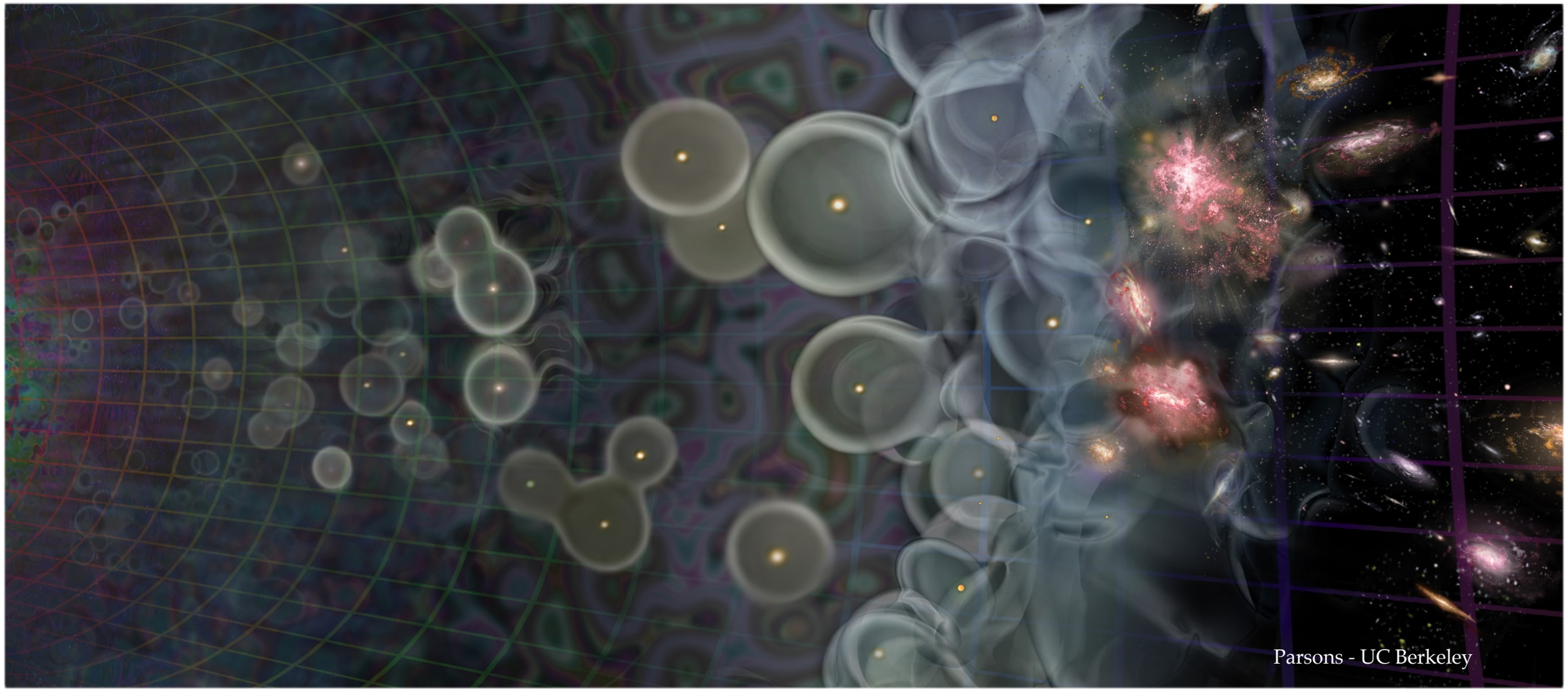

Archival Lyman-Continuum and Theoretical Reionization Analysis vs Z

A.L.C.A.T.R.A.Z.

Isaac Meisenheimer
Rogier Windhorst

A.L.C.A.T.R.A.Z.

Collaborators

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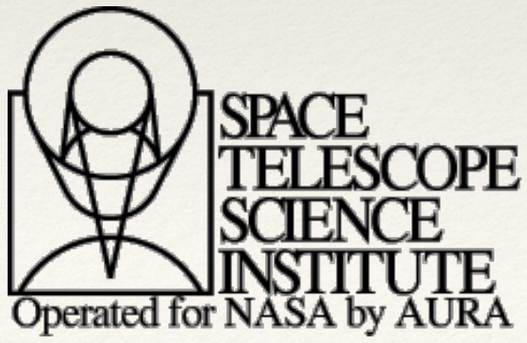
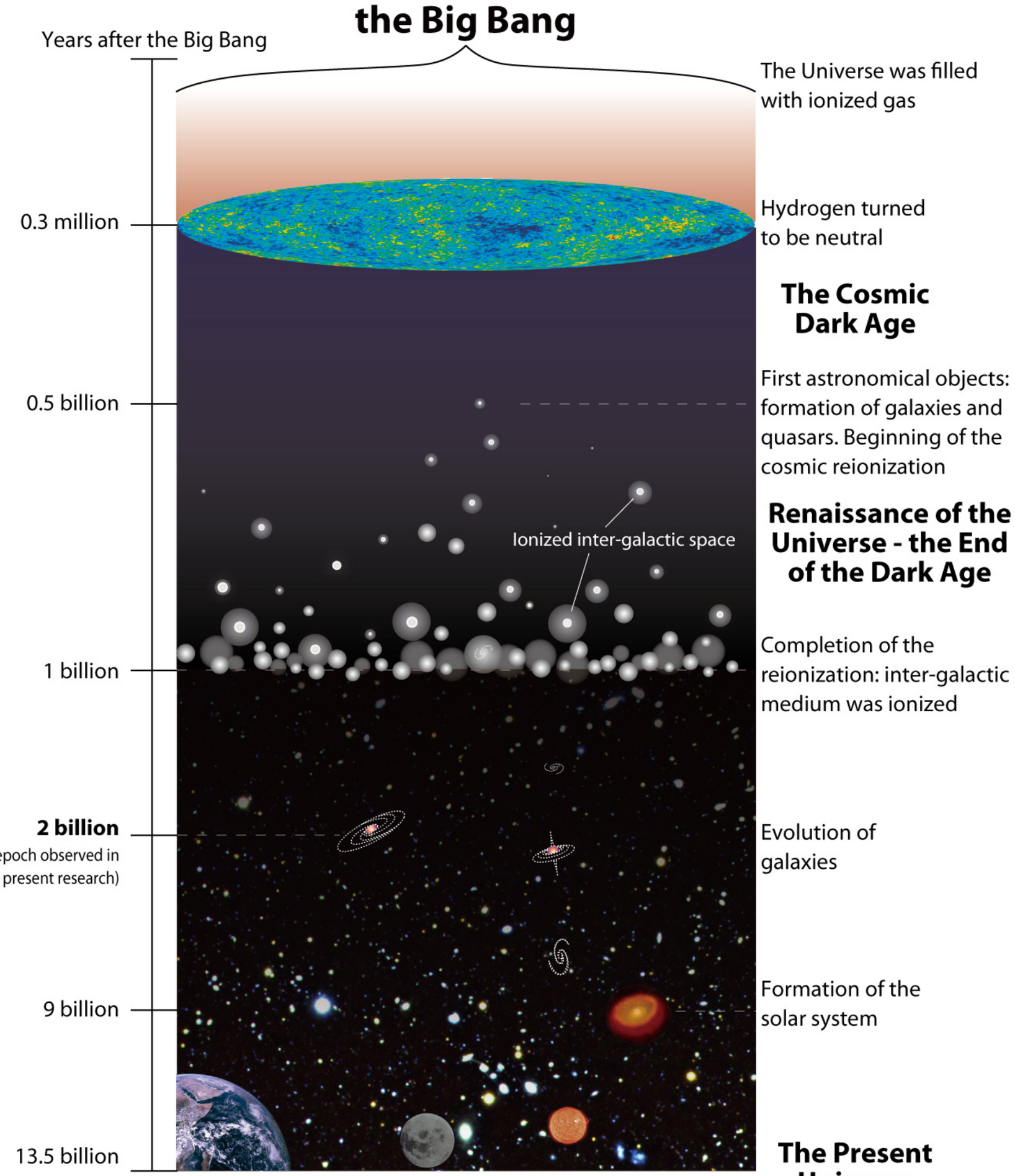


UiO : University of Oslo



images credit: NASA / WMAP Science Team, Subaru Telescope/NAOJ

Great Observatories Origins Deep Survey
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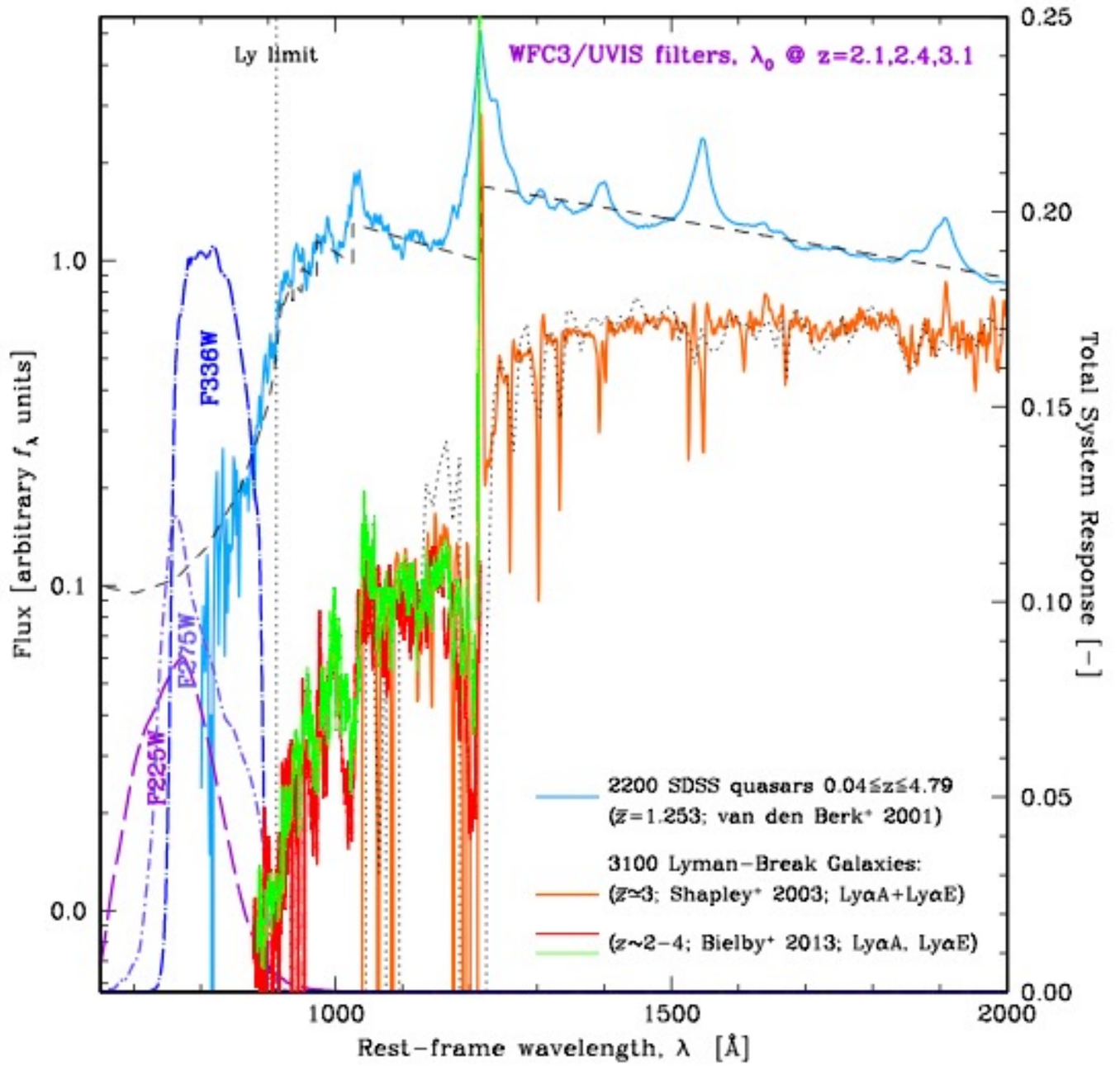

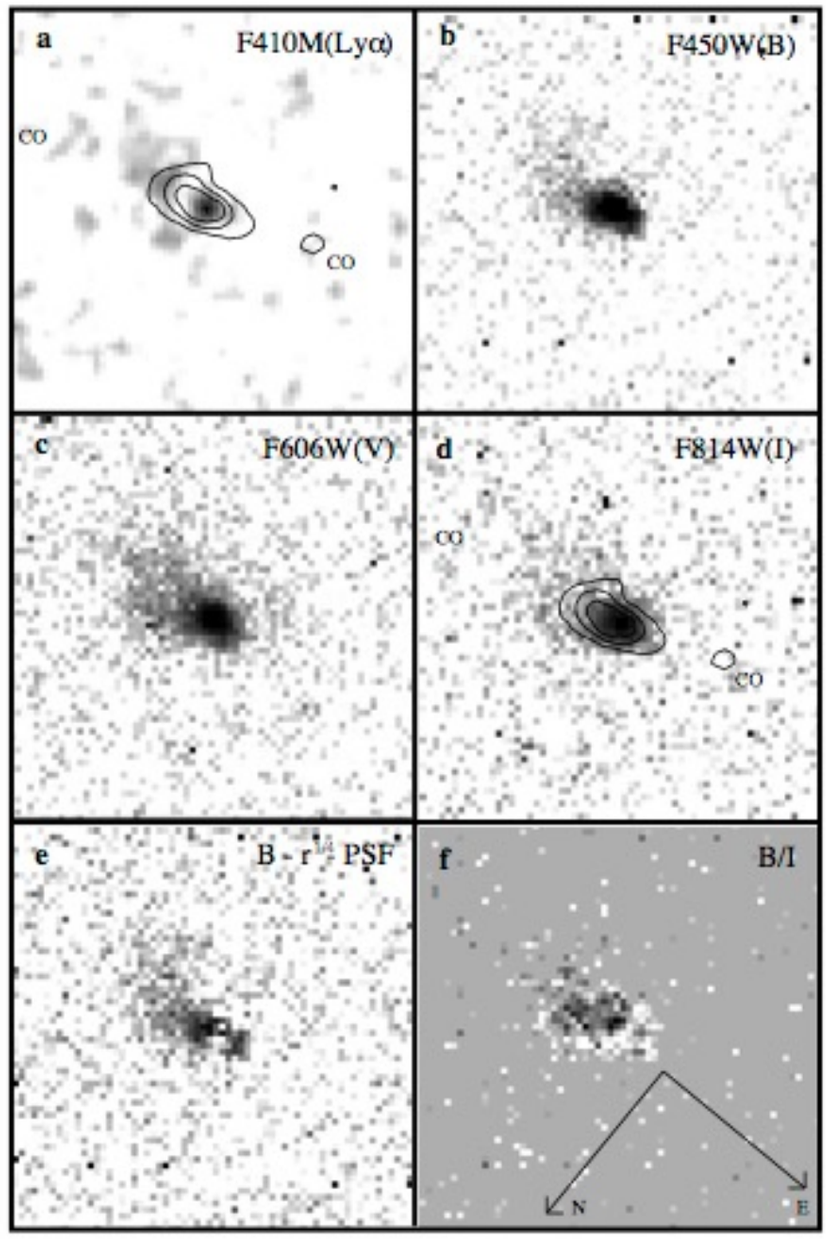

Fig. 1a [Right]: Composite rest-frame UV spectra from 2200 SDSS quasars (blue; van den Berk+ 2001) and 3100 LBGs [Shapley+ 2003 (orange); Bielby+2013 (red/green)]. WFC3 UV throughputs in F225W, F275W, F336W sample LyC for objects at z≈2.26, 2.45, 3.07. **Fig. 1b [RIGHT]**: Radio galaxy with weak AGN at z=2.390 (Windhorst+ 1998) in WFPC2 F410M (redshifted Lyα), B, V and I (longwards of Lyα). Bottom panels show the PSF-subtracted B-band image and (B–I) color gradient. In all panels, a blue cloud is visible towards the upper-left, along which LyC may escape. This is aligned with its radio source and CO- clouds.

Gold vs Silver

TABLE 2
LyC Stack Summaries of Gold Sample (High Quality Spectra)

Filter	z[a]	N[b]	m(LyC,obs)[c]	SNR[d]	m(LyC,1500Å)[e]	SNR(LyC,1500Å)[f]	m(UV$_{1500Å}$)[g]	SNR(UV$_{1500Å}$)[h]	LyC(Aper$_{area}$)[i]	UV$_{1500Å}$(Aper$_{area}$)[j]	f_{esc}[k]
Gold Sample: All Objects											
F225W	2.291 – 2.449/2.369	14	> 30.76	0.08σ	30.76	0.08σ	24.49	195σ	2.132	2.132	
F275W	2.450 – 3.009/2.653	18	30.61	7.50σ	29.95	0.17σ	24.86	159σ	1.687	2.145	
F336W	3.076 – 3.917/3.451	16	30.02	13.45σ	30.16	0.25σ	24.57	123σ	0.679	1.522	
F435W	4.800 – 5.977/5.230	6	> 99.0	0.28σ	99.0	0.28σ	25.72	25σ	1.188	1.188	
Gold Sample: AGN only											
F225W	2.291 – 2.291/2.291	1	> 34.68	0.05σ	34.68	0.05σ	25.93	10.67σ	6.260	6.260	
F275W	2.470 – 3.009/2.697	7	31.01	6.66σ	29.70	0.17σ	24.98	124σ	1.740	1.063	
F336W	3.217 – 3.474/3.346	2	29.14	9.32σ	29.72	0.22σ	23.99	125σ	0.518	0.773	
Gold Sample: Galaxies Only											
F225W	2.291 – 2.449/2.369	13	> 30.43	0.08σ	30.43	0.08σ	24.44	201σ	2.083	2.098	
F275W	2.450 – 2.975/2.625	11	30.64	8.17σ	30.59	0.06σ	24.80	119σ	0.484	2.675	
F336W	3.076 – 3.917/3.466	14	29.98	12.57σ	30.32	0.16σ	24.69	97σ	0.662	1.668	
LyC Stack Summaries of Silver Sample (High and Intermediate Quality Spectra)											
Silver Sample: All Objects											
F225W	2.262 – 2.449/2.360	32	31.57	9.20σ	30.78	0.08σ	24.59	238σ	1.588	2.311	
F275W	2.450 – 3.009/2.650	33	29.71	14.17σ	30.03	0.21σ	24.97	184σ	3.120	2.243	
F336W	3.076 – 4.149/3.511	30	30.70	11.48σ	30.77	0.22σ	24.58	149σ	0.880	1.929	
F435W	4.379 – 5.979/5.081	13	27.50	4.69σ	27.71	3.29σ	25.39	45σ	1.923	1.188	
Silver Sample: Galaxies Only											
F225W	2.262 – 2.449/2.359	30	31.53	9.41σ	30.76	0.08σ	24.55	201σ	1.460	2.345	
F275W	2.450 – 2.975/2.638	26	29.90	9.77σ	30.15	0.13σ	24.98	154σ	2.989	2.530	
F336W	3.076 – 4.149/3.522	28	30.79	10.30σ	30.58	0.25σ	24.65	131σ	0.784	2.000	

[a] Redshift range of galaxies included in stack/average redshift of stack.
[b] Number of galaxies with high or intermediate quality spectroscopic redshifts used in stack.
[c] Observed total magnitude of LyC of stack ($AB_{mag}/''^2$)
[d] Signal to noise ratio of LyC detection in stack
[e] Observed total magnitude of LyC of stack (AB_{mag}) measured in UV$_{1500Å}$ stack aperture (green; see Fig. 5–8)
[f] Signal to noise ratio of LyC detection in stack measured in UV$_{1500Å}$ stack aperture
[g] Observed rest-frame UV$_{1500Å}$ magnitude of stack
[f] Signal to noise ratio of LyC detection in stack measured in UV$_{1500Å}$ stack aperture (green; see Fig. 5–8)
[h] Size of LyC aperture in arcseconds
[i] Size of UV$_{1500Å}$ aperture in arcseconds
[j] Escape fraction of LyC where $f_{esc} = \frac{(f_{1500}/f_{LyC})_{stel}}{(f_{1500}/f_{LyC})_{obs}}$

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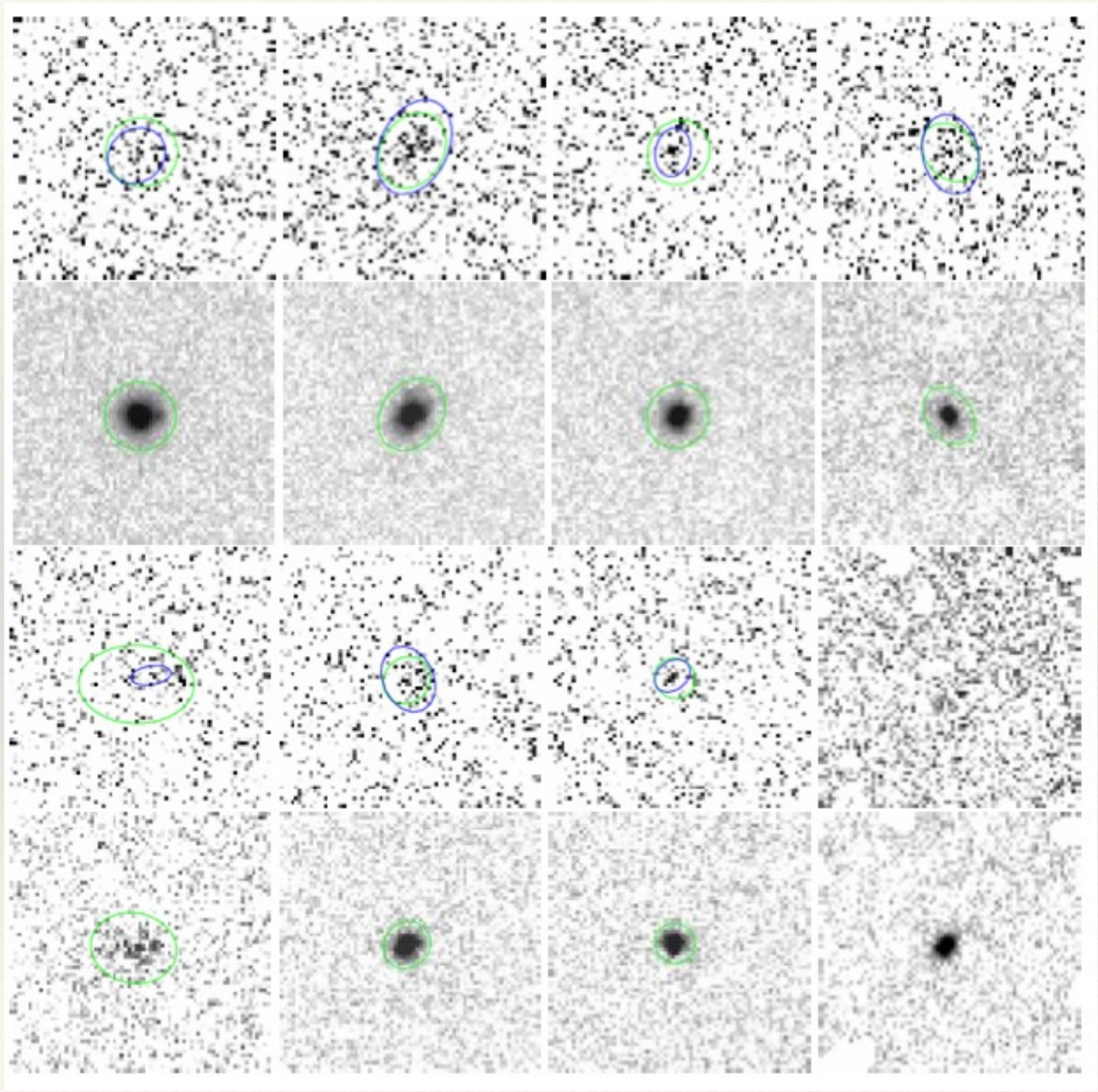
From Left to Right: Image stacks of Gold +Silver sample in the HST WFC3 filters F225W at z=2.26–2.47 (left), F275W at z=2.47–3.08 (middle left), F336W at z=3.08–4.35 (middle right), and ACS F435W filter at z=4.35–6 (right columns): *(Row 1):* LyC *(Row 2):* UVC for All Gold+Silver objects; *(Row 3):* LyC & *(Row 4):* UVC for (Gold) AGN. Blue ellipses indicate SExtractor LyC apertures using a 1σ detection criterion. Green ellipses are SExtractor MAG AUTO elliptical apertures, using the centroids and aperture of the restframe 1500A˚ UV-continuum (UVC) stacks. All image-stacks are $6.''4 \times 6.''4$.

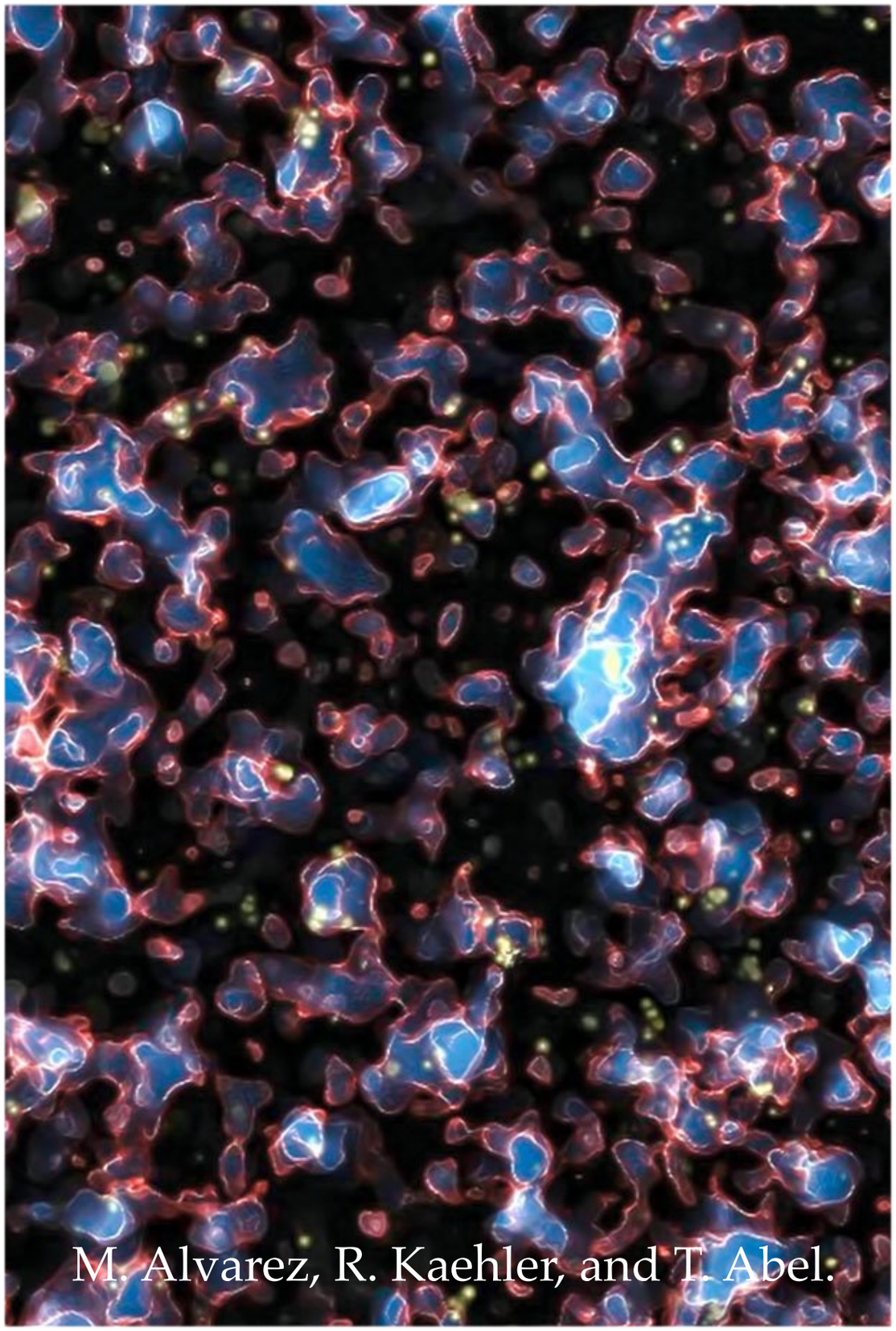
The remarkable result is that, despite very rigorous spectroscopic sample vetting, significant LyC is seen at most redshifts and for all samples.



Archival Lyman-Continuum and Theoretical Reionization Analysis vs Z

A.L.C.T.R.A.Z. 2015-16

- Proposal resubmitted for Hubble Cycle 23 and NSF funding, pending approval.
- Further analysis of HUDF to check results from ERS
- Study galaxy assembly with JWST
- Study Super-Massive Black-Hole Growth with JWST
- Study First Light and Reionization with JWST
- Study best groups and clusters lenses to find z>10



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