The technique for deriving photz can be mainly categorized into template-fitting and machine-learning methods. Template-fitting methods are more physical, which link to the theory and model of galaxies, while machine-learning methods map the relationship between redshift and color using a representative training sample of galaxies with both photometry and known redshifts. Template-based methods have already widely used, and provide better results compared to machine-learning ones.

Among various template-based methods, Eazy has been shown to have best performance (thus with highest citation), producing redshift estimates with the lowest scatter and the smallest fraction of outliers of any of the public photometric redshift codes. Eazy become even more popular after the launch of JWST. Therefore, we chose to adopt Eazy as our future photz code. In recent tests, our primary goal is to investigate how different templates and input filter combinations will affect photz accuracies of Eazy, using galaxy sample of different imaging data (HST, JWST, etc).

Results

1. Archive catalog (all members): In order to ensure that we correctly use the Eazy code, we use Eazy to run Stefanon2017's catalog (16 filters and F160W-selected), and find that our results are consistent with them in terms of scatter and outlier fraction, even though their photz values are the median of ten different codes. This indicate that our code configuration has no problem.

We repeat the above procedures with priors and without priors. We found that the scatters and outlier fractions are not change. So we concluded that the provided prior from Eazy are quite weak constraints during the fitting.

We also try different templates to see the difference. We chose four main templates which are commonly used in the literature. Through comparing derived photzs and true speczs, we found the scatters are almost kept constant using different templates and are identical to that of Stefanon2017, while the outlier fractions vary slightly but the number different are quite small (~3-4 objects). It seems that these templates have almost same performance on Stefanon2017's catalog.

2. HFF catalog (Chao): We repeat the photz measurement of HFF M0416 clusters from Shipley et al. 2018, using the same software (Eazy), configuration file, template, and catalog (i.e., Shipley's catalog, 19 filters). The derived values are almost identical to theirs. This indicates that the usage of Eazy on HFF (and previously on EGS) has no problem. We also take their seven HST bands photometry to derive photz, and compare with Specz, the scatter and outlier fraction become worse compare to that of using 19 filters.

Next we use their seven-band SEDs to derive photz with same configuration but different templates, and then compare with specz. We found that the resulting distributions are is not sensitive to the templates.

Since we have already measured the same cluster as Shipley2018 (i.e., HFF/M0416), We use our SED and their template + configuration to re-derive Photz. The only difference is that our SED are from single Sersic model while their SEDs are from aperture photometry. For objects with specz, we find both Single Sersic method and aperture method can reach consistent results.

3. JWST+HST catalog (Bingcheng+Wen): By using JWST NIRCam model flux ONLY, the photo-z accuracy can reach 18% outlier fraction. If HST NIR photometry is introduced, it help to remove outliers with 3 main characteristics: No breaks recognized after F115W (Majority, correspond to intermediate z); Misidentification btw Lyman and Balmer break (2 peaks in Prob. plot);Vague Lyman Break Point btw F115W and F150W (correspond to z = 10) JWST model flux + HST aperture photometry(or model flux) gives best photo-z measurement (2.0% outlier fraction). It is superior to previous HST+Spitzer at z>4 because of better constraint at rest-frame optical, where EAzY may capture Balmer break.

However, the heterogeneity in multi-band observations can affect the accuracy since the SNR in non-detection/shallow exposure (e.g., Spitzer) can strongly affect chi^2. This requires a careful consideration of flux error input. When employing ~10% additional flux error to JWST photometry, the code derived a balanced result and chi^2 can be comparable with selection criteria established by some published work. Compared with sfhz template, Larson+2023 performs better. This is explained by the lack of high-z red populations in sfhz template. However, excessive red populations at high-z are sometimes unphysical, leaving a caveat in selecting high-z red galaxies.

In terms of using existing photometry catalog from Stefanon+2017, we speculate that HST+JWST photometry (spanning wavelength range from F606W-F444W) should suffice to present satisfying photo-z estimation for high-z (z>4) galaxies. This is also verified when including low SNR ground-base observation or data from Spitzer, there’s no significant differences.

4. JWST AGN (Changhao) : Using spectroscopically confirmed galaxies selected from MUSE-HUDF survey and subsequent mock AGNs created from the galaxy sample, we study the effect of AGN presence on photometric measurement using EAZY for sources with redshift 3~5. We first measure the photometric redshift for our galaxy sample and compared with their spectroscopic redshift results. The photometric redshift are measured using EAZY, with photometry calculated from the 9-bands JWST NIRCam images in JADES field. Overall, templates named as “12\_fsps\_6\_blue” have the best performance in terms of outlier fraction. This results agrees with Larson et al. 2023, from which this template is provided. The outlier fraction is significantly smaller when using GALFITM model flux than using segmentation flux. Especially for sources with the reddest color. Therefore, GALFITM model flux is generally a better choice over segmentation flux when running EAZY.

When running EAZY on mock AGN samples, we find that most AGNs with high Eddington ratio (larger than 0.1) and low dust-attenuation (Av<1.5) have bad phot-z results and are classified as outliers (90% outlier fraction). For AGNs with small Eddington ratio or large dust-attenuation, outlier fraction are low and remains constant (10%).

5. JWST+HST+CFHT+WIRCAM catalog (Limin) : We conducted photometric redshift estimation using our aperture corrected photometry catalog, employing the same bands as Stefanon et al. 2017. Remarkably, our photometric redshift estimates were almost identical to those obtained from Stefanon's catalog. To further validate our method, we tested different templates with and without prior information, yielding comparable results. These findings indicate that our photometry method is reliable for photometric redshift estimation.

We conducted photometric redshift estimation using our aperture corrected photometry catalog, employing the same bands as Stefanon et al. 2017. Remarkably, our photometric redshift estimates were almost identical to those obtained from Stefanon's catalog. To further validate our method, we tested different templates with and without prior information, yielding comparable results. These findings indicate that our photometry method is reliable for photometric redshift estimation.

In particular, we analyzed the photometric redshifts of high-redshift galaxies and discovered that the inclusion of prior information significantly worsened the results. This indicates that for faint galaxies, which are highly likely to be at high redshifts, the addition of any prior information should be avoided.

Catalog file (SED+photz)

Here put the link to download our testing catalog:

https://github.com/CSSTwg/photz/tree/main/catalog

Demo

Here we provide a demo package which include configure file, all available templates, and an input multi-band photometry. People can download and directly run it.

https://github.com/CSSTwg/photz/tree/main/demo

PPT and weekly document

https://github.com/CSSTwg/photz/tree/main/ppt\_weekly\_document