Dropout Galaxies in JWST COSMOS Field

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Abstract

Finding protoclusters in the epoch of reionization plays an essential role in understanding the evolution of galaxies and the early ionized universe. With this aim, we turn our attention to the COSMOS-Web field (α=10:00:27.92, δ=+02:12:03.5), spanning 41'.5 by 46'.5. At the present time, the lack of open access to reduced data triggered us to develop our own image reduction techniques utilize a blend of modified methodologies from previous studies to address challenges such as cosmic-ray artifacts, wisp, and readout noise. Following image reduction, we crossmatch with COSMOS-2020 catalog, resulting in a preliminary multi-broadband imaging catalog. Our approach integrates photometric redshifts and color-color selections. Moreover, this catalog is not only designed for identifying high-redshift dropout galaxies but also potential protoclusters. Additionally, the photometric redshift determinations benefited from the exceptional angular resolution provided by JWST in near-/mid-IR imaging, further enhancing the accuracy and reliability of our results.

Method

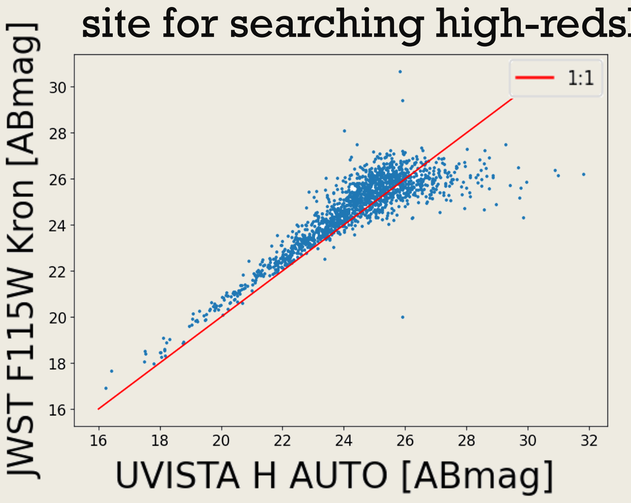
Our method is aiming for searching the prominent Lyα breaks from early galaxies, whose emission is absorbed by the neutral hydrogen along the vast space. The Lyα breaks feature would be captured by the first color criterion. (1) On the meanwhile, second criterion (2) measures the slope of the continuum plateau, making sure the we are not selecting Balmer breaks. Last but not least, to get rid of some red galaxies at low-z camouflage themselves as high-z galaxies, know as "red interlopers", we need to set criterion three (3) to the two-color selection.

Raw JWST Images → **Reduced JWST Images** → **COSMOS JWST Catalog** → **Dropout Candidates** → **F115W-dropout (z ~ 12)**, **F150W-dropout (z ~ 22)**

Customized JWST Pipelines — Photometry, Crossmatching — Color Selection

Results & Discussion

So far, COSMOS-Webb has the largest sky-coverage(~0.5 deg^2) among all surveys conducted by JWST. The field is also covered by previous telescopes ranging from X-rays to Radio. This not only makes COSMOS field one of the best site for searching high-redshift galaxies but also the protoclusters.

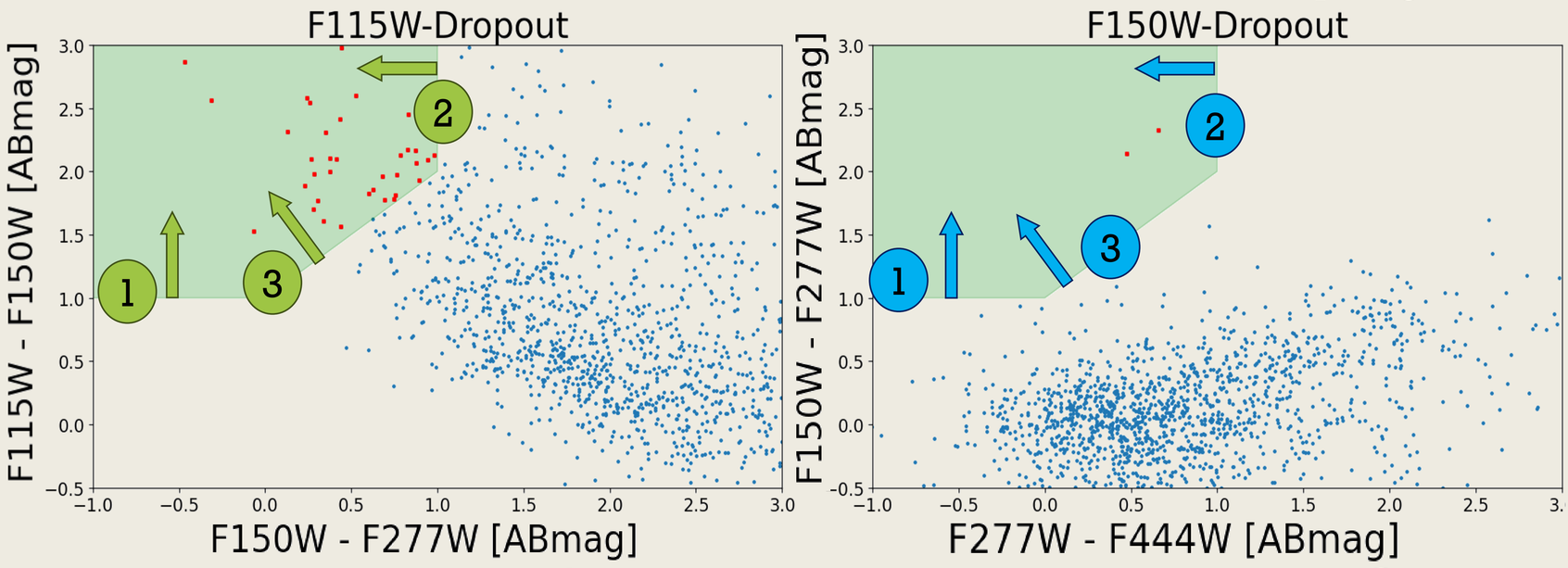


← Fig.1
The comparison of magnitude between UVISTA H-band and JWST F115W-band. The JWST magnitudes agree with those in the UVISTA images within 10%

The search for high-z protoclusters begin with constructing the JWST catalogs, where we aim for the sources that are not detected with the previous telescopes. Therefore, we crossmatched with COSMOS-2020 to eliminate known objects and compare UVISTA H-band with JWST F115W-band (Fig.1) for estimating the flux calibration from our custom pipeline. The magnitudes measured by JWST only differ from UVISTA H-band within ~ 10%, which indicates our reduction method in quite reliable.

Fig.2 ↙ and 3 ↓

The dropout candidates selected based on Harikane+2022 criteria are shown as red datapoints. Circles and arrows are indicators for the color selection criteria of dropout galaxies.



(F115W − F150W > 1.0) — 1
(F150W − F277W < 1.0) — 2
(F115W − F150W > (F150W − F277W) + 1.0) — 3

(F150W − F277W > 1.0) — 1
(F277W − F444W < 1.0) — 2
(F150W − F277W > (F277W − F444W) + 1.0) — 3

Two-color diagram, useful for identifying high-z galaxies, are being made using the JWST 4-bands catalog (F115W, F150W, F277W, F444W). The F115W-dropout colors are used for searching galaxies located at z ~ 12, similarly, F150W-dropout colors are searching for possible candidates at z ~22. We then use CIGALE for fitting the SED (Fig. 5) of each candidates. The redshift of cadidates are distributed over 11.3 to 12.5. Therefore, we are greatly optimistic for finding lots of z>12 galaxies within the COSMOS field.

Fig.5 ↘

The spectral energy distribution (SED) of dropout galaxies from Fig. 4 fitted with CIGALE. The red datapoints indicate the model fluxes. Open purple circles and green triangles indicate the observed fluxes and corresponding upper-limit, respectively.

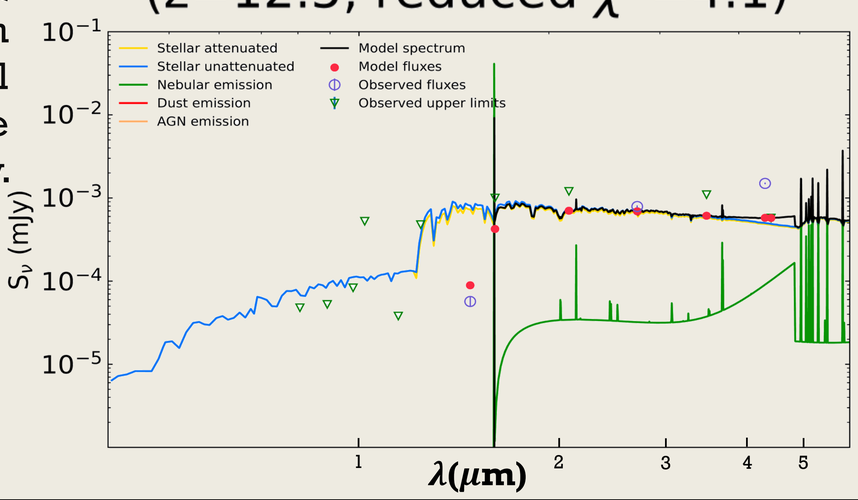


Fig.4 ↘

The example JWST images of dropout galaxies. Red 0.5-arcsec bars are shifted by 0.2 arcsec from the center of the image. The measured fluxes is also attached at lower right.