Imaging of High-z galaxies with the ELT

Simulations: results

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Science Drives and Goals

- Obtain morphological information of primordial (z>4, up to ~10) galaxies to provide insights on mode and times scales of galaxy early assembly (sizes, SF densities, signs of interactions, AGN, etc.)
  - primordial galaxy are expected to be knotty/high SB (lensing observations, local LBGs, theory) ⇒ need ~10 mas resolution

- Detection limits of most distant galaxies (deep fields, depth vs area), high-z SNe etc.

➡ Investigate competition/synergy with JWST (nearIR imaging) by identifying ELT niche

Single high-z galaxy simulations

Method: Use M.Puech's pipeline by projecting data cubes to produce continuum images (in H, K bands)

Galaxy templates: *HST/ACS images* of z≲0.2 (late-type/Irr) galaxies

- pixel size allows suitable spatial resolution at z>~4
- H-band at z=4 probes rest-frame wl of ACS obs (no K-corr)

Empirical relations used to extrapolate and rescale *fluxes and sizes* of local templates $K_s(M_s,z)$, $R_H(z)$, $R_H(\lambda)$, $L_K(R_H)$ (H-K_{AB} neglected), intrinsic SB increases with z (quite uncertain!)

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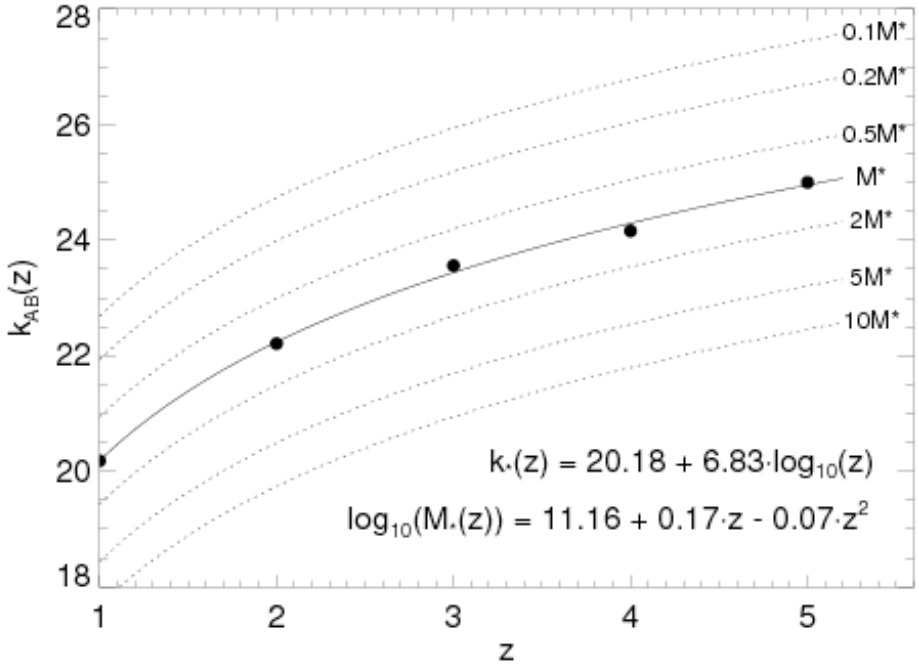

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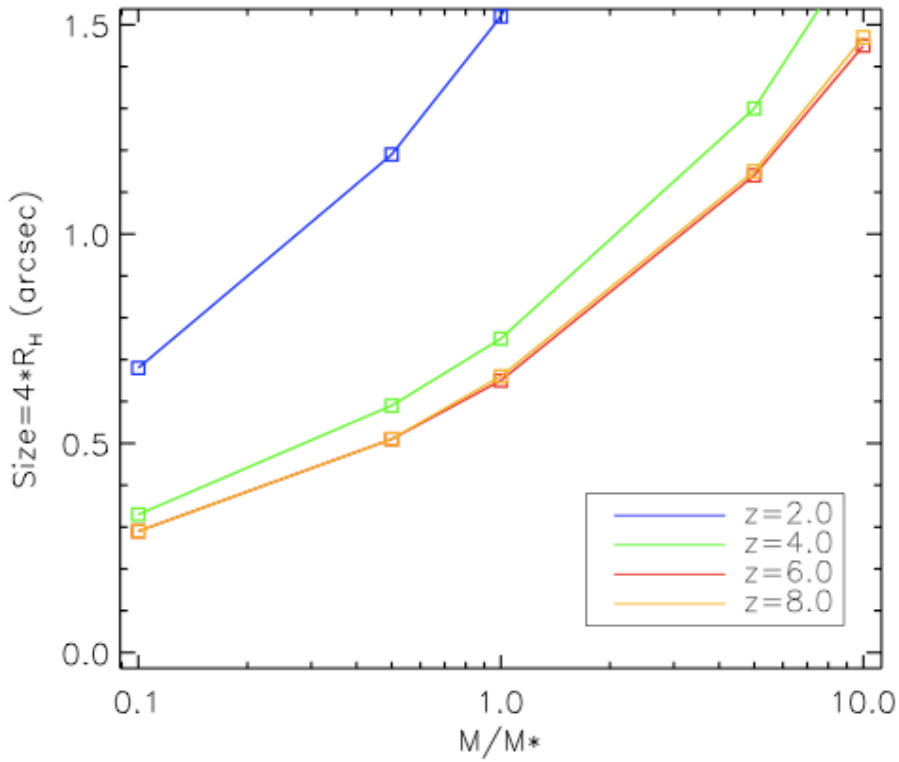

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Reference case: M_s^* galaxy at z=4, H_{AB}=24.3

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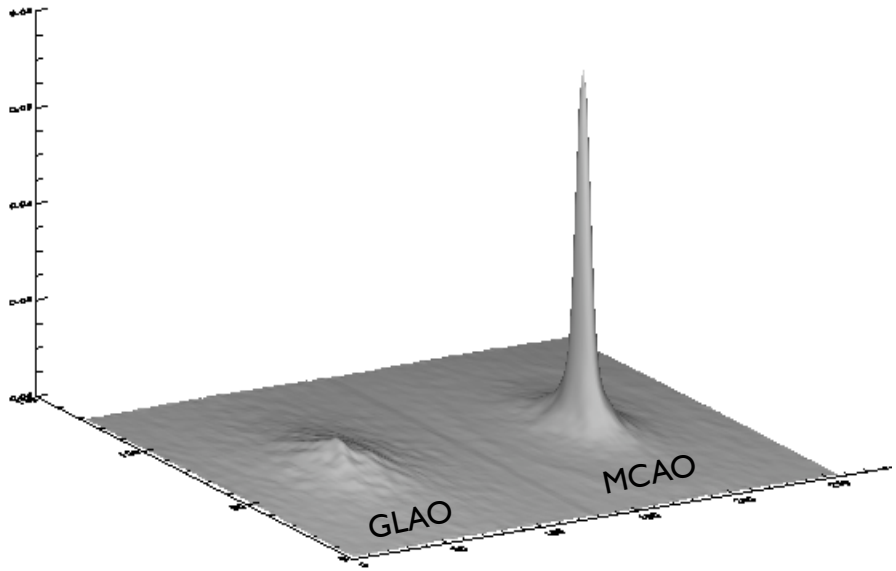
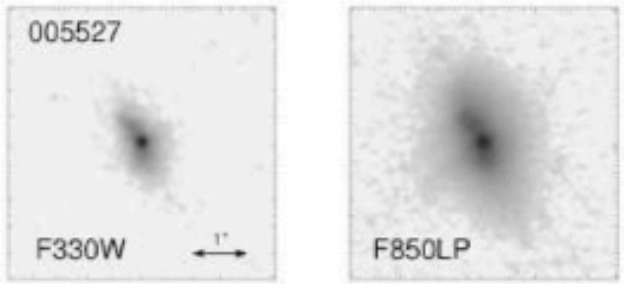
Instrumemt params (default)

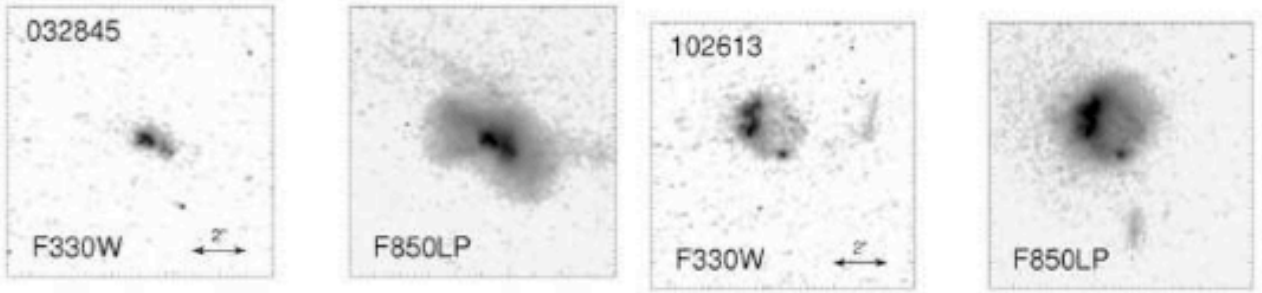
D=42m ExpTime=10h
Pixel=30 (4) mas
PSFs: MCAO (0.8" seeing): 50% SR
(GLAO also used)
Sky=15.8 AB/arcsec^2 in H (continuum+OH), 10x lower between OH-lines (from Joe's plot/data)
(incl. thermal bckgrd which dominates in K_s)

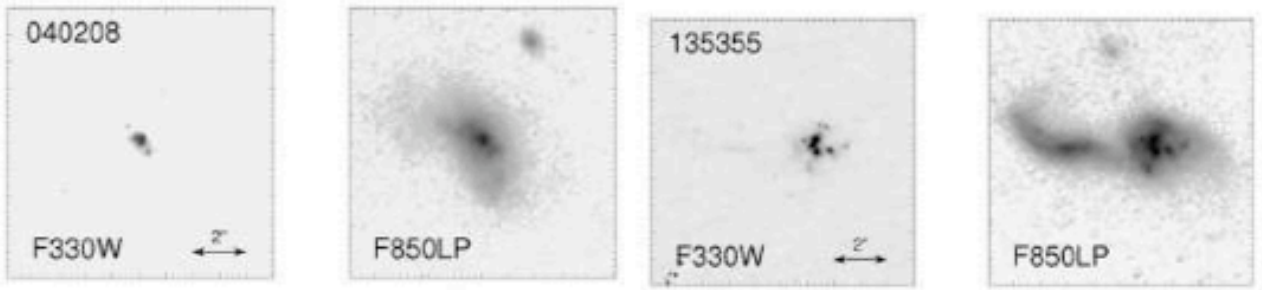


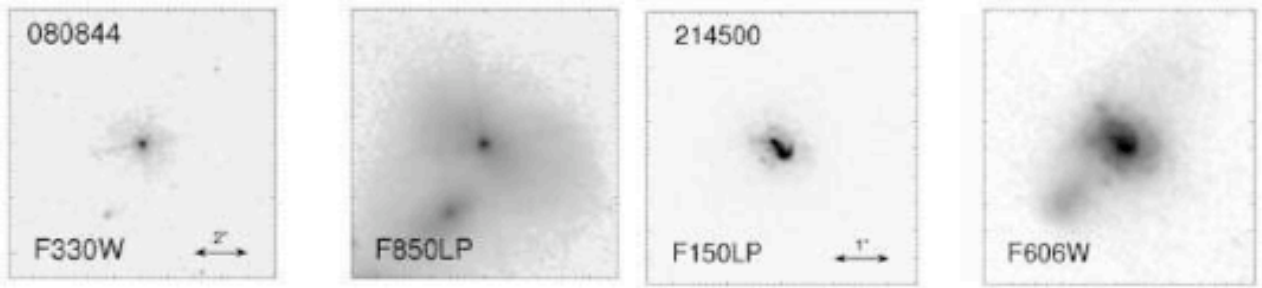
ACS follow-up of "super compact UV luminous galaxies" (UVLGs) by Heckman et al. (from GALEX + SLOAN), local analogs of z~3 LBGs



ID	z	ACS Filters
TadPole	0.031	F475W,F606W,F814W
LBG0055	0.167	F330W,F850LP
LBG0328	0.142	F330W,F850LP
LBG0402	0.139	F330W,F850LP
LBG1026	0.160	F330W,F850LP
LBG1353	0.198	F330W,F850LP



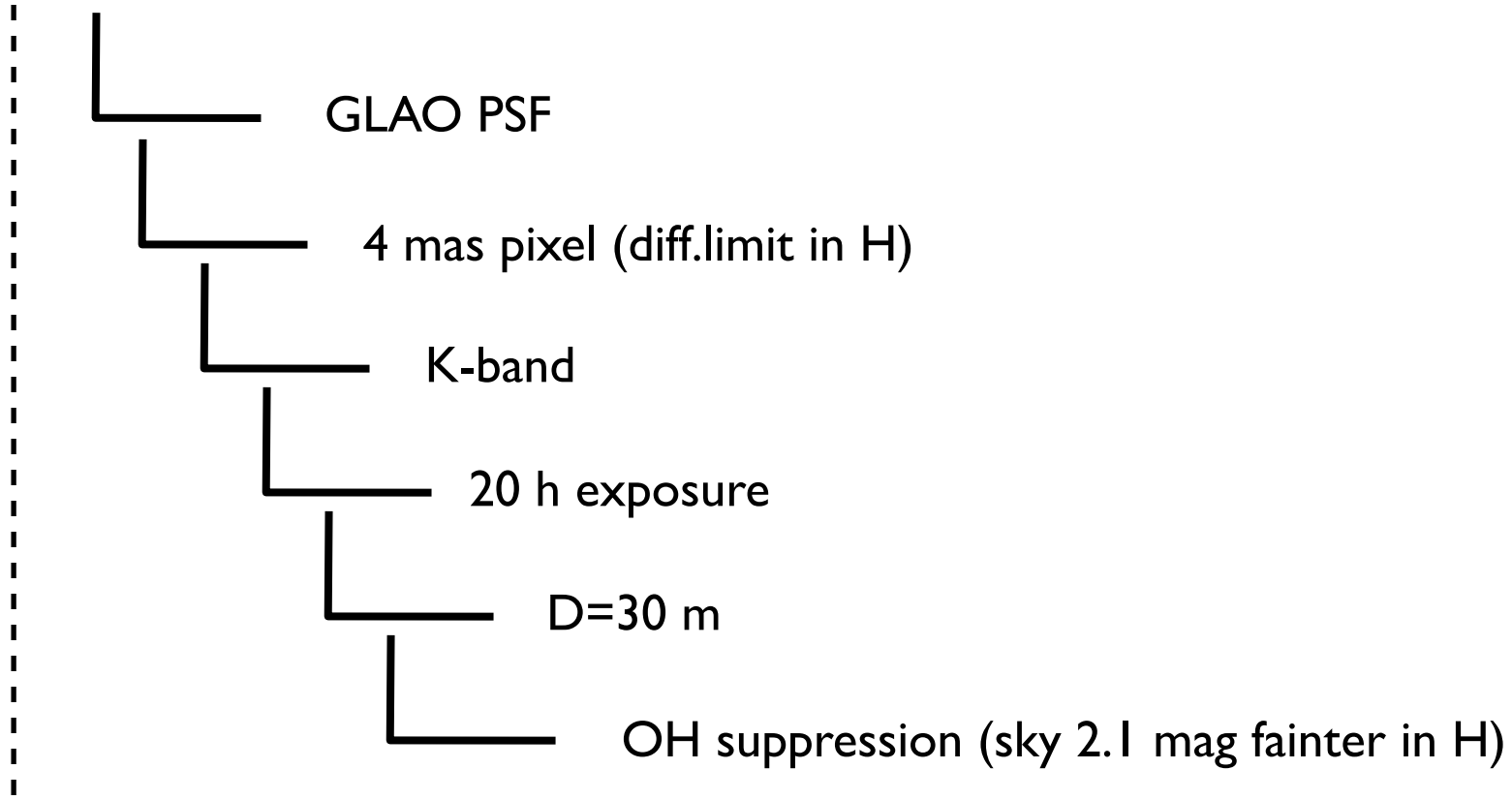




Exploration of Physical and Observing parameters

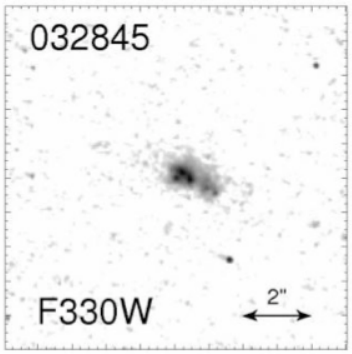
S/N (M/M*=0.1, 0.5, 1.0, 5, 10, z=2,4,6,8, {p_i})

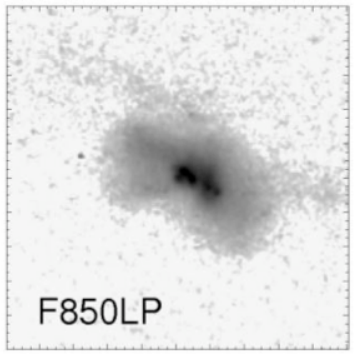
Reference case (M*, z=4, 42m, 30 mas, 10h, MCAO-PSF, H-band, All-templates)



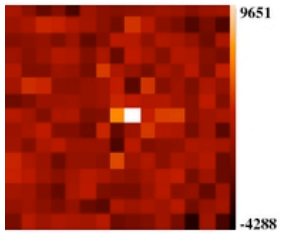
Each template as a fnct(M,z) as observed with JWST in F150W, F200W

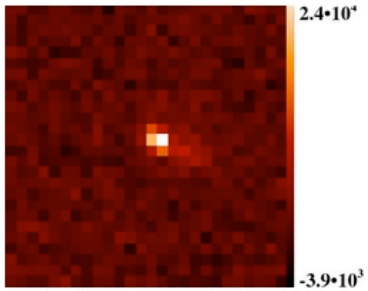
LBG032845 z=4 (ref.case)

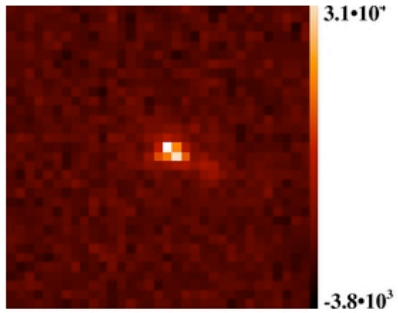


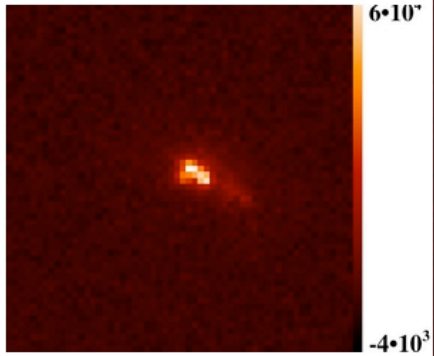


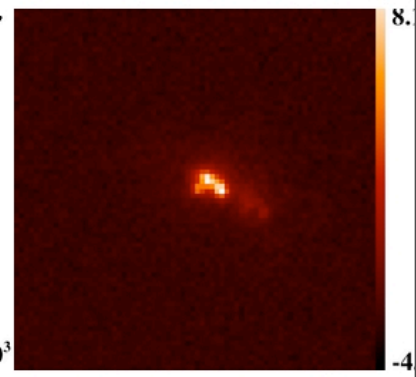
ACS/HRC pxl at z=0.14 = 70pc → 10 mas at z=4
H-band at z=4 → 330 nm rest-frame
~M* at z=4 → H_{AB}=24.3



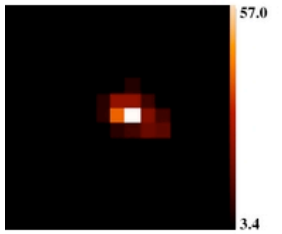


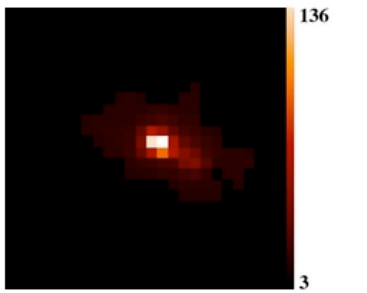


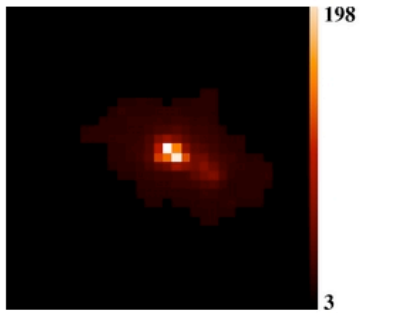


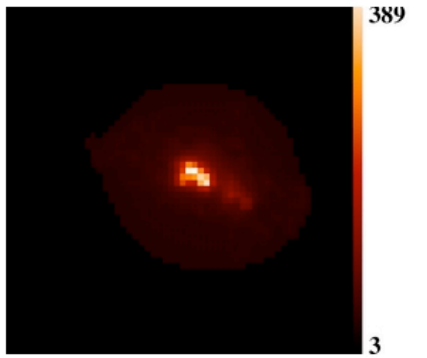


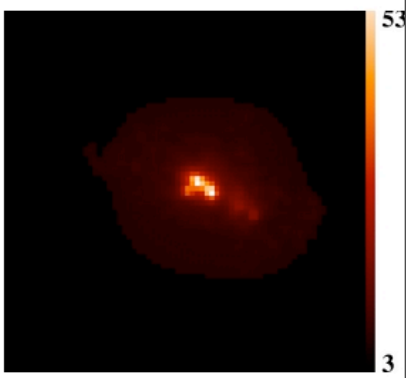
S/N maps





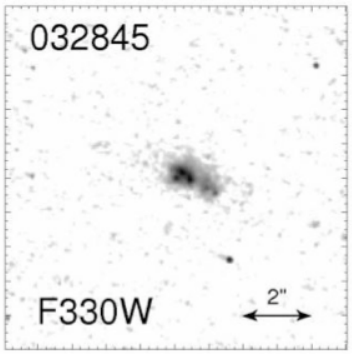


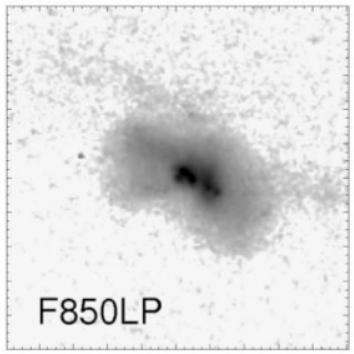




0.1 M* **0.5 M*** **1.0 M*** **5 M*** **10 M***

LBG032845 z=4 (ref.case)





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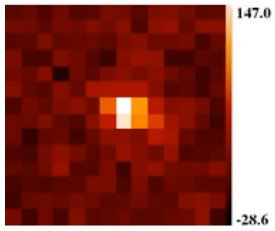
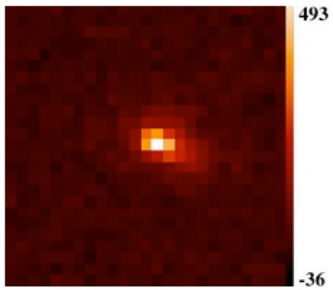
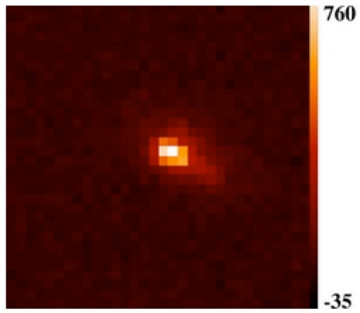
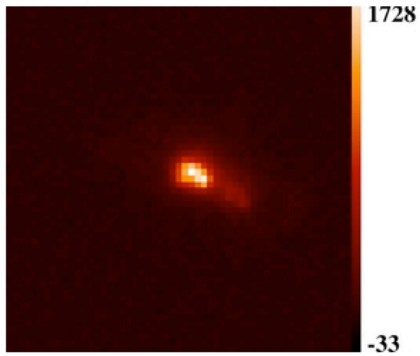
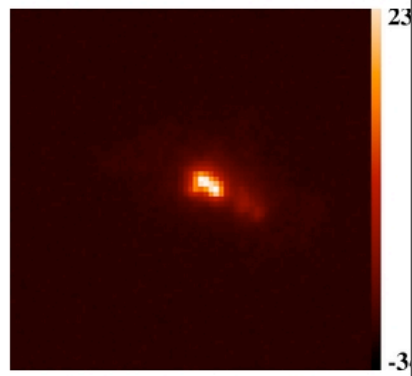


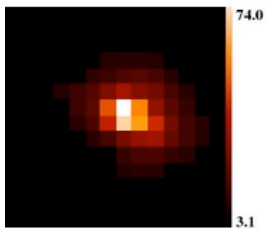


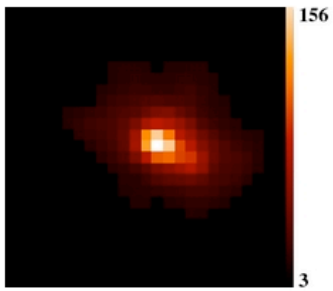


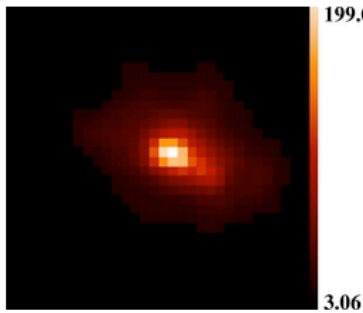


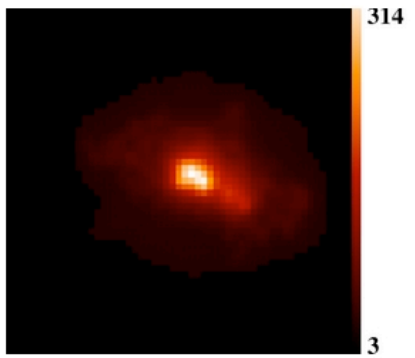


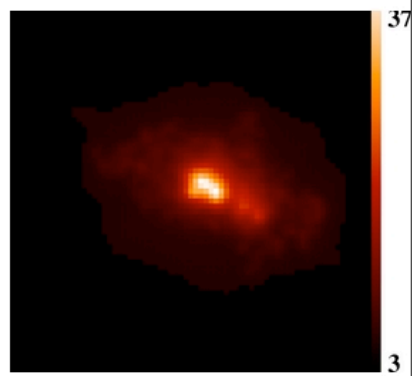
S / N maps











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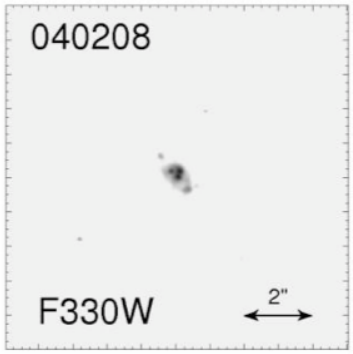
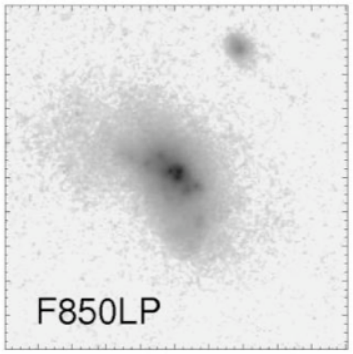
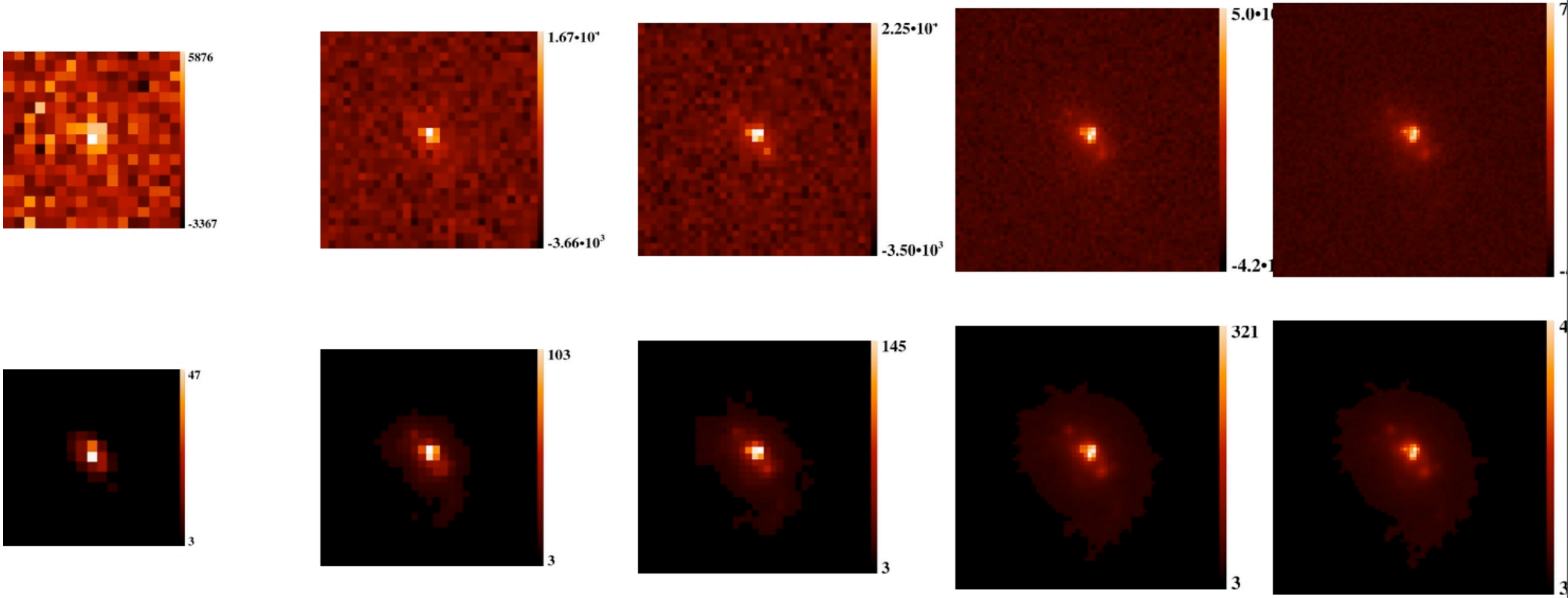
LBG040208 z=4 (ref.case)





ACS/HRC pxl at z=0.14 = 70pc → 10 mas at z=4
H-band at z=4 → 330 nm rest-frame
~M* at z=4 → H_{AB}=24.3



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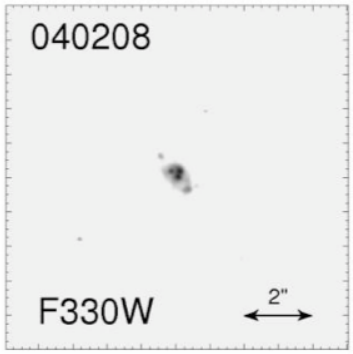

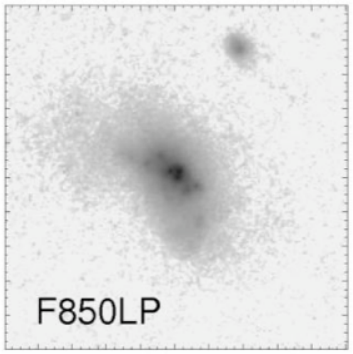

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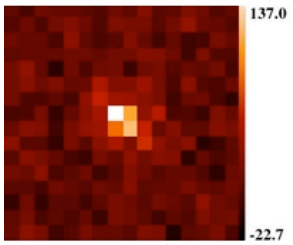
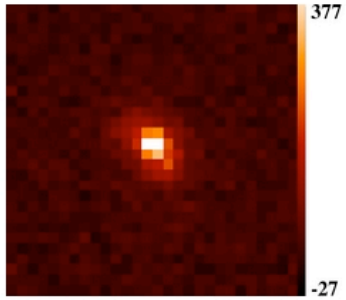
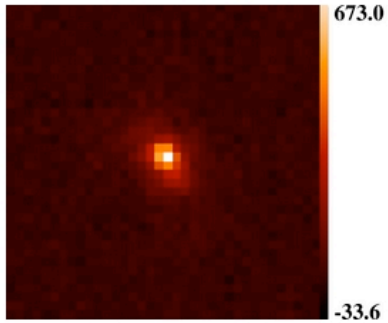
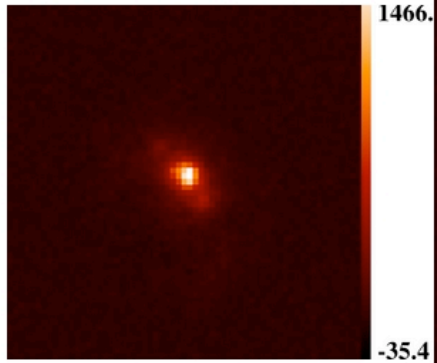
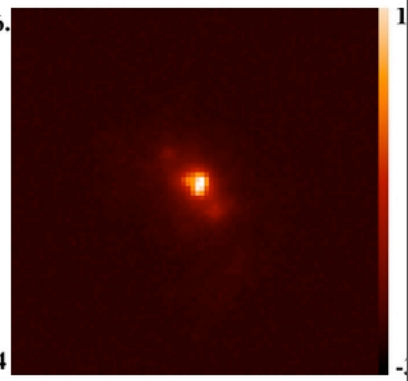
JWST/NIRCam F150W

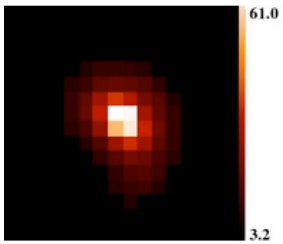


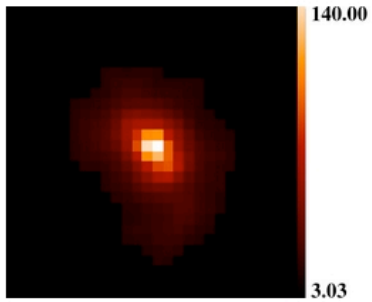


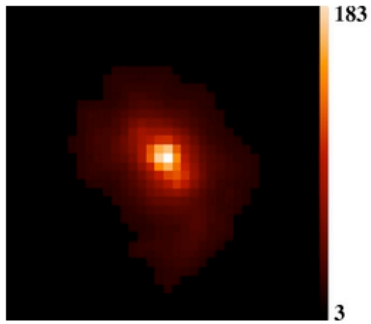


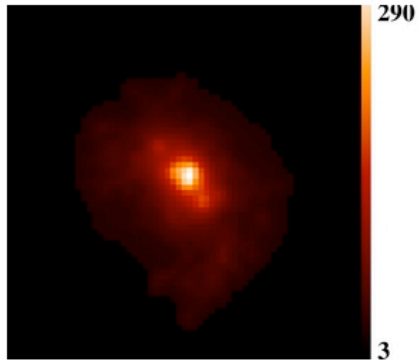


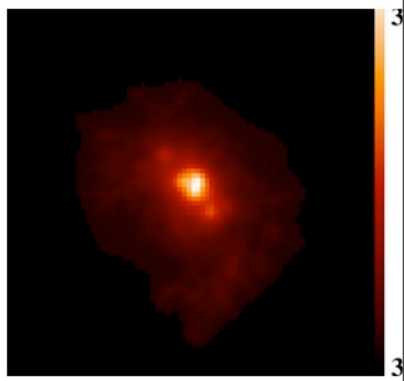






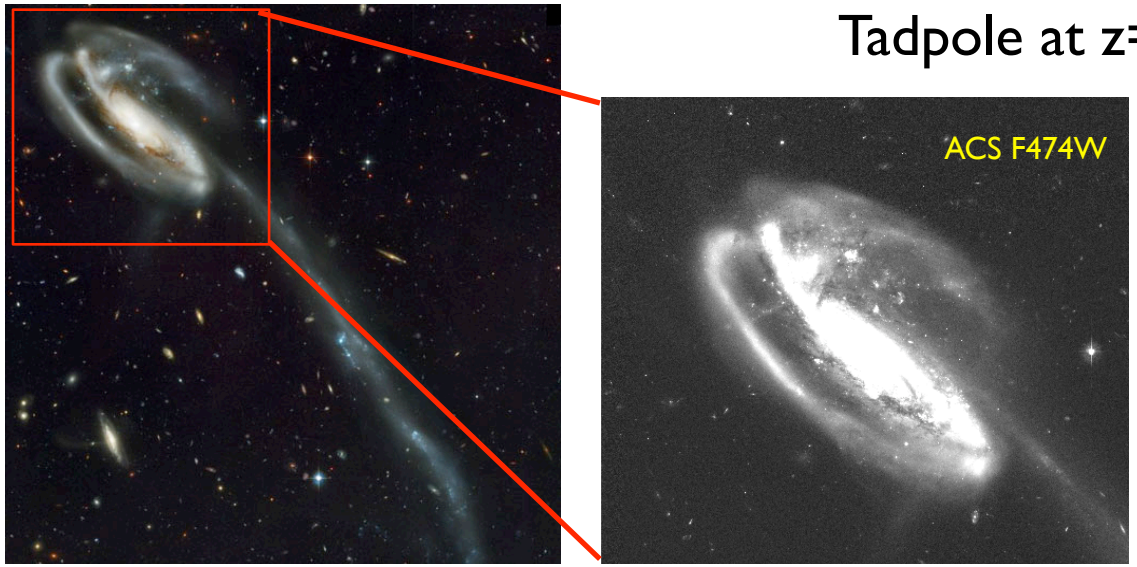




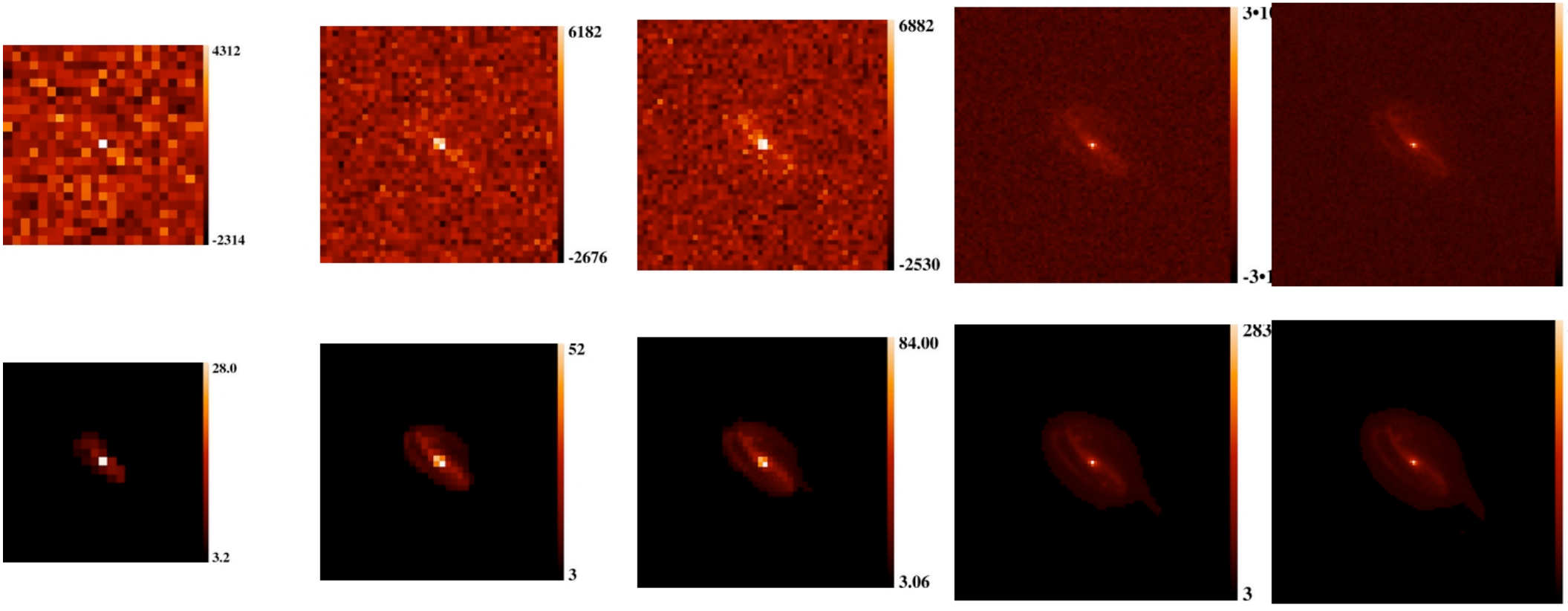


0.1 M* **0.5 M*** **1.0 M*** **5 M*** **10 M***

Tadpole at z=4

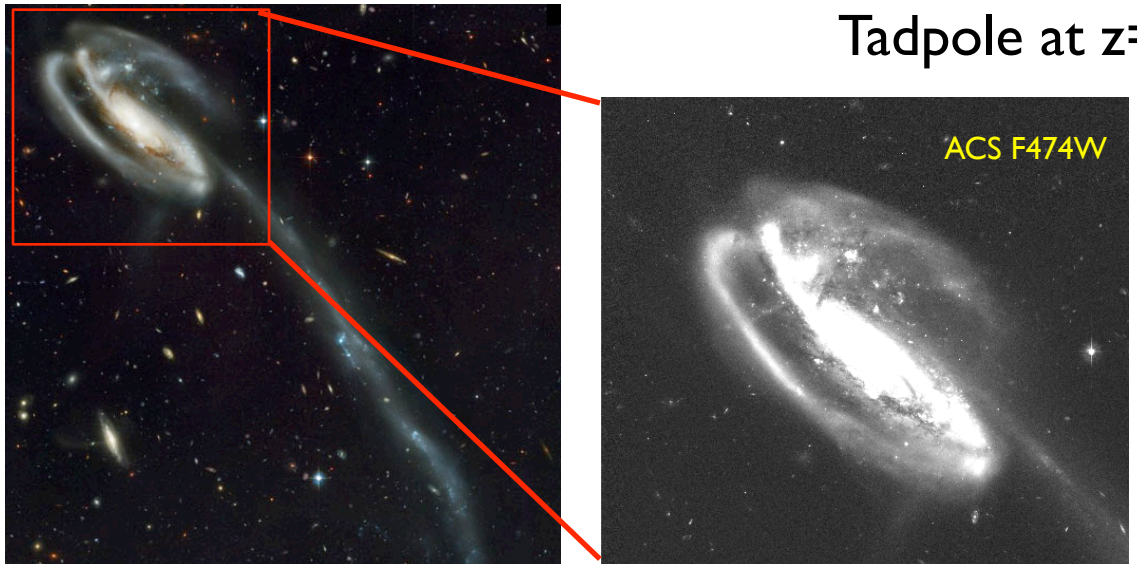


ACS/WFC pxl at z=0.03 = 30pc → 4 mas at z=4
H-band at z=4 → 330 nm rest-frame (≠obs 474 nm)
~M* at z=4 → H_{AB}=24.3



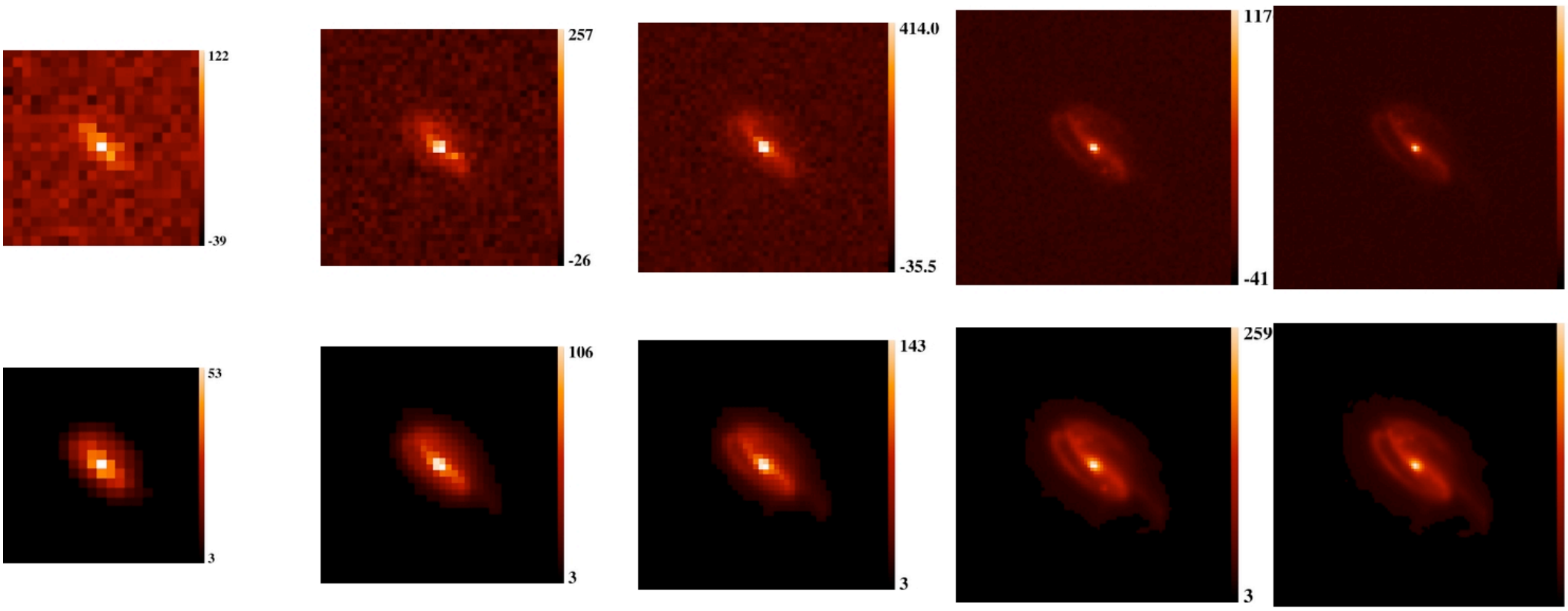
0.1 M* **0.5 M*** **1.0 M*** **5 M*** **10 M***

Tadpole at z=4



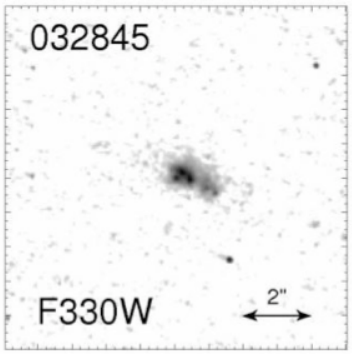
ACS/WFC pxl at z=0.03 = 30pc → 4 mas at z=4
H-band at z=4 → 330 nm rest-frame (≠obs 474 nm)
~M* at z=4 → H_{AB}=24.3

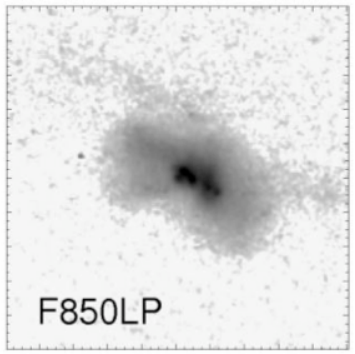
JWST/NIRCam F150W

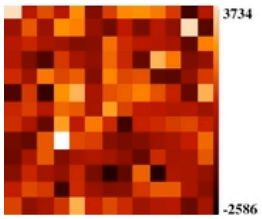


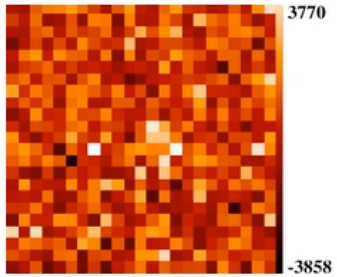
0.1 M* **0.5 M*** **1.0 M*** **5 M*** **10 M***

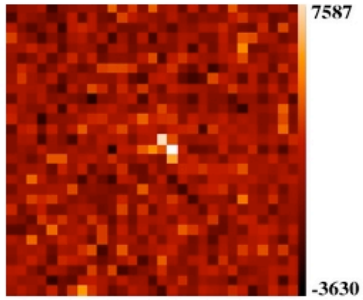
LBG032845 at z=8 (ref.case)

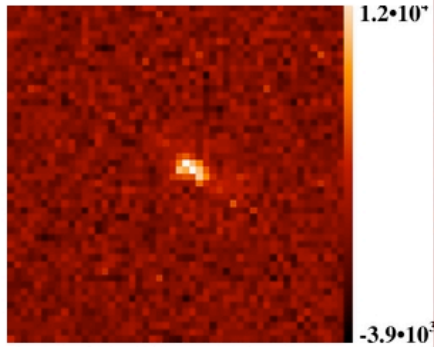


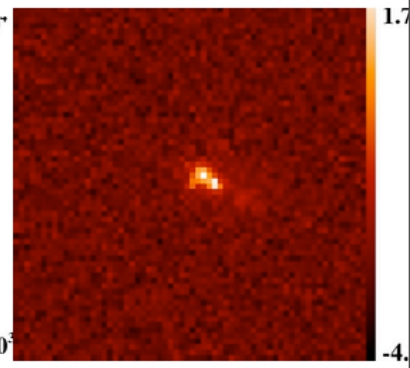




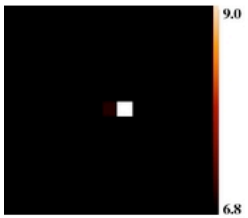


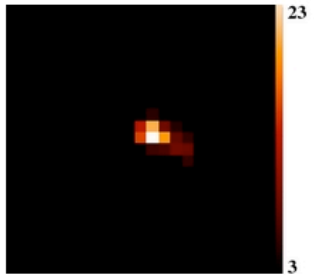


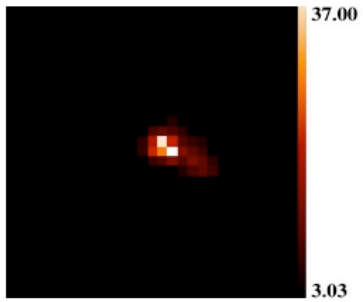


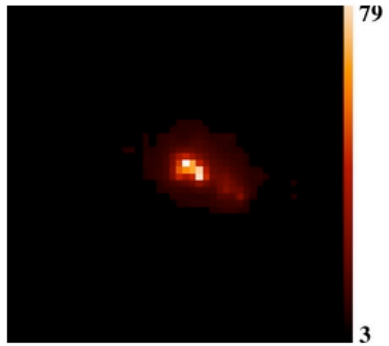


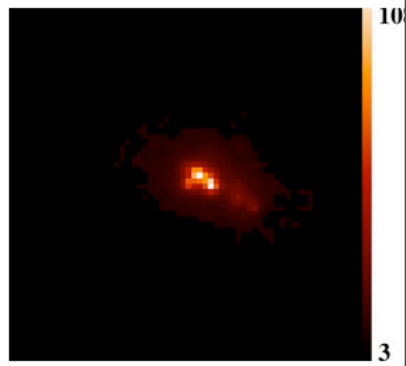
S / N maps











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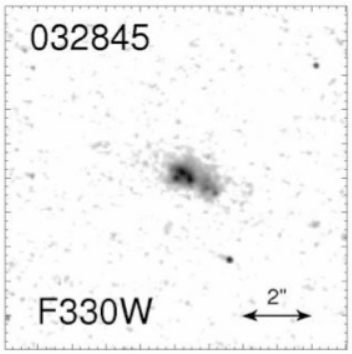
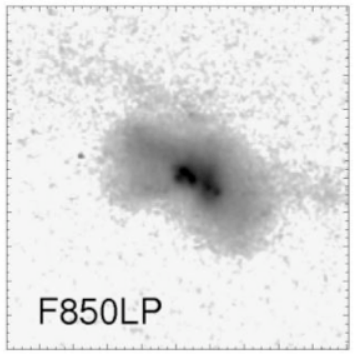
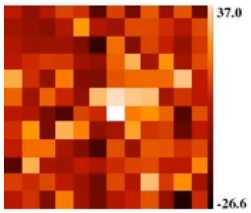
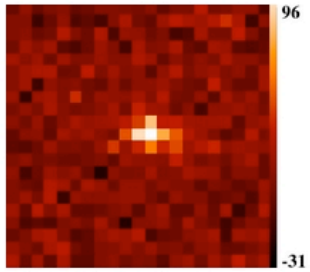
LBG032845 at z=8 (ref.case)

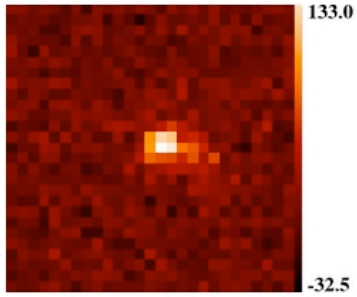


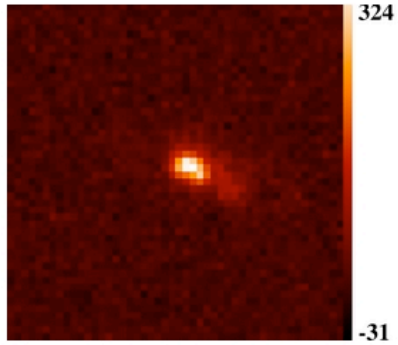


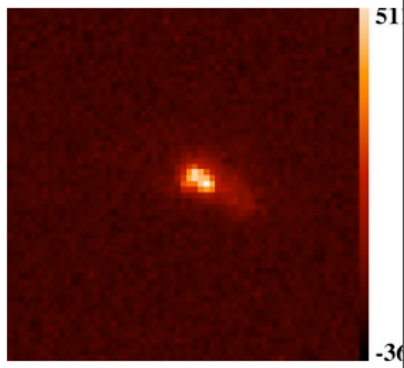
JWST/NIRCam F150W











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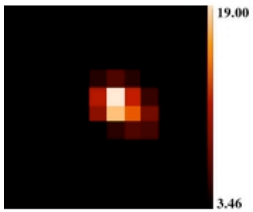

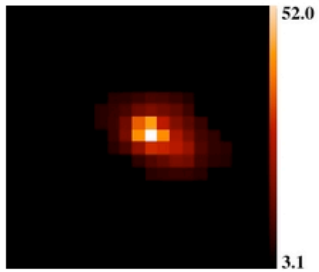

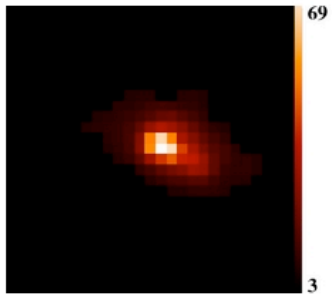

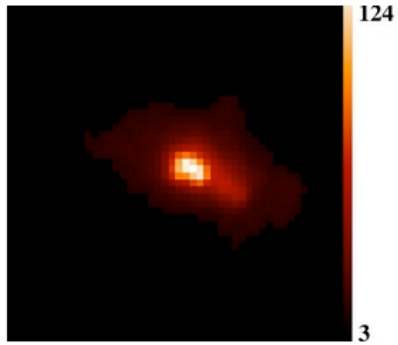

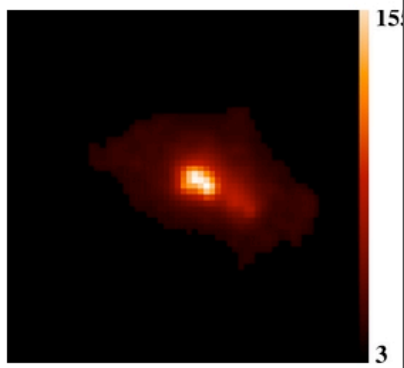

0.1 M* **0.5 M*** **1.0 M*** **5 M*** **10 M***

From single galaxies to deep fields

"Skylens": a shapelet-based imaging simulator

Meneghetti, Grazian et al. 2008 (AA, 482, 403)

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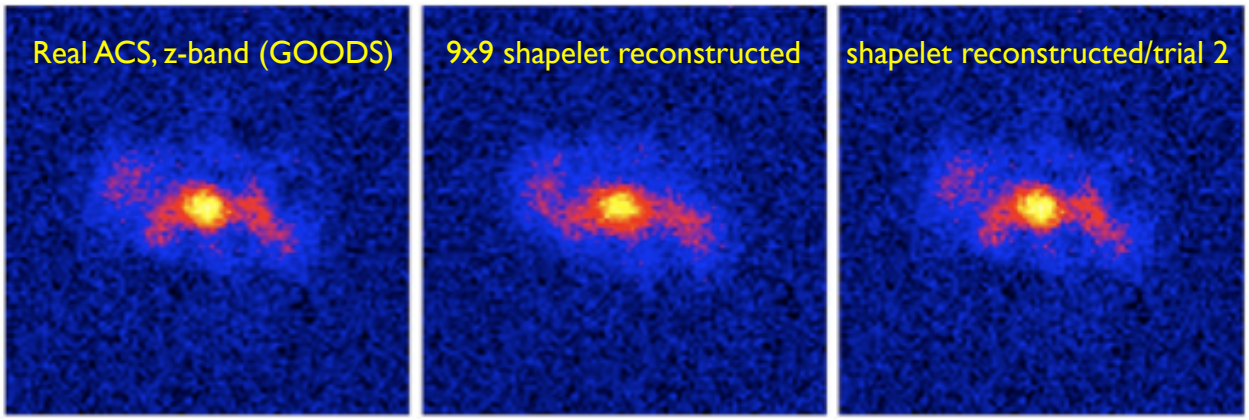

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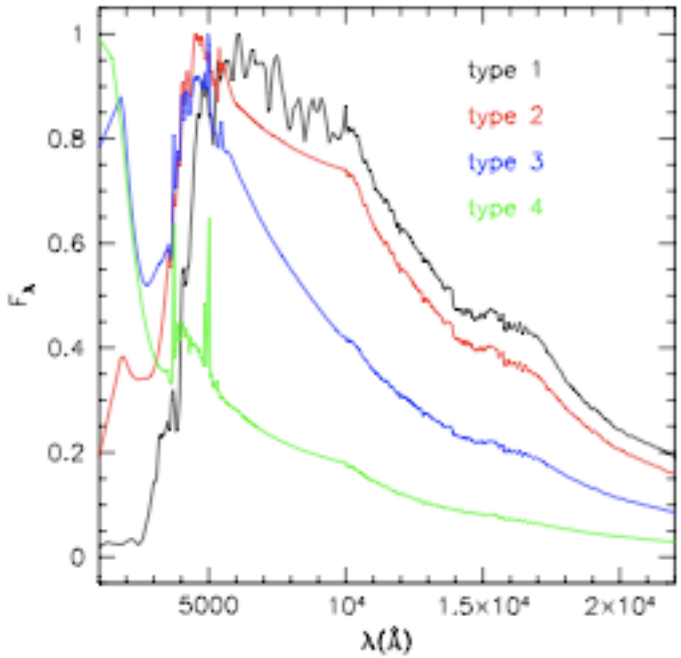

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- Reproduce number counts and size distributions observed in HST deep fields

From single galaxies to deep fields

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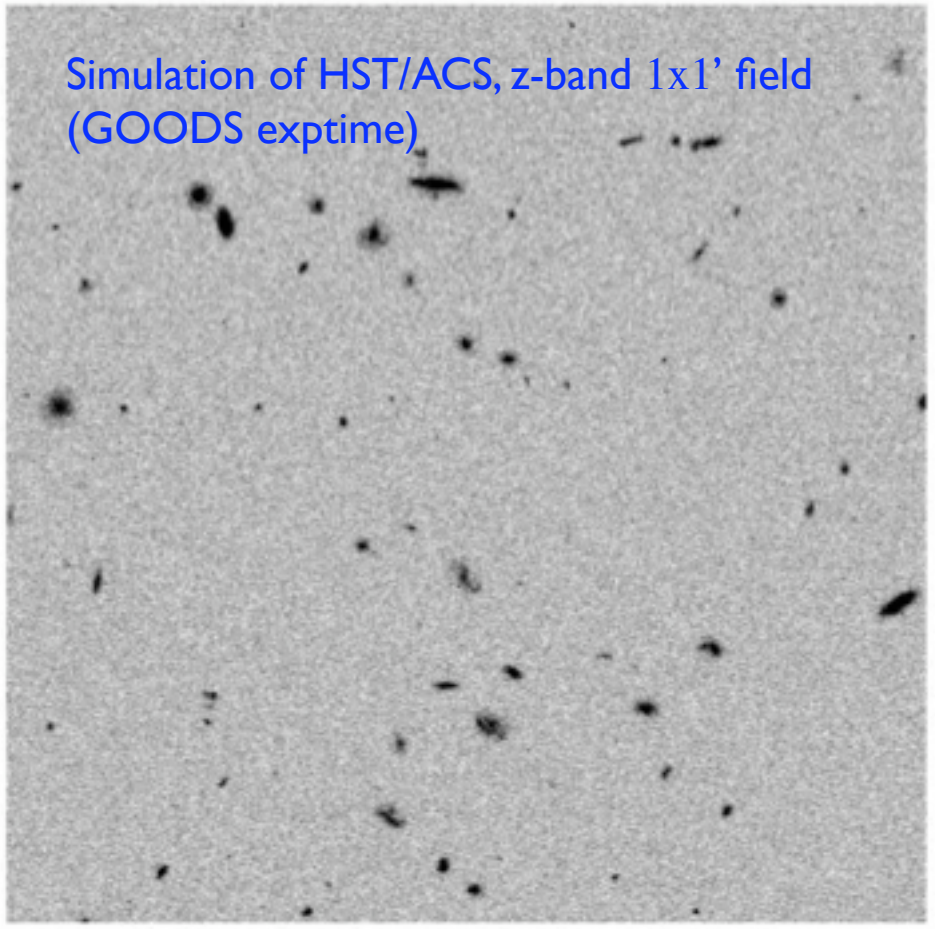
- Size vs mag empirical relation
- Galaxies morphologies are generate coefficients in template library
- Reproduce number counts and size HST deep fields
- Used for LBT, Dune, ..



Summary and Next steps

- ELT performance on imaging of high-z galaxies critically depends on unknown SB distribution of primordial galaxies
- Sanity/consistency checks? (MAD deep field, or GC MAD observations)
- FoM of imaging performance: compute morphological parameters (e.g. Asymetty A, Concentration C, Smoothness/Clumpiness S) and compare input vs output values (ELT($\{p_i\}$) vs JWST)
- Adapting **skylens** (developed for Dune) to ELT case (Grazian, Meneghetti by the end of Nov) to produce deep fields
- Suggestions ??