SEARCHING FOR

EXTREME HIGH REDSHIFT GALAXIES WITH 3D-HST

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EXPLORING COSMIC DAWN

ABSTRACT

With ever increasing capabilities, we are now able to push galaxy evolution studies to extreme high redshift (z>7). At these early times, the first galaxies begin forming stars. This light, however, is quickly absorbed by the neutral intergalactic medium. The result is that the Lyα line of hydrogen is lost. But with the recent upgrades to HST, we can now utilize the multiplexing capacity of grism spectroscopy to explore large samples of these systems. By taking near-IR spectra for every object in the field-of-view simultaneously, we can begin searching for galaxies with a favourable circumgalactic gas distribution where Lyα may be measured.

In this study we build on the work of 3D-HST to expand prior redshift distribution to include extreme high redshift galaxies (1<z<13). We systematically explore the emission lines of 100,000 photometric candidates over the five CANDELS fields using Bayesian techniques to quantify line detections. A flat prior is contrasted as control. We present preliminary results of 29 spectroscopic candidates selected for the first time as extreme high redshift galaxies. Follow-up of confirmed candidates will strengthen existing samples of distant galaxies and constrain properties of the early universe.

3D-HST

The 3D HST is a Hubble Space Telescope Treasury Program[1,2] to survey ~600 square arcminutes of sky with near-infrared slitless grism spectroscopy. This multiplexing grating + prism approach allows multi-wavelength spectral coverage of all field objects simultaneously. This is particually useful for morphological studies of resolved sources.

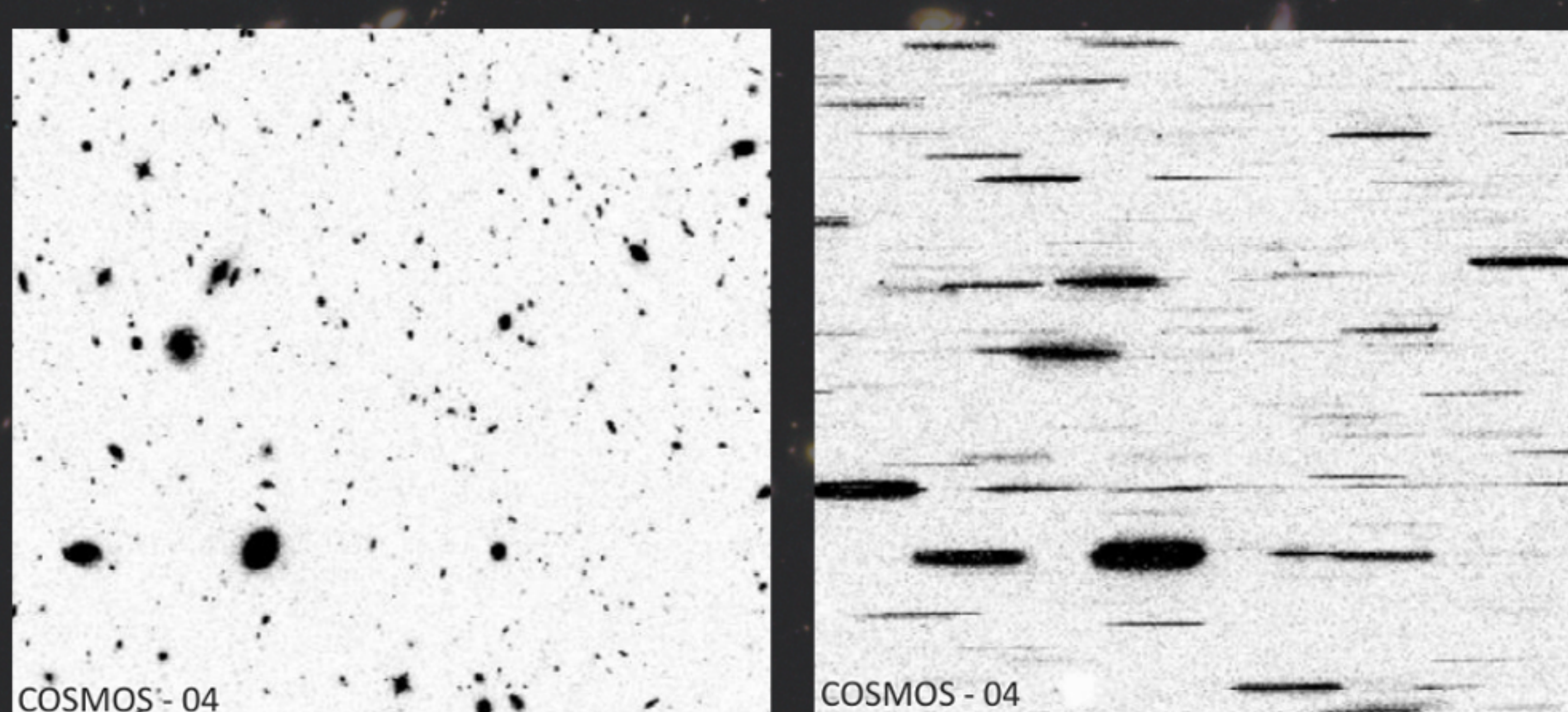

FIGURE 1: Pointing 4 of the COSMOS field. (left) Interlaced $J_{IR} = J_{125} + JH_{140} + H_{160}$ mosaic created from CANDELS +3DHST photometry used for spatial modelling. (right) Raw interlaced grism frame prior to cleaning. [Momcheva+15]

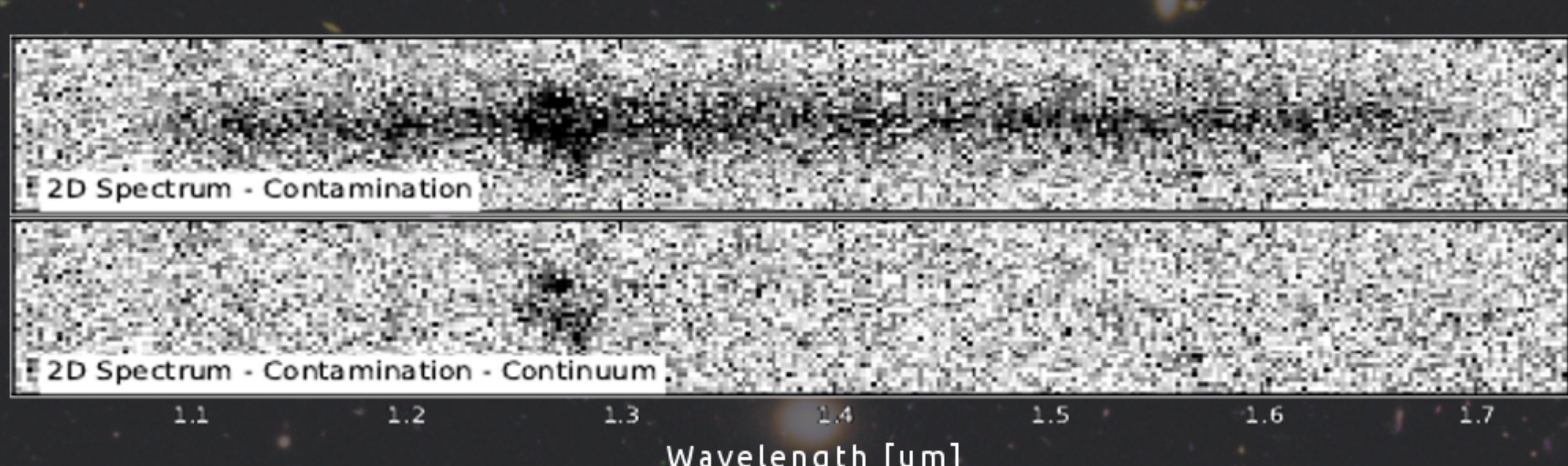

FIGURE 2: Cleaned (top) and continuum subtracted (bottom) 2D spectrum of object 16623 in GOODSN-04 measured with the G141 grism. An emission line is evident at 1.28um. Spectra are optimally extracted by considering the spatial profile of the photometric target image across the spectral trace. [Momcheva+15]

3D HST overlaps with over 70% of the well-studied CANDELS fields, providing a complement of multiwavelength photometry. When combined with other ground-based measurements, 3D-HST constrains an spectral energy distributions (SEDs) of an unprecedented number of galaxies, competitive with ground based efforts.

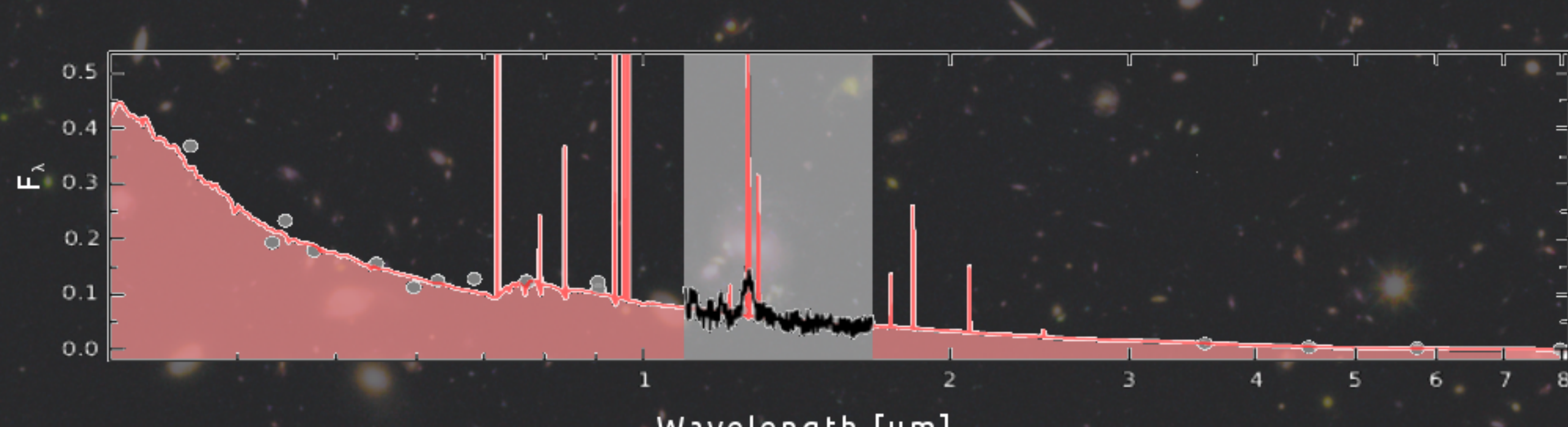

FIGURE 3: Spectral profile of object 16623 in COSMOS-04. Grey photometric points constrain the spectral energy distribution template fit in red. The black grism spectra shows agreeement with template. [Momcheva+15]

METHODS

Attempting to estimate the redshifts of distant galaxies with 3D-HST necessitates a Bayesian approach to combat spectral noise. As such, we obtain a redshift distribution for each object by fitting a library of spectral templates to photometric data using the EAZY software package[3]. This is adopted as our prior.

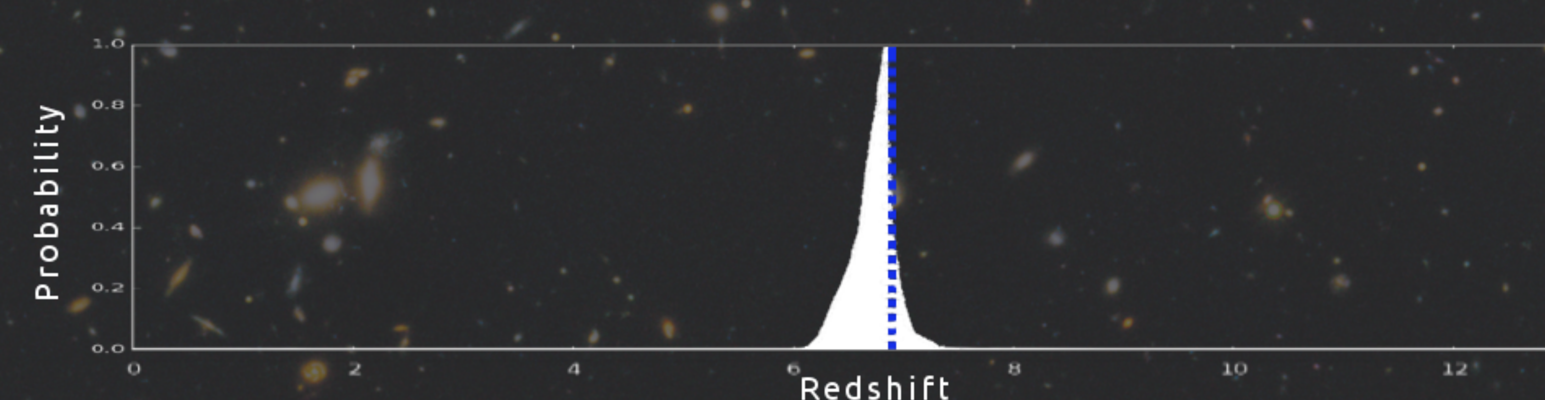

FIGURE 4: Redshift distribution for object 41637 in GOODS South. The photometric prior redshift distribution (white) matches well with the final grism redshift (blue) at z = 6.9.

Grism spectra are then processed using a novel line detection technique described in Maseda[4]. In short, a 1D spectrum is extracted from the grism frame and cleaned. No continuum is subtracted. The prior is convolved with a set of expected emission lines to determine a line probabilty spectrum, taking the spatial extent of the galaxy into account. Redshift are then determined from the now identified emission line.

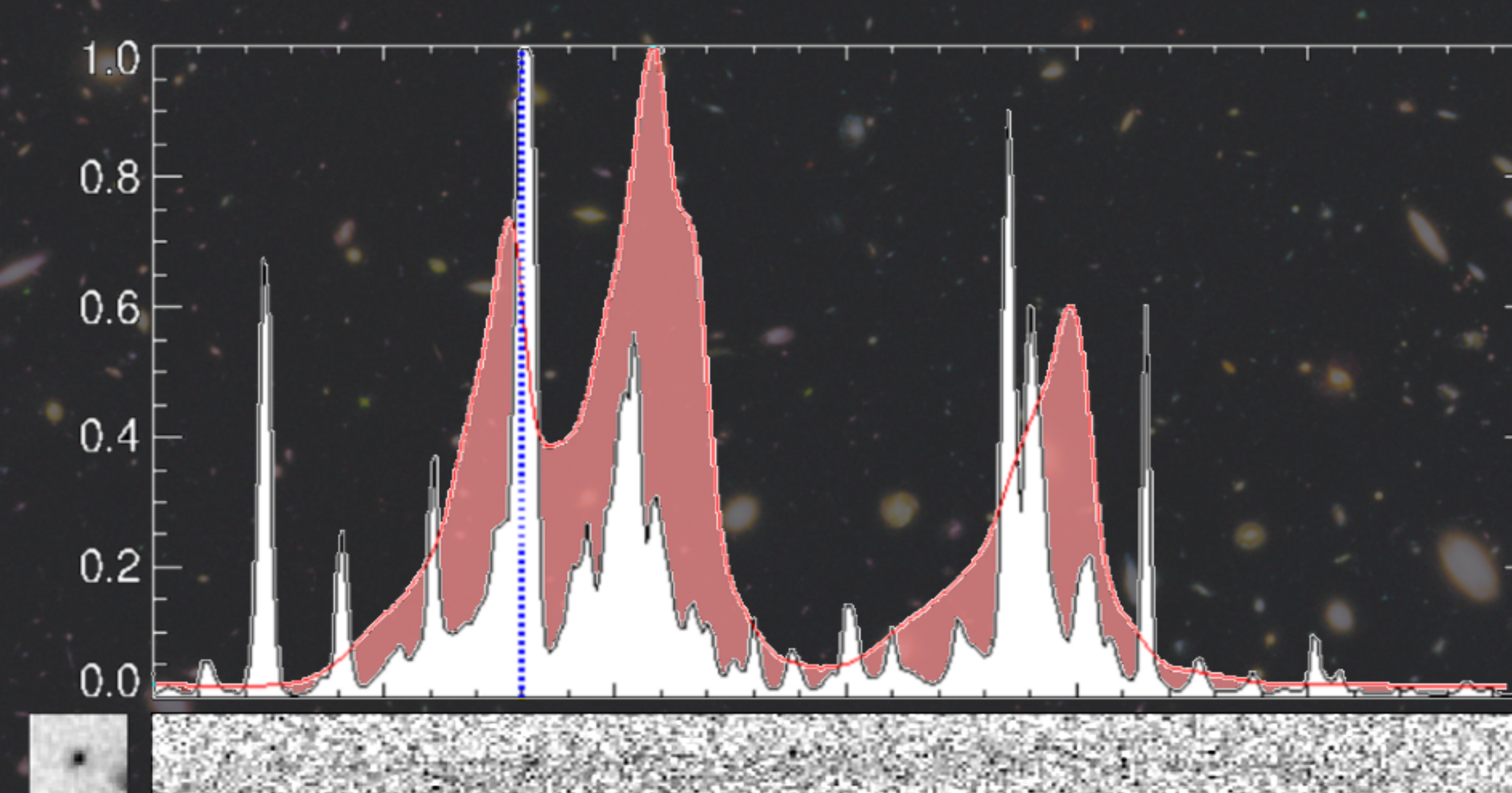

FIGURE 5: Spectral profile of object 41637 in GOODS South. The bottom grism frame is compressed into a 1D probabilty spectrum (white) using the image frame at left. The convolved prior distribution (red) is used to qualify the lline detection (blue) corresponding to z = 6.9.

RESULTS

2,000 objects with viable line detections are carefully reviewed by hand, rejecting many Hα false-positives and grism frame failues. A total of 29 objects are selected as extreme high redshift candidates at a mean redshift z = 6.3. It should be noted that none of these final candidates were found using Lyα, suggesting that systems with favorable circumgalactic gas distributions are extremely rare. Further work will check individual photometric frames and equivalent widths before follow-up with high resolution spectrographs.

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REFERENCES

[1] Momcheva et al. (2015) ApJS, 225, 2

[2] Brammer et al. (2012) ApJS, 200, 2

[3] Brammer et al. (2008) ApJ, 686, 2

[4] Maseda et al. (*submitted*) ApJ

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UNDERGRADUATE

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