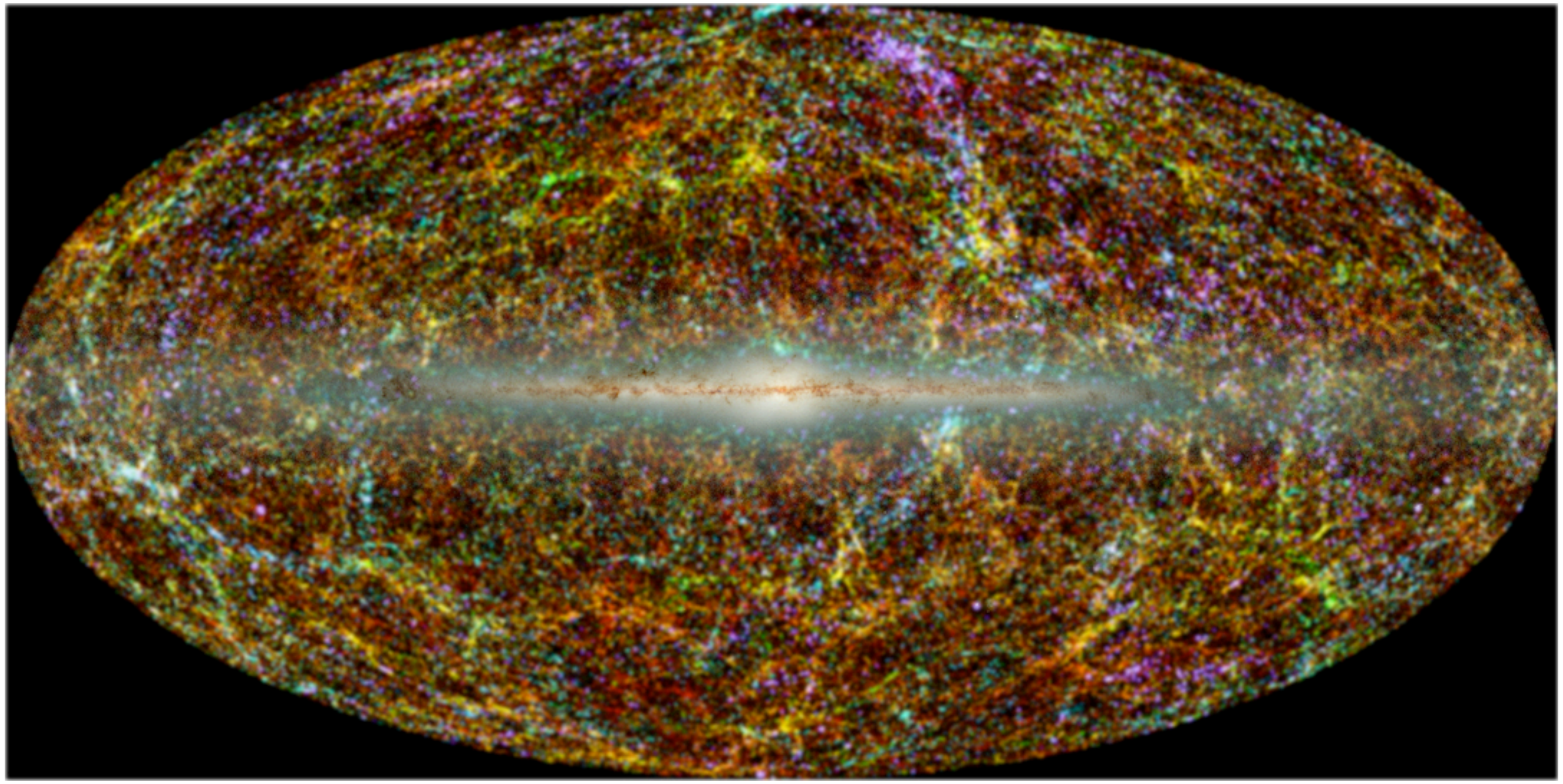
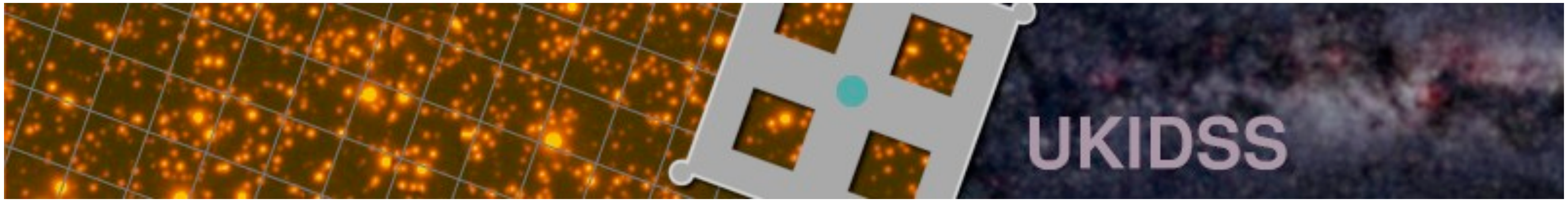
SASIR: Static Science Case

Jason Xavier Prochaska
UCO/Lick Observatory
UC Santa Cruz

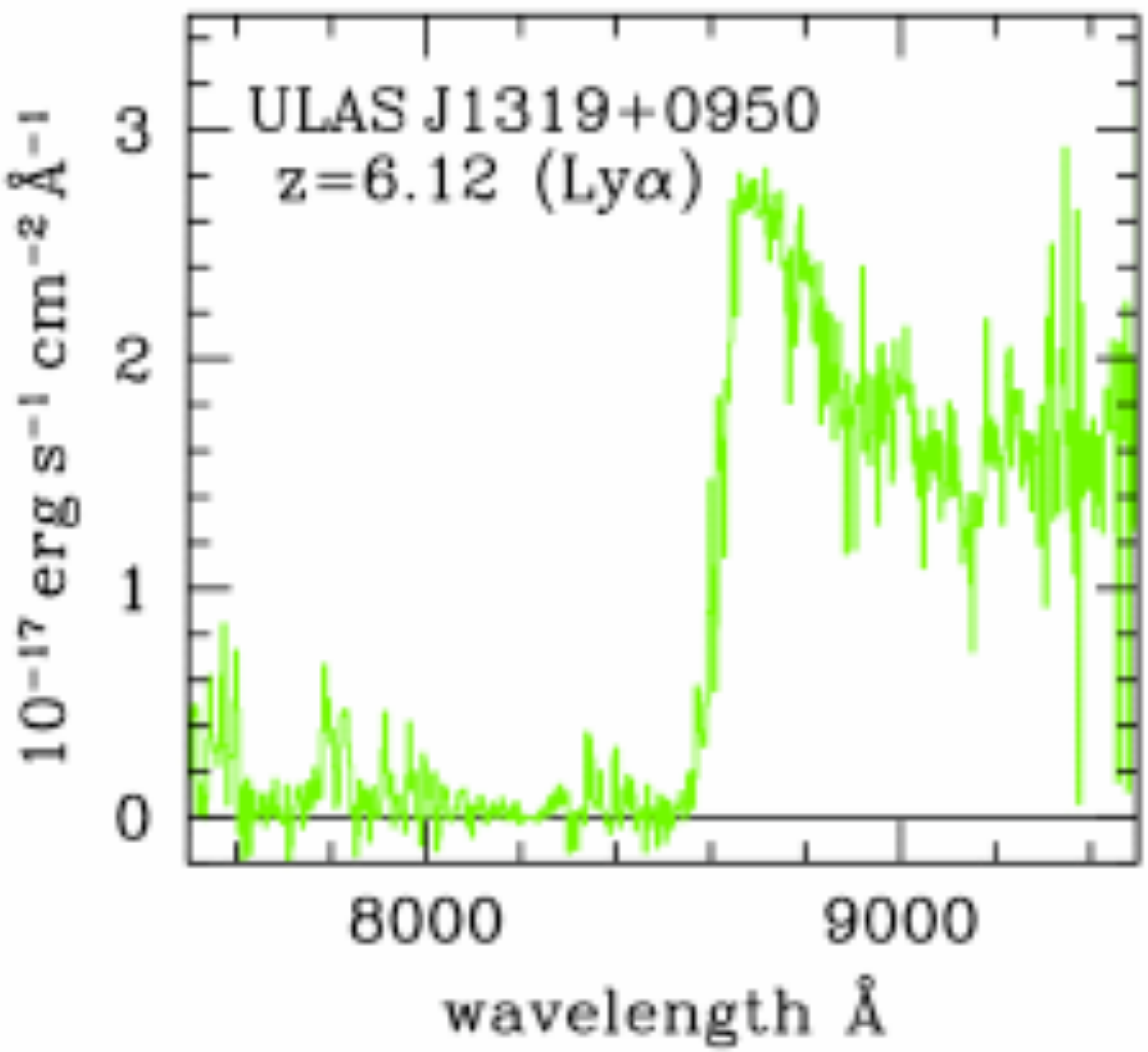
SASIR and Static Science

- SASIR
  - Deep yJHK imaging
  - Full northern sky
  - 0.6" image quality
- Science areas
  - Low mass stars
  - Low z galaxies
  - High z galaxies
  - High z quasars
- Bottom line
  - Hard to imagine a science area not addressed by SASIR
  - Strategy: Focus on the unique science enabled to 'sell' the project



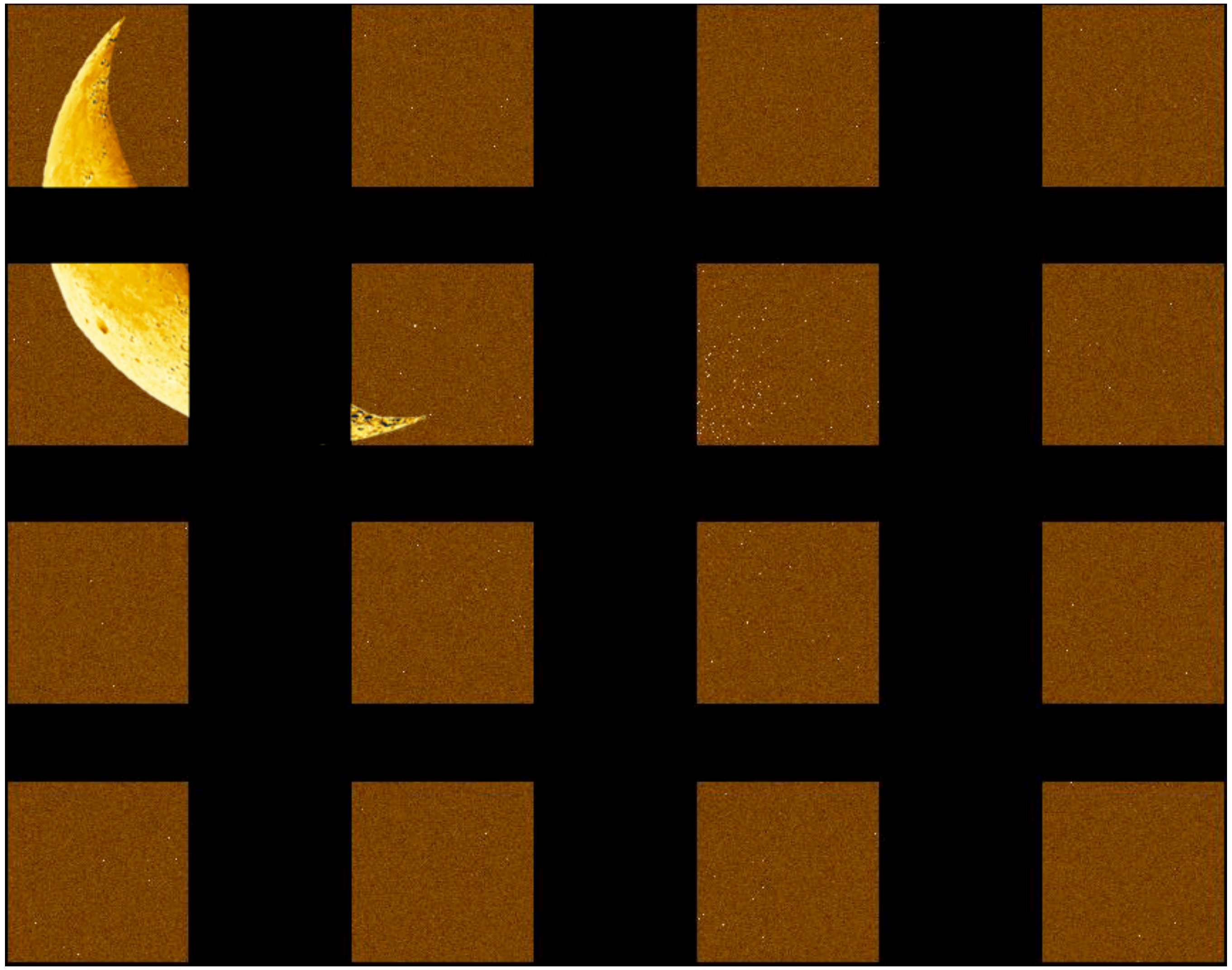


- Dedicated IR survey
  - UKIRT 4m IR optimized
  - yJHK with a 0.2 sq deg field
- Surveys
  - LSA
    - 4000 square degrees
    - JHK = 20.9, 20.2, 20.2 (AB)
  - Galactic Plane (1800 sq. deg)
    - Variable stars
  - DXS (Deep extragalactic)
    - 35 sq. deg
    - JK = 23.4, 22.85 (AB)
- Status
  - Mature project
    - Data Release 3 in December 2007
    - >20 papers published
  - Nearing completion



VISTA

- Dedicated IR survey
  - New, 4m IR optimized
  - yJHK with a 0.6 sq deg field
- Surveys
  - VIKING
    - 1500 square degrees
    - zyJHK = 23.1,22.3, 22.1, 21.5, 21.2 (AB)
    - BAO, high z quasars
  - VHS
    - Full sky (20,000 sq. deg)
    - JK = 21.2, 20.0 (AB)
    - High z quasars?
  - No synoptic survey planned
- Status
  - Key projects announced
  - Operations by end of 2008



Space IR Missions

- Pending
  - Herschel
  - JWST
    - Single pointings
  - WISE
    - All sky, but shallow
- Proposed
  - None at 'MIDEX' level
  - SMEX
    - PI: H. Ford
    - Failed
  - JDEM?
  - No synoptic survey planned

SASIR: Static Sky

- Strategic Advantages
  - Wider (5x) than UKIDSS
  - Deeper (2 mag?) than VISTA
  - Northern sky
  - No K band in space
  - Synoptic
- Science advantages
  - Synoptic
  - Wider+deeper
    - Very rare, very faint, very red objects
  - Northern sky
    - Synergy with PANSTARS
    - Keck, GTC, Subaru, etc.

Exciting Logo
Goes Here

SASIR: Static Sky

RED

FAINT

RARE

SASIR: Static Sky

RED

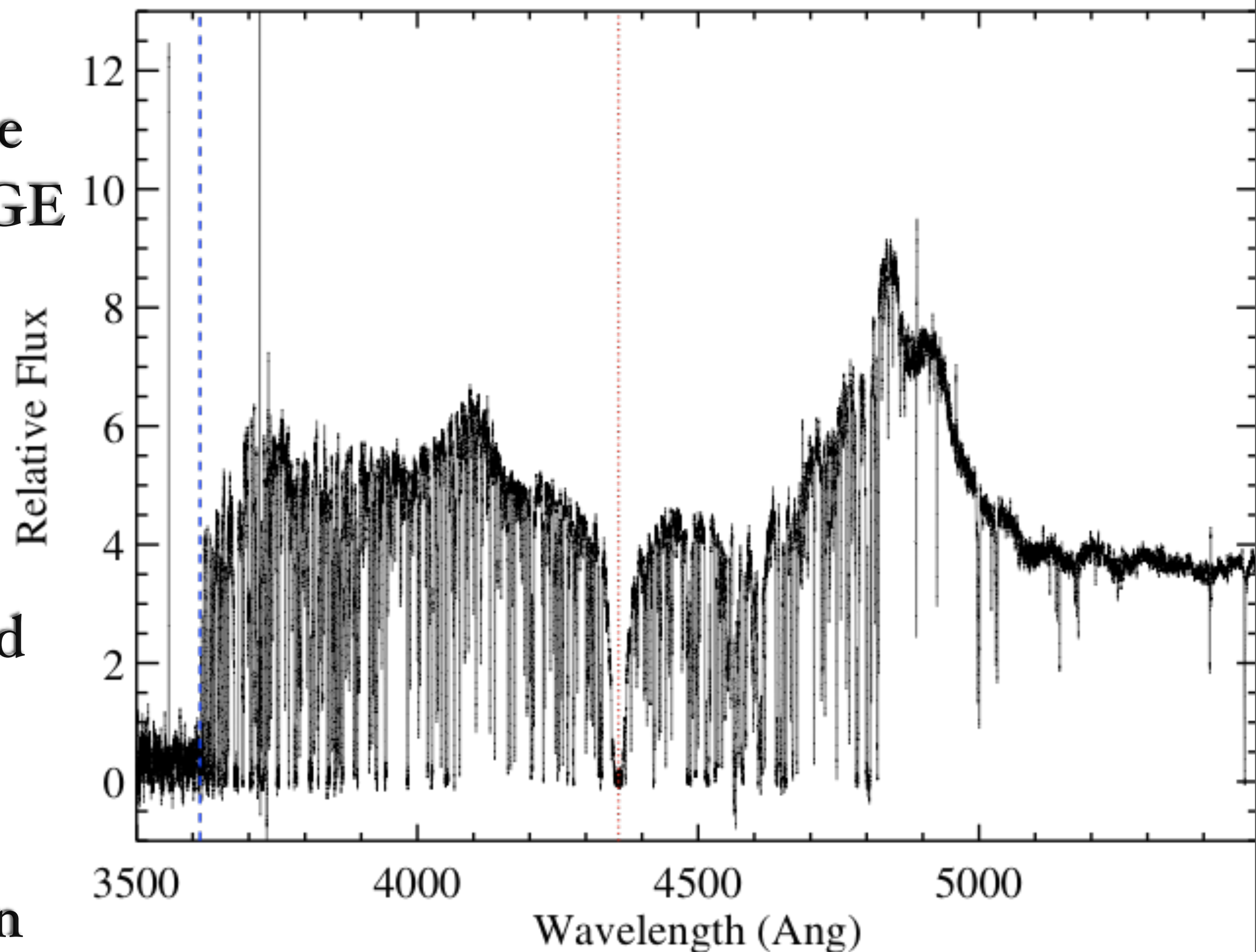
FAINT

RARE

e.g. High Redshift Quasars

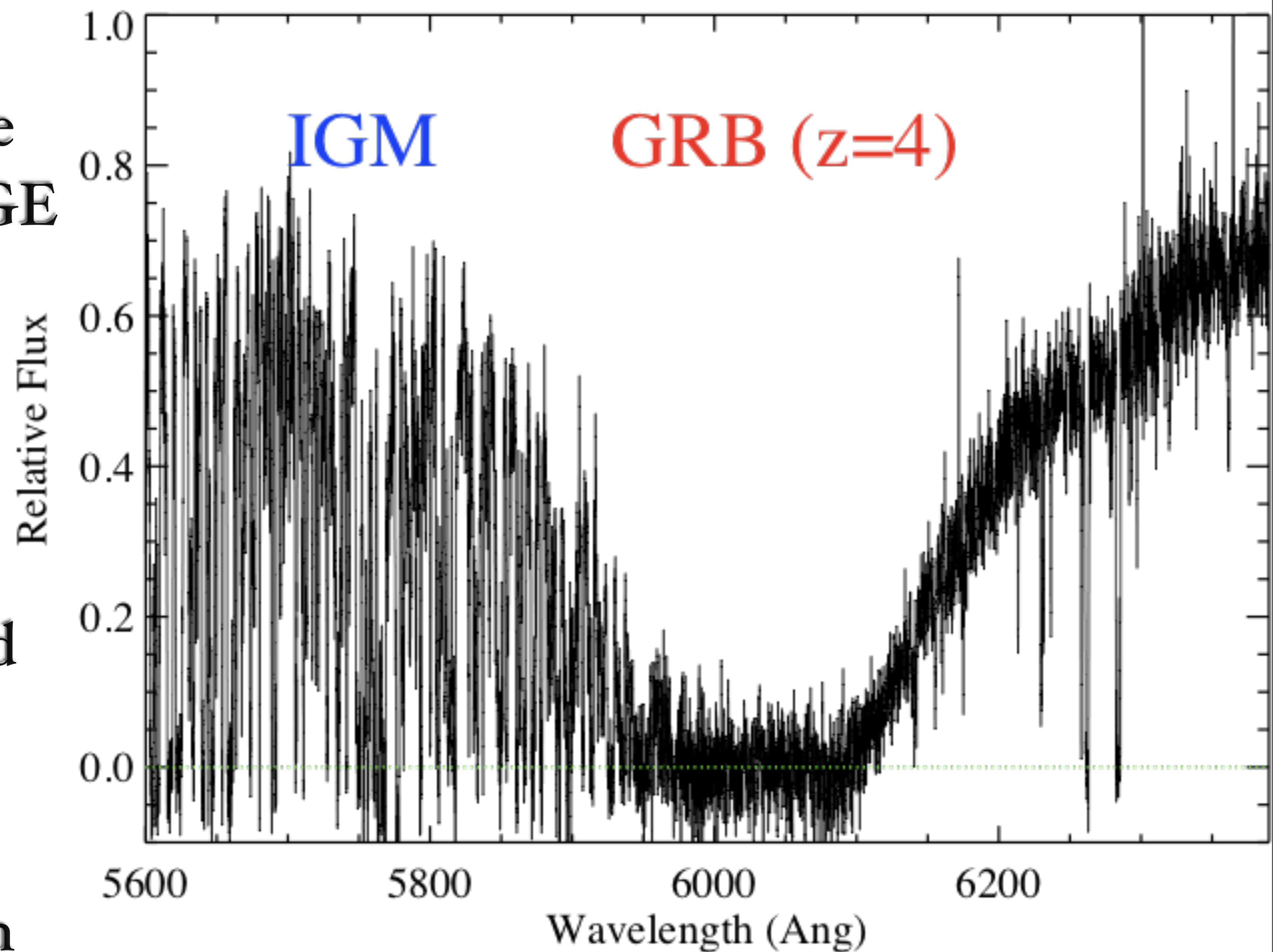
z~3 Quasar

- No Gunn-Peterson effect
  - If baryons were evenly distributed and neutral, the Lya opacity would be HUGE
  - Observations
    - ✦ Quasars at z<6 do not show a Gunn-Peterson 'trough'
    - ✦ GRB sightlines agree
- Conclusion(s)
  - Baryons are in a diffuse and ionized medium
    - ✦ IGM observations dictate this
    - ✦ Reionization
  - Or (unlikely) baryons are in compact objects



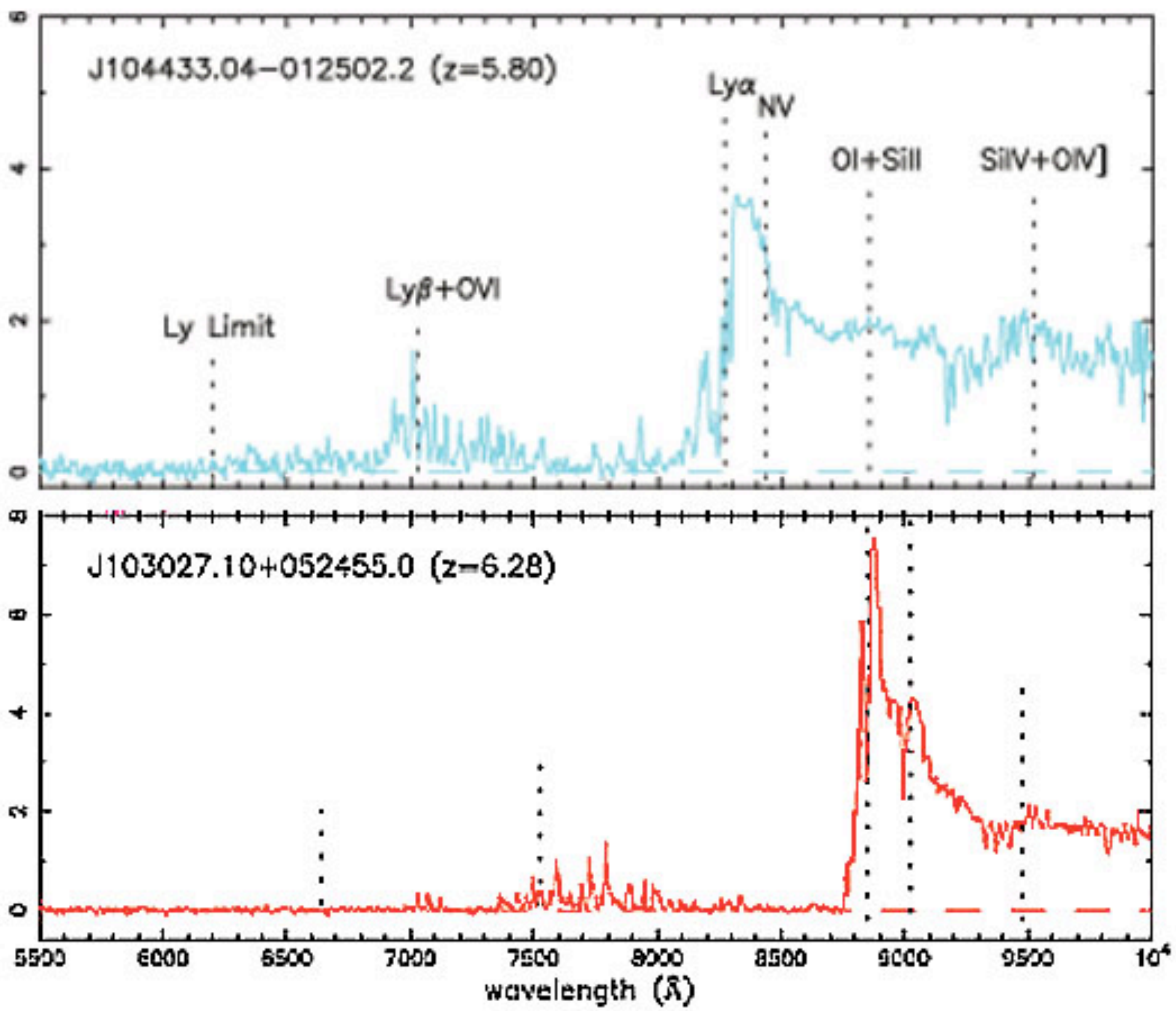
z~3 Quasar

- No Gunn-Peterson effect
  - If baryons were evenly distributed and neutral, the Lya opacity would be HUGE
  - Observations
    - Quasars at z<6 do not show a Gunn-Peterson 'trough'
    - GRB sightlines agree
- Conclusion(s)
  - Baryons are in a diffuse and ionized medium
    - IGM observations dictate this
    - Reionization
  - Or (unlikely) baryons are in compact objects



z~6 Quasars

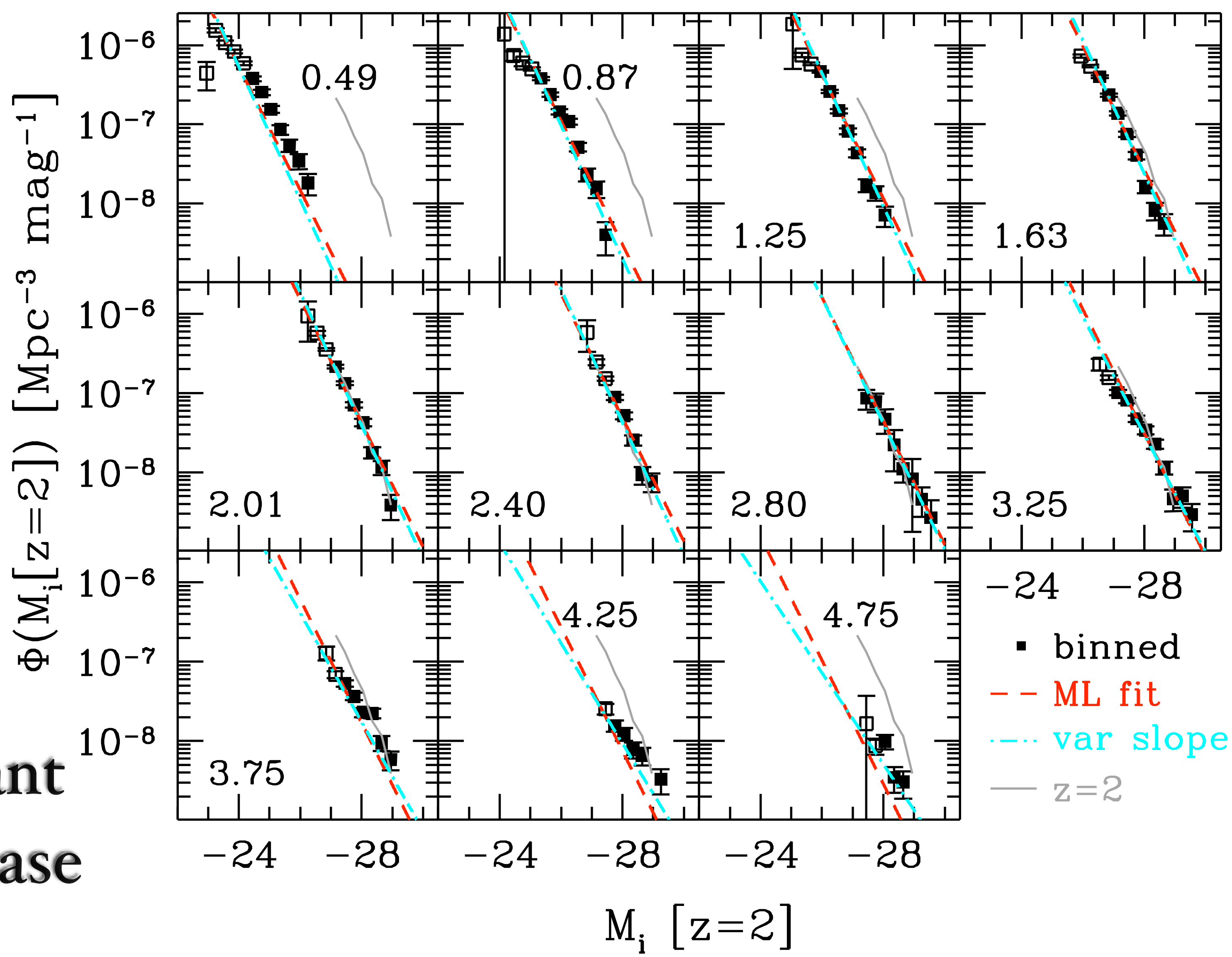
- Discovery
  - SDSS optical imaging
    - Including z-band
  - APO follow-up IR imaging
  - Keck follow-up spectroscopy
    - SDSS team
- Science
  - Reionzation
    - Number density constrains number of ionizing photons available
    - Lya forest becomes optically thick at z~6
  - IGM physics
  - Growth of black holes
- Higher-z
  - Need IR imaging
  - Need deeper imaging



Quasar Luminosity Function

- QSO surveys
  - SDSS + 2DF
    - Optical imaing + spectroscopic follow-up
  - ~10,000 quasars at z>2
- Luminosity function
  - Extremely rare objects
    - $\Phi(M^*) \sim 10^{-7}$ Mpc^{-1} mag^{-1}
  - Double power law
    - Shallow faint-end
    - Steep bright end: $\Phi(L) \sim L^{-3.2}$
  - Poorly constrained at z>4
- Extrapolate
  - Assume the shape holds constant
  - Assume M* continues to decrease exponentially
    - $\Phi^* = \exp[-0.43\ z]$

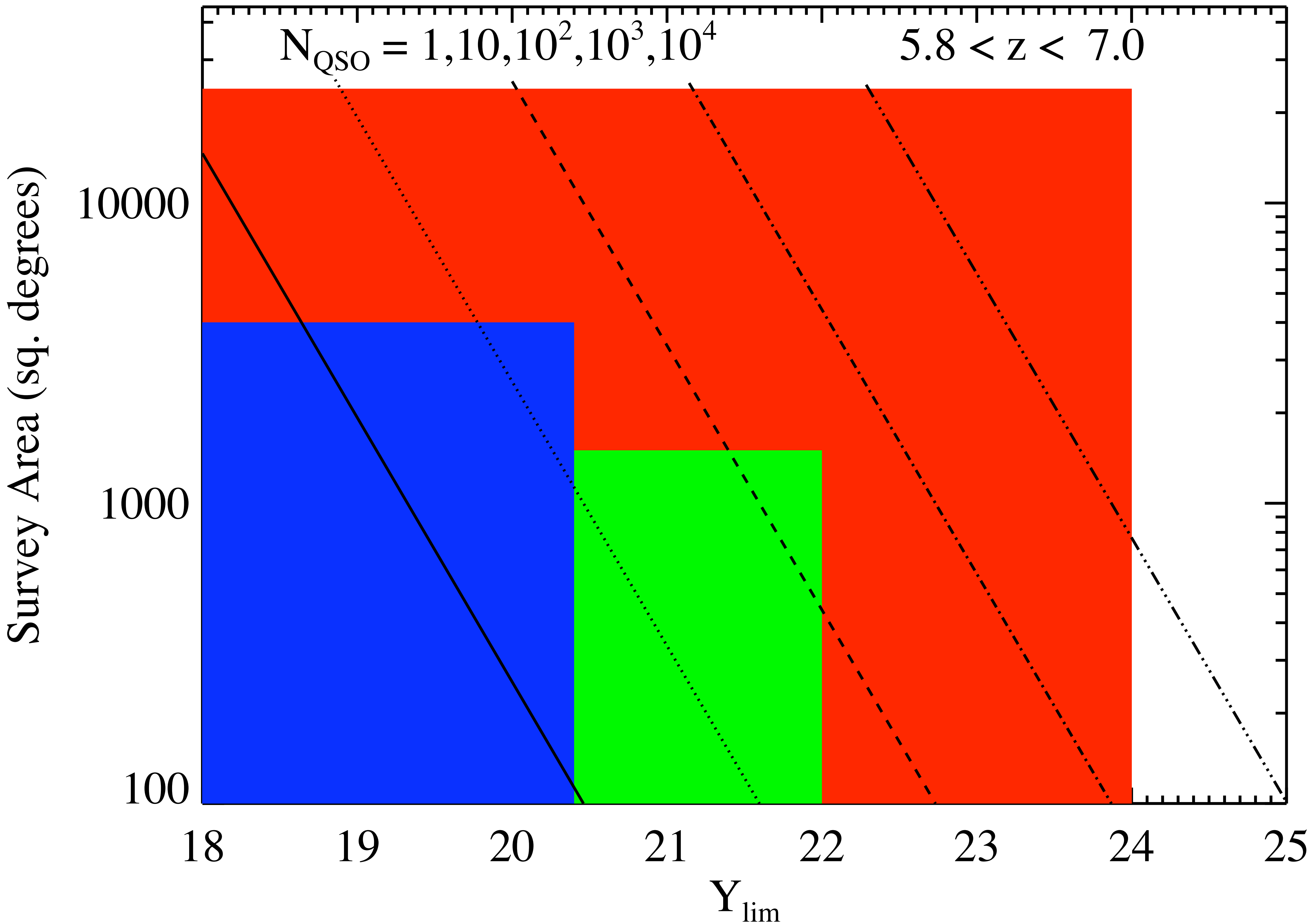
Richards et al. (2005)



Quasar Luminosity Function

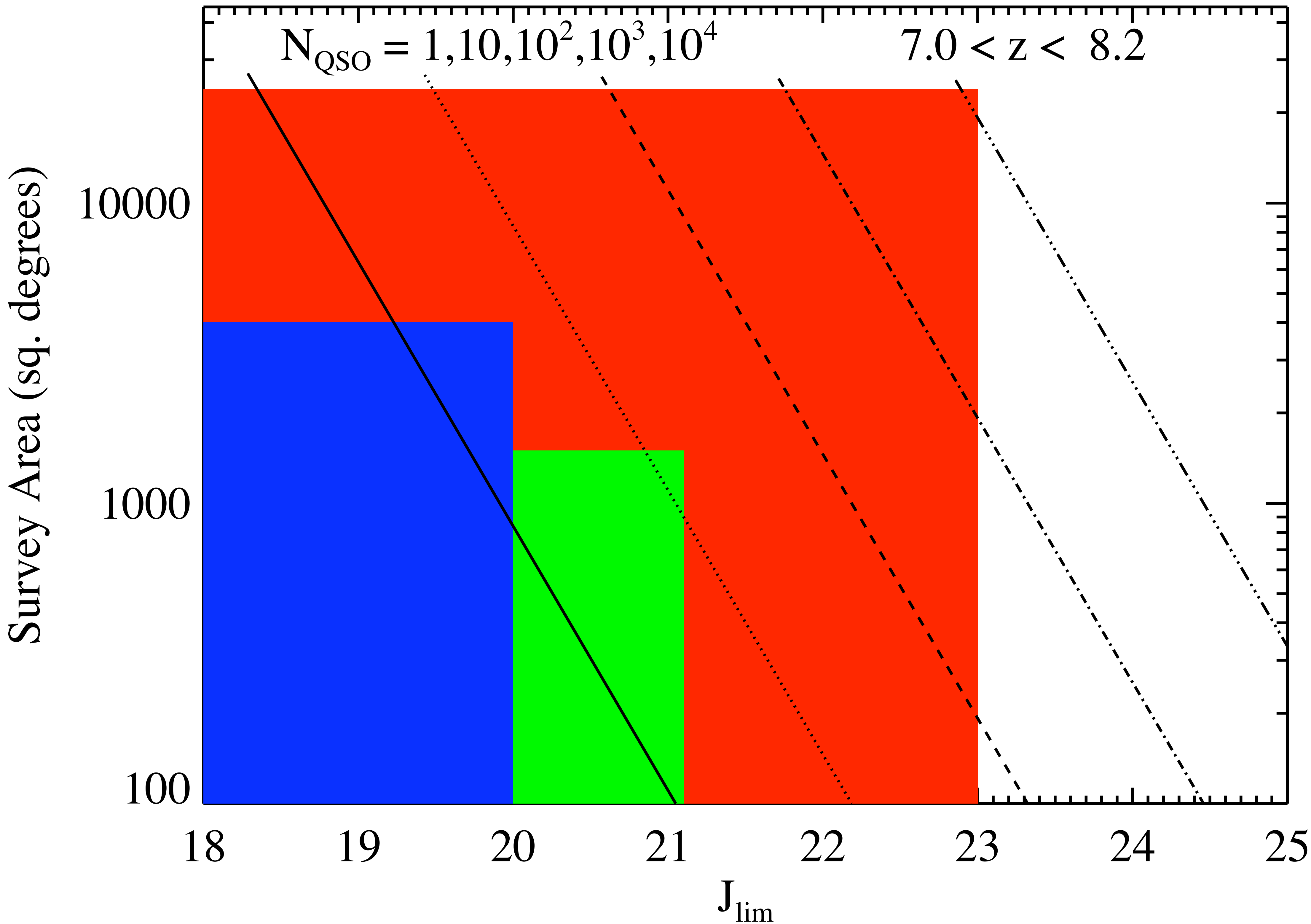
- QSO surveys
  - SDSS + 2DF
    - Optical imaing + spectroscopic follow-up
  - ~10,000 quasars at z>2
- Luminosity function
  - Extremely rare objects
    - $\Phi(M^*) \sim 10^{-7}$ Mpc^{-1} mag^{-1}
  - Double power law
    - Shallow faint-end
    - Steep bright end: $\Phi(L) \sim L^{-3.2}$
  - Poorly constrained at z>4
- Extrapolate
  - Assume the shape holds constant
  - Assume M* continues to decrease exponentially
    - $\Phi^* = \exp[-0.43\, z]$

z~6 Quasars



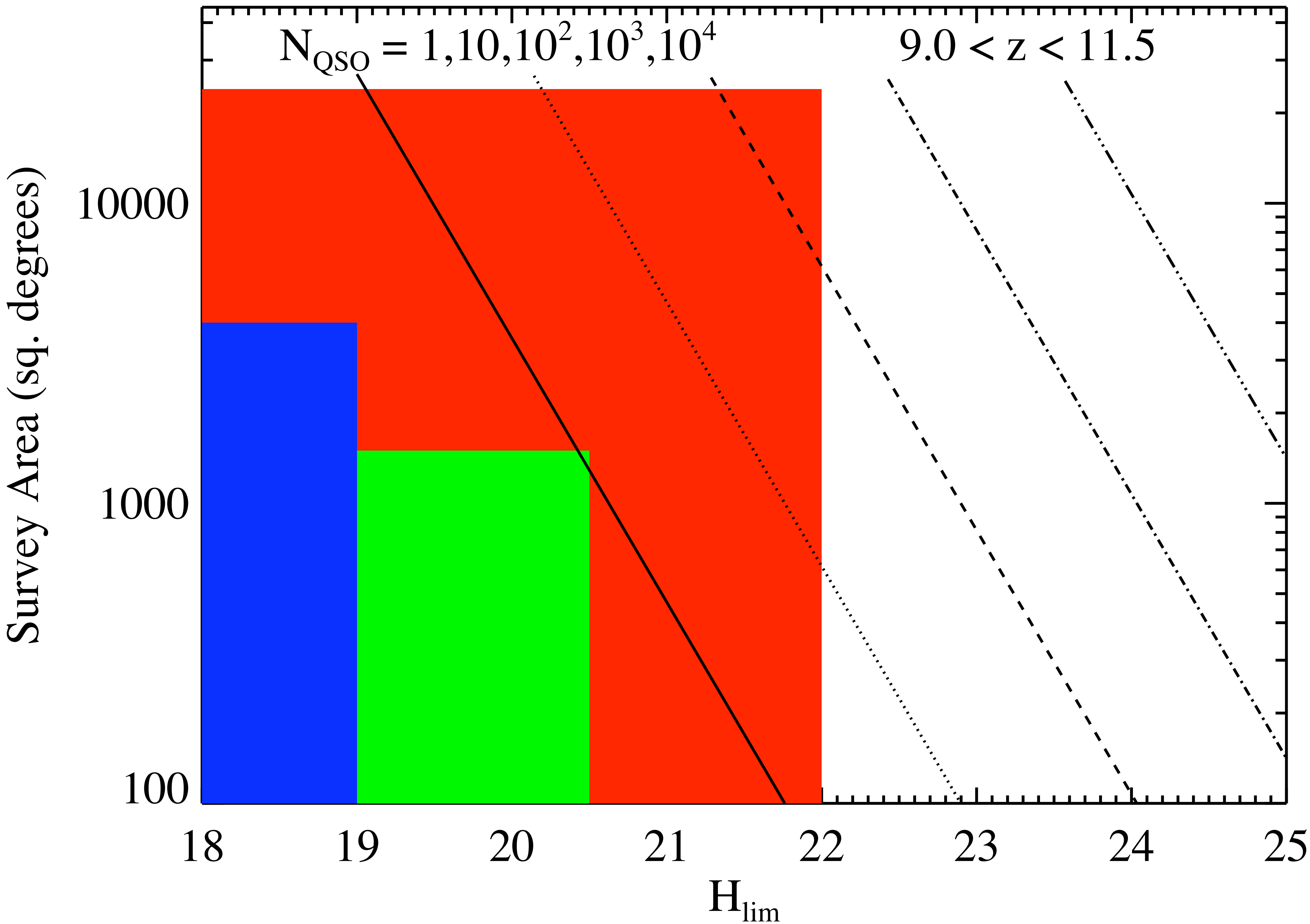
$N_{QSO} = 1, 10, 10^2, 10^3, 10^4$
$5.8 < z < 7.0$
Survey Area (sq. degrees)
10000
1000
100
18
19
20
21
22
23
24
25
Y_{lim}

z~8 Quasars

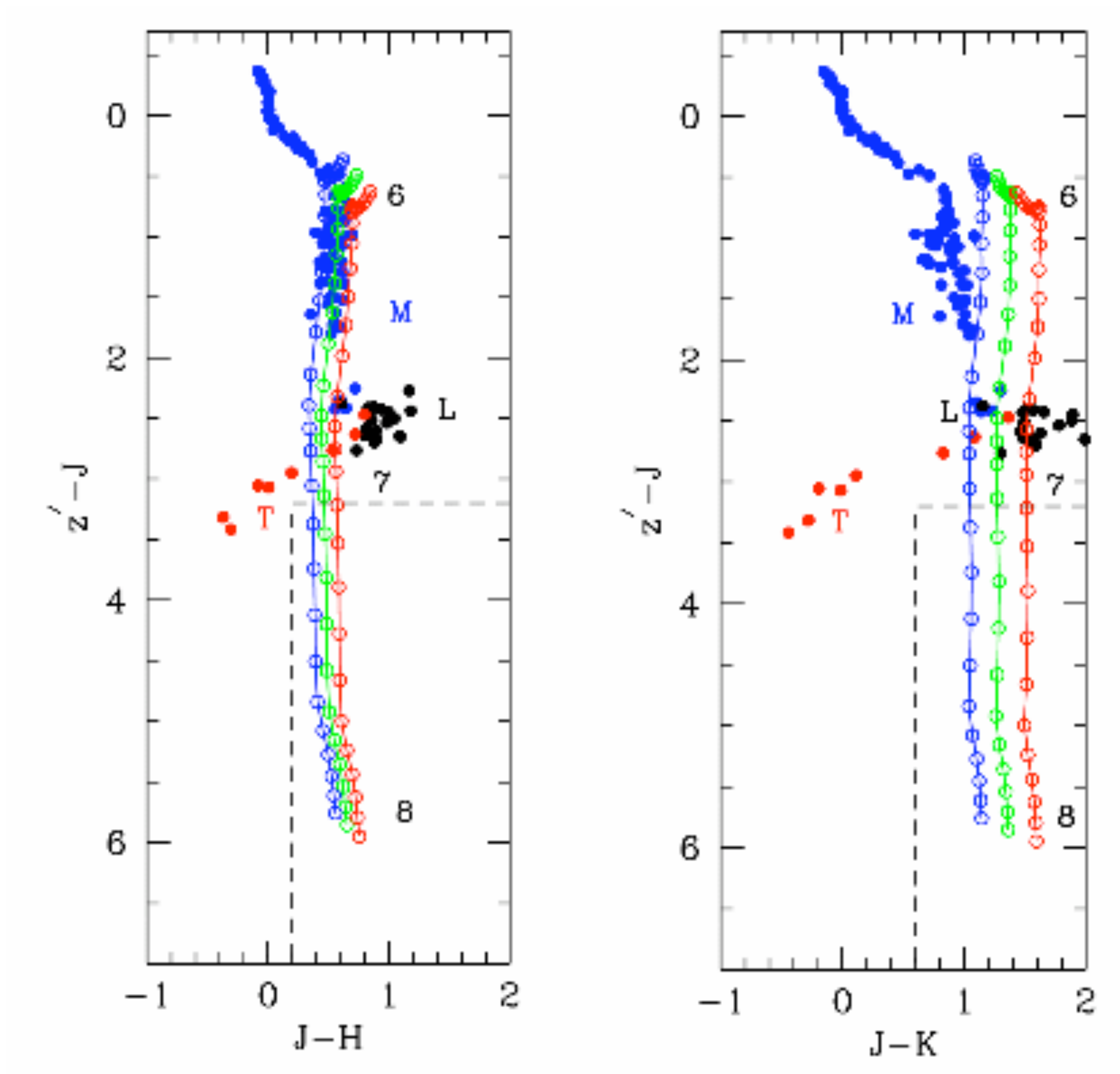


$N_{QSO} = 1, 10, 10^2, 10^3, 10^4$
$7.0 < z < 8.2$
10000
1000
100
Survey Area (sq. degrees)
18
19
20
21
22
23
24
25
J_{lim}

z~10 Quasars


N_{QSO} = 1,10,10^2,10^3,10^4
9.0 < z < 11.5
Survey Area (sq. degrees)
10000
1000
100
18
19
20
21
22
23
24
25
H_{lim}

Stellar Contamination?



Static Science: Red Galaxies and Reddened QSOs

- Science
  - Stellar mass buildup
  - Growth of black holes
- Observational challenge
  - Rare, Red, Faint
  - Galaxies
    - K > 19, J-K > 2, $n_{DRG} = 10^{-4}$ Mpc^{-3}
  - Quasars
    - K > 19, R-K > 4, J-K > 1.7
- Requirements
  - Modest area (1000 sq. deg.)
  - Modest depth
  - DRG science will be paved by UKIDSS and VISTA
    - Reddened AGN too?

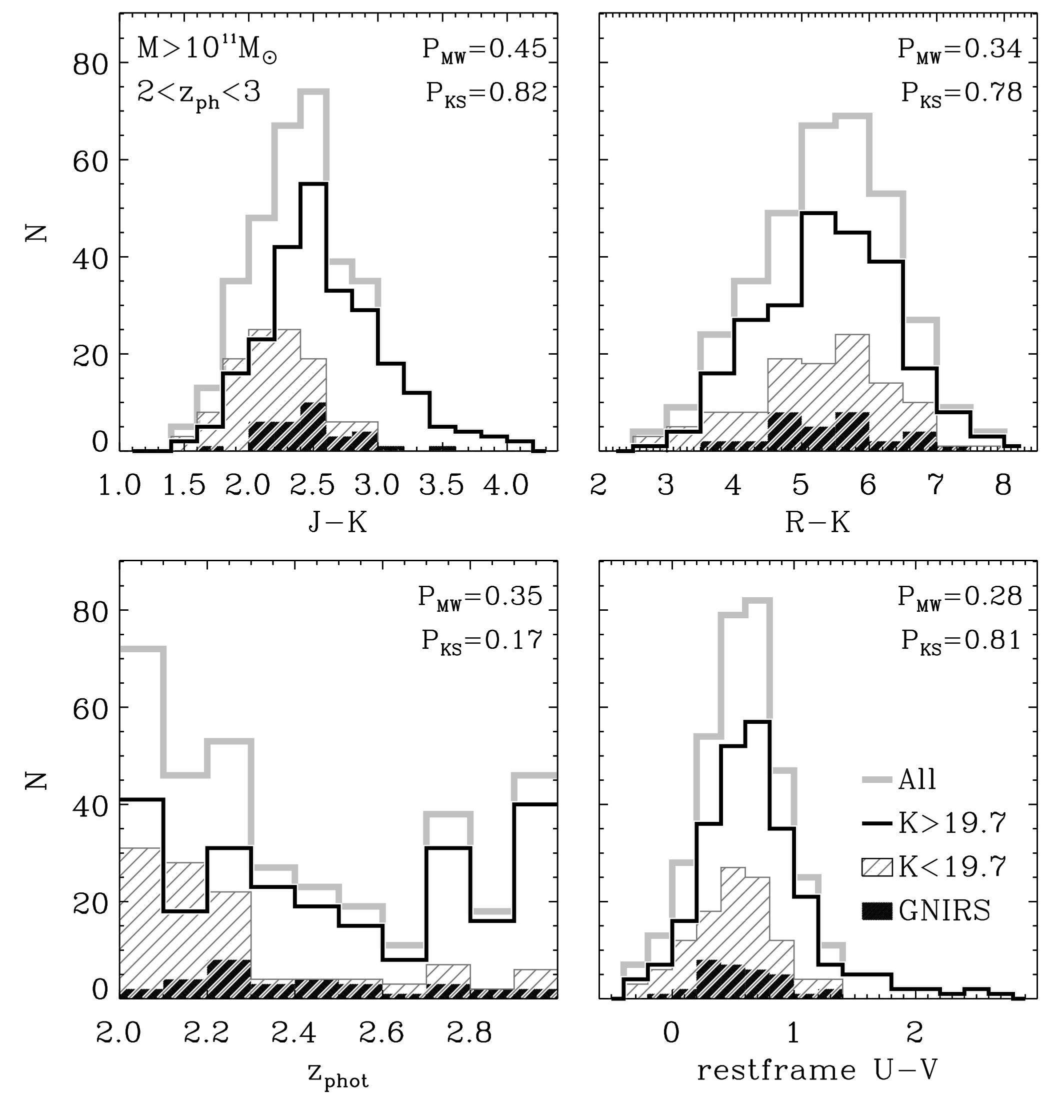


FIG. 1.— Comparison between the photometric properties of the GNIRS sample at $2 < z_{phot} < 3$ and a mass-limited sample ($M > 10^{11} M_{\odot}$) at $2 < z_{phot} < 3$. The probabilities (P) that the GNIRS sample and the full mass-selected sample have similar distributions, as derived using a Mann-Whitney (MW) and a Kolmorov-Smirnov (KS) test, are given in the panels. Additionally, we divide the mass-selected sample into its K-bright ($K < 19.7$) and K-faint ($K > 19.7$) members. The GNIRS sample may be less representative for a K-bright sample, as the redshift distribution is different.

Static Science: Red Galaxies and Reddened QSOs

- Science
  - Stellar mass buildup
  - Growth of black holes
- Observational challenge
  - Rare, Red, Faint
  - Galaxies
    - $K > 19$, $J\text{-}K > 2$, $n_{DRG} = 10^{-4}$ Mpc^{-3}
  - Quasars
    - $K > 19$, $R\text{-}K > 4$, $J\text{-}K > 1.7$
- Requirements
  - Modest area (1000 sq. deg.)
  - Modest depth
  - DRG science will be paved by UKIDSS and VISTA
    - Reddened AGN too?

Static Science: Red Galaxies and Reddened QSOs

- Science
  - Stellar mass buildup
  - Growth of black holes
- Observational challenge
  - Rare, Red, Faint
  - Galaxies
    - K > 19, J-K > 2, $n_{DRG} = 10^{-4}$ Mpc^{-3}
  - Quasars
    - K > 19, R-K > 4, J-K > 1.7
- Requirements
  - Modest area (1000 sq. deg.)
  - Modest depth
  - DRG science will be paved by UKIDSS and VISTA
    - Reddened AGN too?

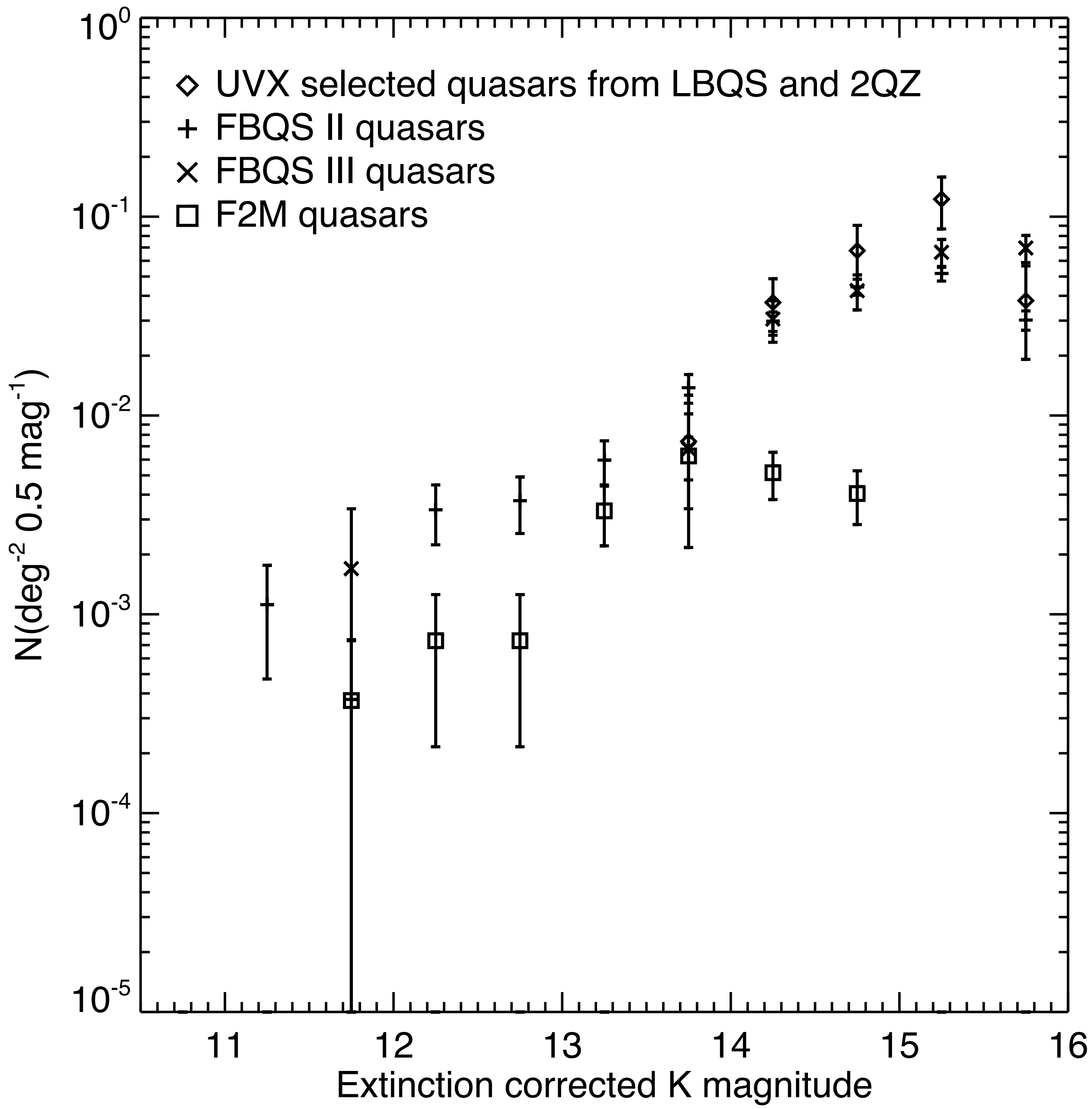


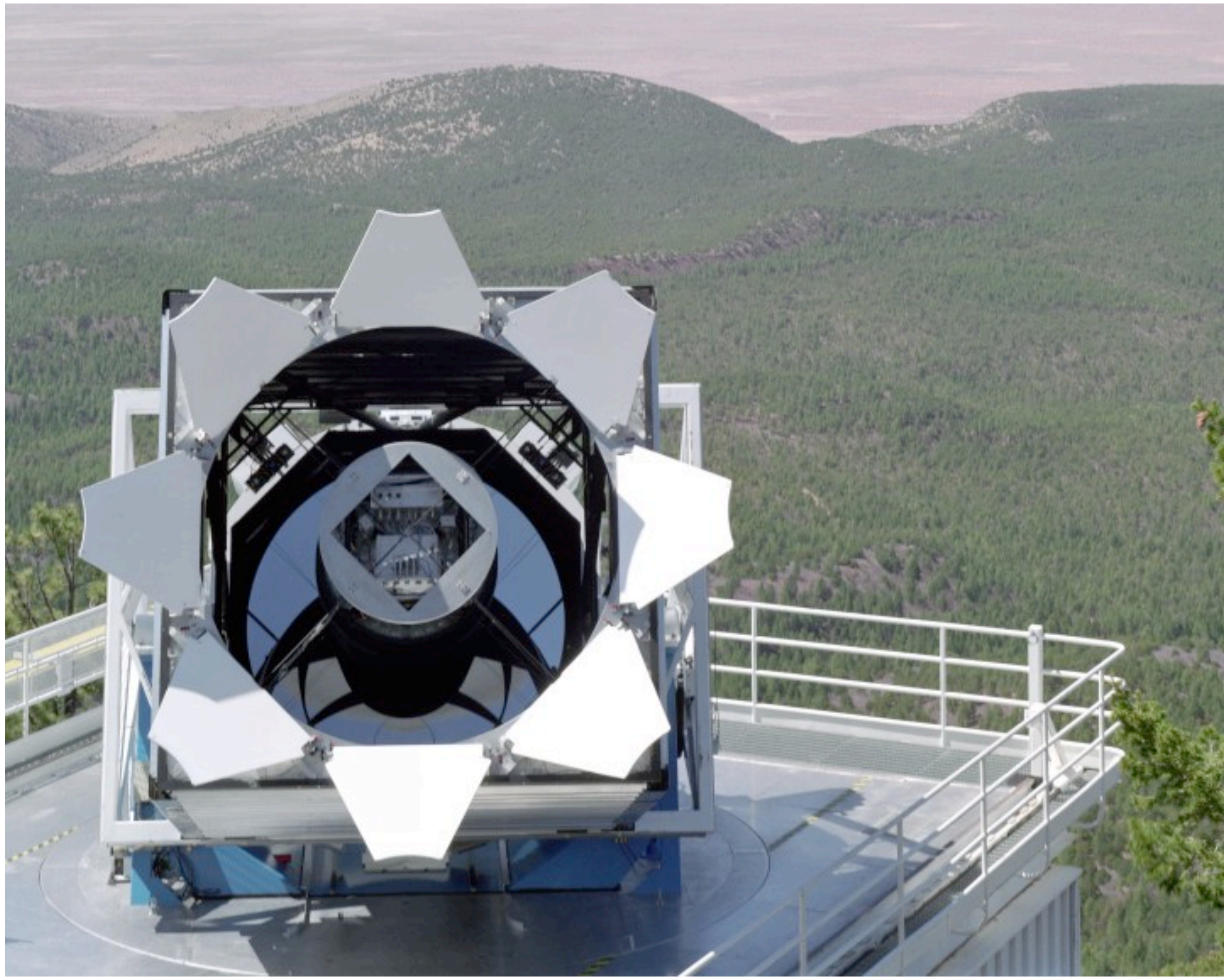
Fig. 19.— Spatial density of quasars on the sky of F2M red quasars corrected for K-band absorption and compared with FBQS II and III (assuming no absorption for those quasars).

Static Science: High z Clusters

Catchy Adam Stanford
image goes here

Static Science: SDSS synergy

- Science
  - Large-scale structure
  - Stellar mass of modern galaxies
  - Correlations with CMB, SZ
- Observational challenge
  - Large area
    - Northern sky
  - Faint (K > 21)
- Other projects
  - UKIDSS/LSA
    - Will have modest success
  - VISTA/VHS
    - Less overlap with SDSS, but 2dF
- Additionally
  - Connect to PANSTARS + push to higher z



Static Science: SDSS synergy

- **Science**
  - Large-scale structure
  - Stellar mass of modern galaxies
  - Correlations with CMB, SZ
- **Observational challenge**
  - Large area
    - Northern sky
  - Faint (K > 21)
- **Other projects**
  - UKIDSS/LSA
    - Will have modest success
  - VISTA/VHS
    - Less overlap with SDSS, but 2dF
- **Additionally**
  - Connect to PANSTARS + push to higher z

Title Query Results 7/31/08 9:29 AM

Sign on

SAO/NASA Astrophysics Data System (ADS)

Query Results from the ADS Database Go to bottom of page

Retrieved **200** abstracts, starting with number **1**. Total number selected: **979**. Sort options

#	Bibcode / Authors	Score Date / Title	List of Links / Access Control Help
1	2008ApJ...676.1281M Metchev, Stanimir A.; Kirkpatrick, J. Davy; Berriman, G. Bruce; Looper, Dagny	1.000 04/2008 A Cross-Match of 2MASS and SDSS: Newly Found L and T Dwarfs and an Estimate of the Space Density of T Dwarfs	A E F L X R C S U
2	2008MNRAS.384.1178B Bilir, S.; Ak, S.; Karaali, S.; Cabrera-Lavers, A.; Chonis, T. S.; Gaskell, C. M.	1.000 03/2008 Transformations between 2MASS, SDSS and BVRI photometric systems: bridging the near-infrared and optical	A E F L X R C S O U
3	2008ChJAA...8..119W Wang, Dan; Zhang, Yan-Xia; Liu, Chao; Zhao, Yong-Heng	1.000 02/2008 Two Novel Approaches for Photometric Redshift Estimation based on SDSS and 2MASS	A E F G X R C U
4	2007AJ....134.2398C Covey, K. R.; Ivezić, Ž.; Schlegel, D.; Finkbeiner, D.; Padmanabhan, N.; Lupton, R. H.; Agüeros, M. A.; Bochanski, J. J.; Hawley, S. L.; West, A. A.; and 8 coauthors	1.000 12/2007 Stellar SEDs from 0.3 to 2.5 μm: Tracing the Stellar Locus and Searching for Color Outliers in the SDSS and 2MASS	A E F L X R C U

Static Science: SDSS synergy

- Science
  - Large-scale structure
  - Stellar mass of modern galaxies
  - Correlations with CMB, SZ
- Observational challenge
  - Large area
    - Northern sky
  - Faint (K > 21)
- Other projects
  - UKIDSS/LSA
    - Will have modest success
  - VISTA/VHS
    - Less overlap with SDSS, but 2dF
- Additionally
  - Connect to PANSTARS + push to higher z

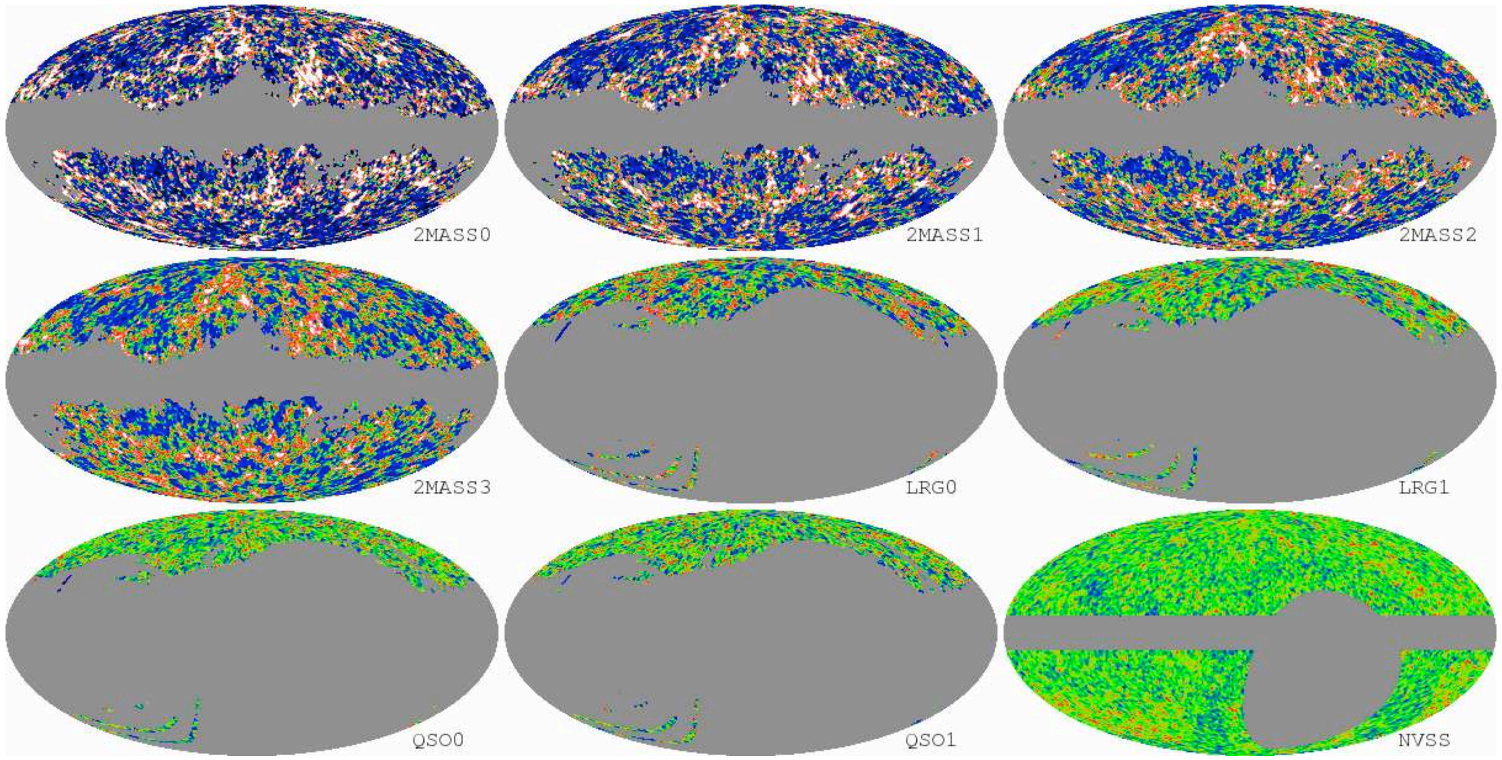


FIG. 1: The overdensity maps of various tracer samples in Galactic coordinates. The scale runs from $g = -1$ (black, no galaxies) to $g = -0.25$ (blue), $g = 0$ (green), $g = +0.25$ (red), and $g = +1$ (white, $\geq 2\times$ mean density).

Static Science: Galactic

- Science possibilities
  - Star forming regions
  - Low mass stars
    - Faint + cold
  - NEOs ?
    - Is there an angle for the IR?
- What is the 'killer app' here?
  - Very faint, very rare objects, very red objects

SASIR Static Science

Area	Faint?	Red?	Rare?	Vary?	Impact	Status	Team
High z QSOs	√	√	√	L	Reionization, black holes, IGM	1st draft	JXP
Reddened QSOs	√	√	?	?			
z>1 Galaxy Clusters	√	√	√	No			
DRGs	√	√	⊗	No			
Nearby low-mass stars	√	√	√	Proper motion			
Your science goes here							You