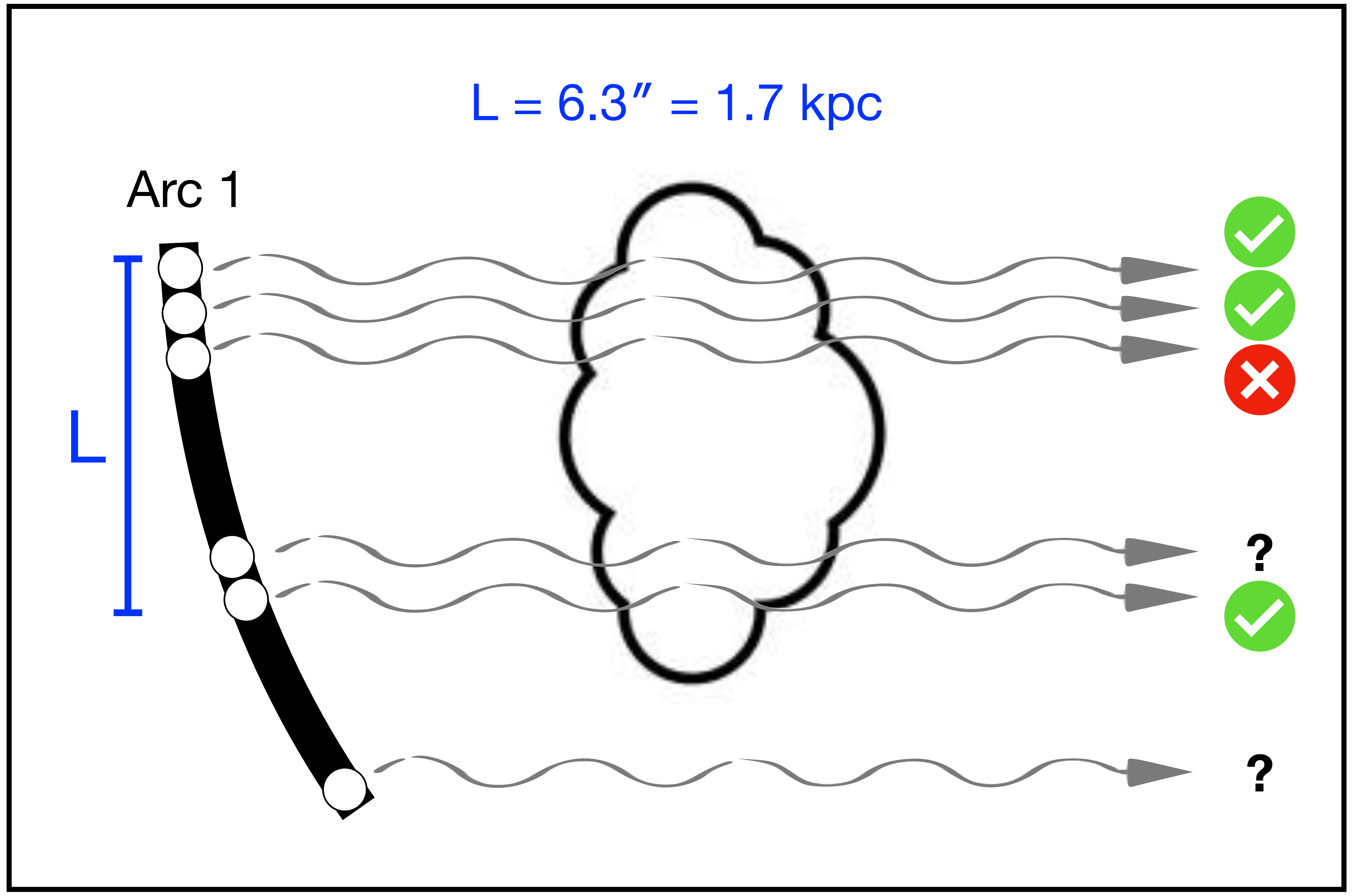

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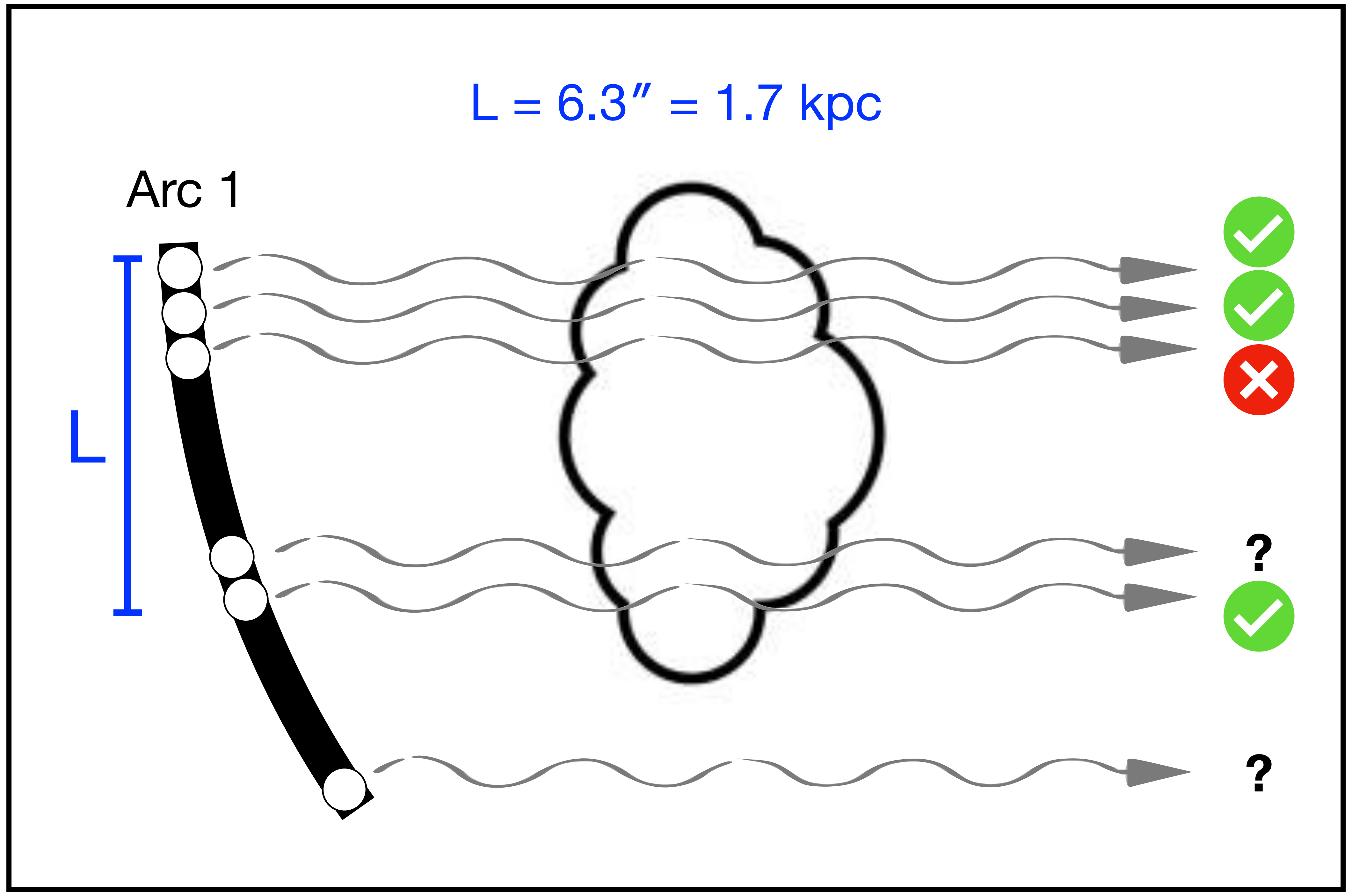

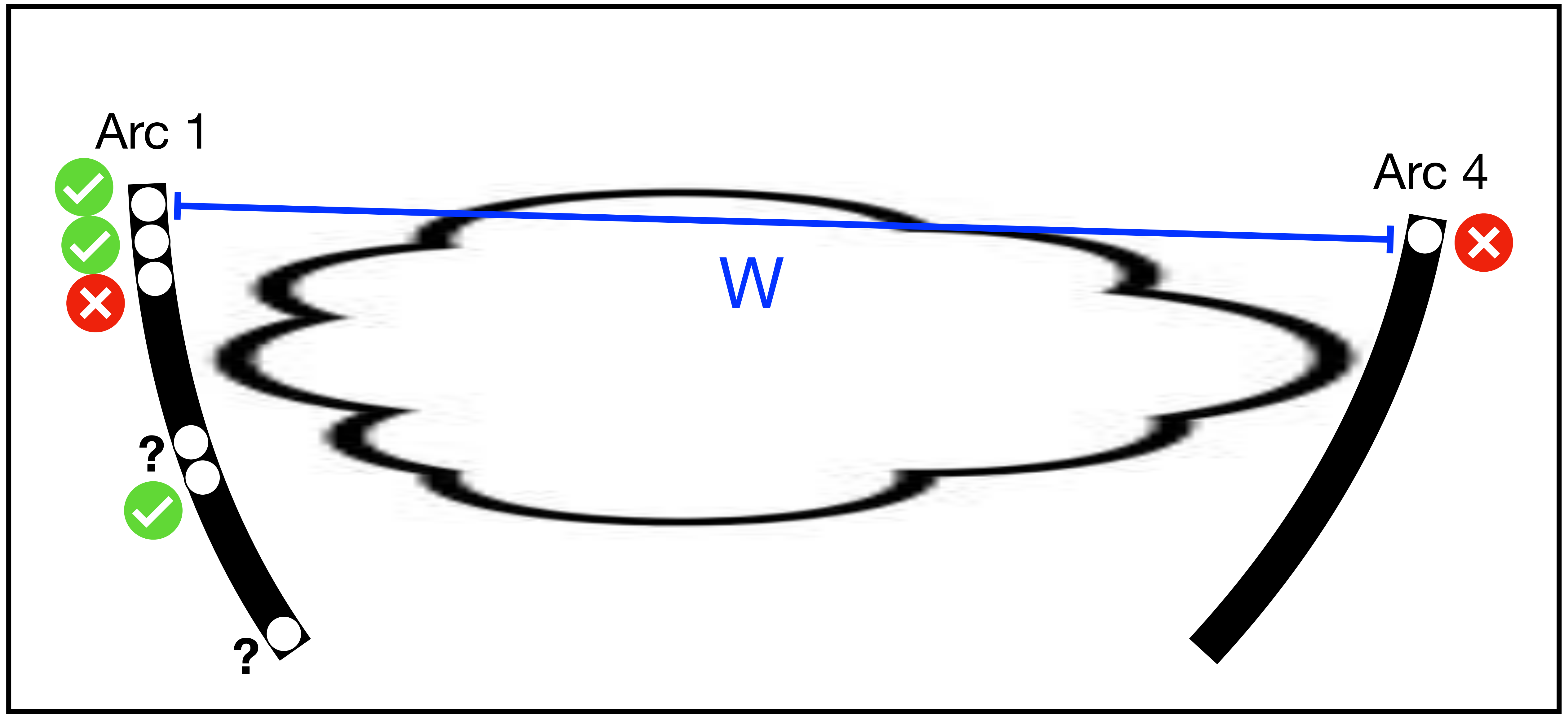

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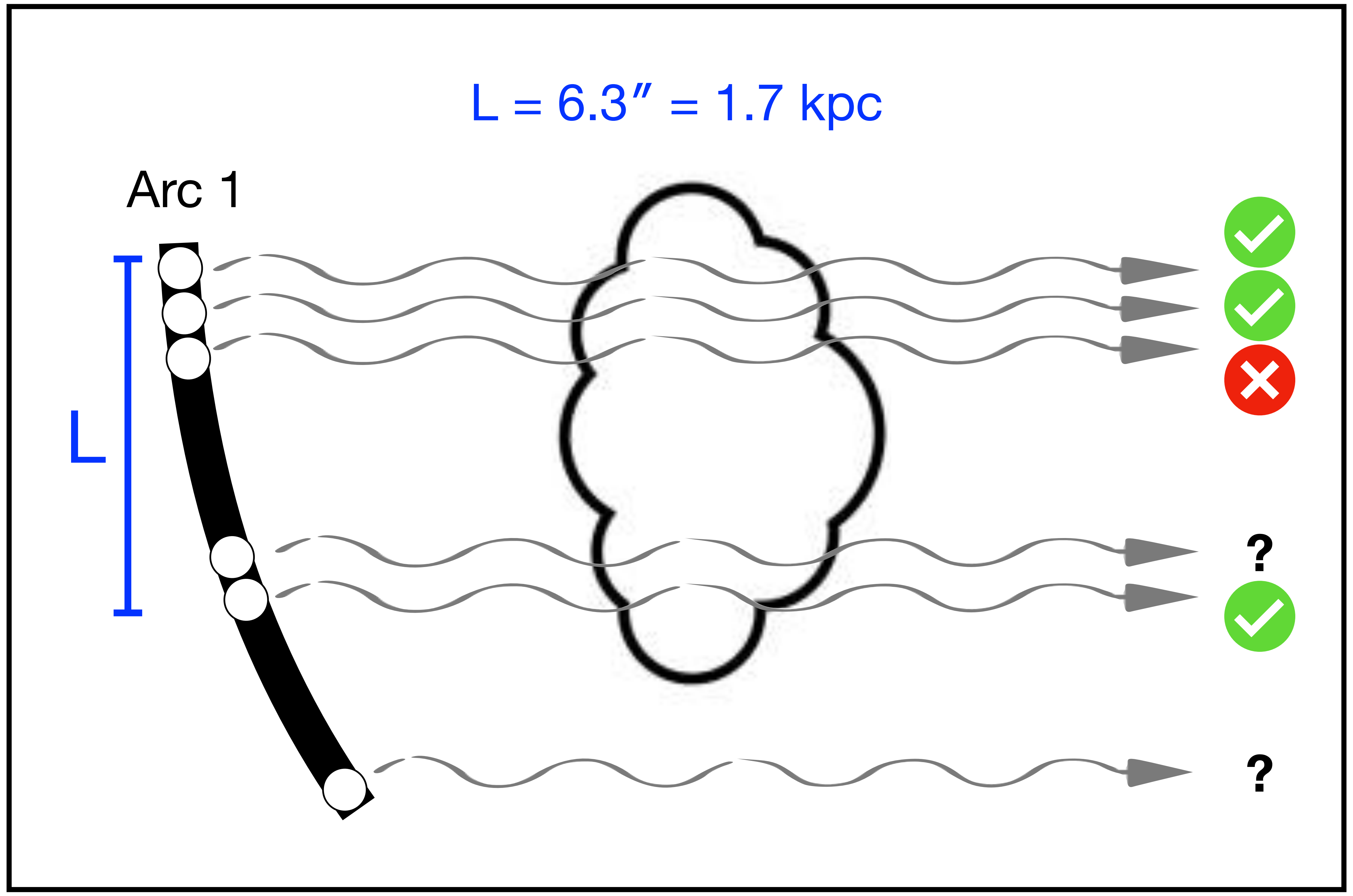

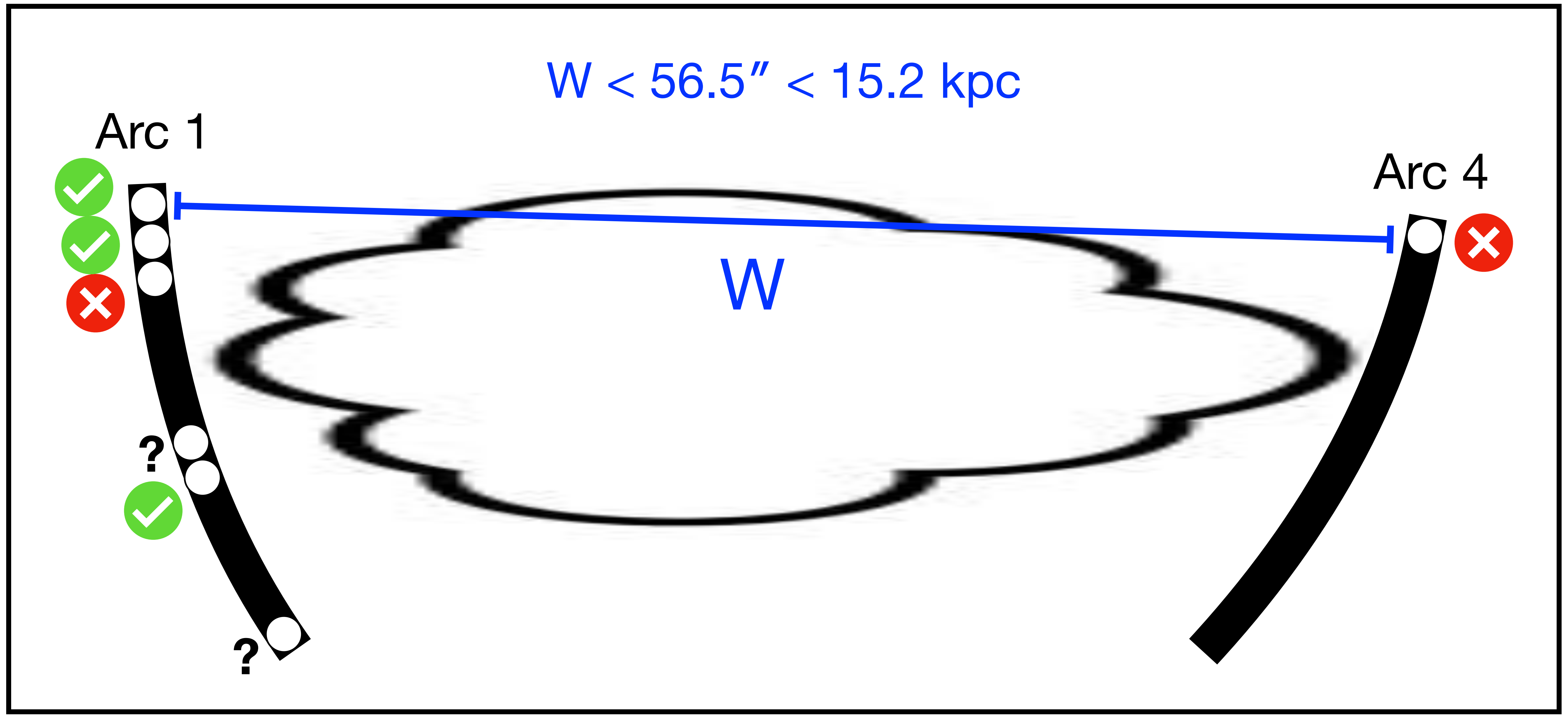

M(HI) = 8×10^{2} — 7×10^{4} $M_{\odot}$

We can estimate the size of the foreground absorbers in 2D and the HI mass.

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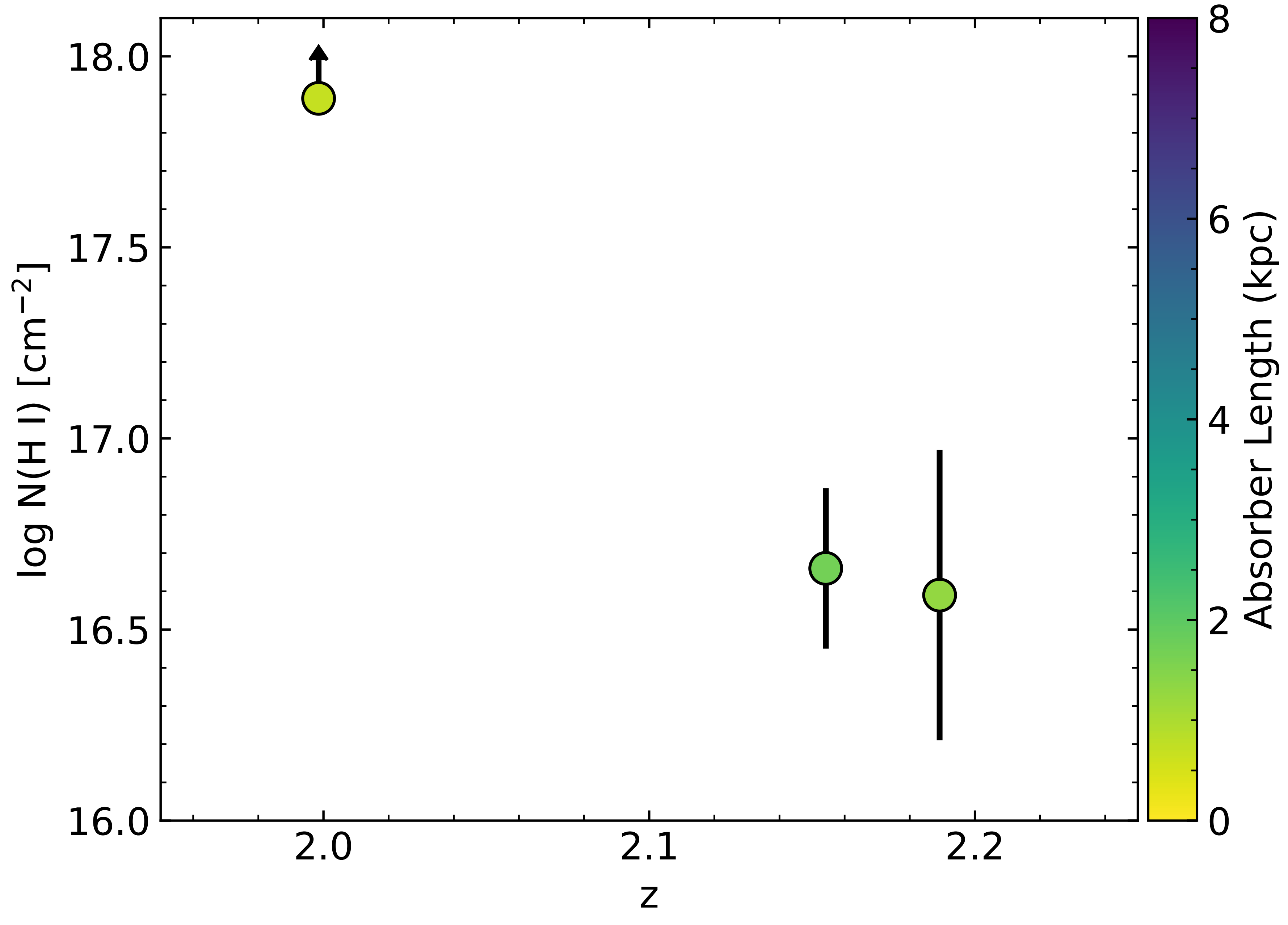
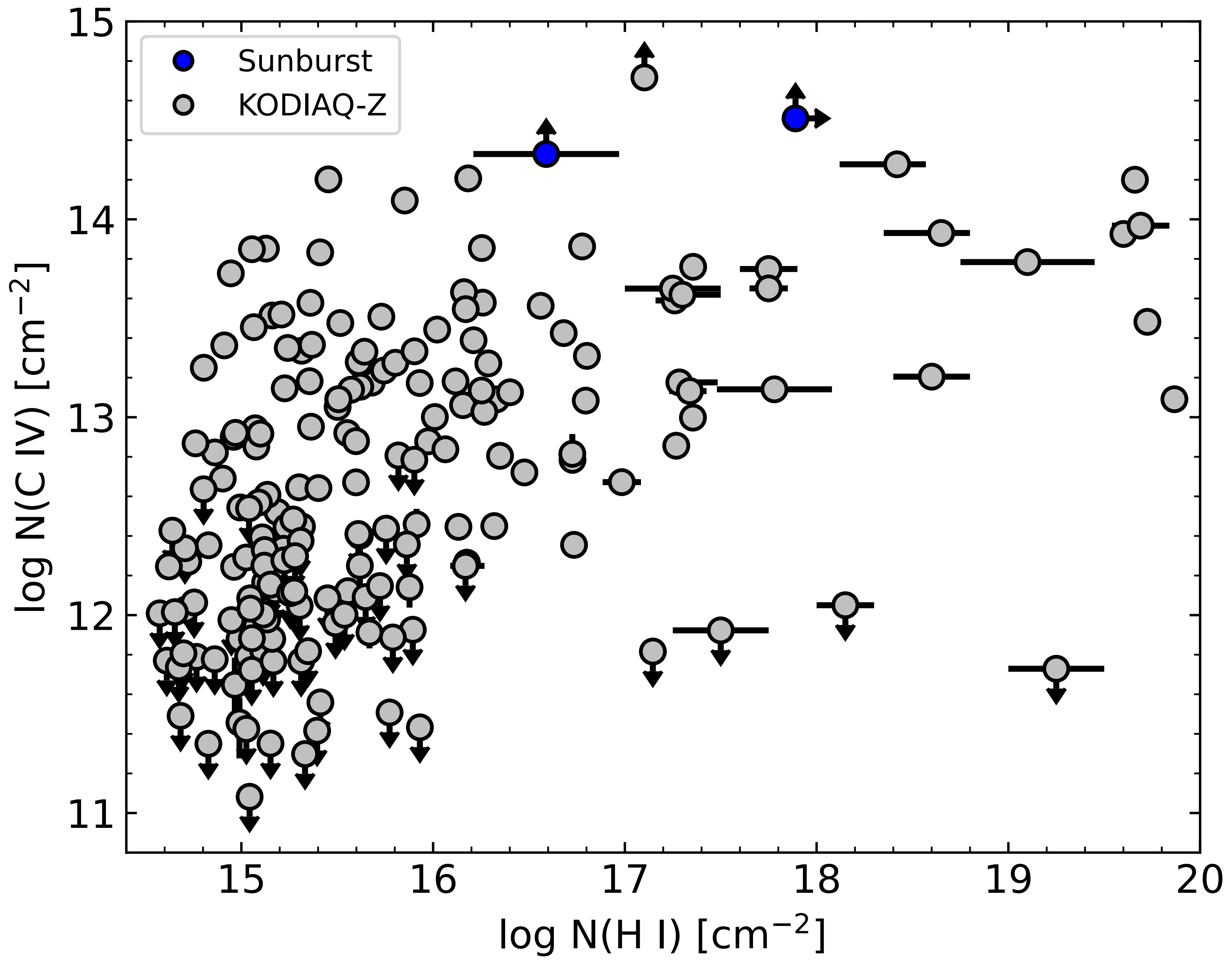
Absorber Characteristics





This is the first time absorbers at z~2 have been probed at extremely small separations.
These absorbers exhibit IGM and CGM absorber characteristics.

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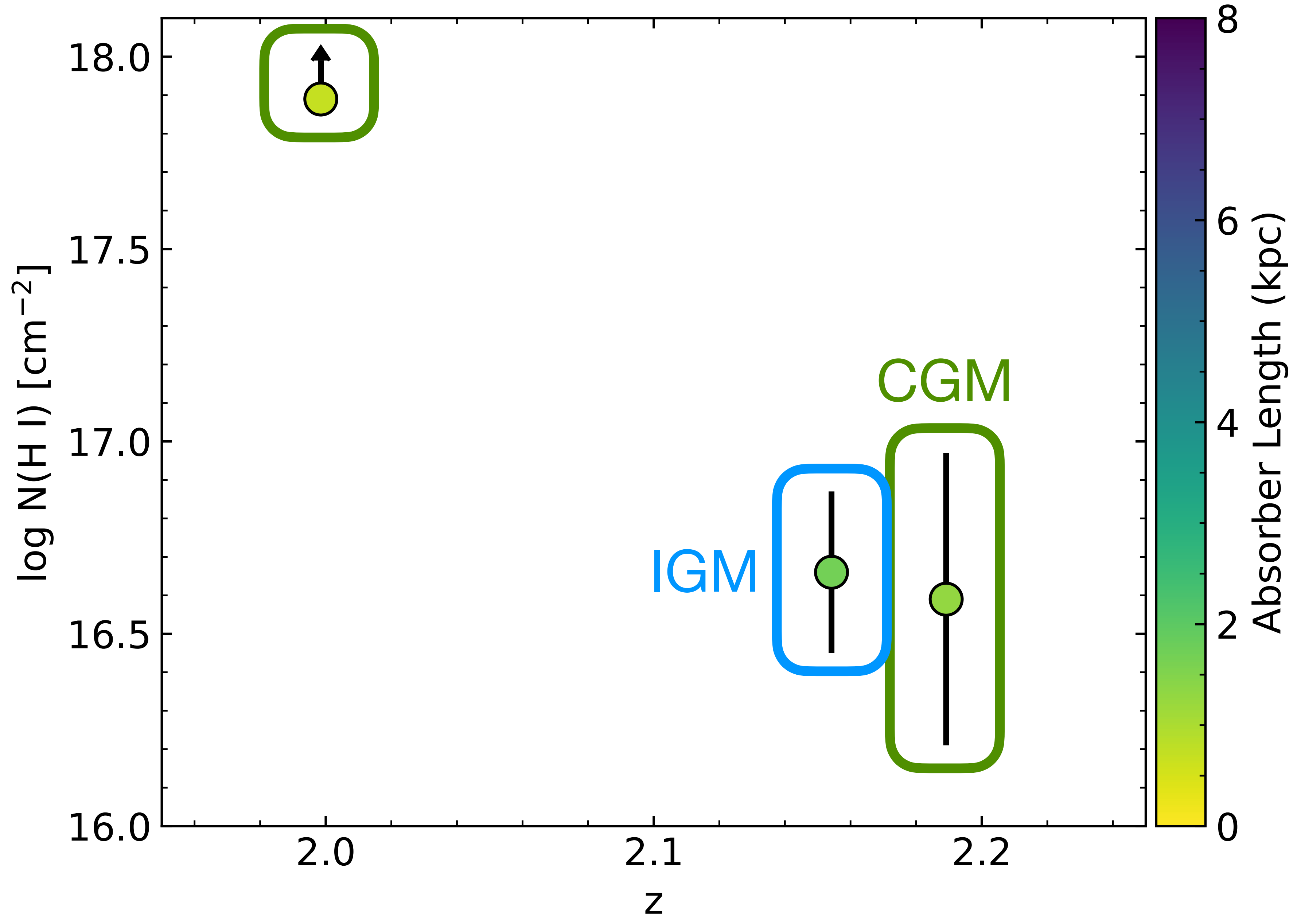
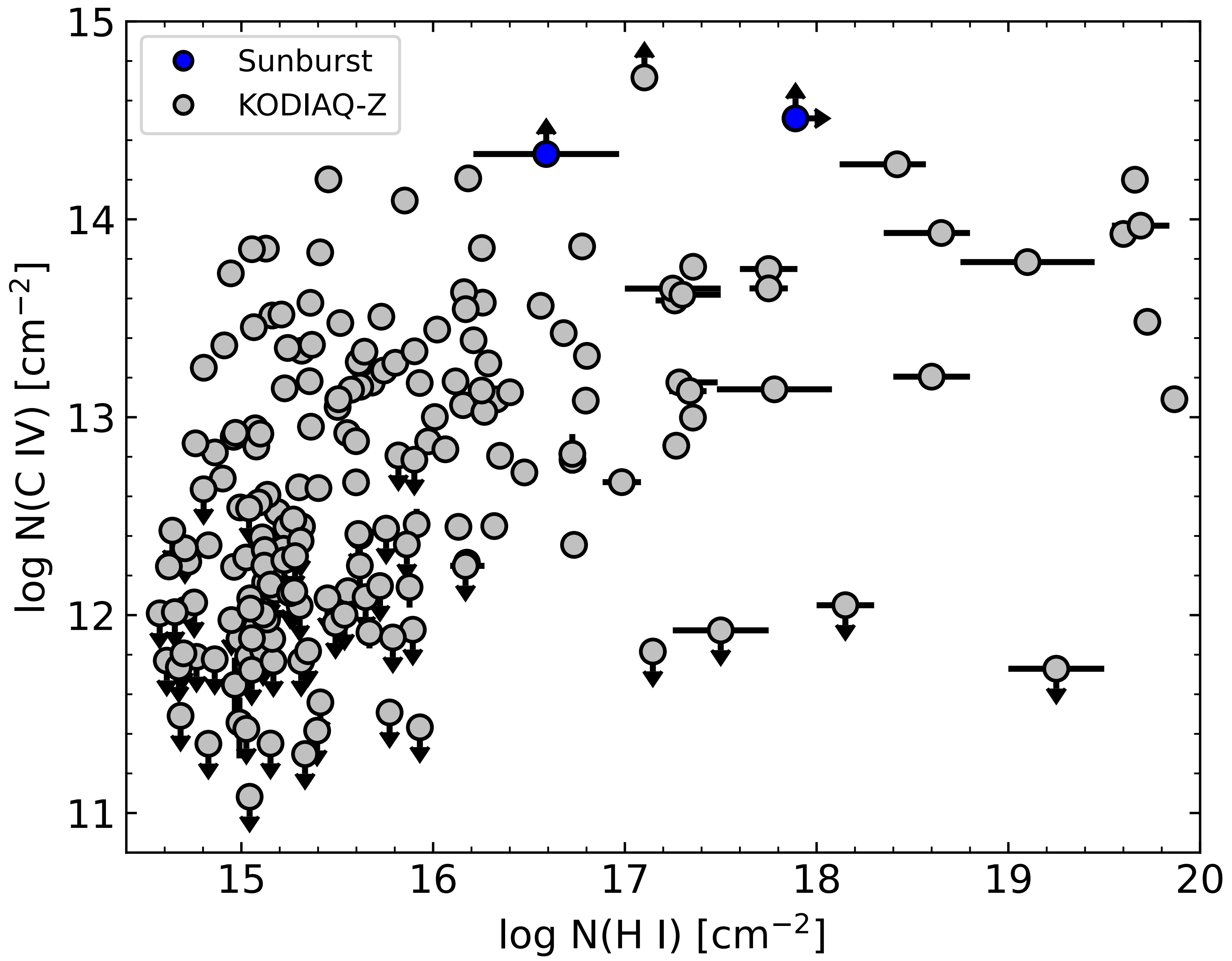
Absorber Characteristics





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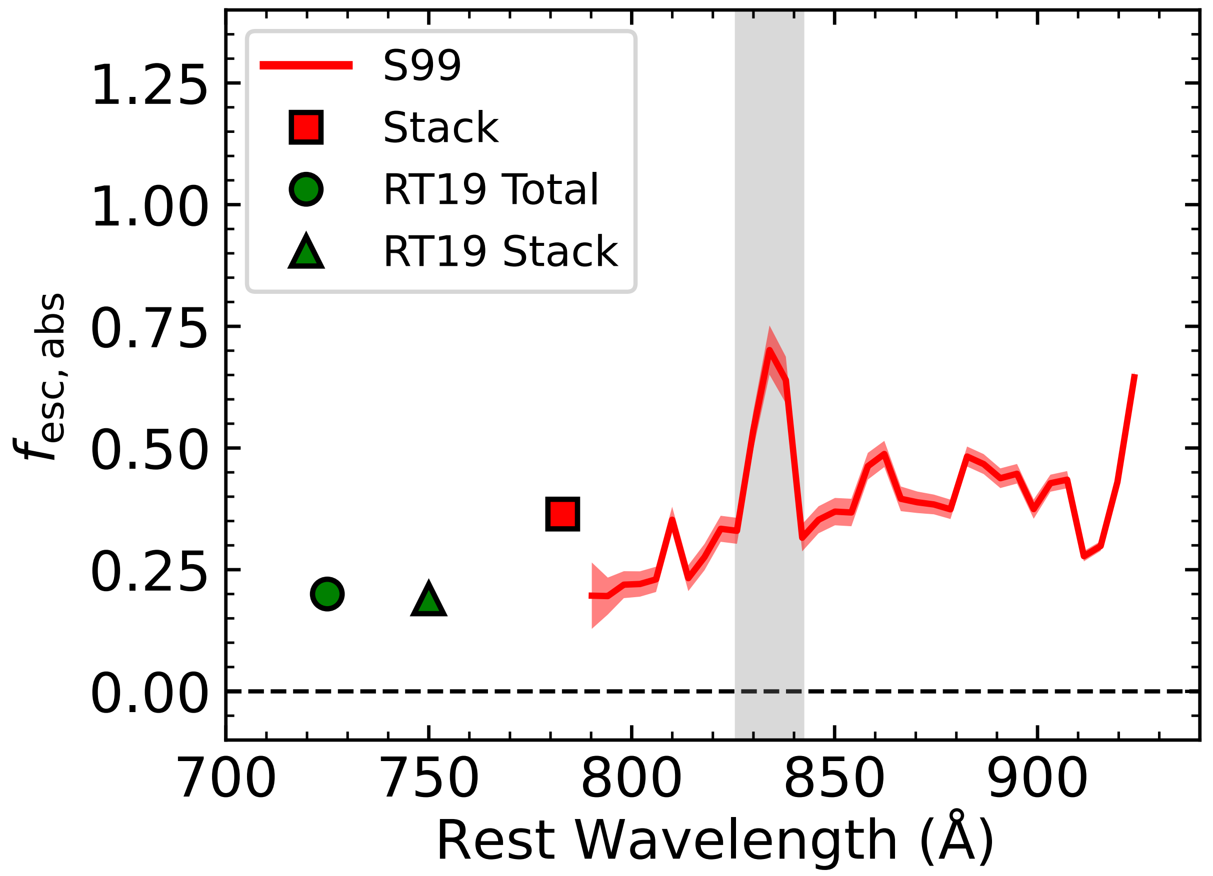
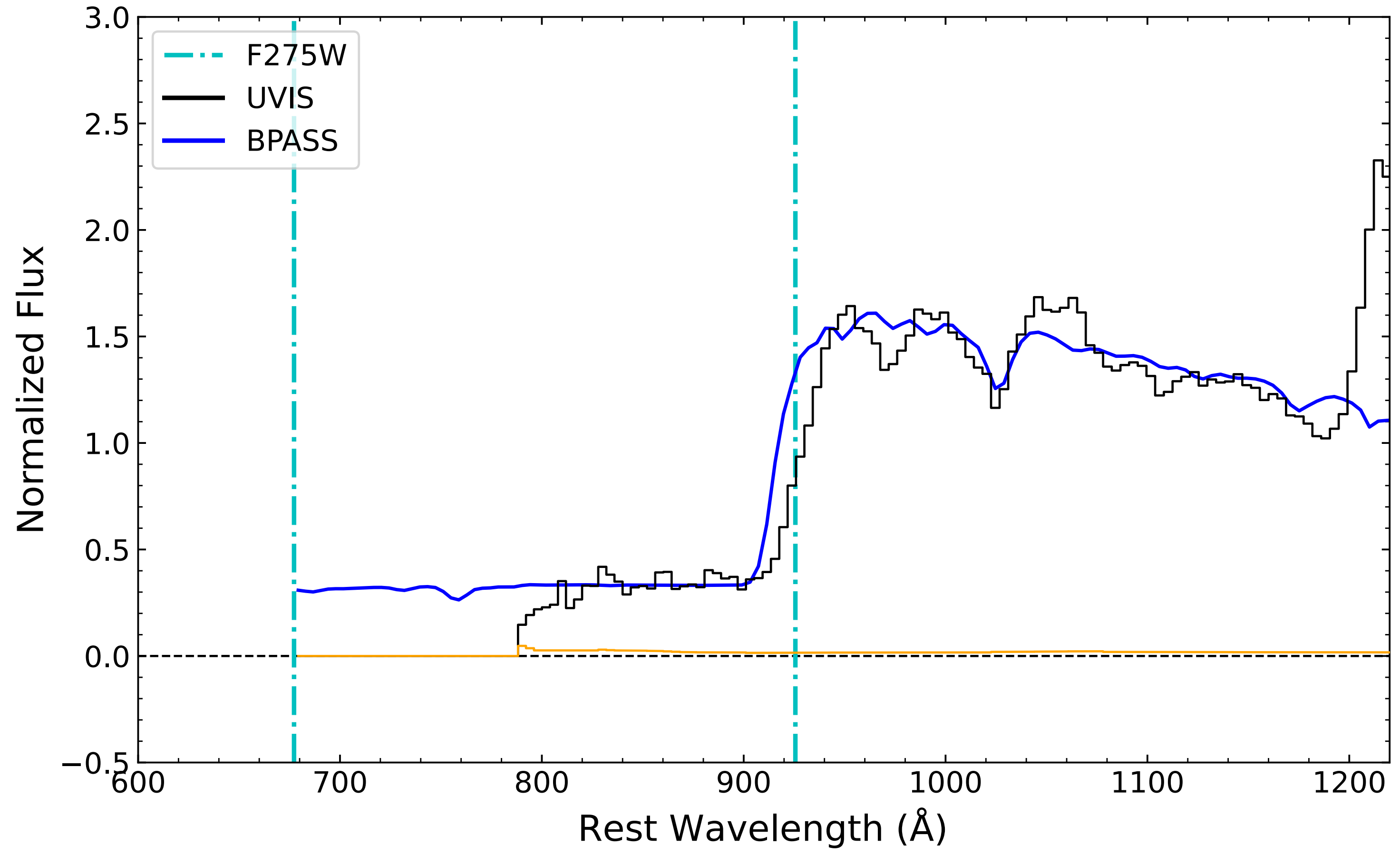
Berg et al. 2024a in prep

Summary

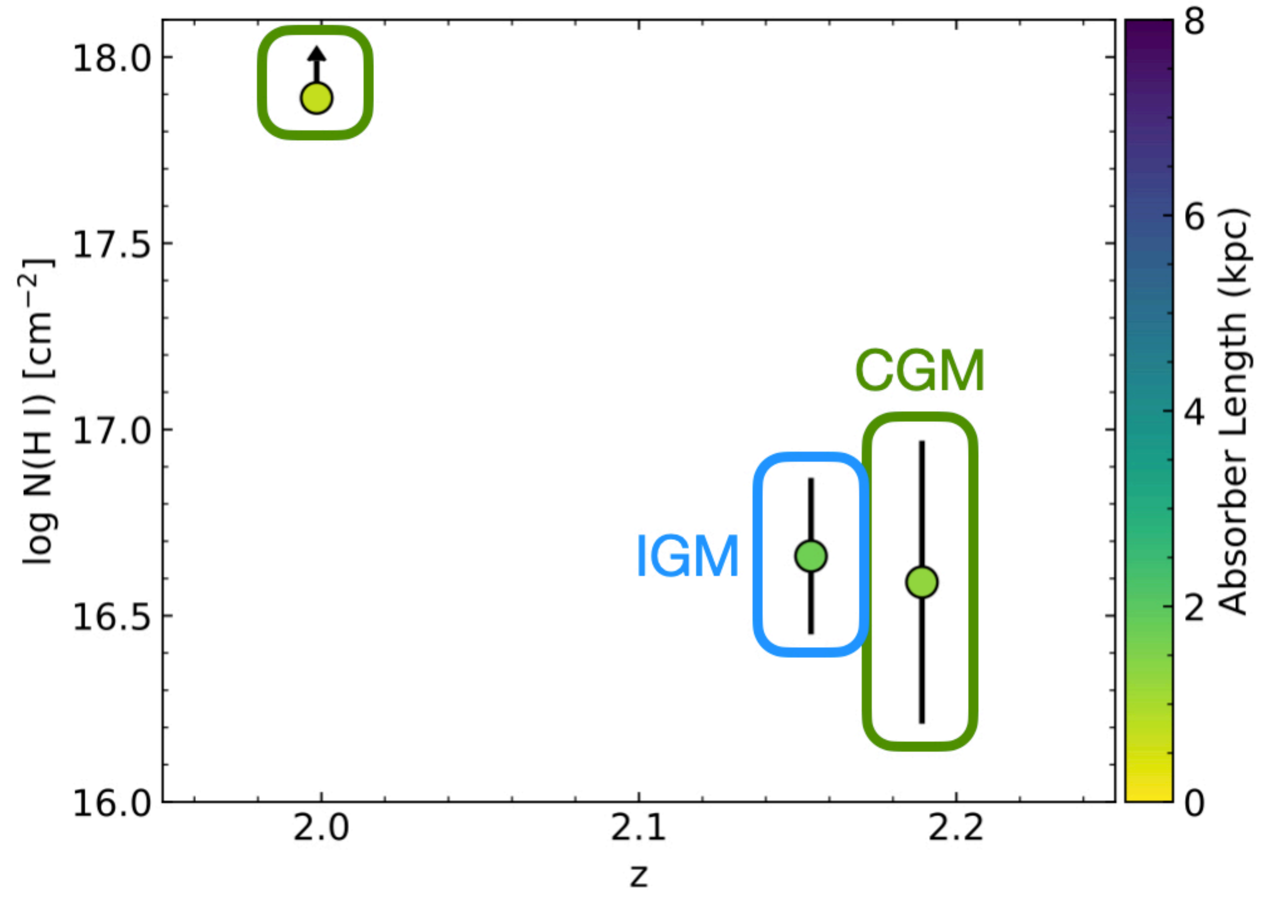
1. We can measure the ionizing stellar continuum of the Sunburst Arc. The absolute escape fractions are high, ranging from 27-36%.



2. Dust needs to be included in the models to fit the observations.



3. We can estimate the size and HI mass of the foreground absorbers at z~2.



New position this fall!
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m.a.berg@tcu.edu

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