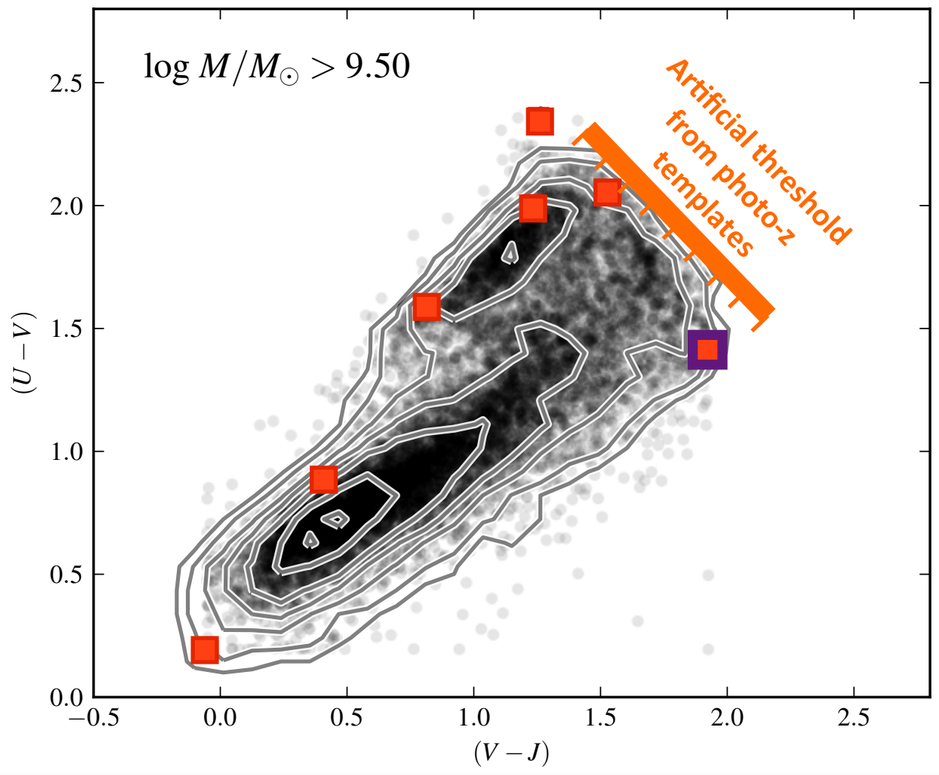
Highly Obscured, Massive, Evolved Galaxies at $z > 1$

Gabriel Brammer (STScI, ESA/AURA) & the 3D-HST team

Abstract

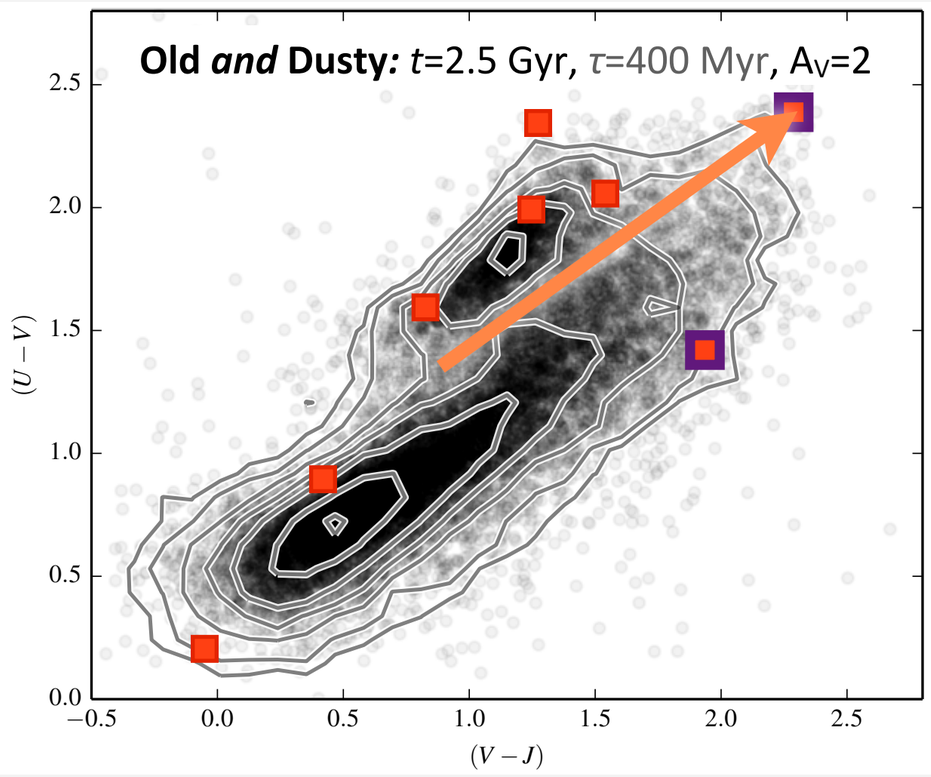
Among the most massive galaxies at $z > 1$, we have uncovered a significant population of galaxies with unique SEDs that are best fit with highly-obscured evolved stellar populations (log $M/M_\odot > 11$, $A_V > 2$, age > 1.5 Gyr). These are not galaxies at the detection limit or galaxies with the most extreme optical-IR colors: they have always been lurking in IR-selected photometric surveys but with their redshifts significantly overestimated and subsequently-biased derived stellar population properties. Characterizing this population has previously been impossible even with medium-band near-IR photometry due to strong degeneracies between photometric redshifts and SED shapes. We can now begin to critically break those generacies with robust emission-line redshifts obtained from the 3D-HST slitless spectroscopy survey (Hα and [OIII] emission lines at $1 < z < 2$). Understanding this population is imperative for interpreting the evolution of the high-mass end of the galaxy stellar mass function; these galaxies are particularly demonstrative of how the capabilities of JWST—rest-frame optical imaging at $z >> 2$ and deep NIR spectroscopic characterization—will be crucial for unlocking the dusty, high-redshift universe.

UVJ rest-frame colors

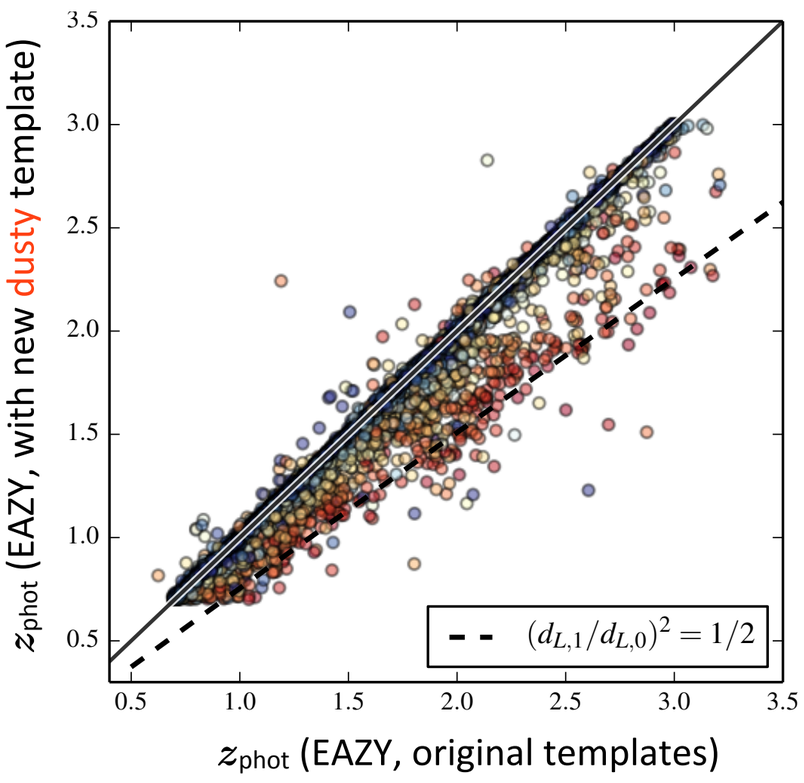


The default EAZY photo-z template set does not adequately span the full color space of the galaxy population, and therefore imposes an artificial threshold in derived rest-frame colors (e.g., *U–V, V–J*) at the reddest colors.

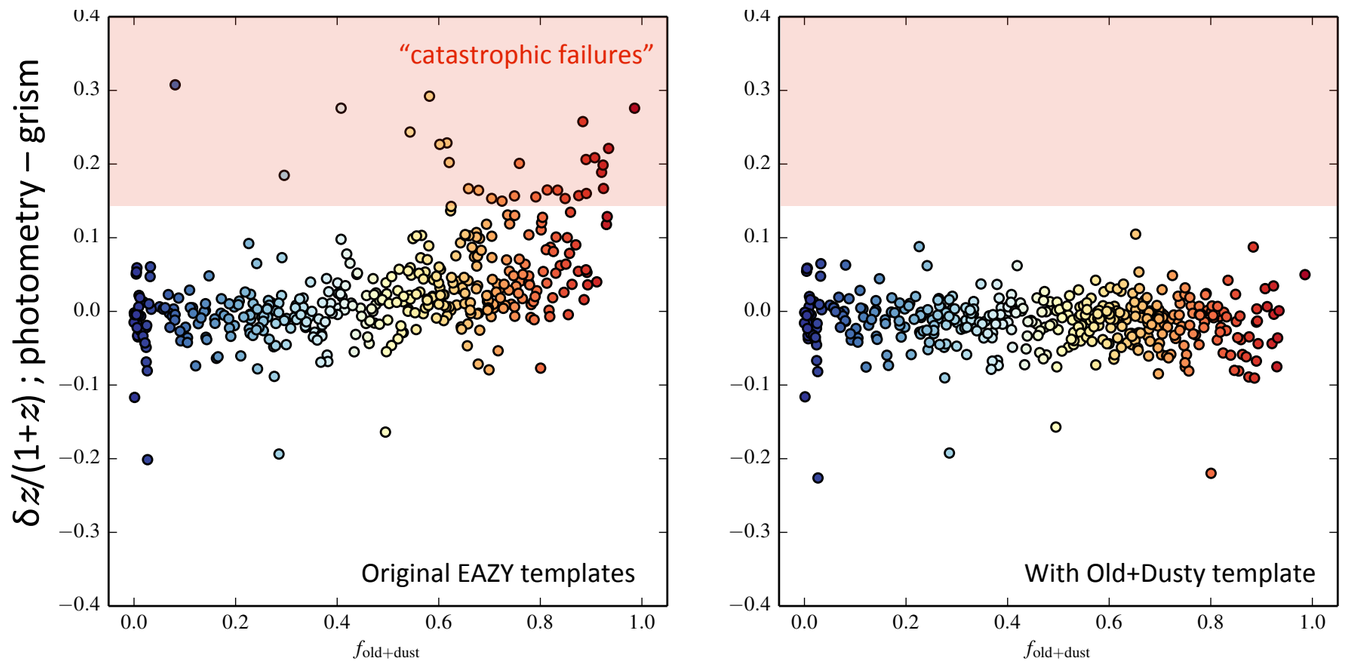
Probing the reddest colors requires an additional template that is both <u>old</u> (>2 Gyr) and <u>dusty</u> (A_V=2).



Redshifts

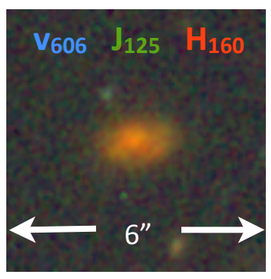


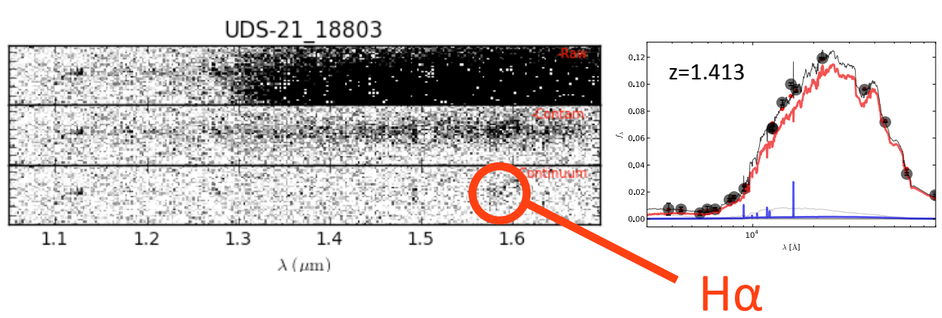
Adding the new template significantly changes the derived photometric redshifts, generally pushing the reddest objects to (substantially) lower redshifts.

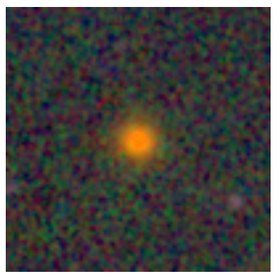


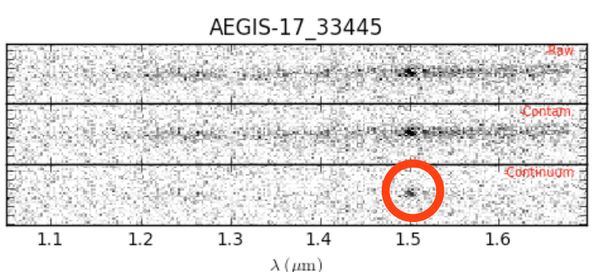
Are the new redshifts correct? It is often extremely difficult to obtain spectroscopic redshifts of these reddest galaxies. With deep WFC3/IR grism spectra and no target preselection, **3D-HST** is able to obtain *spectroscopic redshifts* of galaxies spanning the full color range. Now comparing to the grism redshifts, the new template does indeed dramatically improve the photometric redshifts of the reddest galaxies.

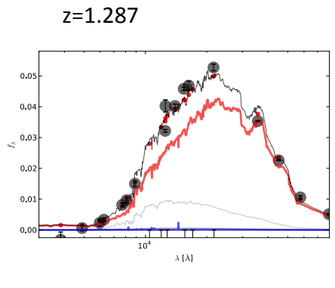
WFC3/IR grism spectra











Hα