Quasars/AGN with WFIRST: Science Goals vs. Performance

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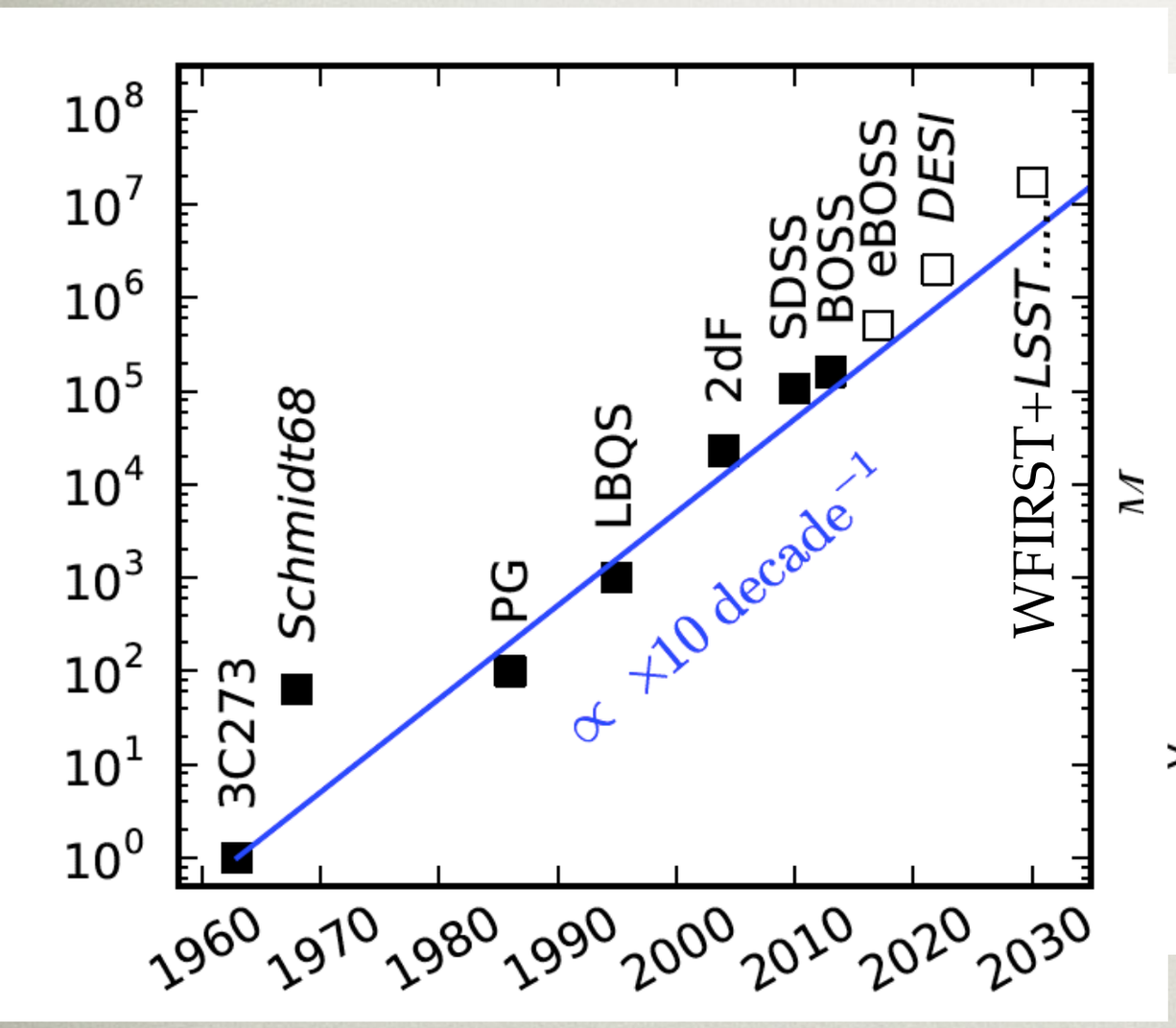
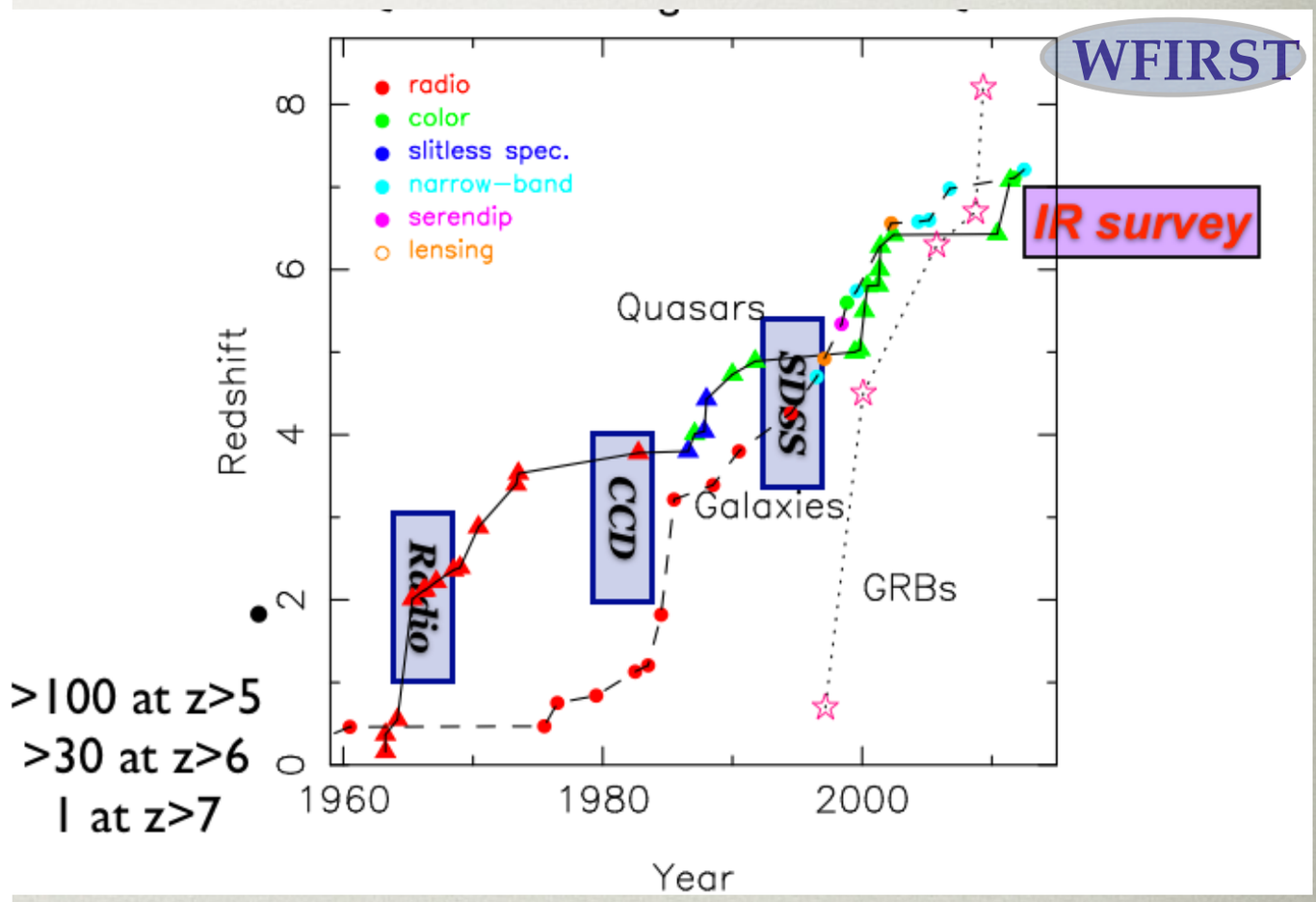
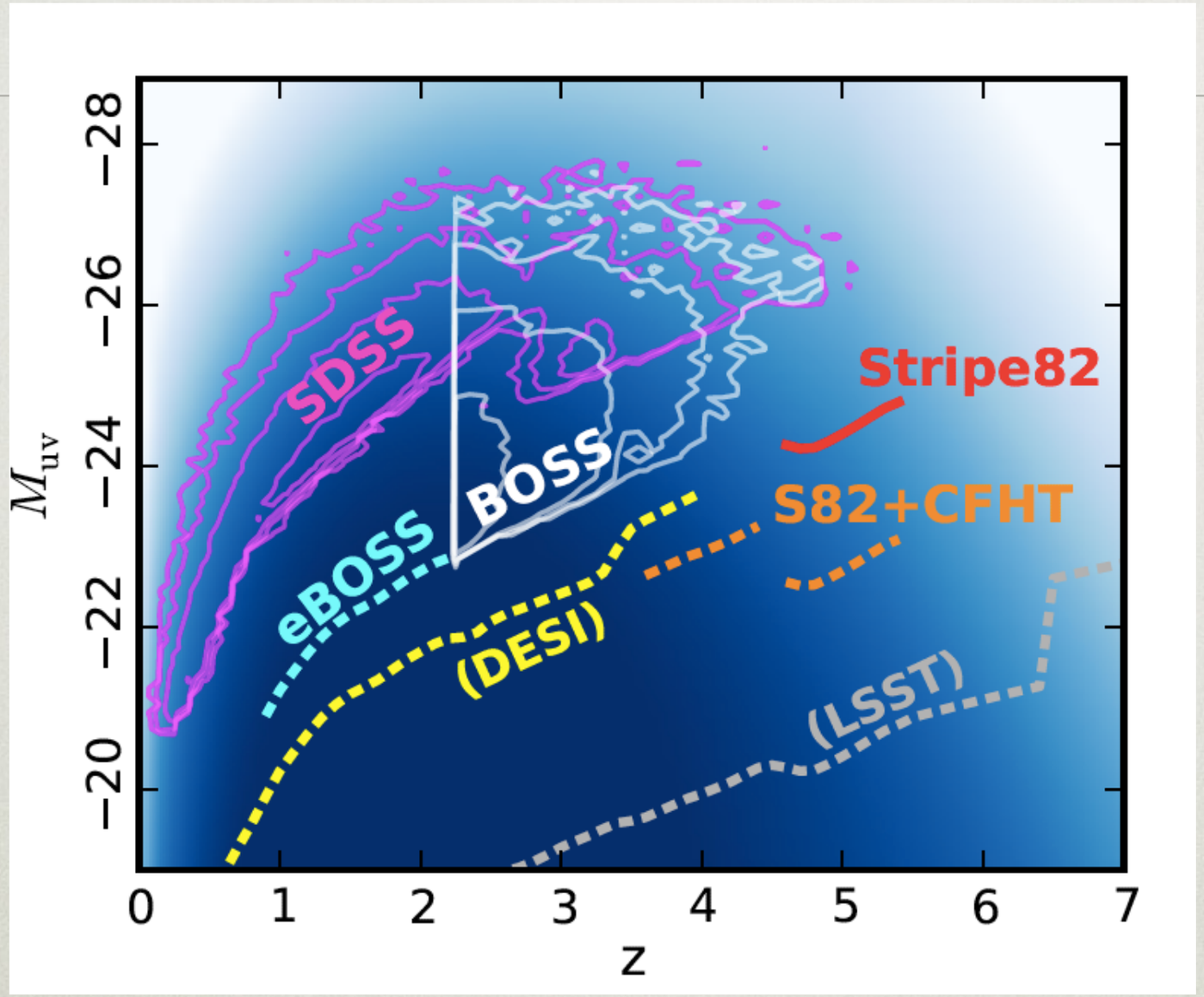
Quasar Surveys



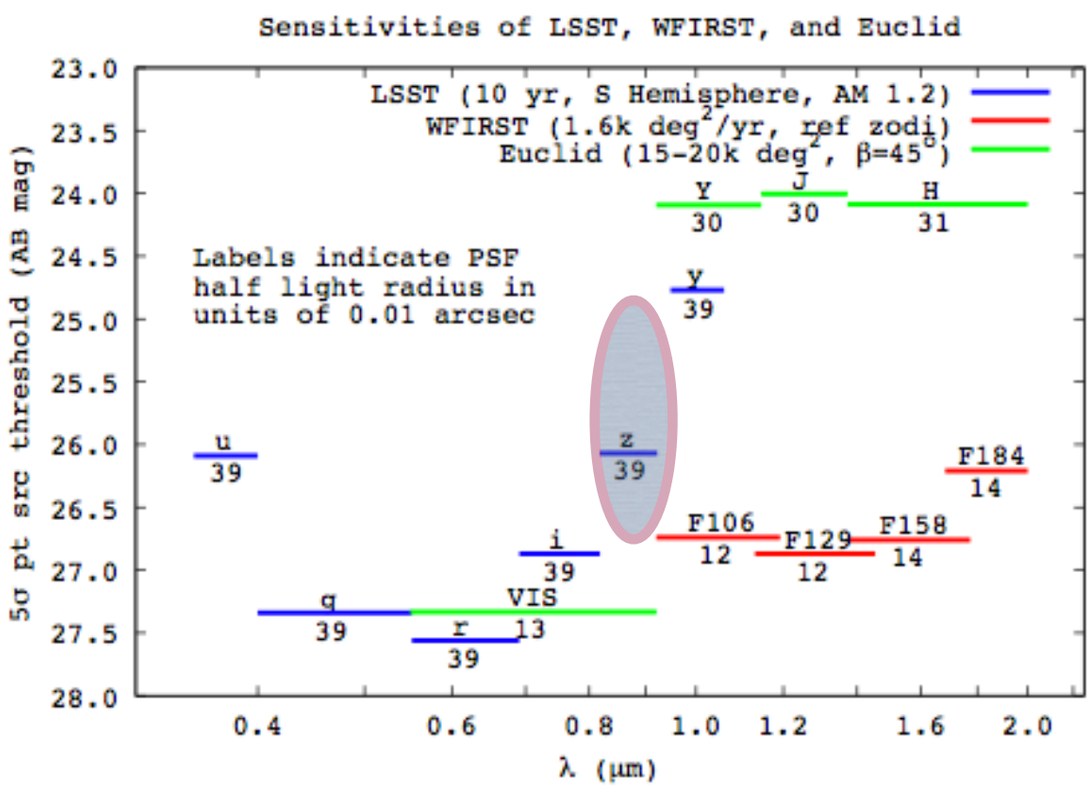


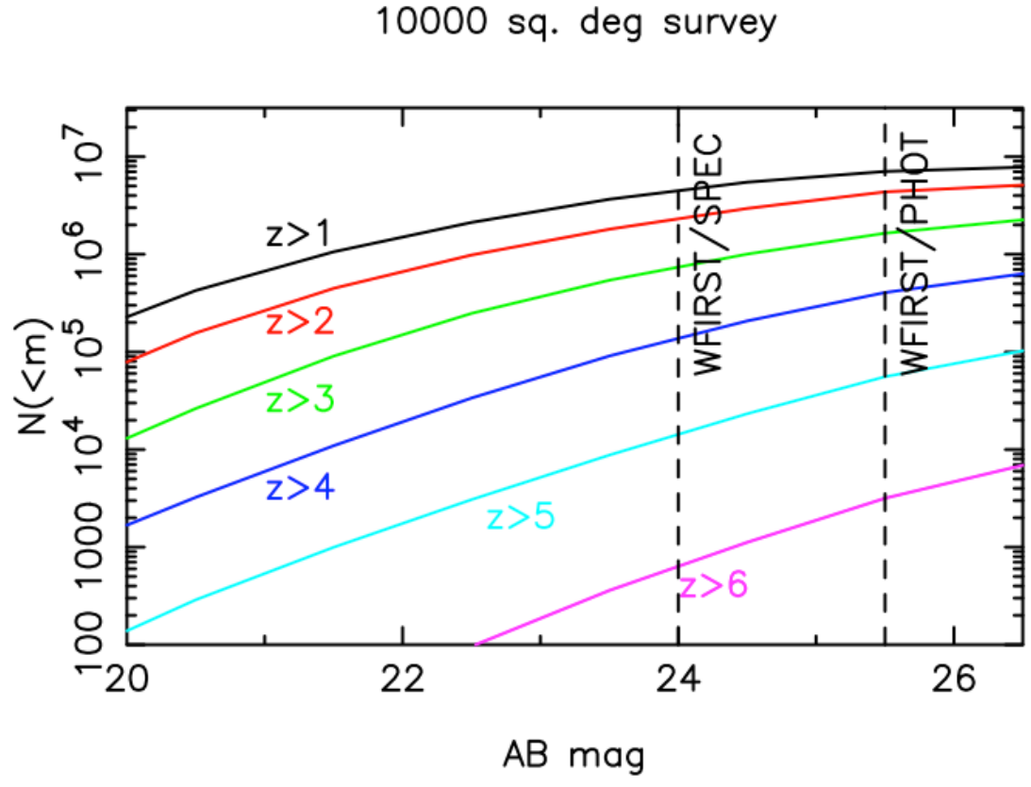
SDSS-DESI-LSST-WFIRST



- Next generation surveys: faint quasars at z>4
  - early BH growth
  - UV background
  - reionization probes

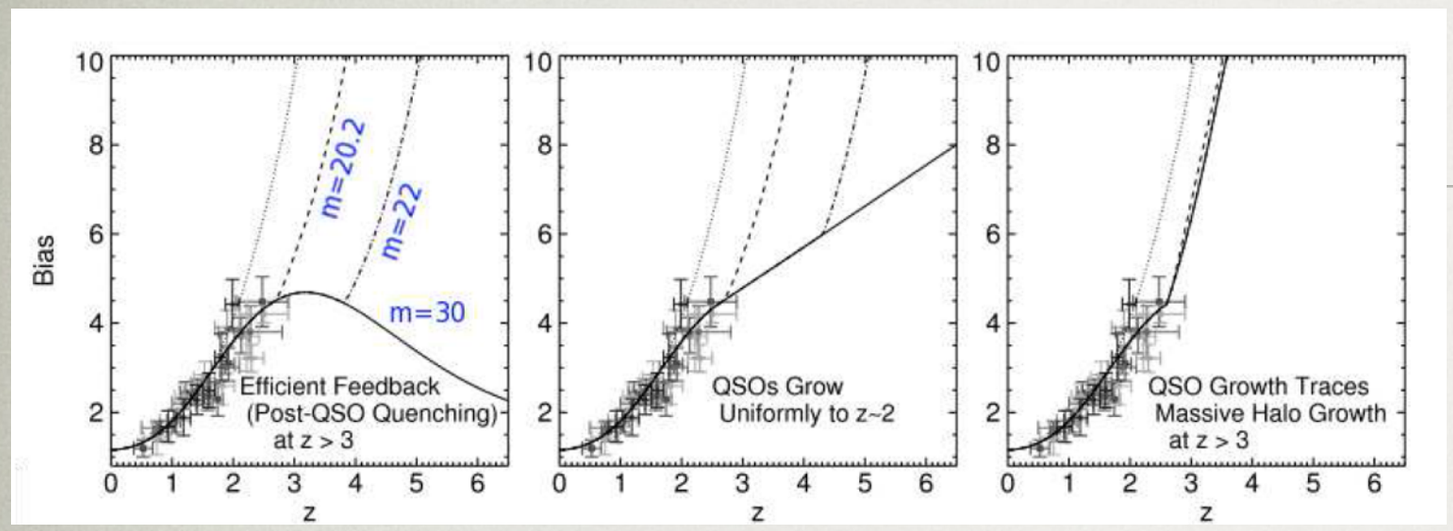
WFIRST Quasar Survey: Depth and Numbers



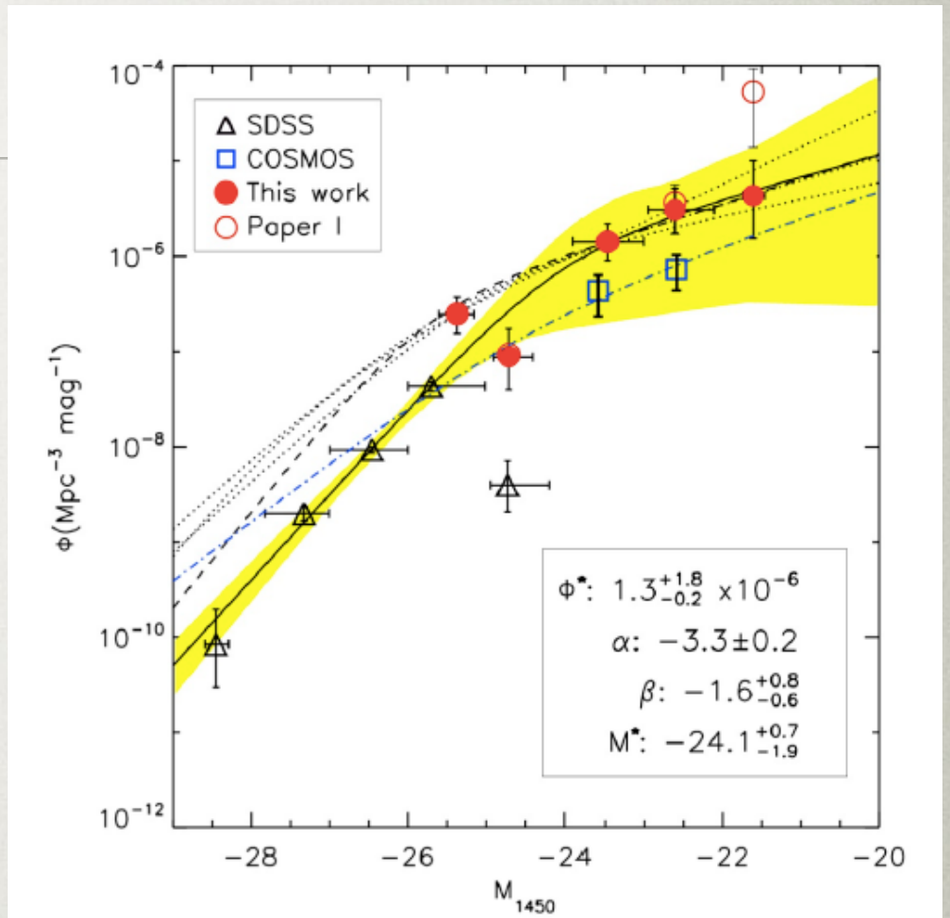


- WFIRST+LSST
  - reaches AB~25.5 for z=0-10 by color selection
  - EUCLID reaches AB~24, with larger area
  - **z-band depth a key limiting factor for high-z quasar selection -> LSST too shallow**
- A redshift survey of ~10 million quasars from both photo-z and spec-z (with grism)
  - **one million quasar redshifts at z>3: interesting for dark energy science?**
    - WFIRST HLS: two million [OIII] galaxies at z=2-3

Key science: Quasar LF and Clustering



Hopkins et al. 2007



Caption: QLF at z~4 from Glikman et al. (2011). Note the substantial uncertainties below the knee in the QLF.

- Quasar luminosity function:
  - uncertain at z>4
  - probes early BH growth
  - UV background and reionization budget
  - in 2025: uncertainty most likely at z>5
- Quasar clustering
  - powerful probes of quasar/galaxy coevolution
  - needs large area and depth
- **Key question: redshift determination with WFIRST**

Photometric Redshift

Brescia et al.

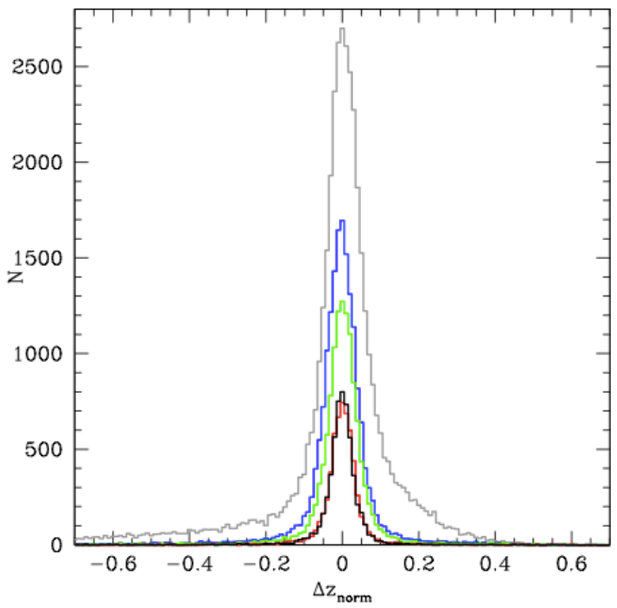
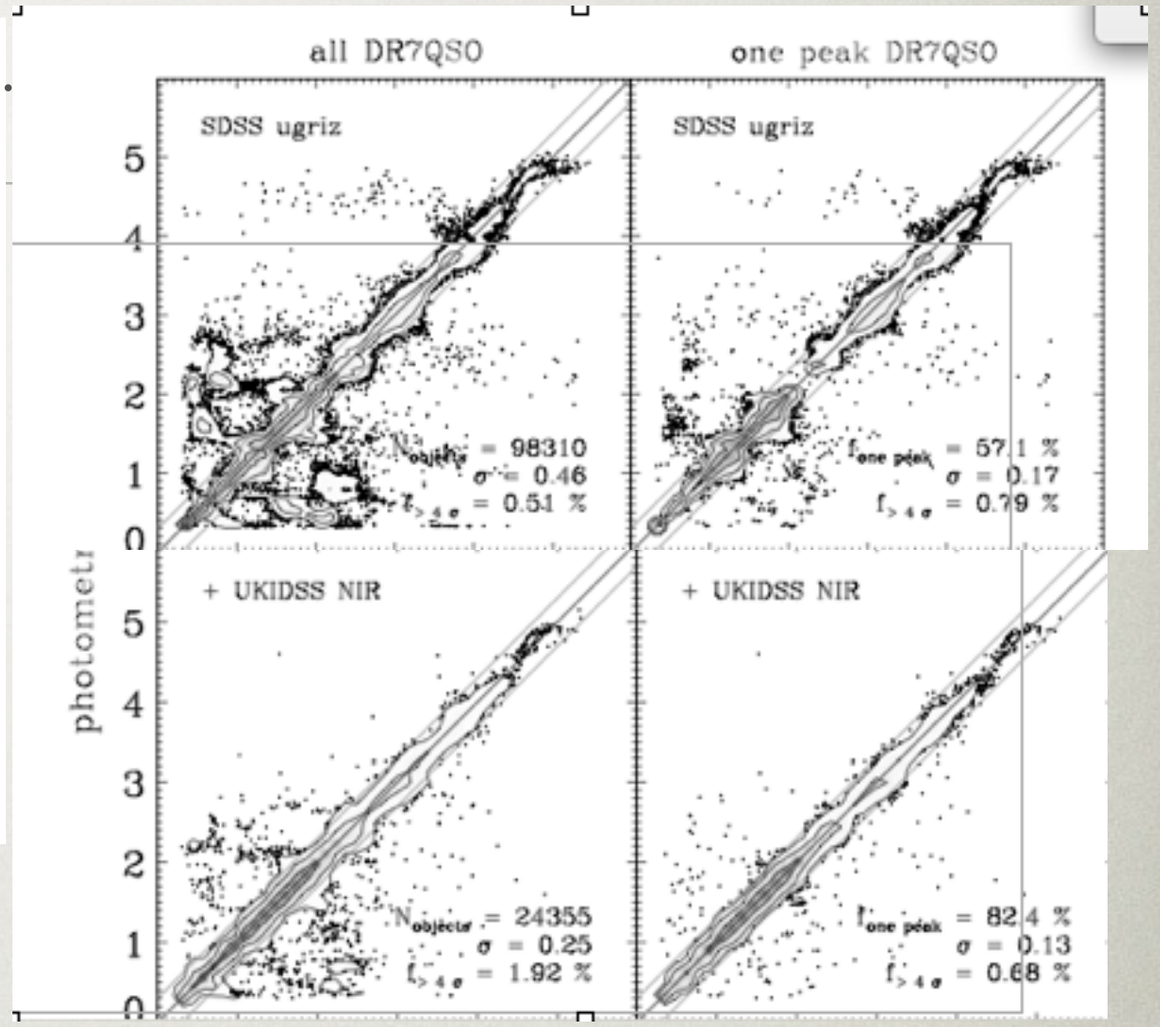


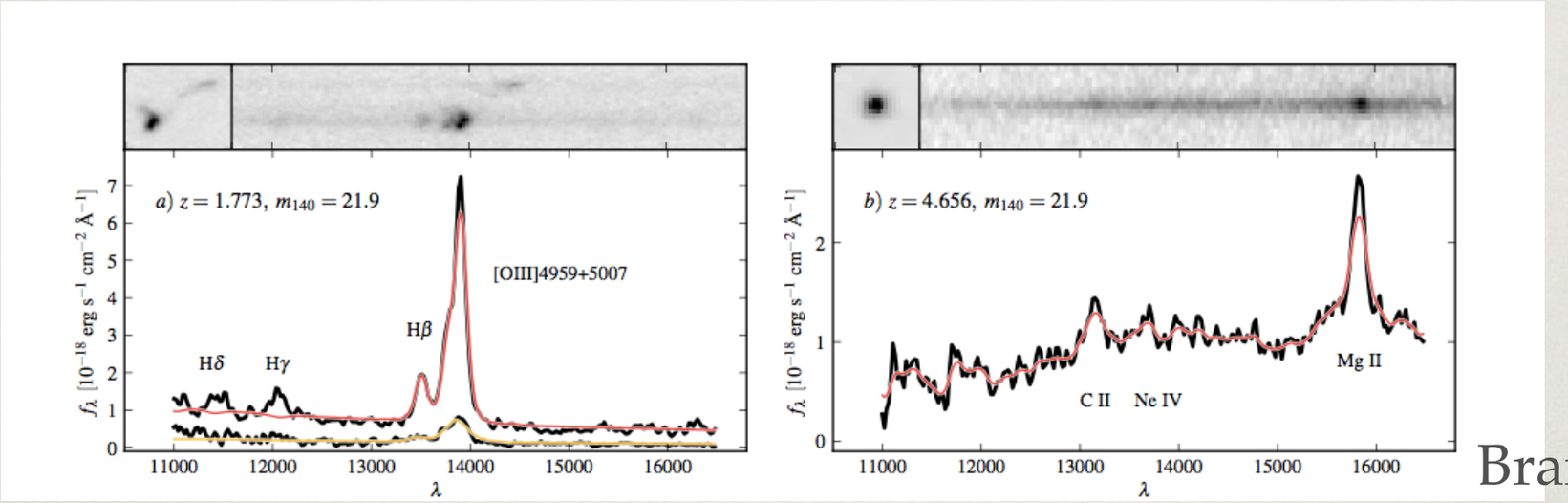
Fig. 4.— Δz_{norm} distributions for all five cross-matched test data sets. Lines are referred to, respectively, SDSS (gray), SDSS+GALEX (blue), SDSS+UKIDSS (green), SDSS+GALEX+UKIDSS (red) and SDSS+GALEX+UKIDSS+WISE (black).



Bovy et al.

- WFIRST + LSST photo-z comparable to SDSS+UKIRT photo-z
  - sigma(z) = 0.1 - 0.3
  - redshift failure rate ~3%
  - OK for quasar LF
  - **But needs deep spectroscopy calibration**
  - **needs better redshift for large scale structure studies**

How deep can WFIRST go with Grism for Quasar Redshifts?



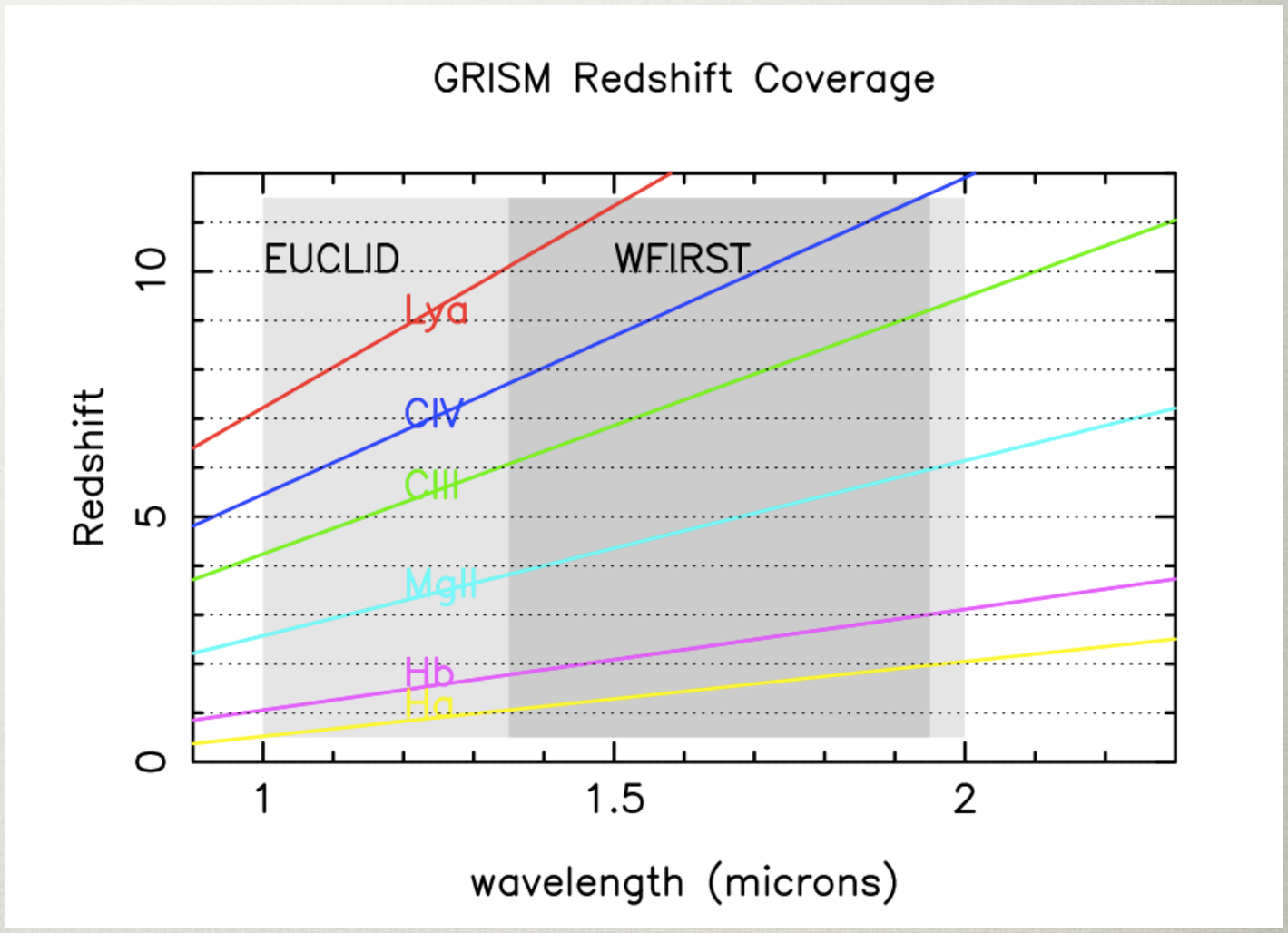
Brammer et al. 2012

- Powerful redshift machine:
  - quasar broad line resolved
  - measure both flux and width
  - for z>5, reaches AB ~24 for detection of average CIV lines

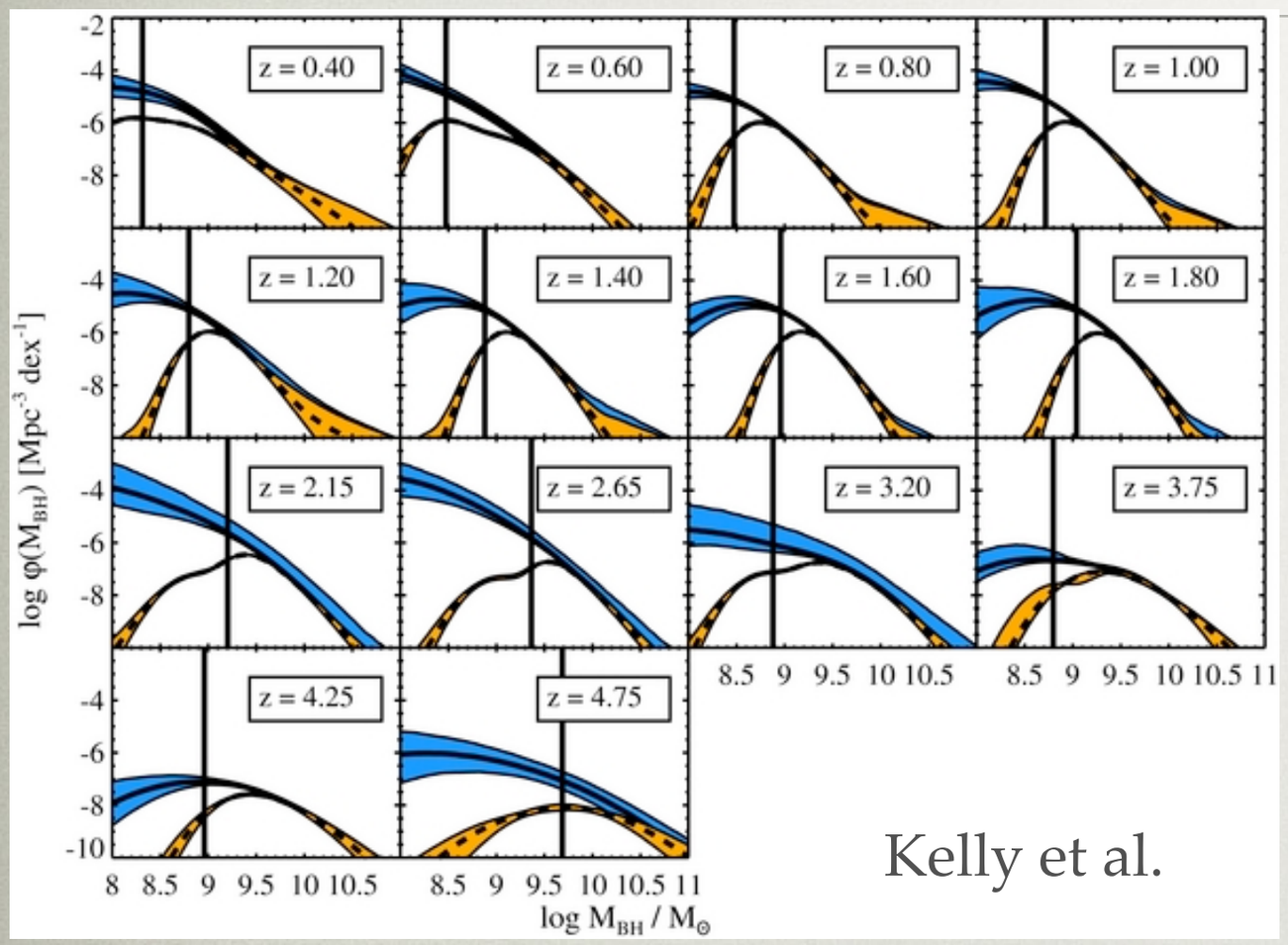
Survey	wavelength	resolution	depth
3d-HST	1.1-1.6	150	5E-17
EUCLID	1.0 -2.0	250	3E-16
WFIRST	**1.35 - 1.95**	**600**	**5E-17**
PFS	0.38-1.26	1900-3500	5E-17
DESI	0.36-0.98	2000-5500	1E-16

Challenges for Grism Redshifts

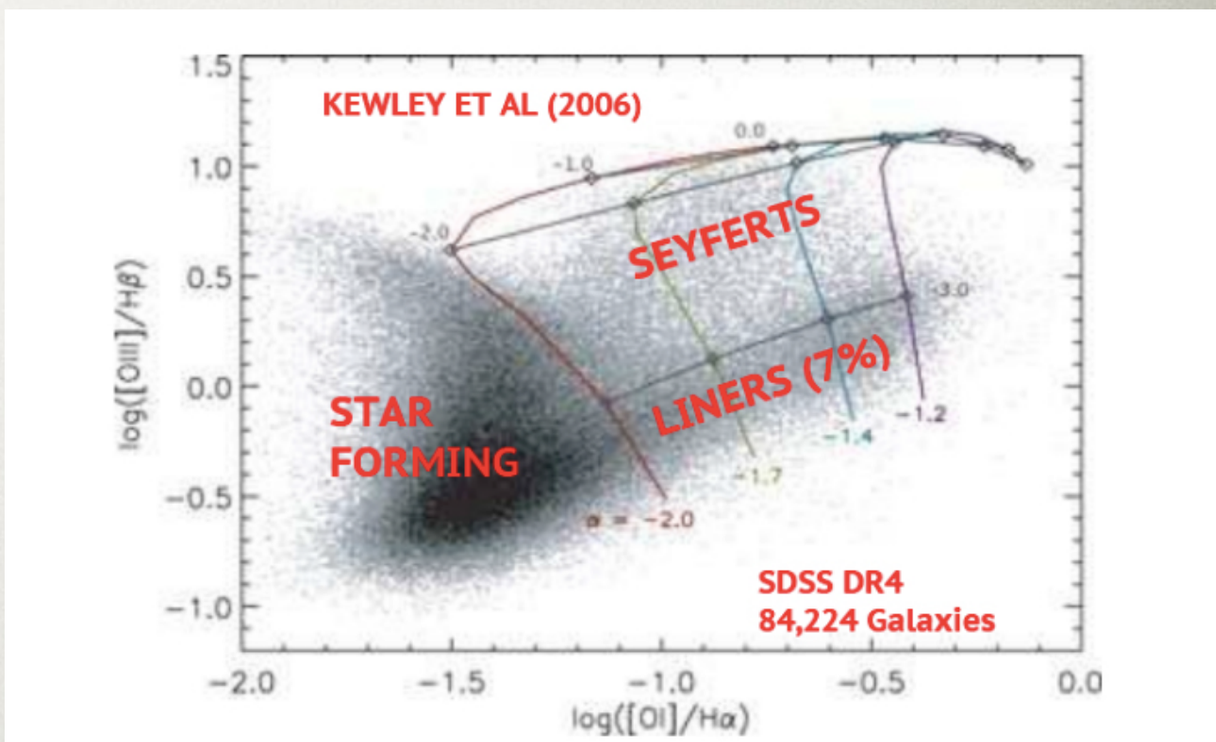
- One-line detections
  - 9<z<10: only CIV available
  - 3<z<6: only MgII available
  - **wider grism wavelength coverage (bluer preferred for reionization Ly alpha)**
- Combining photo-z with grism-z for redshift determination
- **Extensive simulations needed to study grism capabilities**



Example Grism Science

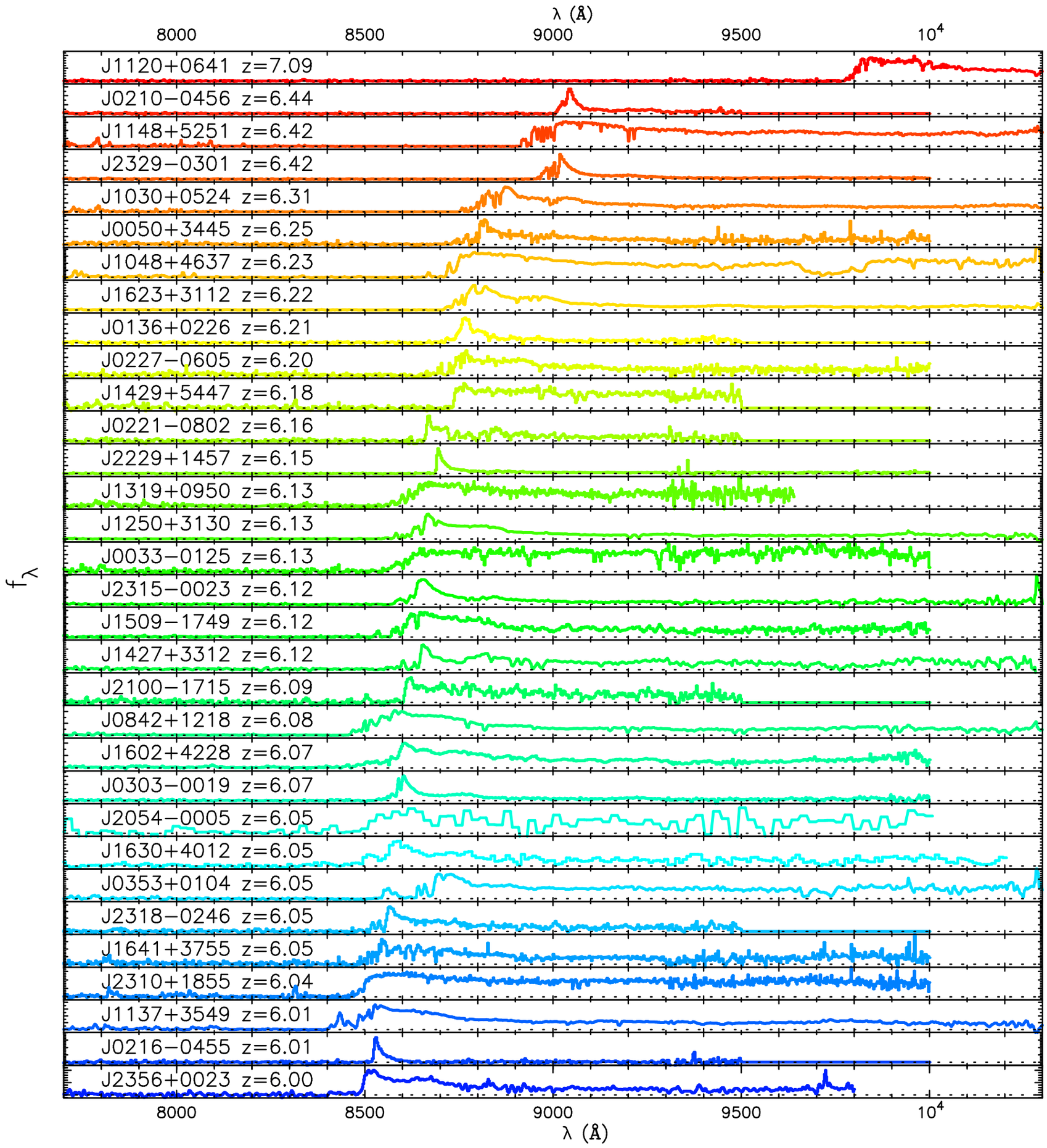


Kelly et al.



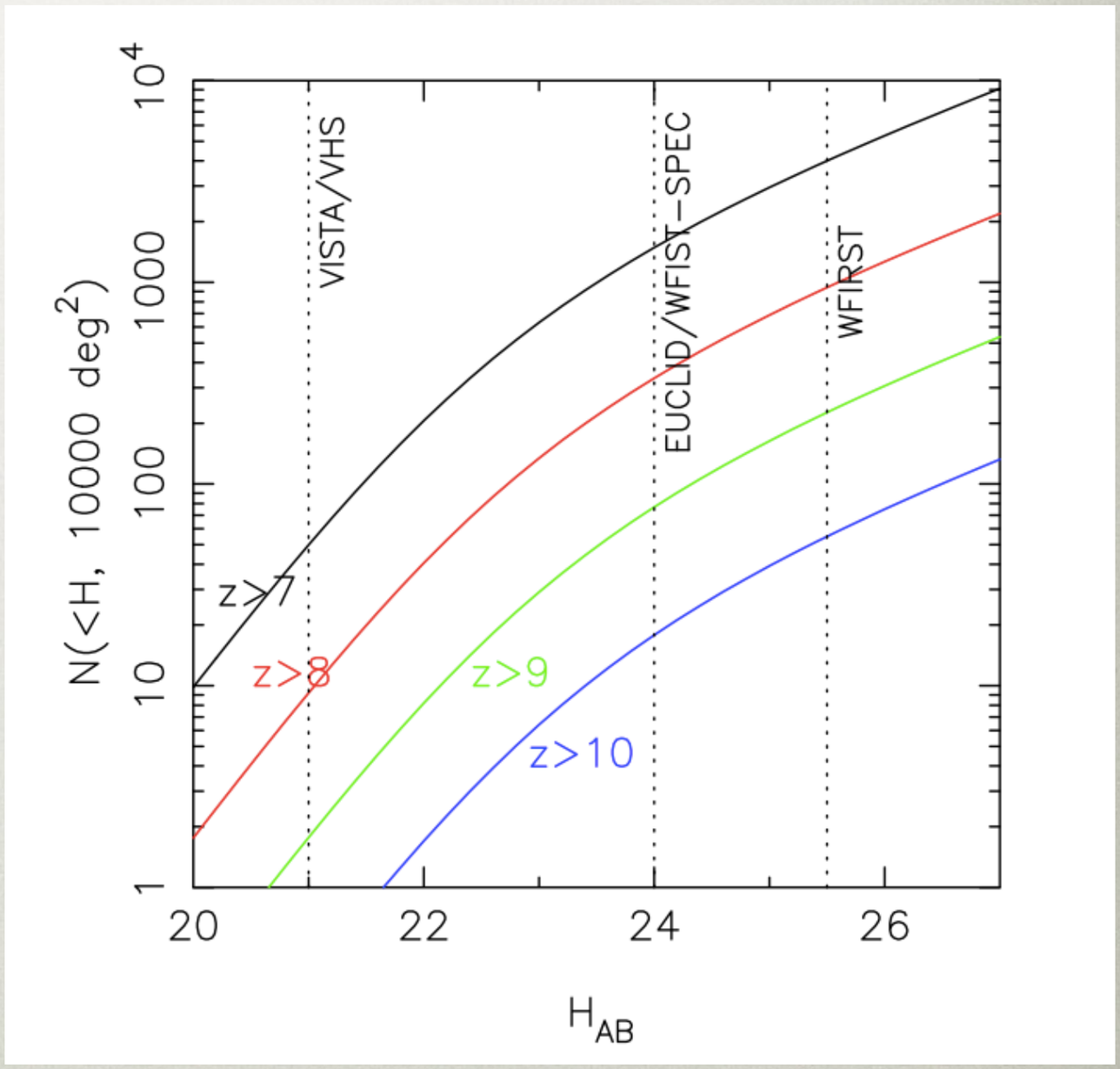
Kewley et al.

- BH mass function
  - broad line resolved
  - BH mass from MgII/Hbeta
  - map accretion history of low-L AGN
- AGN emission line diagnostics
  - lines well separated
  - BPT diagrams to study AGN/galaxy co-evolution and ISM physics
  - yesterday's talks

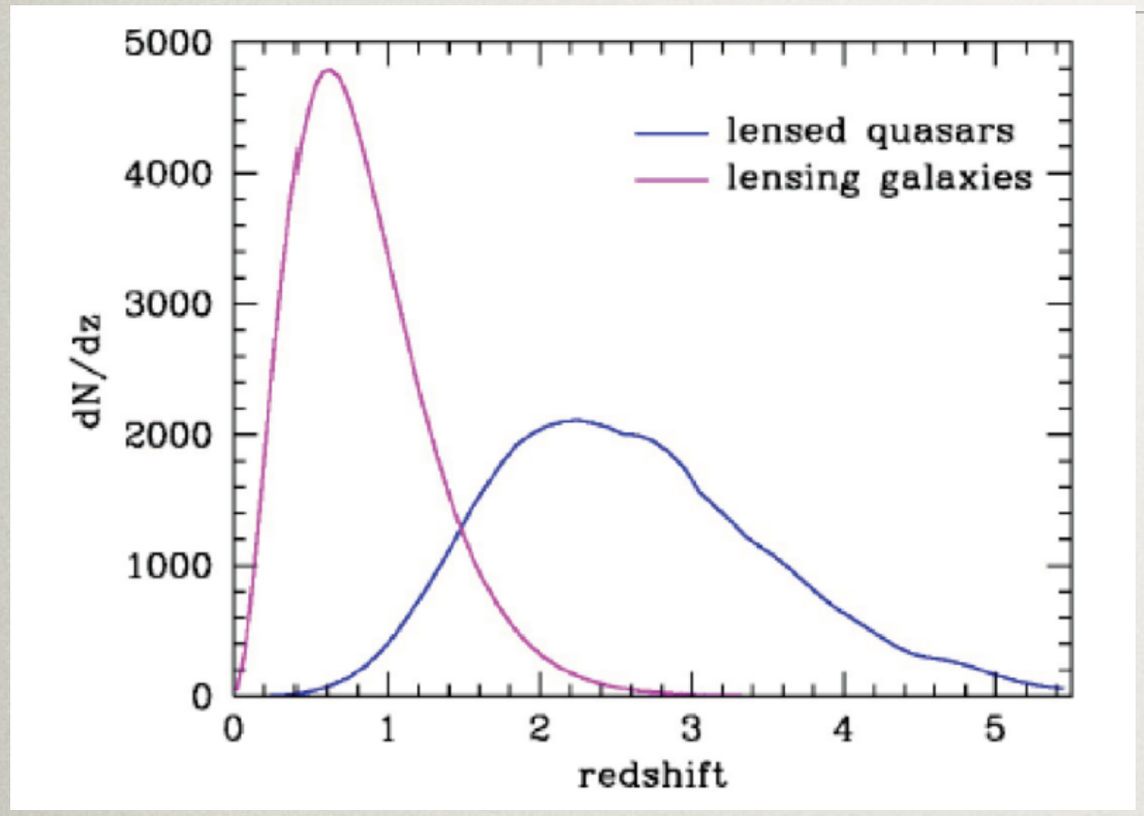

λ (Å)
8000
8500
9000
9500
10^4
J1120+0641 z=7.09
J0210−0456 z=6.44
J1148+5251 z=6.42
J2329−0301 z=6.42
J1030+0524 z=6.31
J0050+3445 z=6.25
J1048+4637 z=6.23
J1623+3112 z=6.22
J0136+0226 z=6.21
J0227−0605 z=6.20
J1429+5447 z=6.18
J0221−0802 z=6.16
J2229+1457 z=6.15
J1319+0950 z=6.13
J1250+3130 z=6.13
J0033−0125 z=6.13
J2315−0023 z=6.12
J1509−1749 z=6.12
J1427+3312 z=6.12
J2100−1715 z=6.09
J0842+1218 z=6.08
J1602+4228 z=6.07
J0303−0019 z=6.07
J2054−0005 z=6.05
J1630+4012 z=6.05
J0353+0104 z=6.05
J2318−0246 z=6.05
J1641+3755 z=6.05
J2310+1855 z=6.04
J1137+3549 z=6.01
J0216−0455 z=6.01
J2356+0023 z=6.00
f_λ

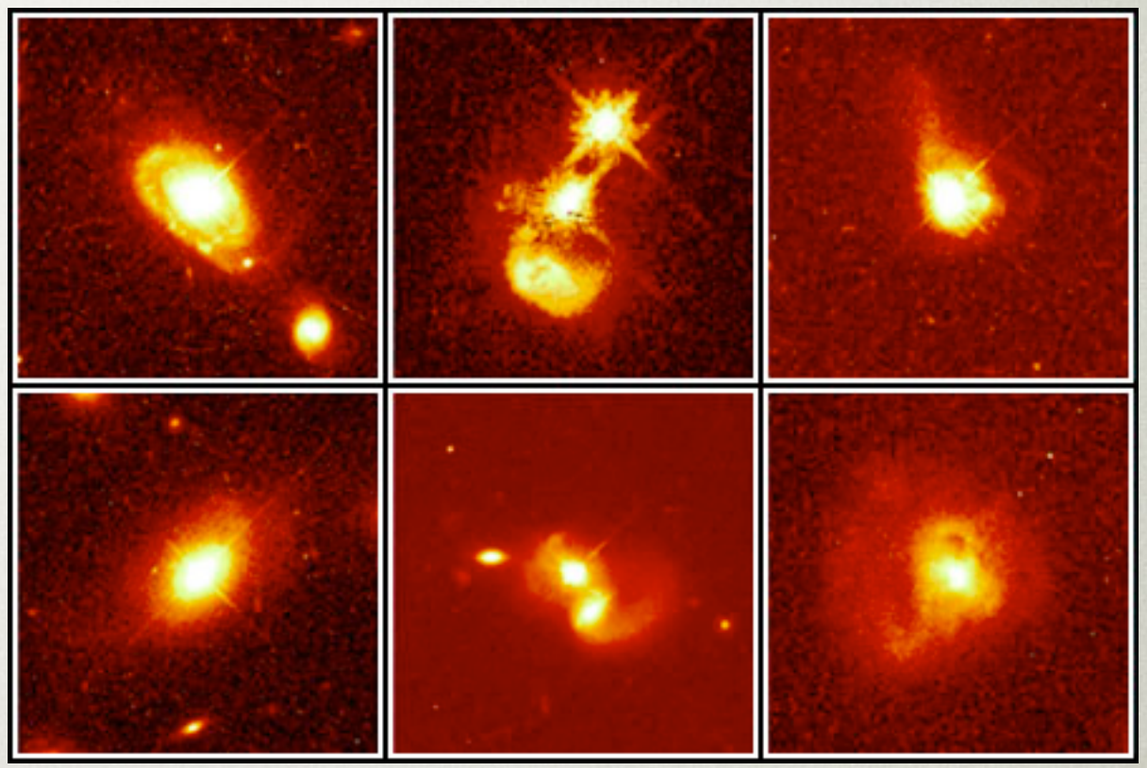
Reionization-Era Quasars

- Ground-based surveys not effective at z>8
- LF knee likely at AB~23-25 at high-z: this is the sweet spot for quasar discovery
- WFIRST will sample the entire population and determine their contribution to reionization
- **area vs. depth tradeoff: brighter quasars are more valuable - prefer a wider and slightly shallower survey**



High Resolution AGN Science





- Strong quasar lenses
  - expect thousands of systems
  - most will be easily resolved by WFIRST imaging
  - **The ability to use grism to do identification in crowed field key to success**

- Quasar Host Galaxies
  - HST resolution/depth
  - extremely large sample size with wide dynamical range
  - **how well can one model PSF?**

Summary/Questions

- **LSST+WFIRST: next generation 10 million quasar survey**
  - WFIRST enables high-z and spectroscopy
- **Depth vs. Area**
  - quasar survey in general favors a wider/shallower survey -> HLS vs. GO?
- **z-band depth is a key limiting factor of high-z quasar selection**
  - large GO survey project to complement HLS?
- **Grism performance**
  - wavelength extension (bluer?) very beneficial