Deep Keck Multislit Windows Search for z=5.7 LyA Emitters

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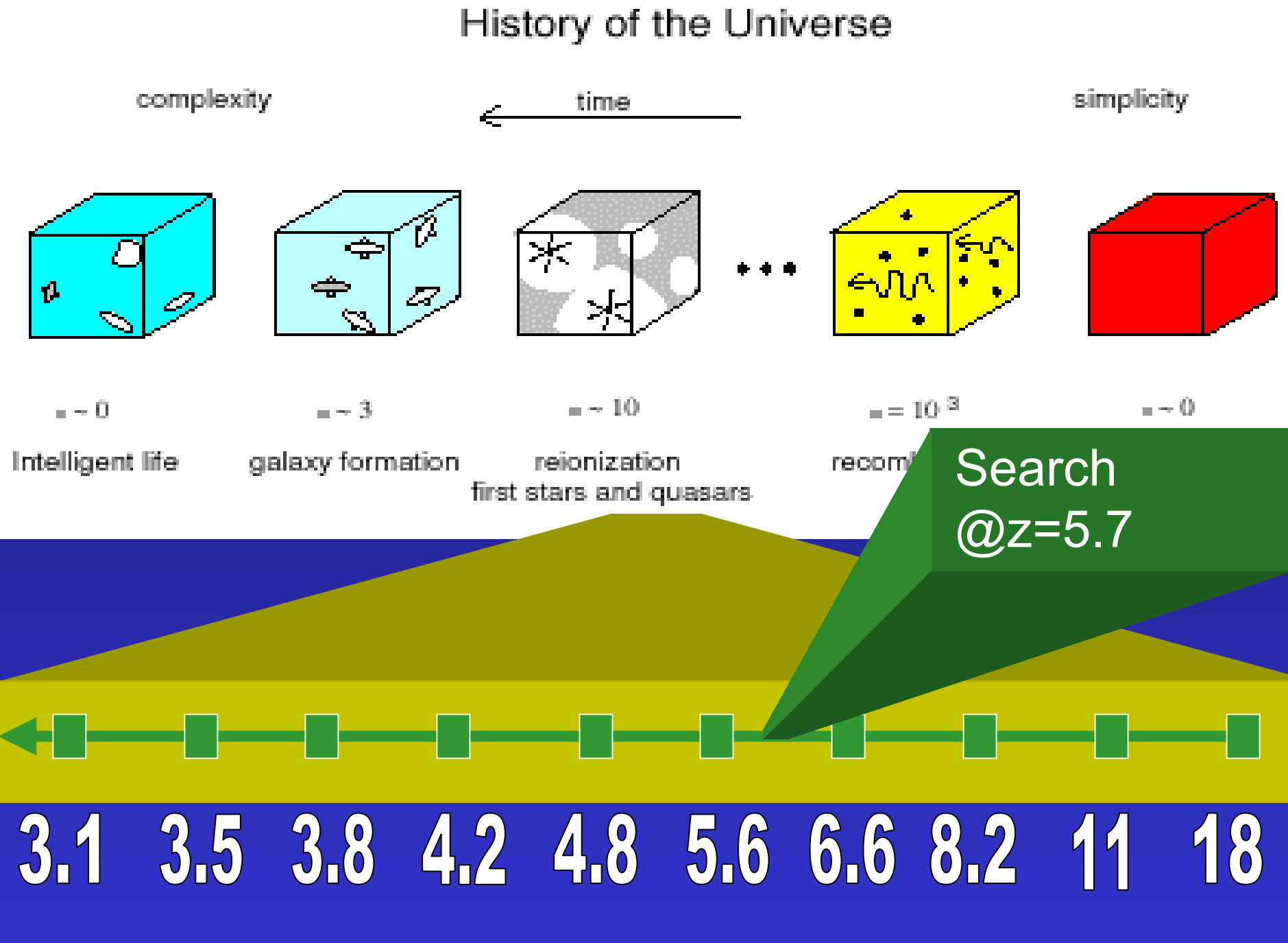
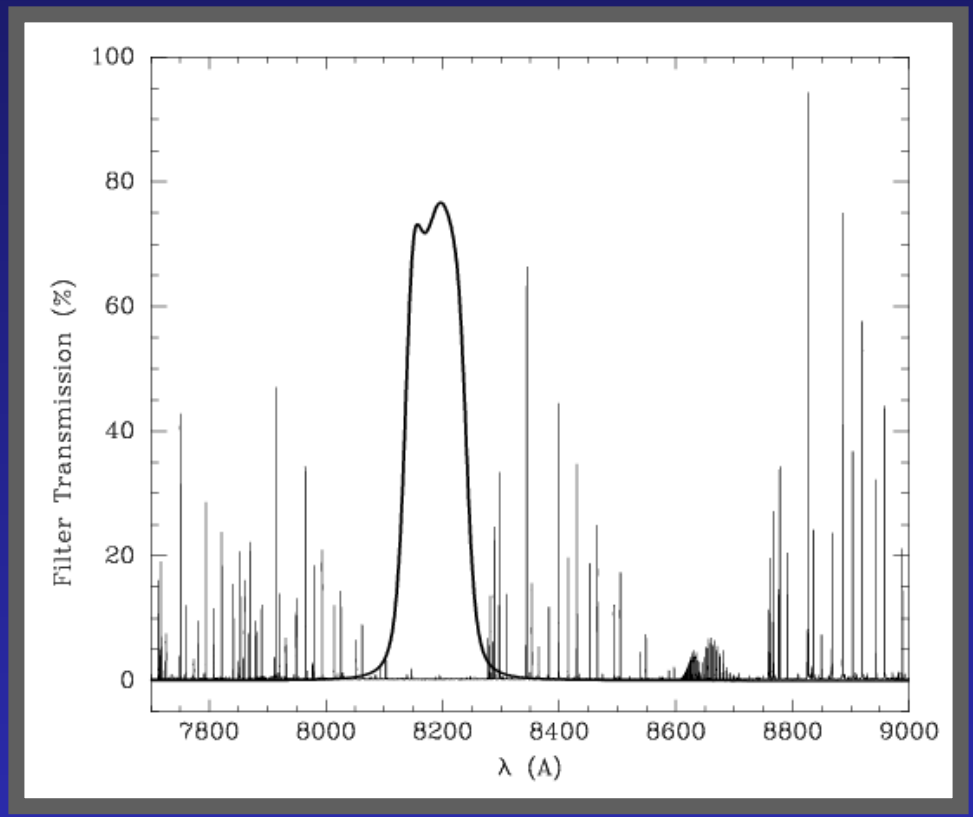
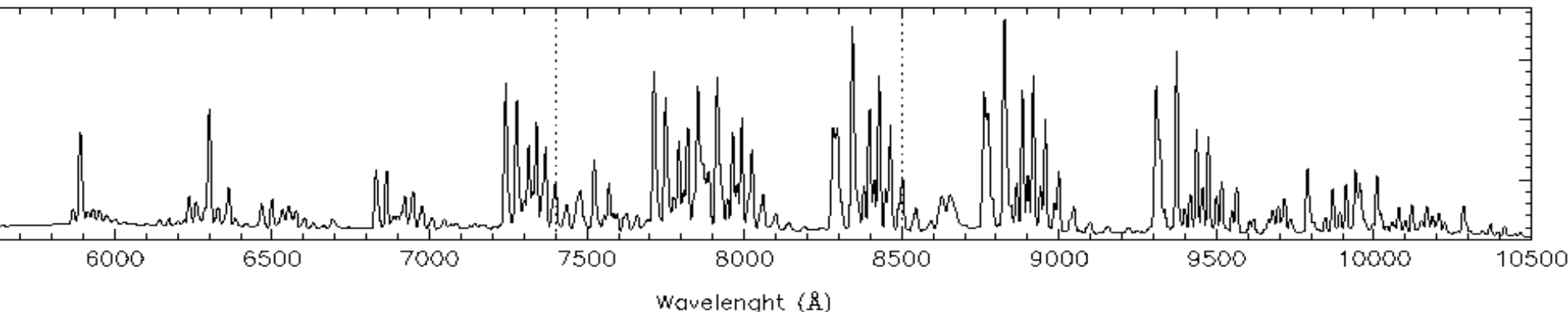

History of the Universe
complexity
time
simplicity
z ~ 0
z ~ 3
z ~ 10
z = 10 3
z ~ 0
Intelligent life
galaxy formation
reionization
first stars and quasars
recom
Search
@z=5.7
3.1
3.5
3.8
4.2
4.8
5.6
6.6
8.2
11
18

Blocking Filter Selects Atmospheric Window



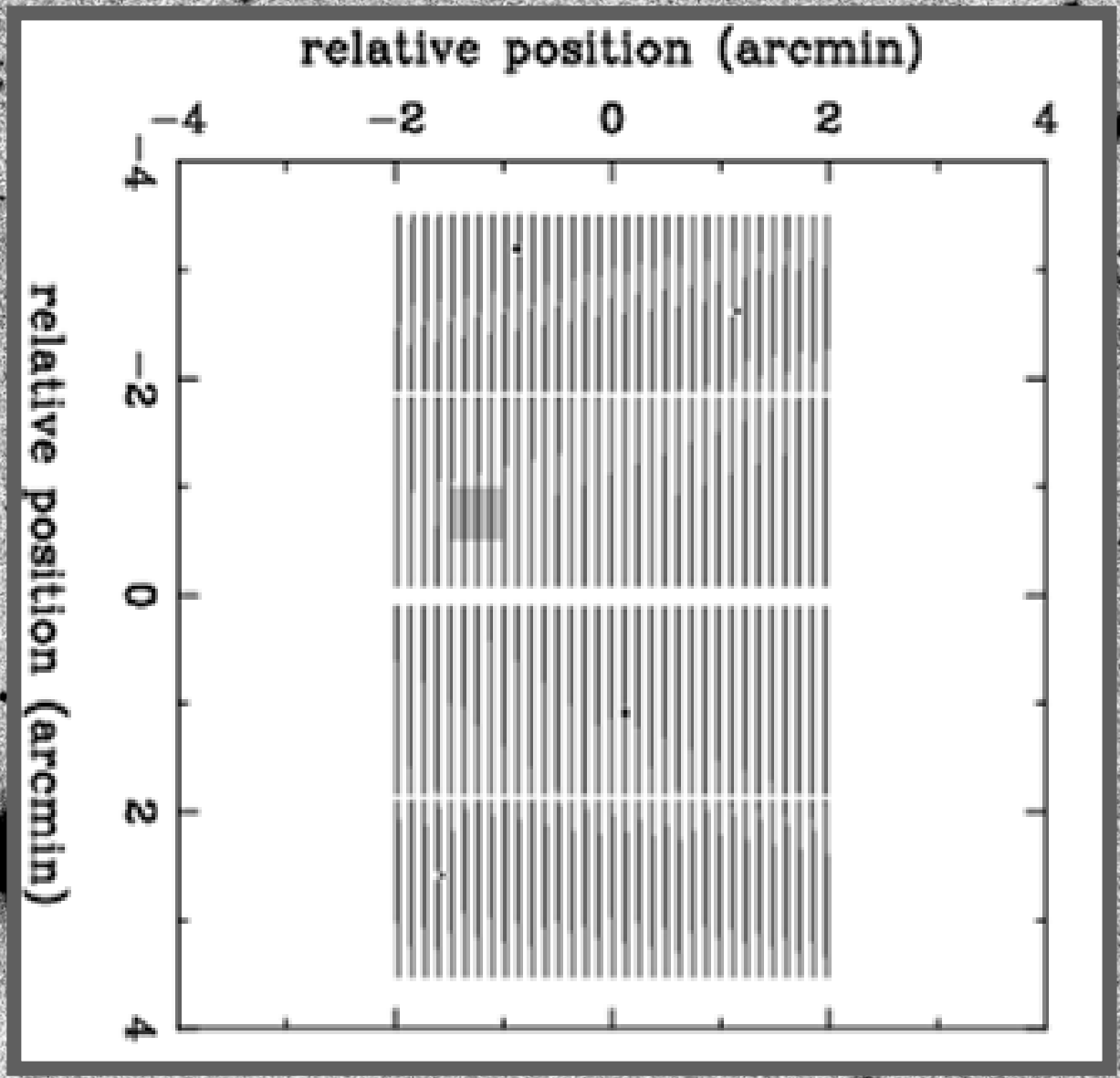
LRIS Night Sky 300 Line Grating 7400Å to 8500Å



Observations & Analysis

- Obtain low resolution LRIS spectra of Cl0024+16 field with narrowband blocking filter and custom mask.
- Sky and continuum subtract stacked image in preparation for automated detection.
- Follow-up with higher resolution LRIS spectra and identification of object location in a deep image of the field.
- Add artificial emission lines to data frames and repeat analysis to determine sensitivity.

Slitmask Subtends 5.1 square arcminutes

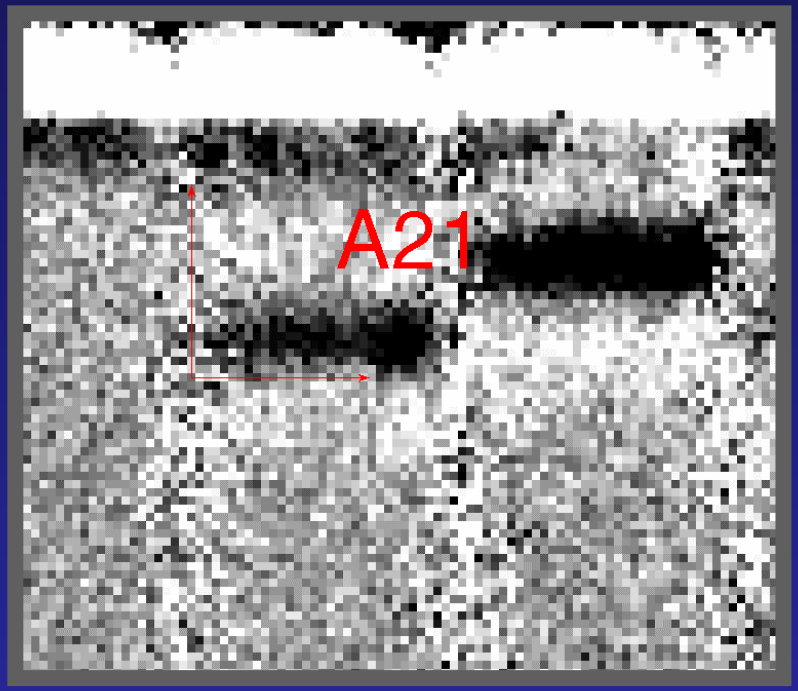


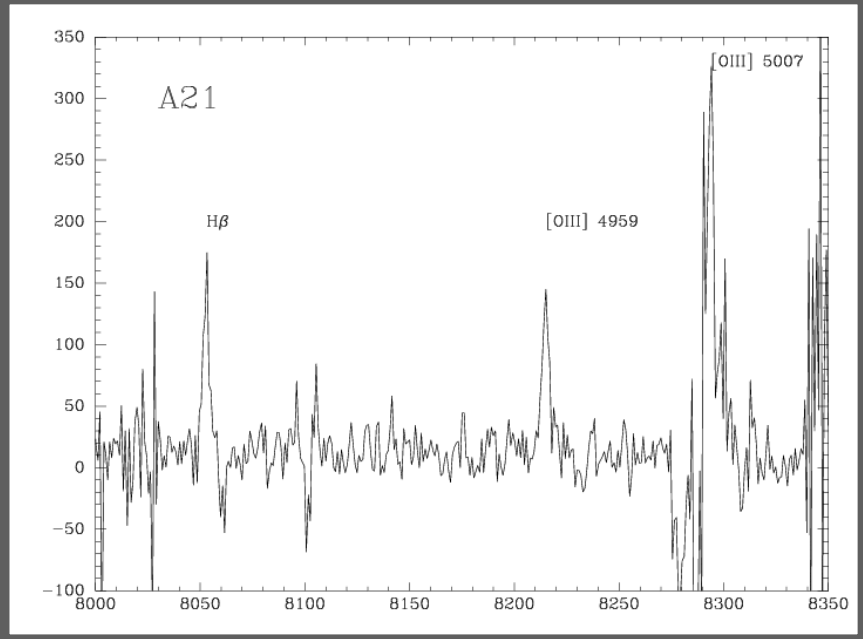
150 A bandpass

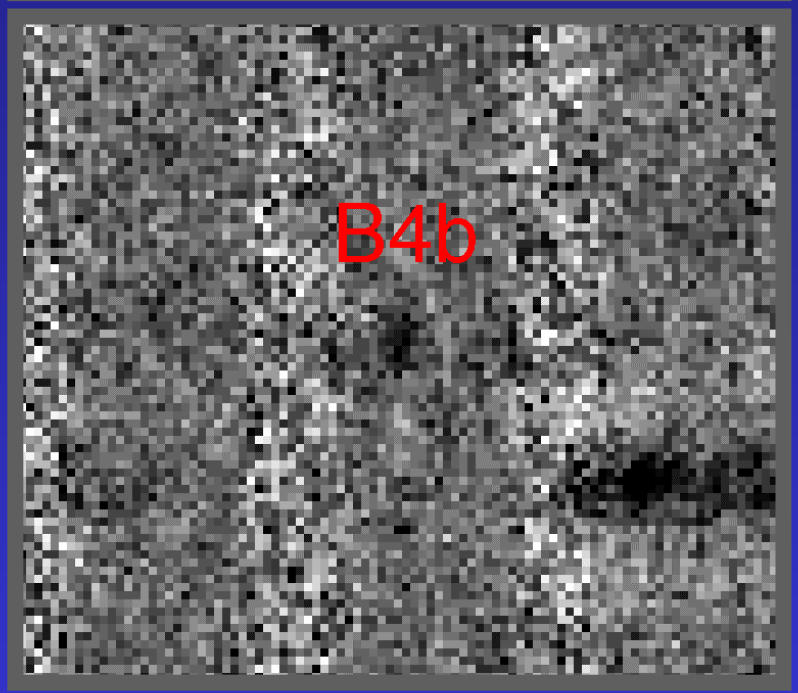
Lya @ z=5.661-5.785

20 A Resolution

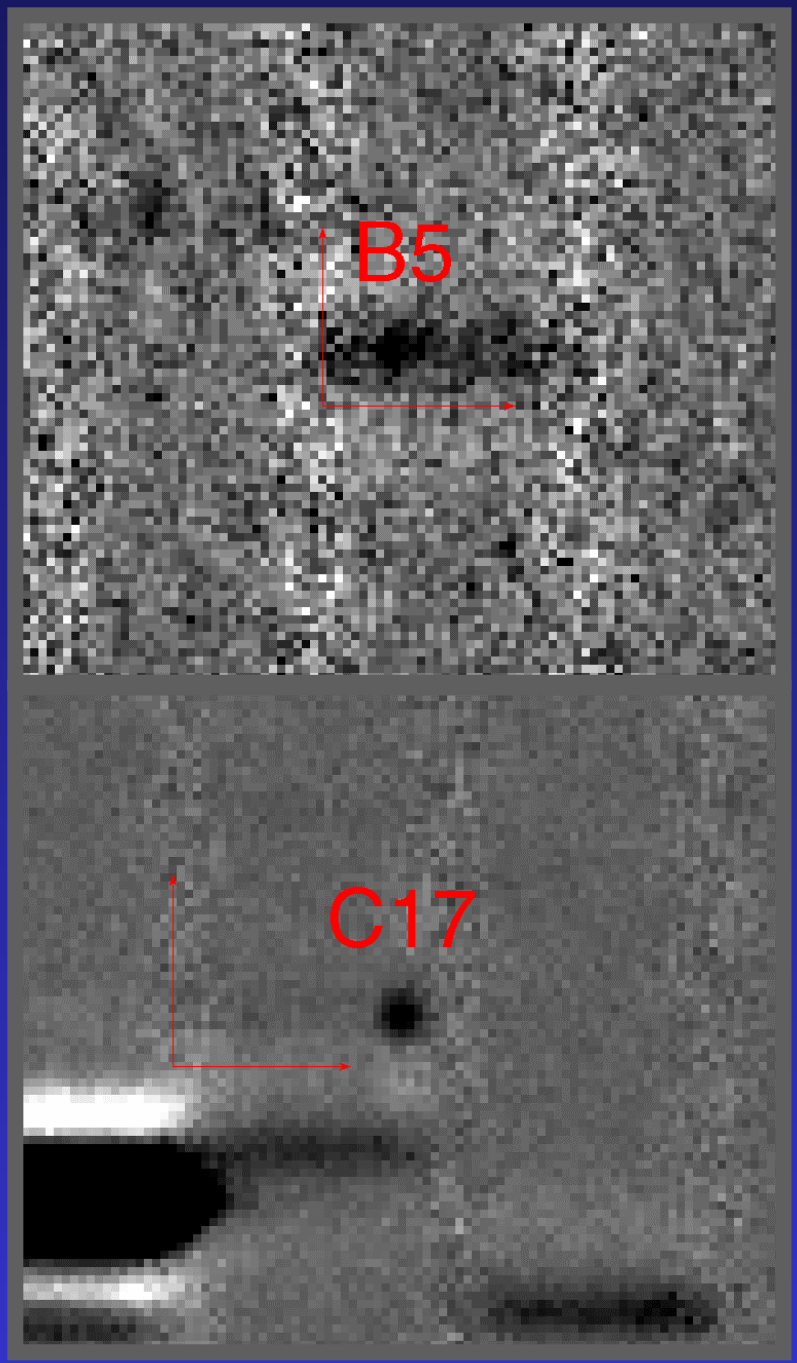
Find 9 emission line objects but none are Lya.





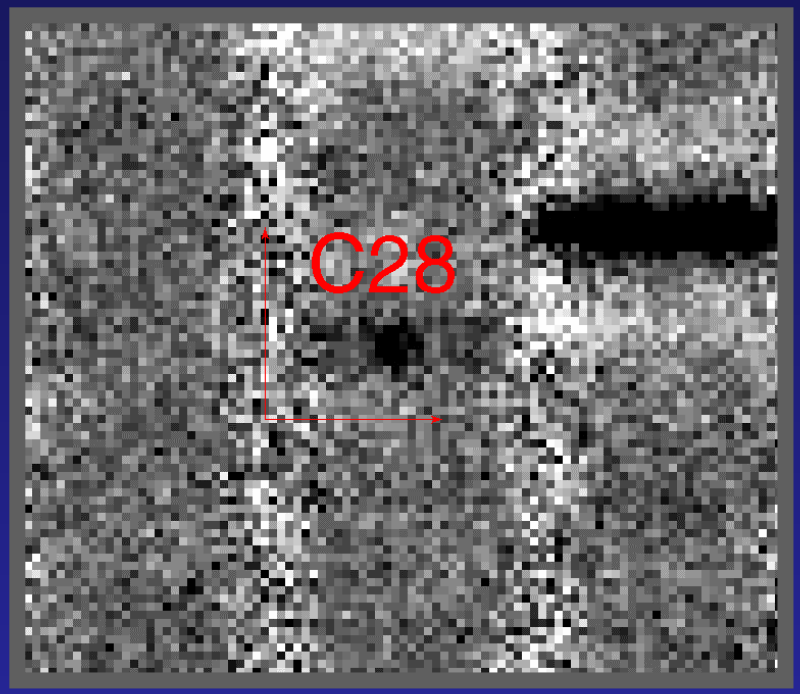


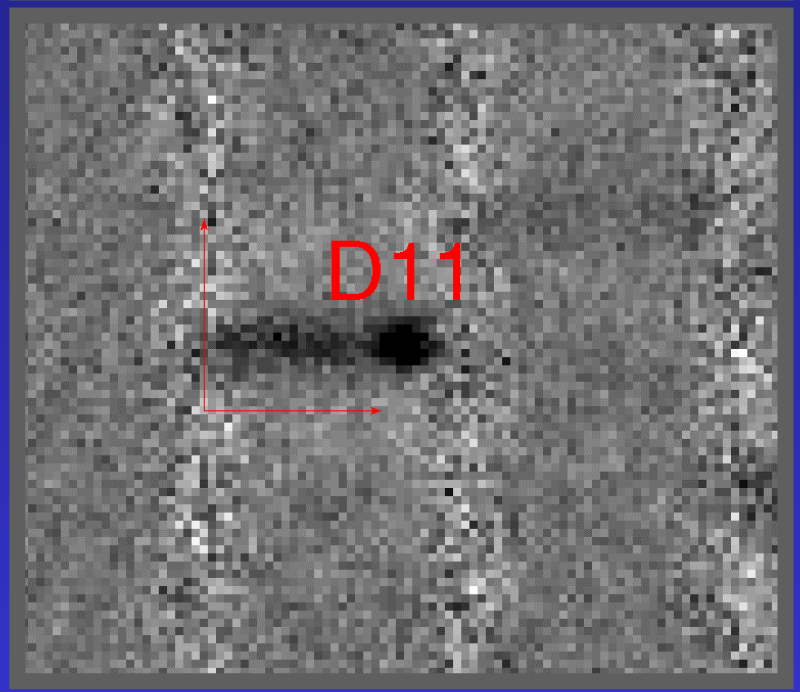
Object not redetected on follow-up mask. Position lies near a faint spiral galaxy seen in V band image. Line is not LyA. Line flux = 1.1e-17 erg/s/cm2.



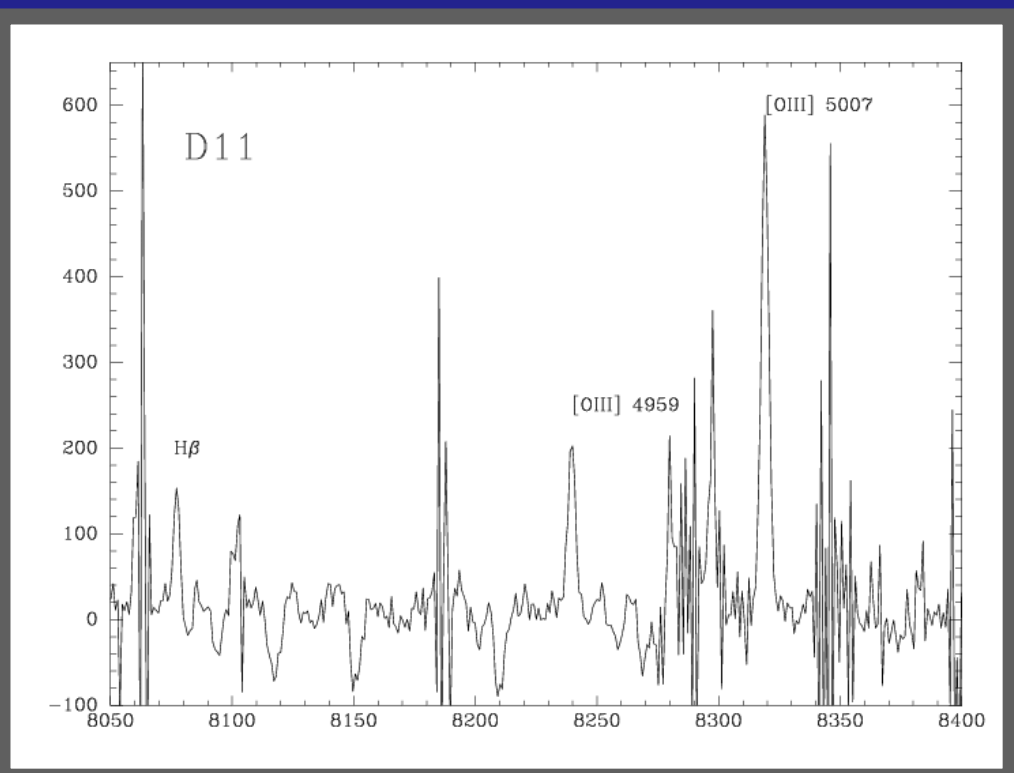
Absence of a continuum break across the line rules out an identification as LyA. Line flux = 0.84e-17 erg/s/cm2; EW = 9 A.

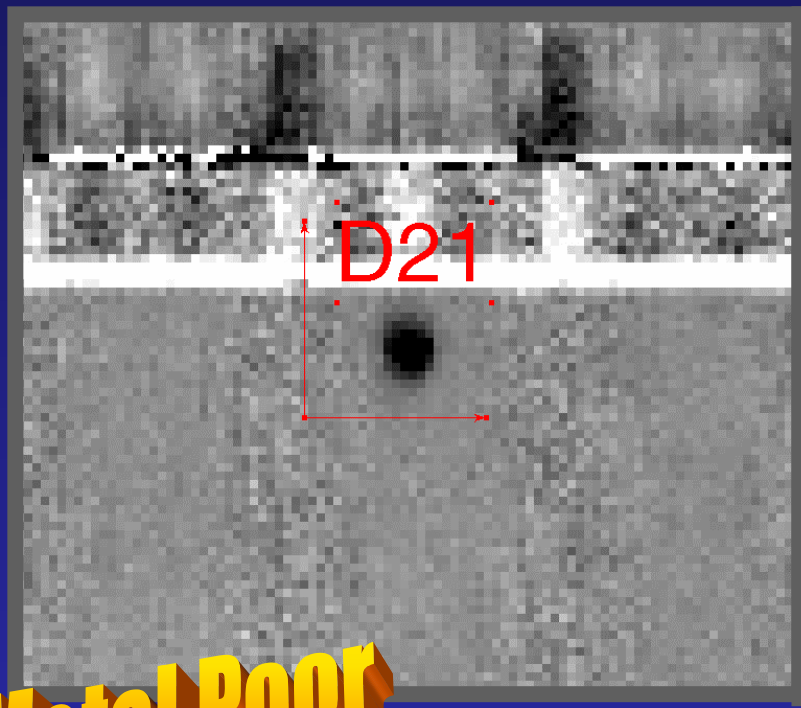
Possible V band counterpart renders identification as LyA unlikely. Line flux = 4.8e-17 erg/s/cm2; EW = 490 A.

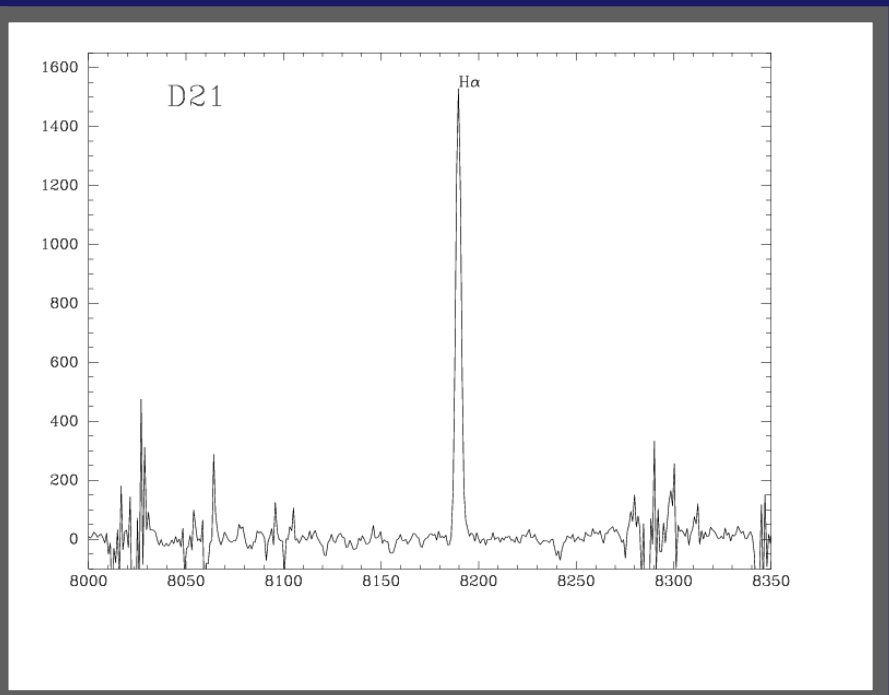




Detection of possible V band counterpart and absence of continuum break render LyA identification suspect. Line flux = 1.7e-17 erg/s/cm2; EW = 80 A.

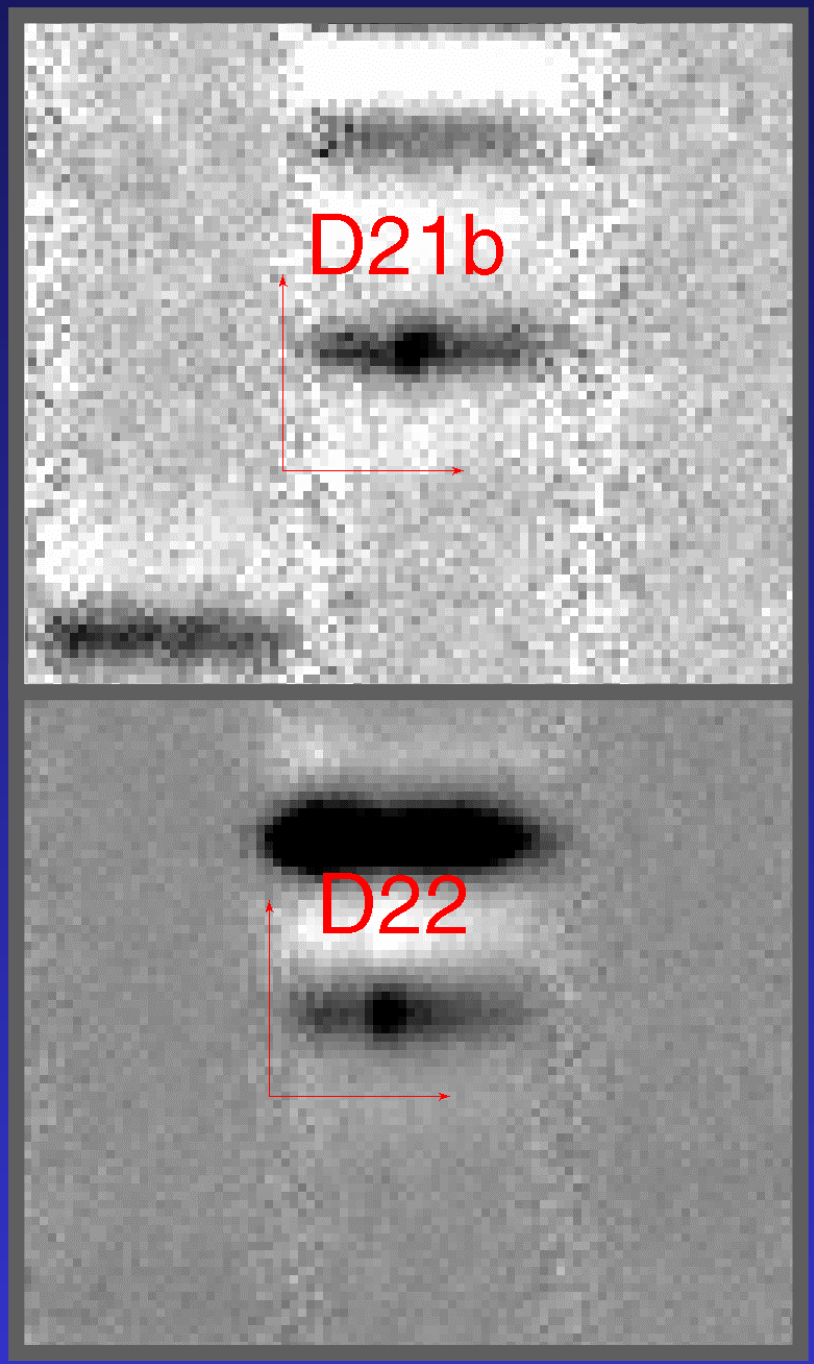






Metal Poor

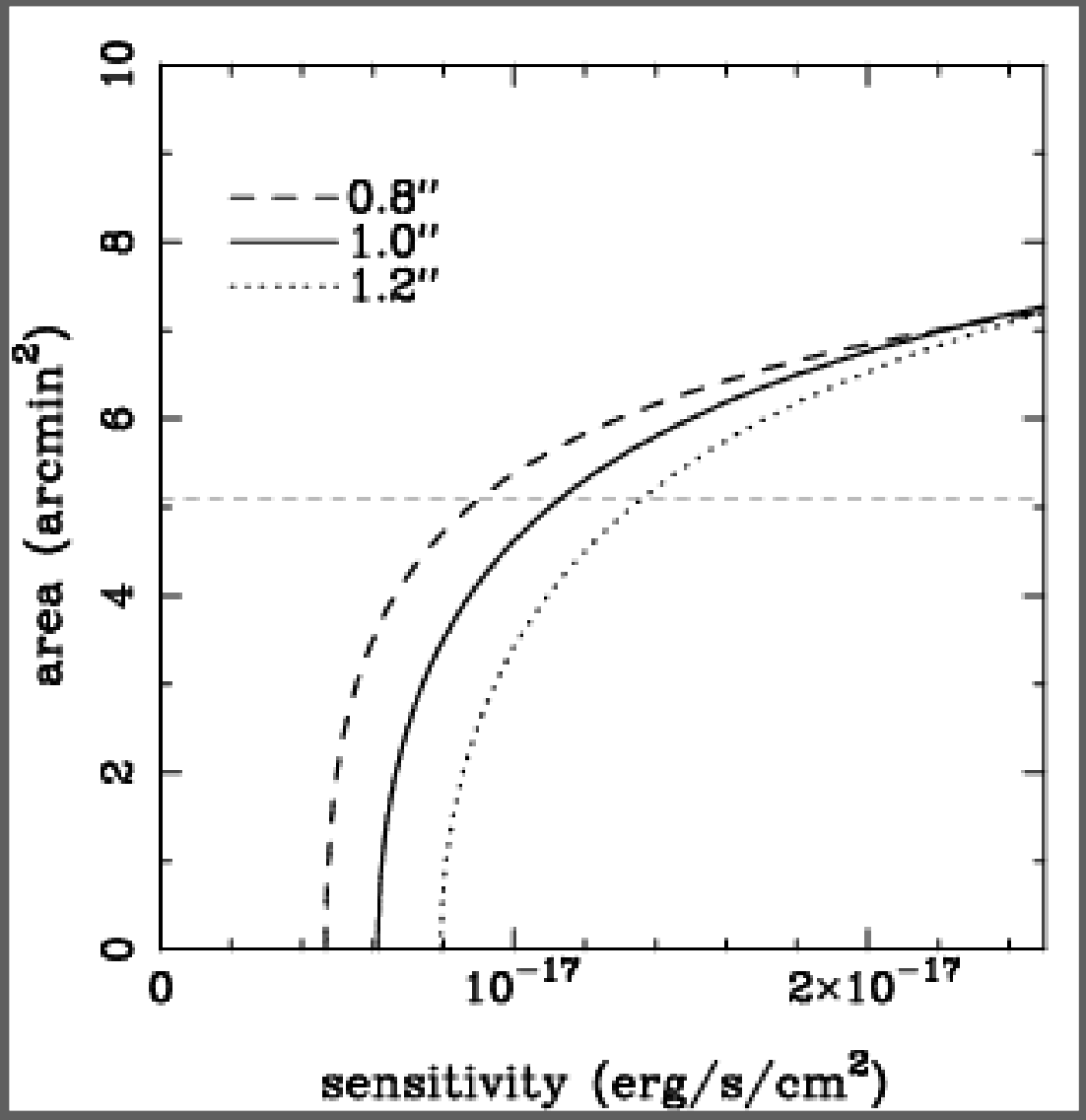
Object lies near cluster caustic. Single line detected in follow-up spectrum covering 7080-8970 A. Blue spectrum contains several lines, however, and we find the single line is hydrogen alpha at z=0.24. This ultra low metallicity dwarf galaxy lies in front of the cluster. Line flux = 24.4e-17 erg/s/cm2; EW > 500 A.

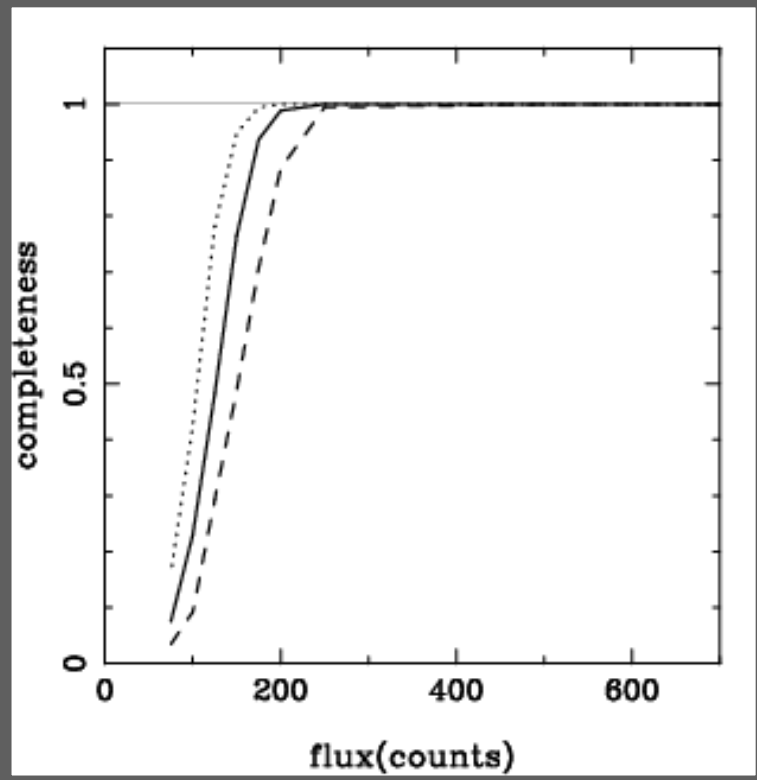


Lack of continuum break rules out identification as LyA. Line flux = 2.7e-17 erg/s/cm2; EW = 32 A.

Lack of continuum break rules out LyA identification. Tentative identification as hydrogen alpha. Faint second line detected at correct wavelength for [NII] 6584.

Simulations

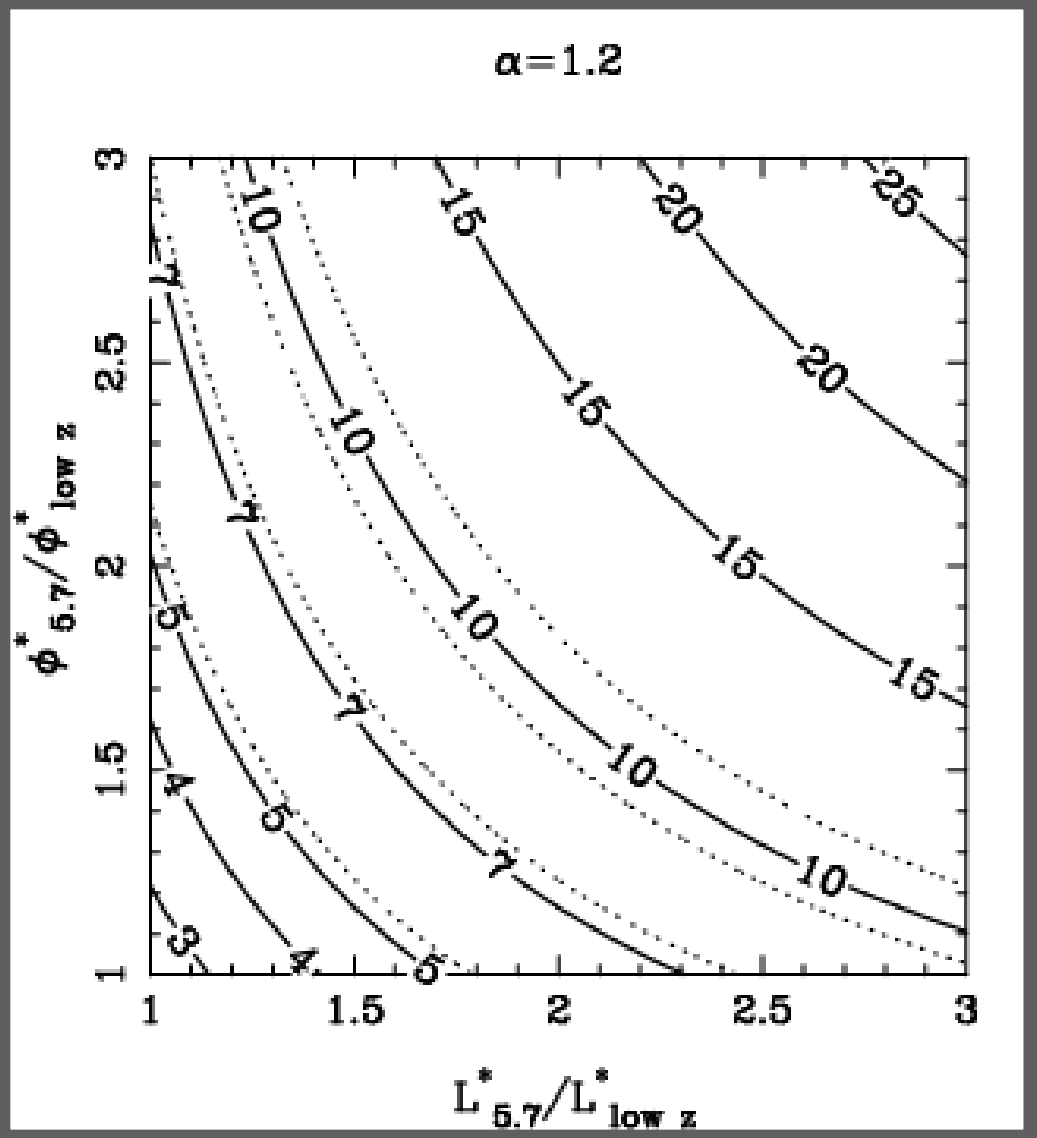




(Left) Impact of slit losses on effective survey area.

(Top) Completeness determined from simulations.

Constraints on the Lya Emitting Population



- Predicted number of LyA emitters depends on assumptions about underlying luminosity function.
- Adopt fiducial L*(0) = 3.26e42 erg/s and phi*(0) = 0.0055 Mpc-3
- Dotted lines show 99% confidence contour for 0, 1, 2, 3 objects detected.

Ionization of IGM by LyA Emitters?

Critical Production Rate of Ionizing Photons (Madau et al. 1999):

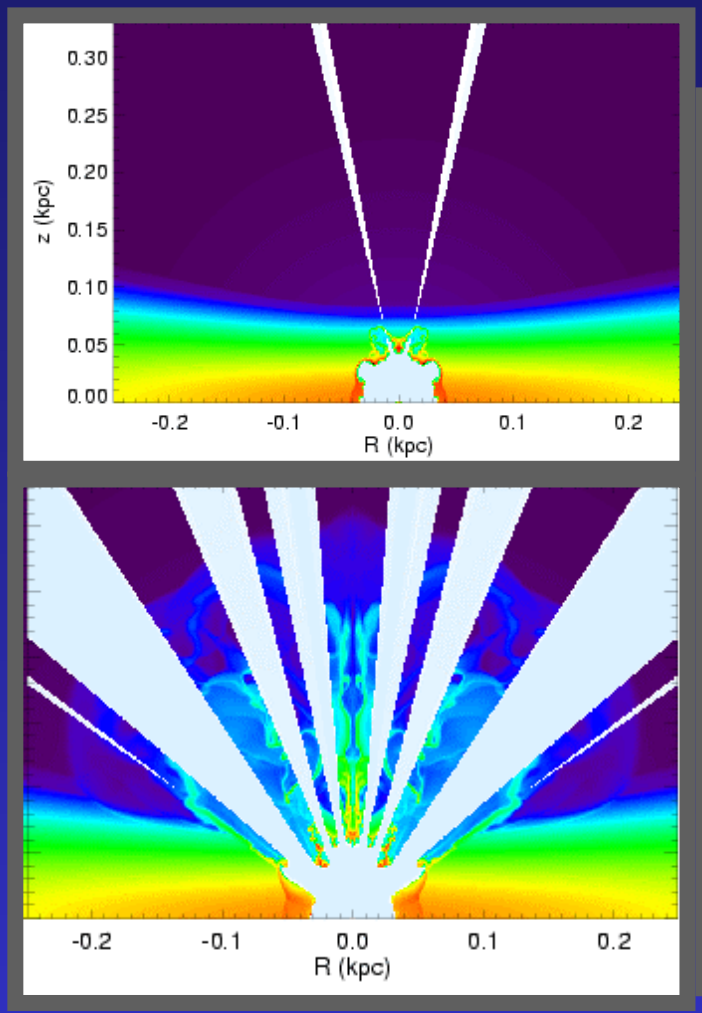
$$\dot{N}_H = 10^{51.34}\ \mathrm{s}^{-1}\ \mathrm{Mpc}^{-3}\ C_{30} \left(\frac{1+z}{6.7}\right)^3 \left(\frac{\Omega_b h_{70}^2}{0.041}\right)^2$$

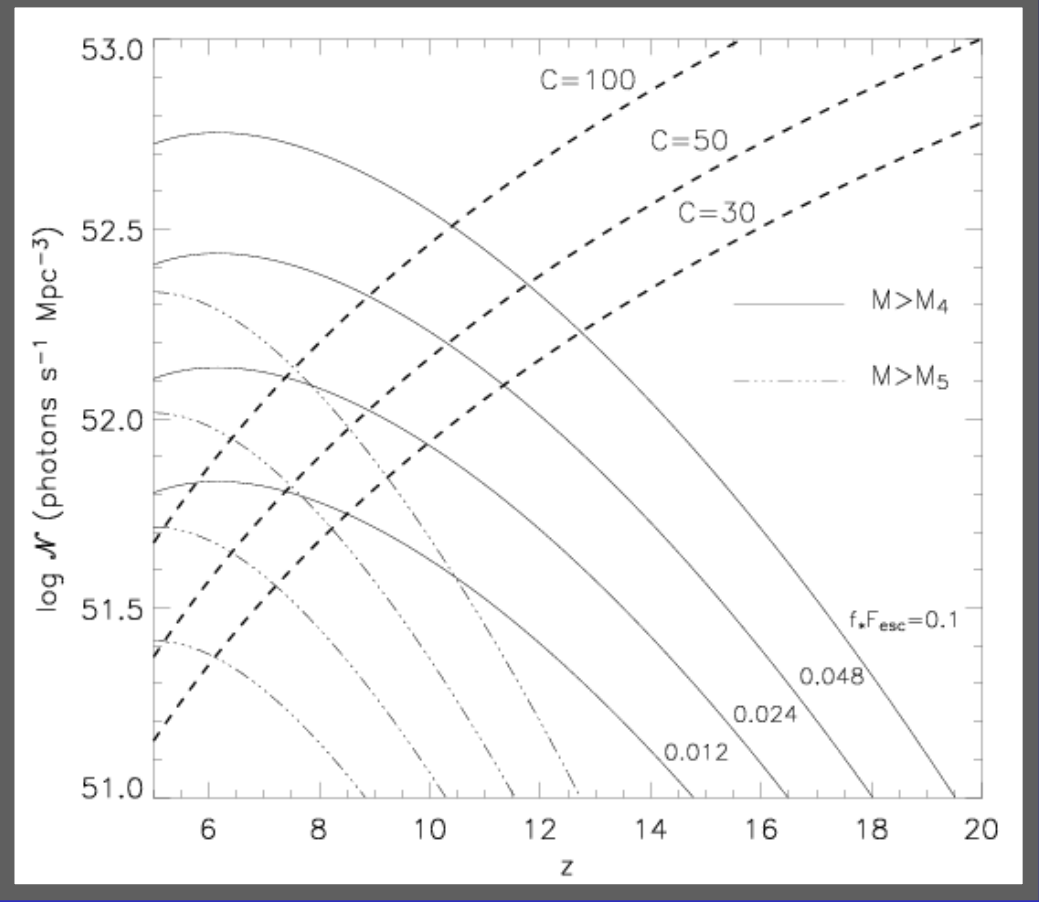
Conversion from SFR to Critical LyA Luminosity:

$$\mathrm{L}_{Ly\alpha} = 0.0223\ L^*_{Ly\alpha}\ \mathrm{Mpc}^{-3} \left(\frac{f_{Ly\alpha}}{f_{esc}}\right) C_{30} \left(\frac{1+z}{6.7}\right)^3 \left(\frac{\Omega_b h_{70}^2}{0.041}\right)^2$$

L > 0.6L* Lya emitters can maintain ionization of the IGM if the Lya escape fraction is less than 28% of the LyC escape fraction

Escape of Ionizing Radiation





Fujita, Martin, MacLow, & Abel 2003

Summary

- Paucity of LyA emitting galaxies implies the z=5.7 population is not more numerous or brighter than LyA emitters at z~3.
- Our result raises the question of whether bright (i.e. > 0.7 L*) LyA emitters can maintain the ionization of the IGM at z=5.7. We argue they can if the LyA escape fraction is less than 39% of the LyC escape fraction.
- Numerical simulations show that the blowout of galactic winds strongly enhances the Lyman continuum escape fraction.