PROBING REIONISATION WITH THE UKIDSS QUASAR J1319+0950

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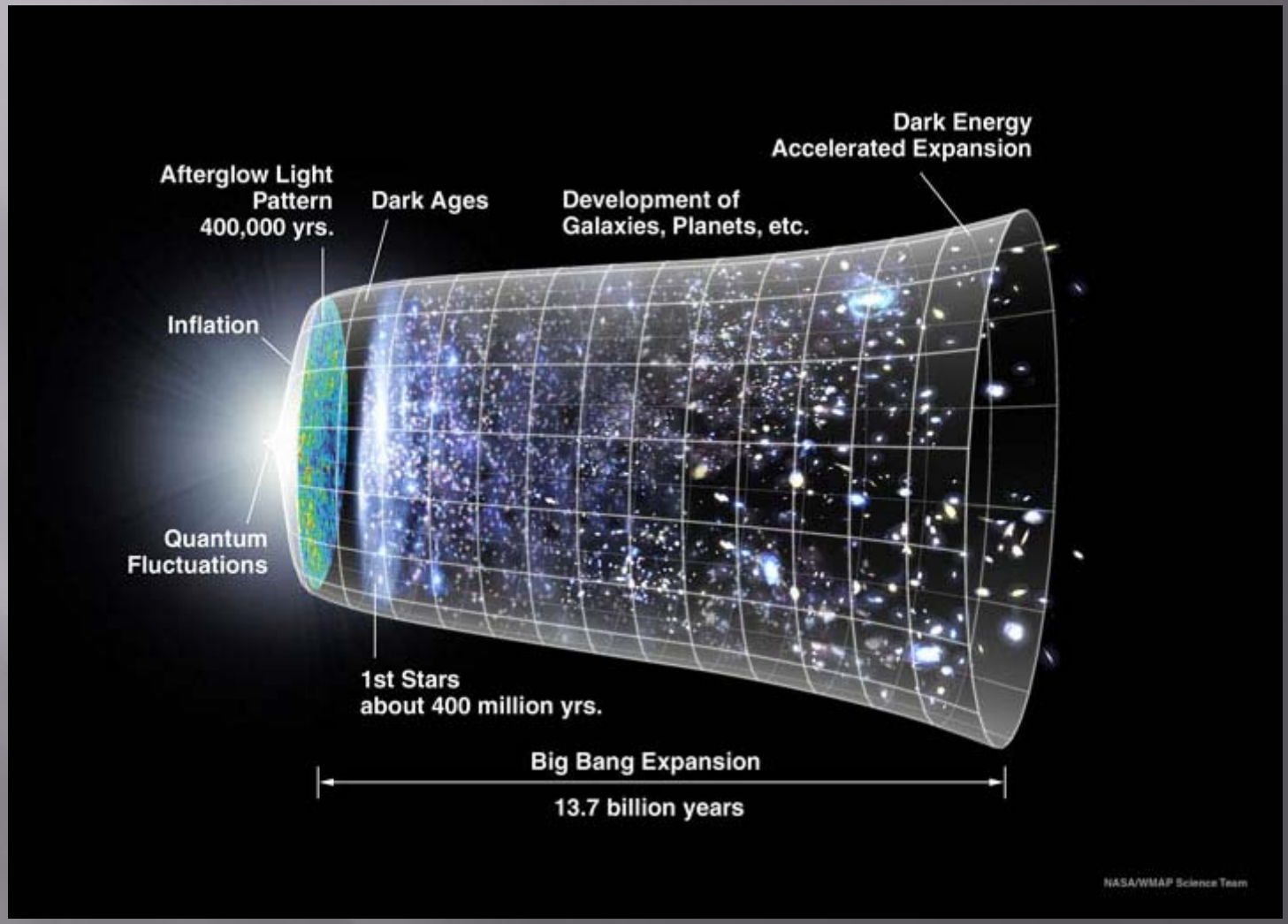
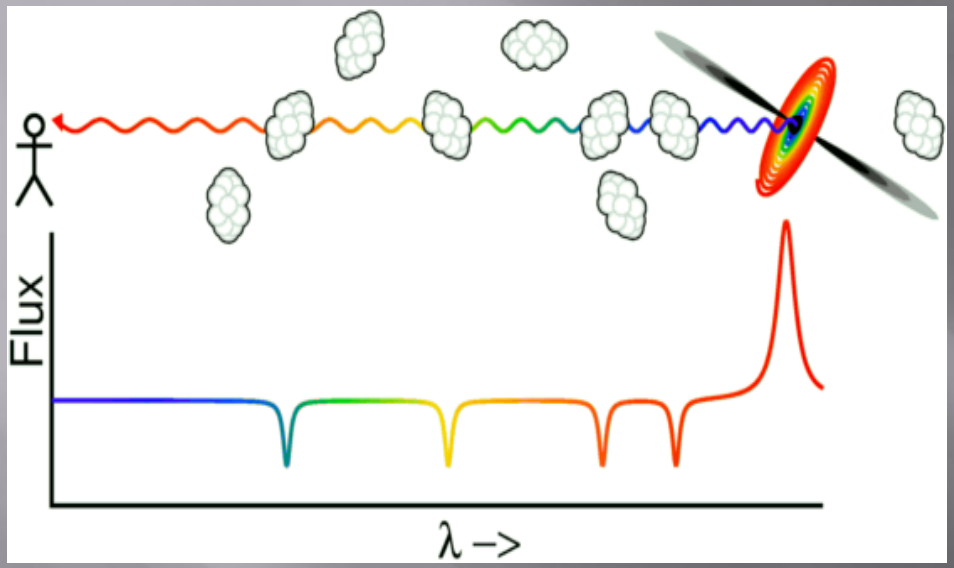

Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
400,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years
NASA/WMAP Science Team

Finding high redshift objects...



- Neutral hydrogen clumps absorb hydrogen at the clump redshift
- Produces absorption blueward of the emission redshift

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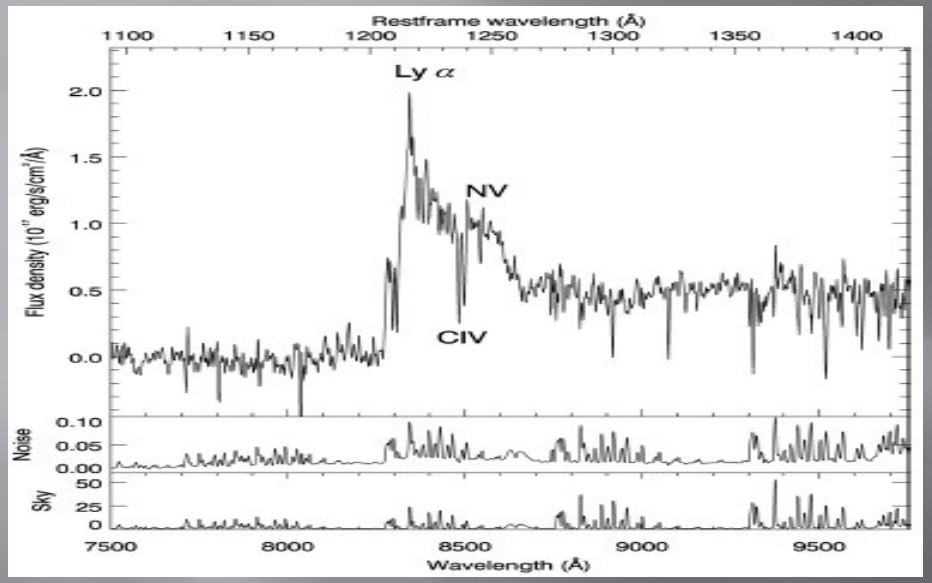
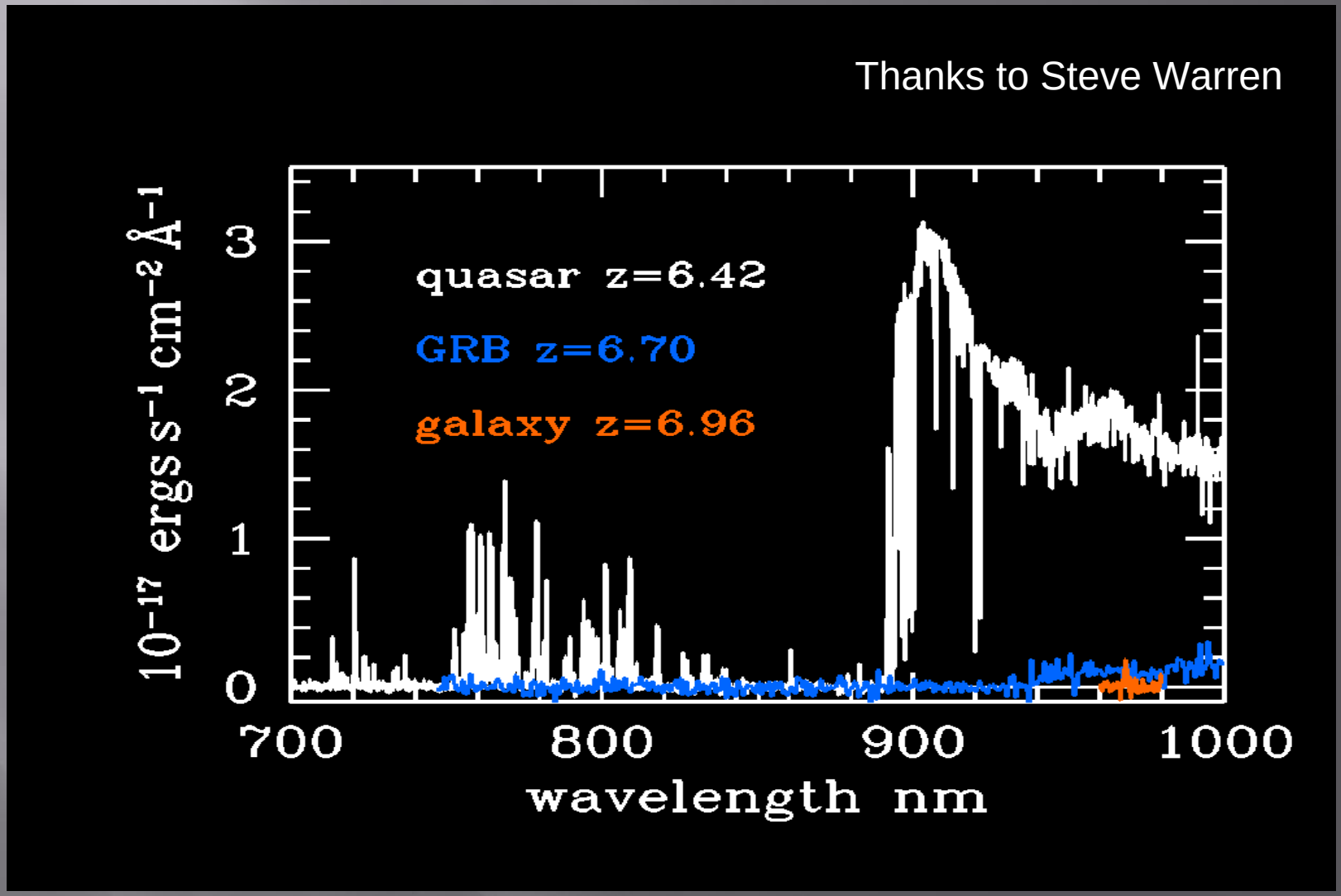
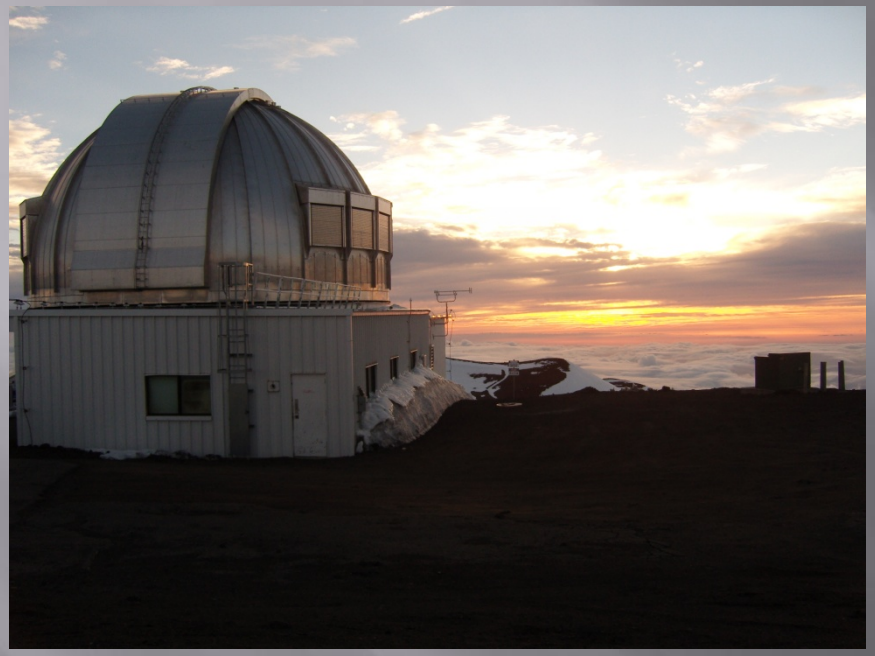


Venemans et al. (2007)

- Neutral hydrogen clumps absorb hydrogen at the clump redshift
- Produces absorption blueward of the emission redshift
- Many clumps leads to complete absorption blueward of Lyα
- Lyα forest


Thanks to Steve Warren
quasar z=6.42
GRB z=6.70
galaxy z=6.96
10^{-17} ergs s^{-1} cm^{-2} Å^{-1}
0
1
2
3
700
800
900
1000
wavelength nm

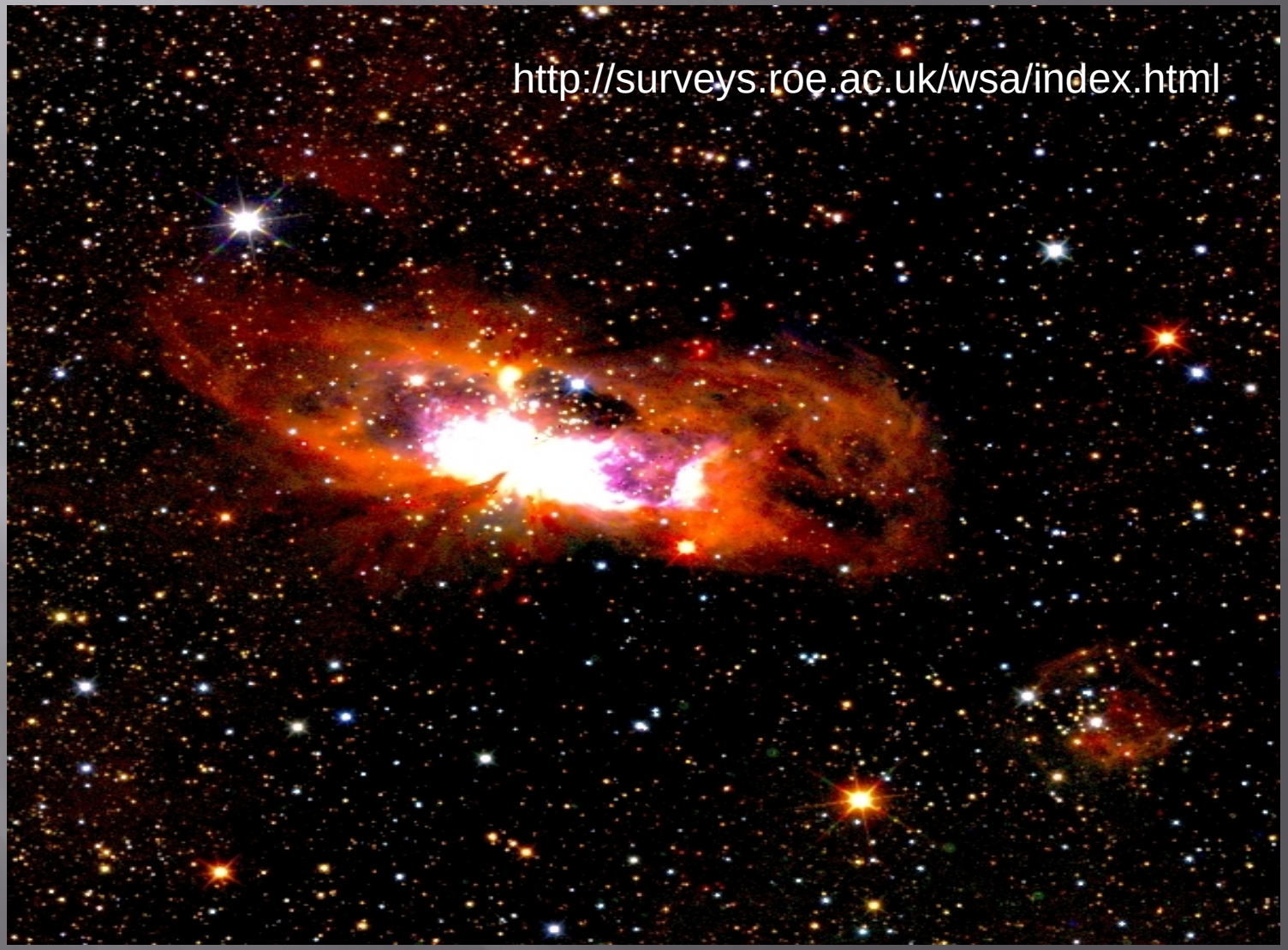
UKIDSS



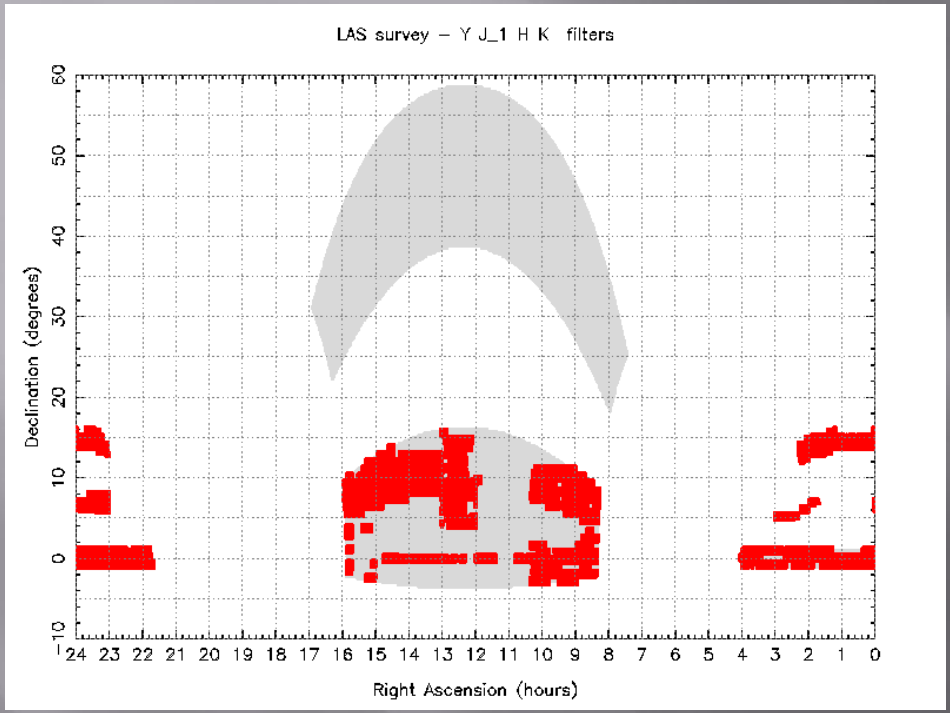
www.ukidss.org

- Optical surveys are limited to z-band dropouts
- UKIRT Infra-red Deep Sky Survey
- At least 3 magnitudes deeper than 2MASS in J,H and K
- Consists of 5 mini-surveys
  - Galactic Clusters Survey (GCS)
  - Galactic Plane Survey (GPS)
  - Deep Extragalactic Survey (DXS)
  - Ultra Deep Survey (UDS)
  - Large Area Survey (LAS)

HII Ionised Region

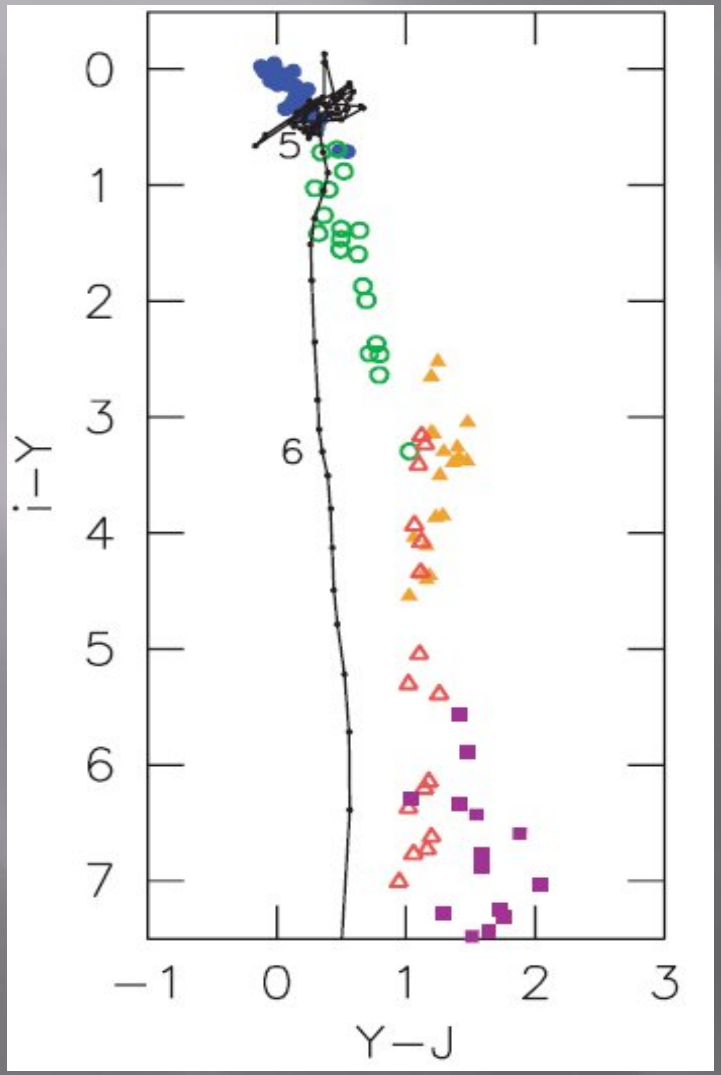


Large Area Survey



- Observes Y (20.2), J (19.6), H (18.8) and K (18.2)
- Aims to cover 4000 deg^2
- Area also covered by SDSS
- DR4: observed 982 deg^2 in all four bands

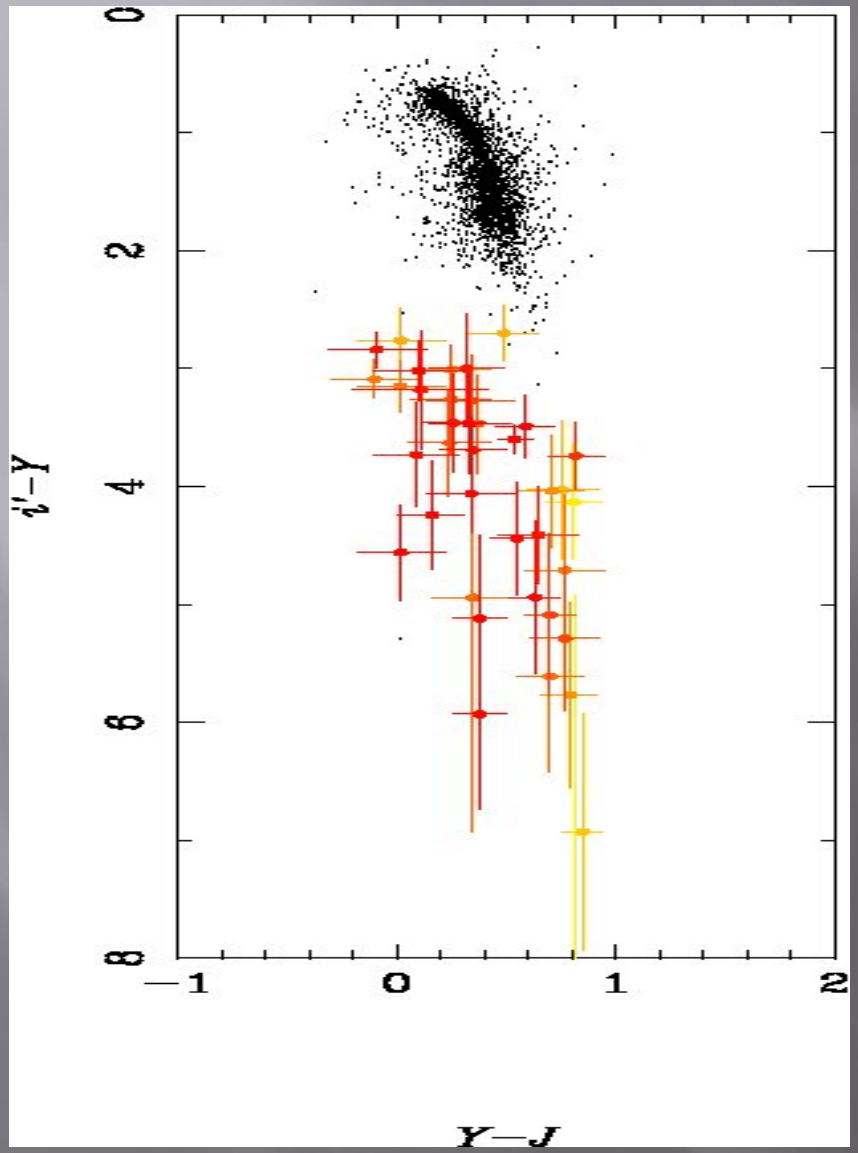
Finding quasars with UKIDSS



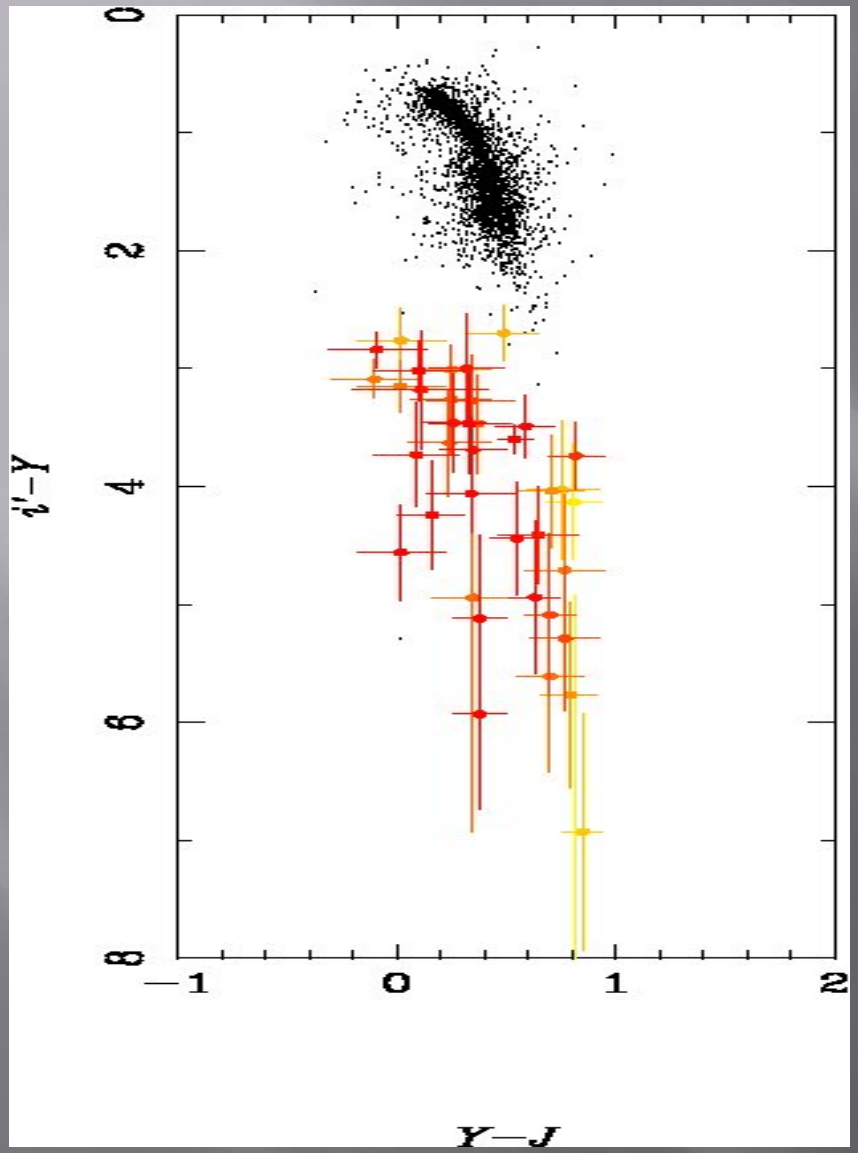
- Use models by Hewett & Madison (2005) and look at expected colours
- Use both SDSS and UKIDSS tables
- Find objects with red i-Y colours and blue Y-J colours

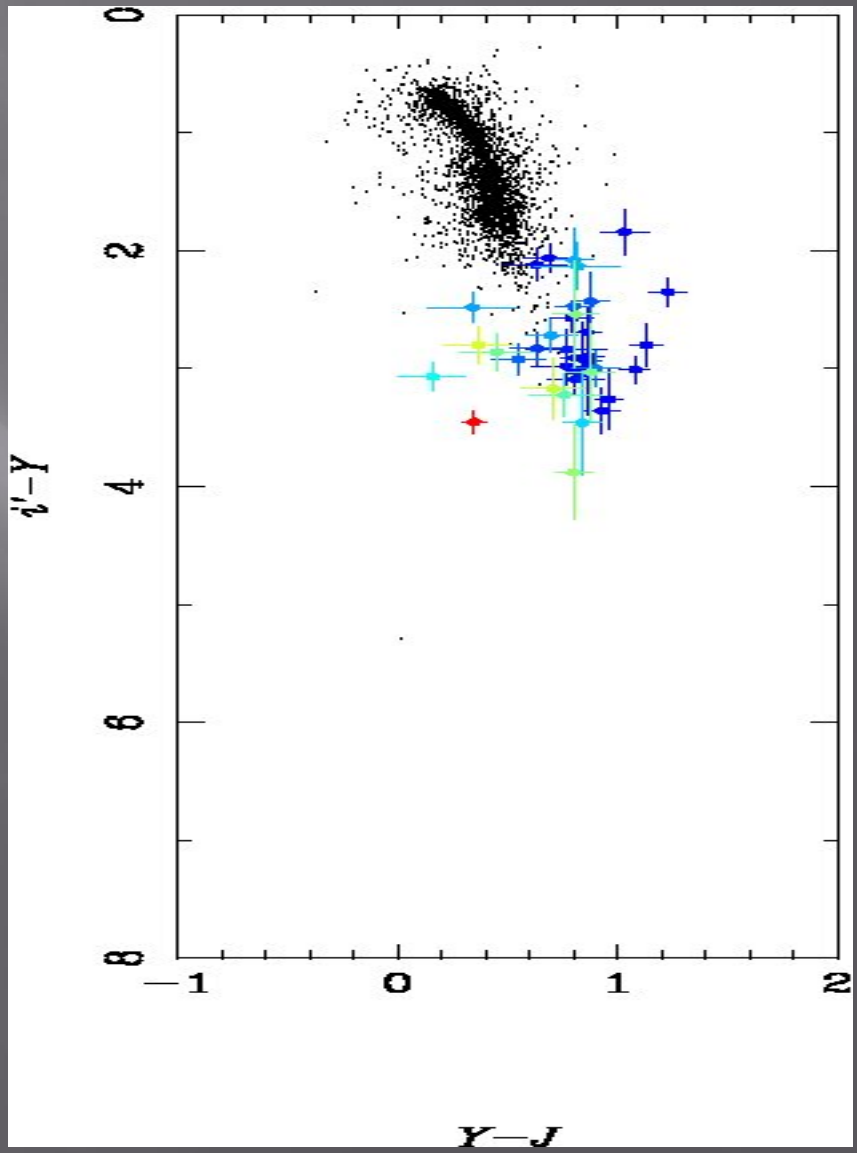
Hewett et al. (2006)

Selected Candidates

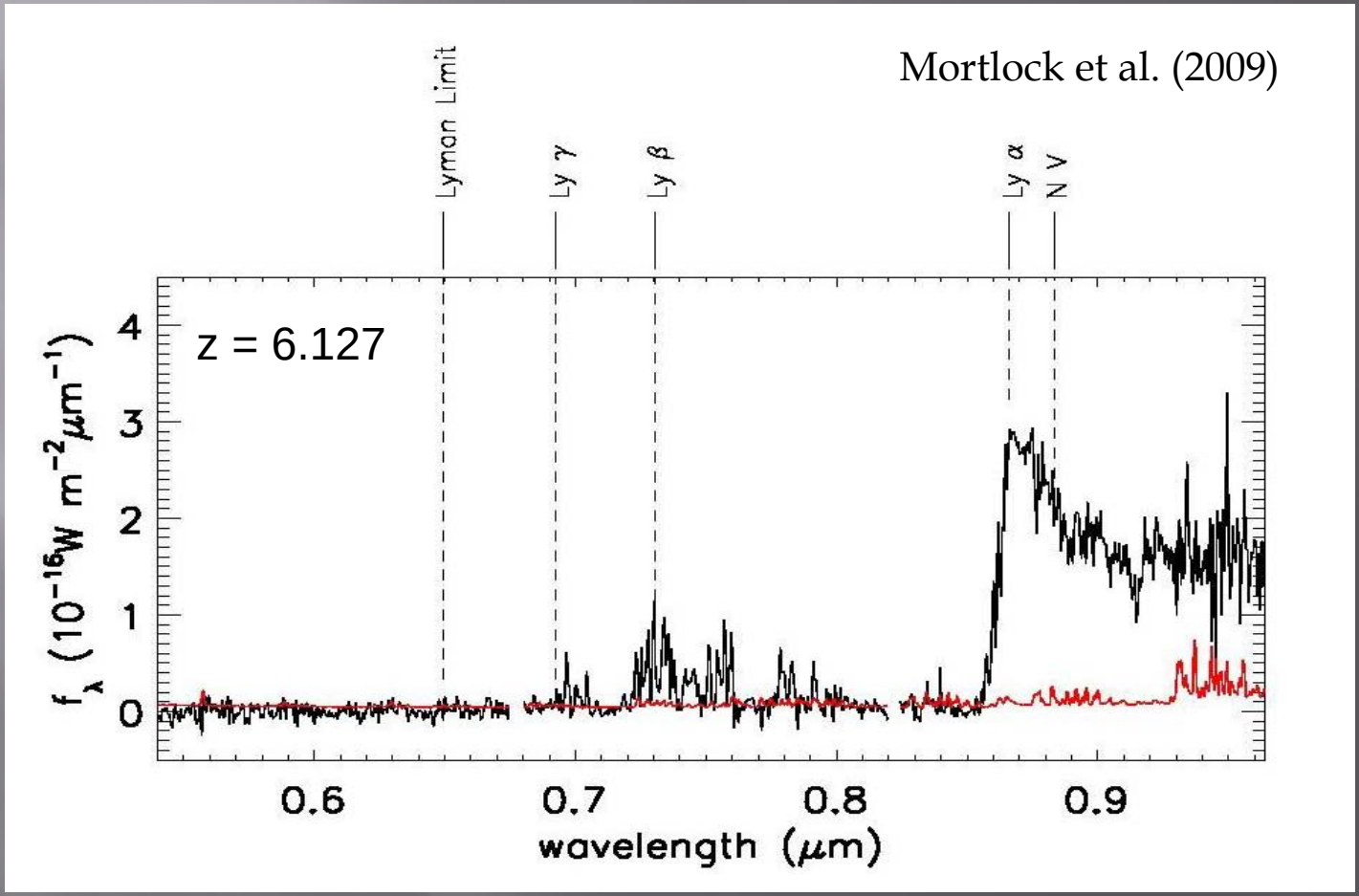


Selected Candidates

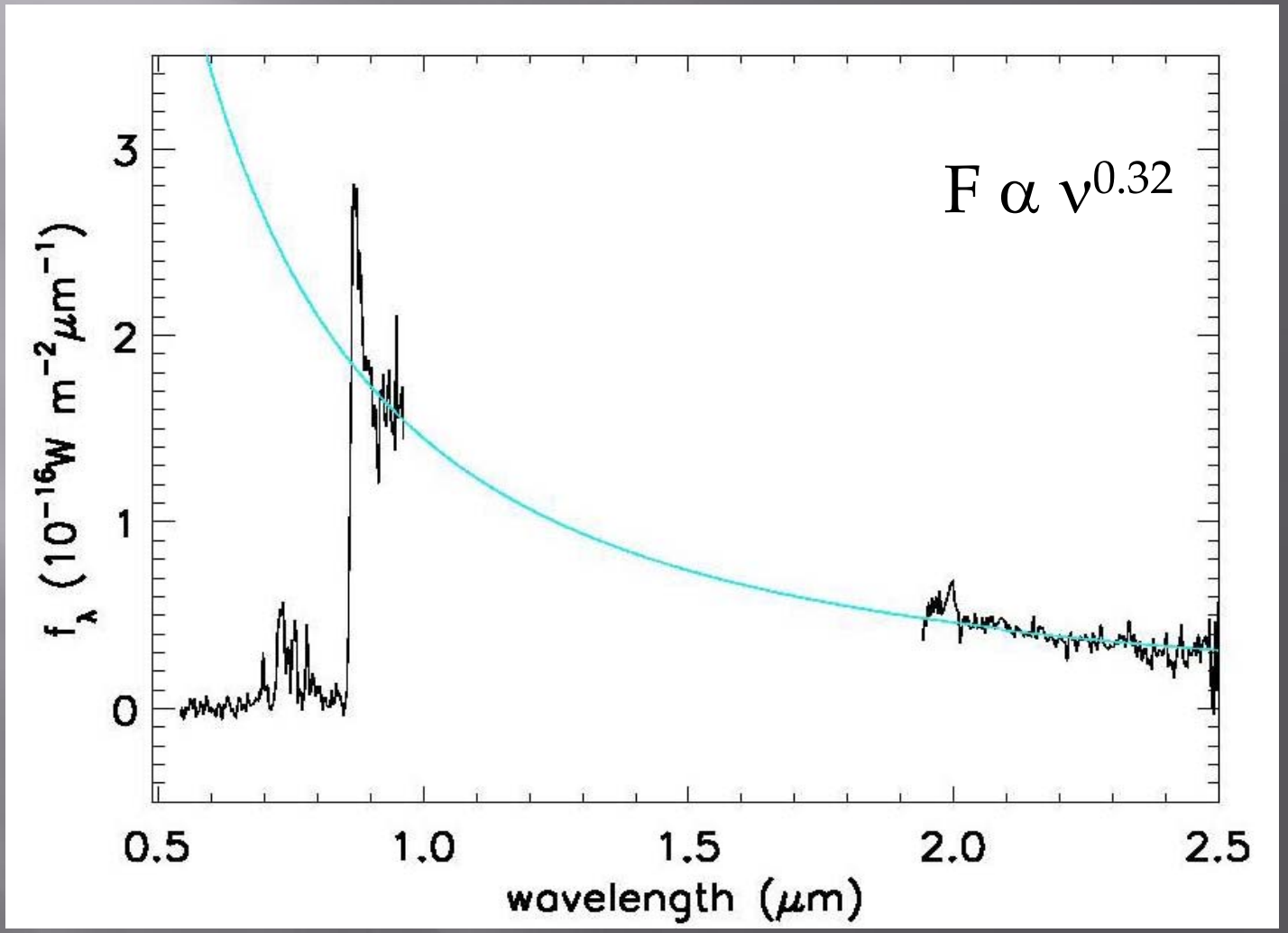




ULAS J1319+0950 – Gemini Spectra

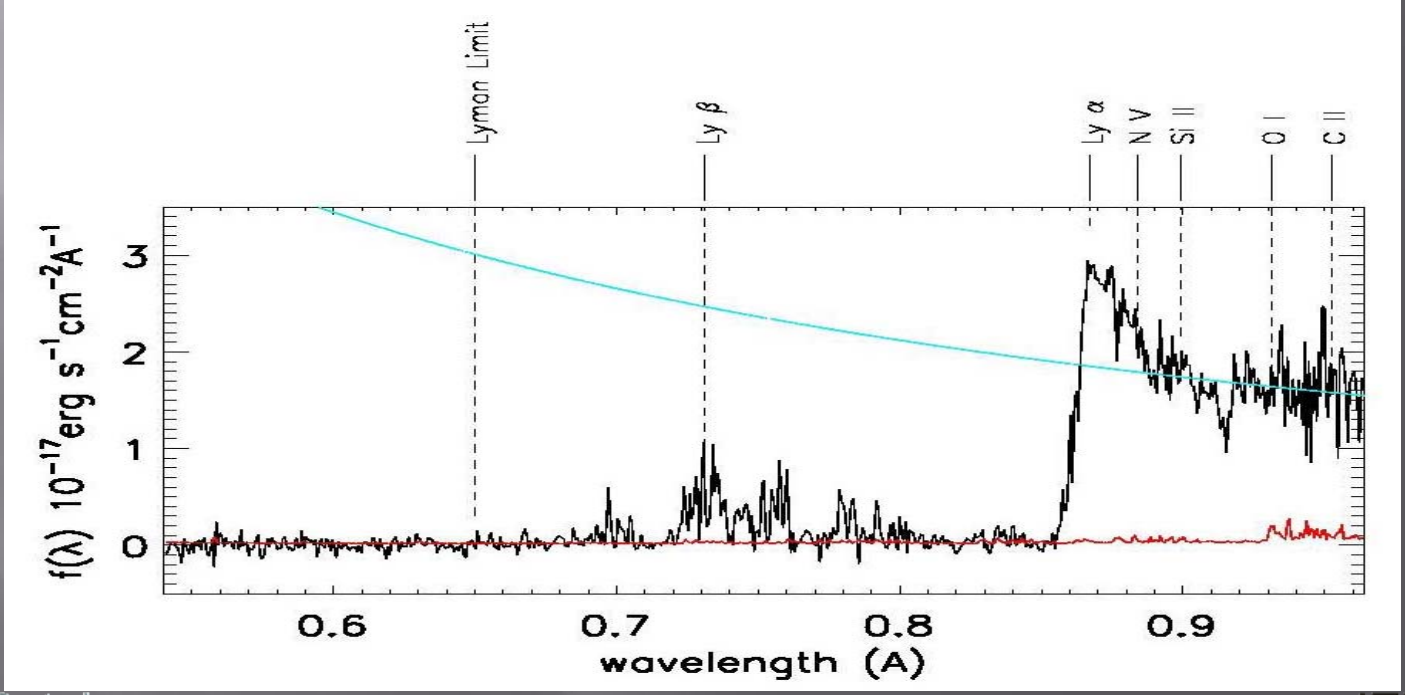


Power Law Fitting



Transmitted Flux Ratio

- SDSS found a number of quasars
- Follow the analysis of Fan et al. (2006)
- Fit a power law to the quasar continuum
- Select an upper limit redshift not affected by Lyα
- Take a region size of $\Delta z = 0.15$
- Measure the ratio of the original flux to the absorbed flux
- Take multiple regions, up to a lower limit at Lyβ



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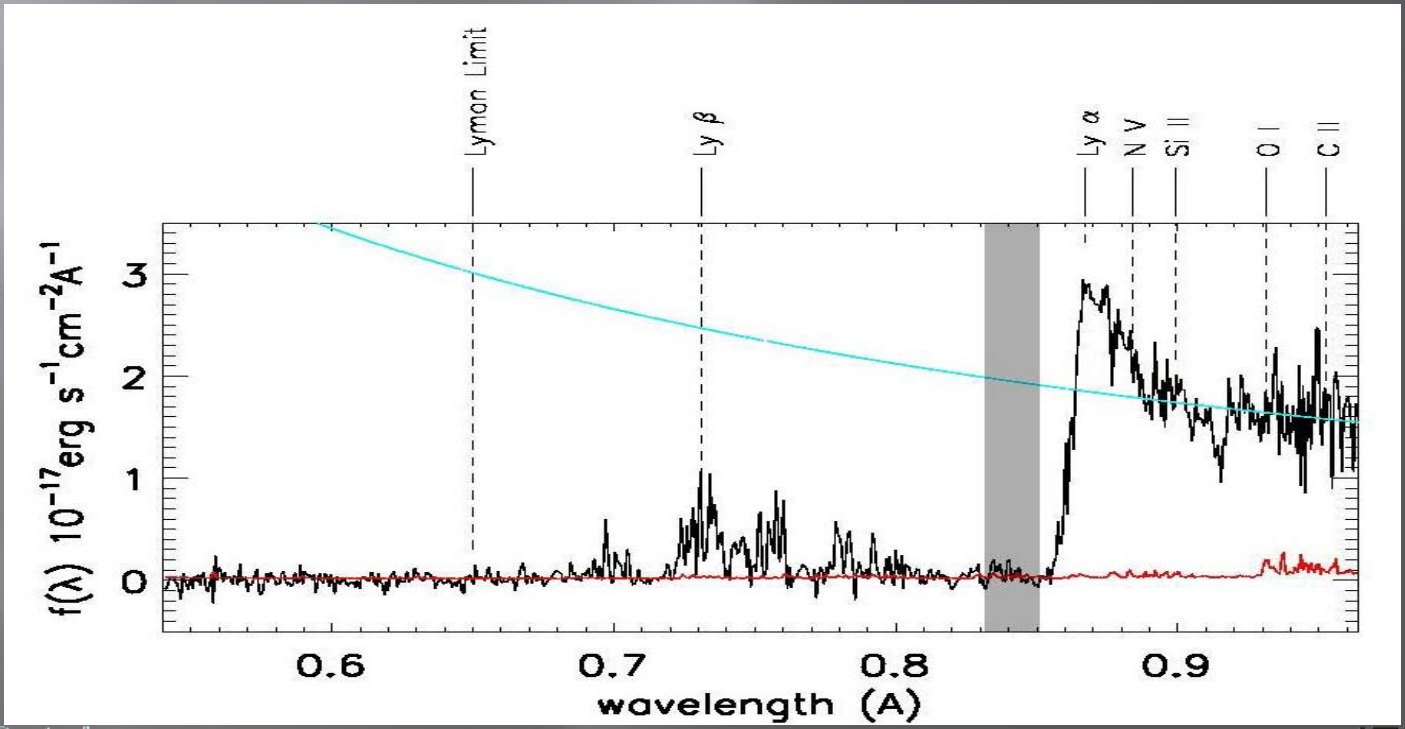

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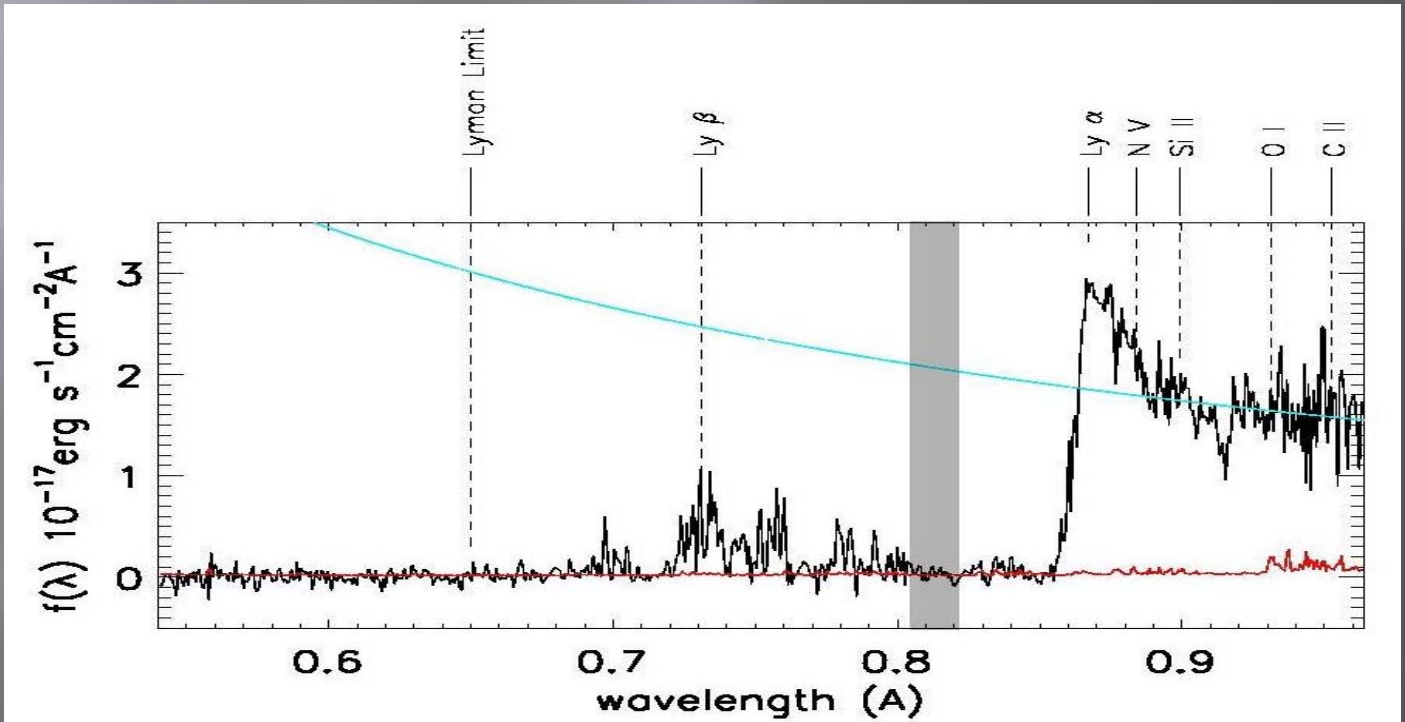
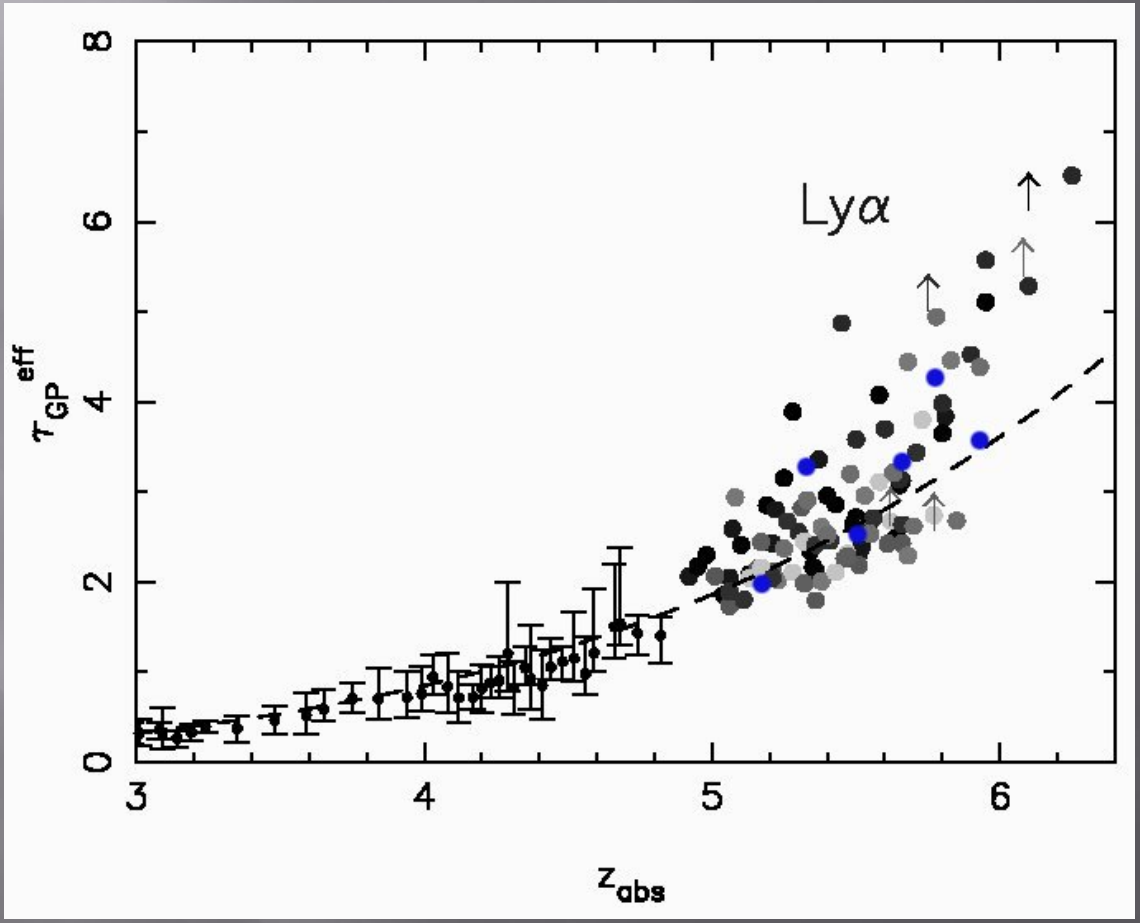


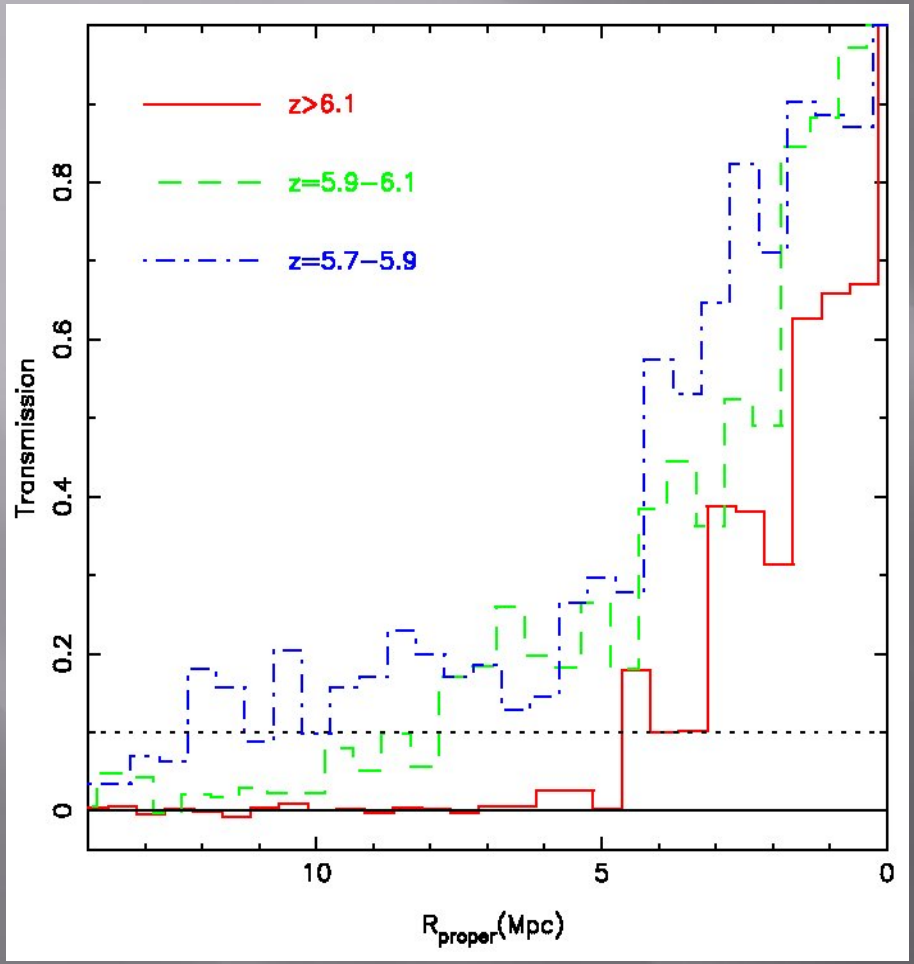
Effective Optical Depth

$\tau = -\ln (tfr)$



Fan et al. (2006)

Proximity Region

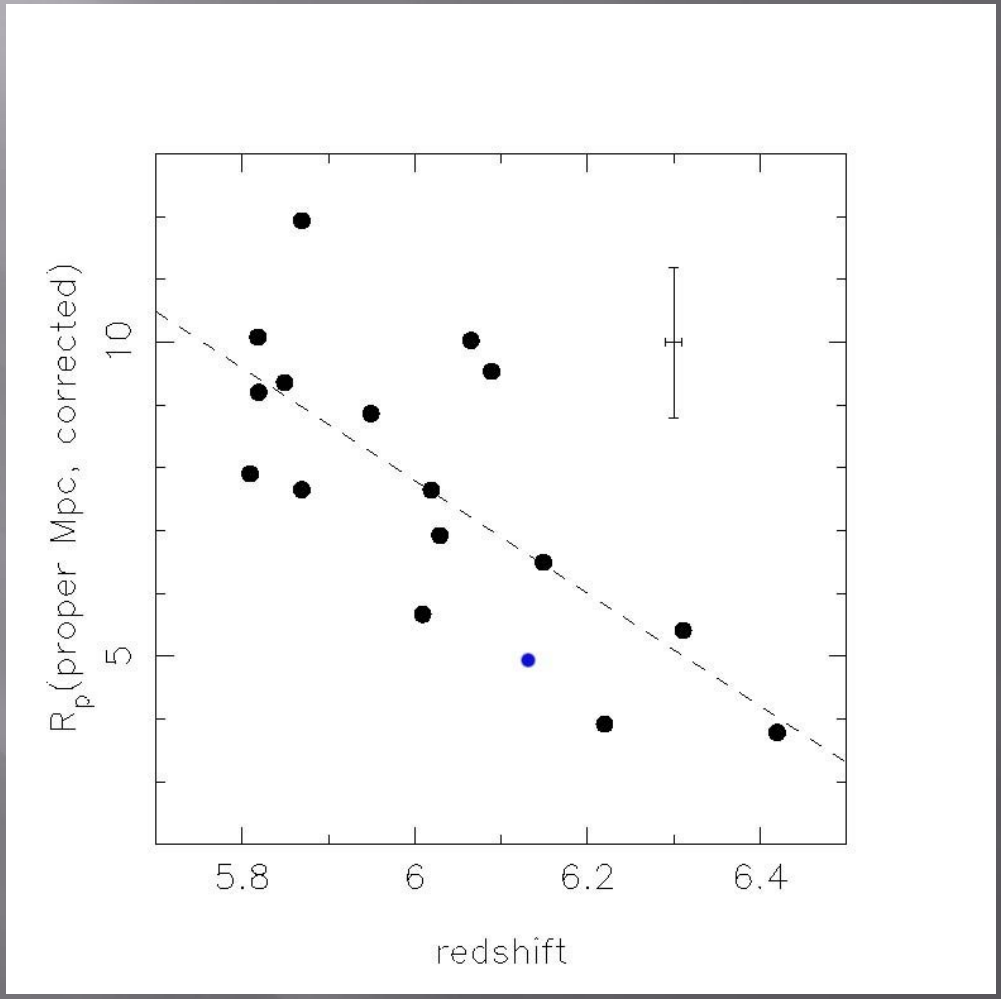


Fan et al. (2006)

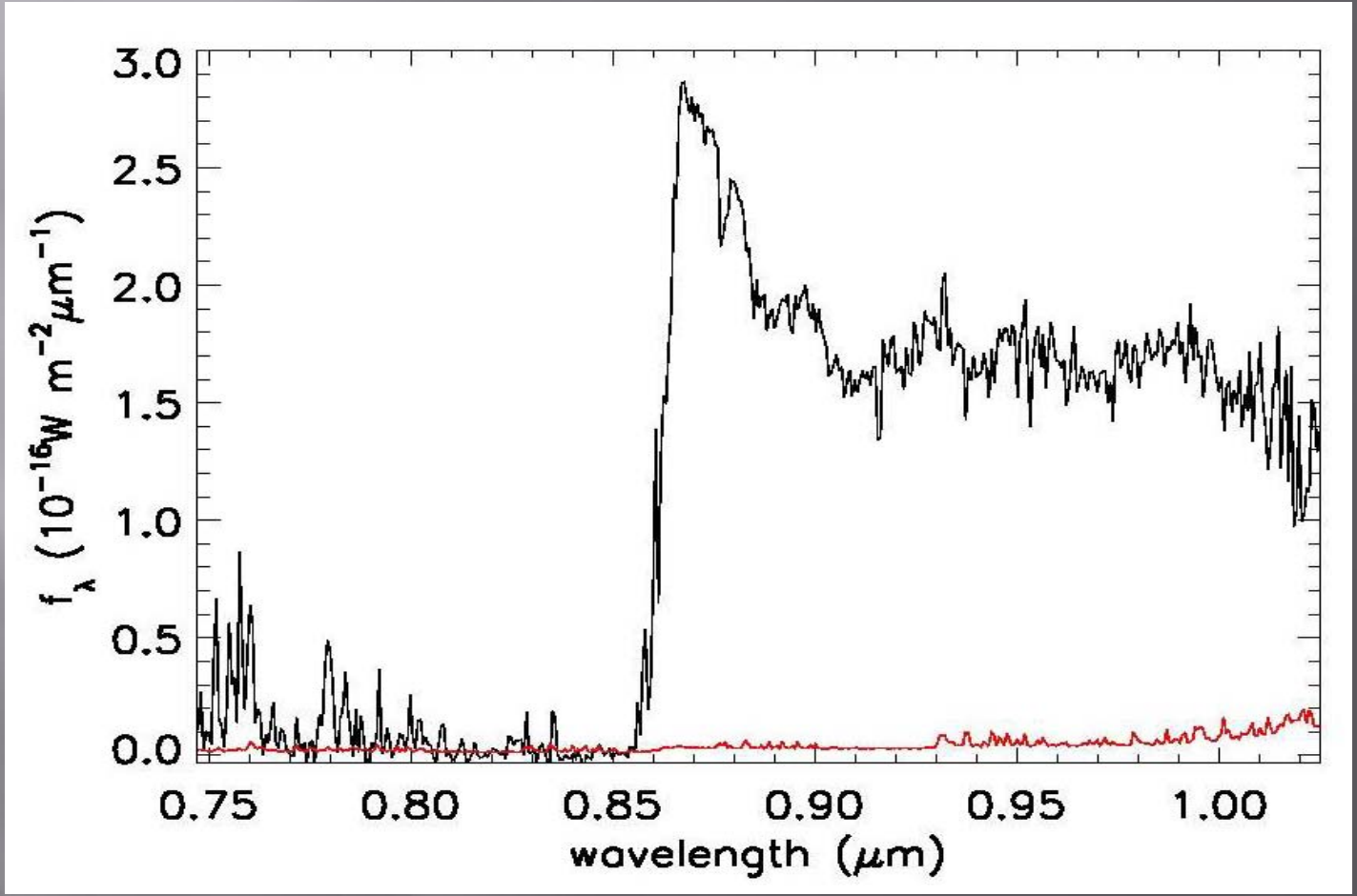
- As the IGM gets more neutral, the absorption nearer Lyα gets stronger
- Damping wings of the absorption affect the Lyα line
- As we go to higher redshifts we expect a sharper cut-off between the emission line and the forest

Proximity Region

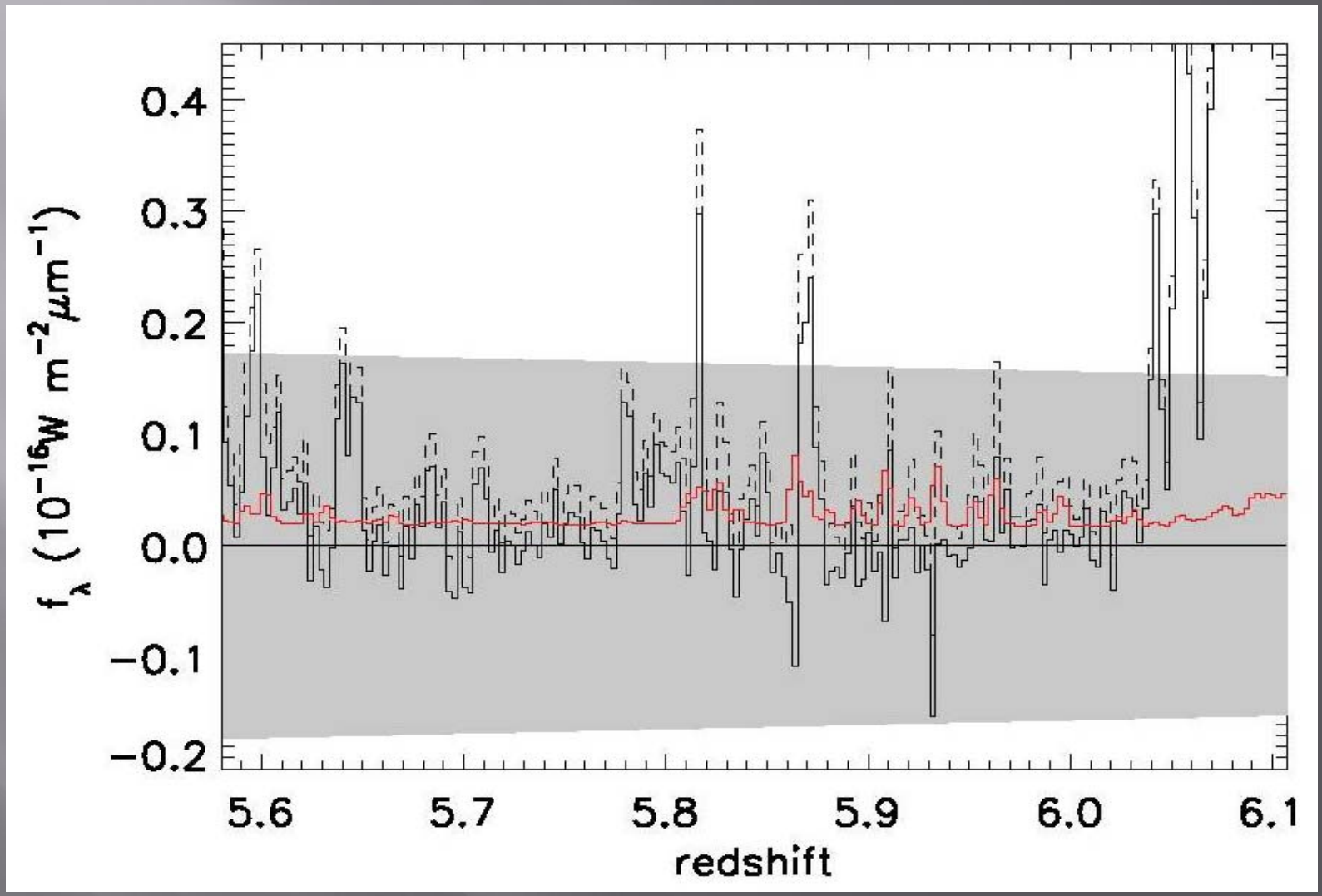
Fan et al. (2006)



J1319 VLT Spectrum



Dark Gaps


0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
f_λ (10^{-16}W m$^{-2}\mu$m^{-1})
5.6
5.7
5.8
5.9
6.0
6.1
redshift

Estimated Numbers of Quasars

- We found two quasars (z=5.72 and z=6.13) and have rediscovered two others (z=5.82 and z=5.93)

- By extrapolating the quasar luminosity function to higher redshifts and accounting for the estimated completeness we expect:

  A $5.8<z<7.2$ quasar every 200 deg^2

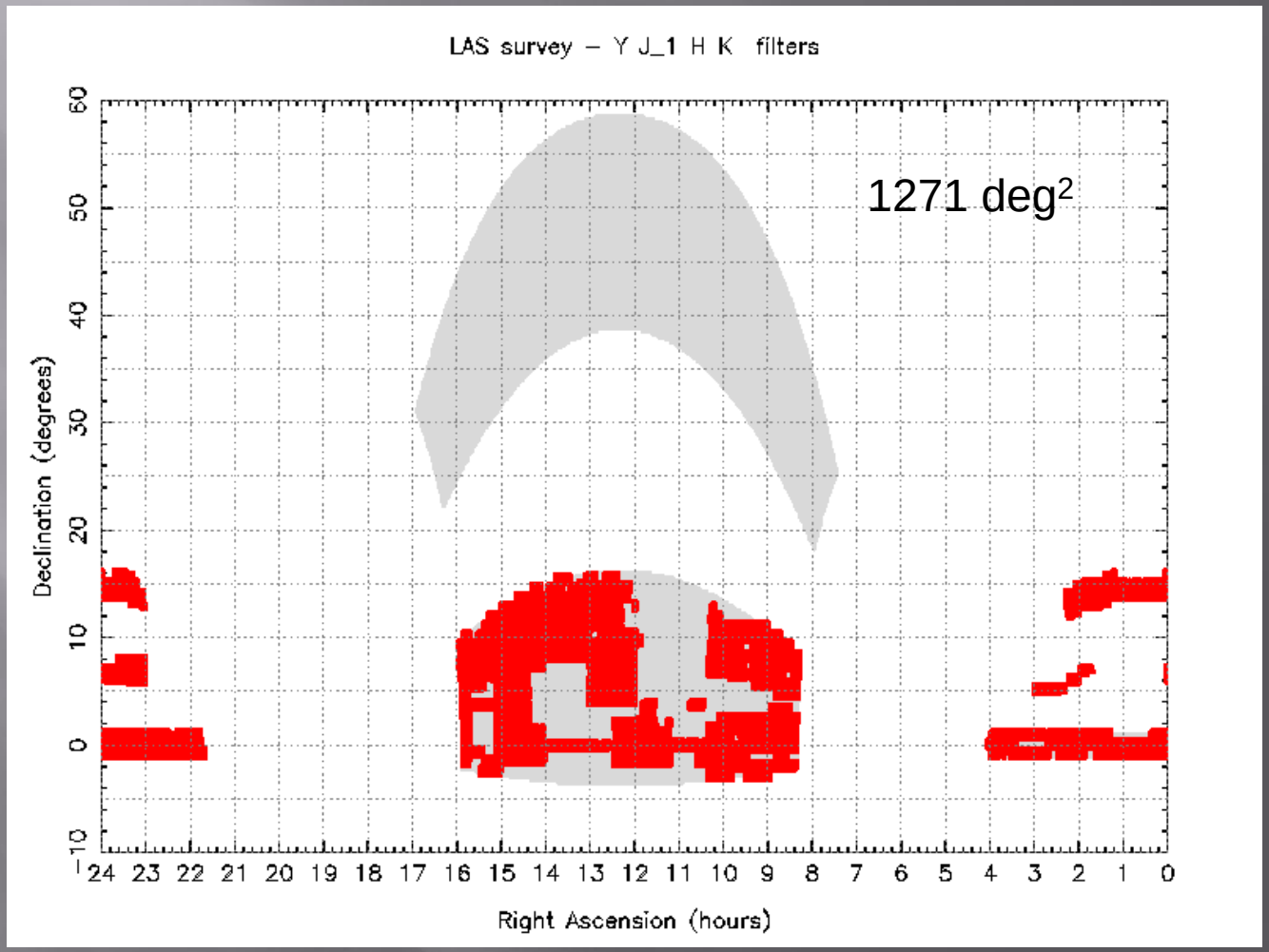
  A $6.4<z<7.2$ quasar every 500 deg^2

- So, from DR4 (Y+J: 1056 deg^2) we expect:

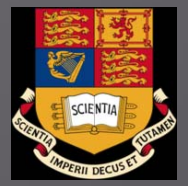
  5.3 +/- 2.3 z = 5.8-7.2 quasars (4 found)

  2.1 +/- 1.5 z = 6.4-7.2 quasars (0 found)

UKIDSS DR5


LAS survey – Y J_1 H K filters
1271 deg²
Declination (degrees)
60
50
40
30
20
10
0
-10
24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Right Ascension (hours)

Summary



- Quasars are ideal probes for determining when re-ionisation occurred
- We can see the evolution of the IGM in their spectra
- Even a small sample of z > 6.4 quasars will reveal the nature of the IGM
- As UKIDSS continues, it will discover these objects