Do Compact Galaxies Have Higher Ionizing Photon Production Efficiencies?

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Distant Galaxies

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Introduction:

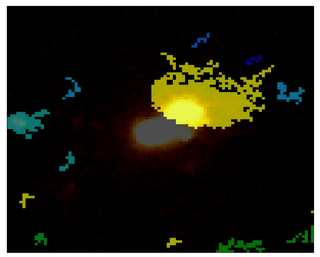
Our project investigates the sizes of high-redshift galaxies near the end of reionization, correlating these sizes with ionizing photon production efficiencies. Papers such as Flury et al. (2022) have shown correlations between compact galaxies and high ionizing photon escape fractions and we are now exploring how size may also be affecting ionizing photon production efficiencies. Understanding this correlation will help us to understand the role of compact galaxies driving reionization. Using data from the James Webb Space Telescope, we employ GALFIT to analyze the sizes of high-redshift galaxies.

- We utilize data from the JADES survey, targeting galaxies at 2 < z < 6 with images in F115W, corresponding to the rest Ultraviolet.
- Thanks to the advent of the James Webb Space Telescope we are now able to observe high z galaxies such as these at better spatial resolution and near-infrared wavelengths.

Reionization marks the era when hydrogen in the early universe transitioned from neutral to ionized due to ionizing radiation. The exact timeline remains uncertain, with ongoing questions about when reionization began after the first light was emitted.

The Bad Pixel Map:

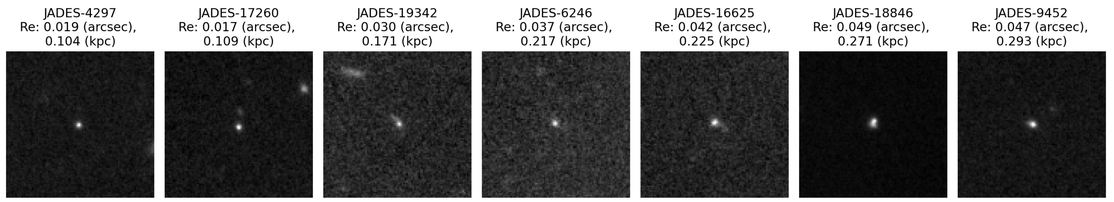
Before GALFIT can run correctly, we must first mask any object irrelevant to the galaxy whose radii we are measuring. BPMs, like the one pictured, will mask unrelated light from our target galaxy during the modeling process. Colored pixelated shapes show the areas GALFIT will mask to focus on our central galaxy.

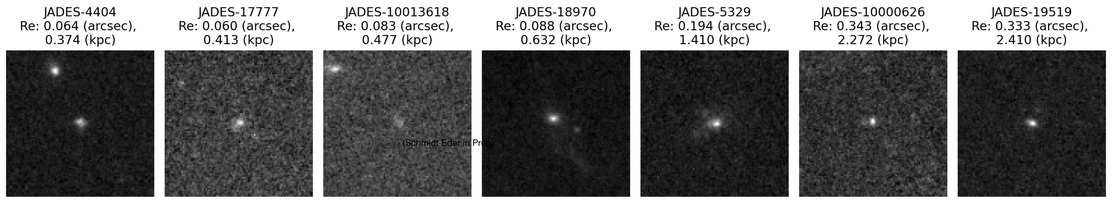


(Schmidt-Eder in Prep)

Results:

Shown here are some of our preliminary results from modeling our galaxies. Galaxies with the most compact fit are shown first, while our more expanded galaxies are shown last. Some galaxies pictured are relatively compact and symmetric, while others include tidal features, or separate celestial objects that would've been masked out during the modeling process.





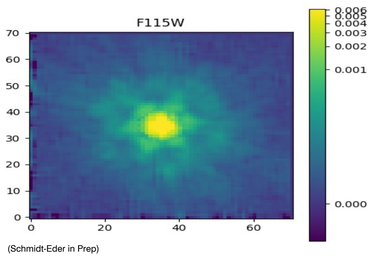
(Schmidt-Eder in Prep)

Preparing GALFIT:

We are employing GALFIT to create 2D synthetic light profiles for galaxies to get a more accurate idea of their effective radii. GALFIT takes several prerequisites including a point spread function, bad pixel map, and galaxy property estimates to properly run. GALFIT utilizes Sersic profiles to fit each galaxy, sometimes requiring multiple Sersic profiles for its fits if the galaxies in question are notably asymmetrical.

Gathering the Prerequisites for GALFIT

- To procure science images, custom Python scripts were employed to cut out postage stamps for 45 galaxies in the GOODS-S field.
- 14 Stars from the same field were selected for the PSFs.

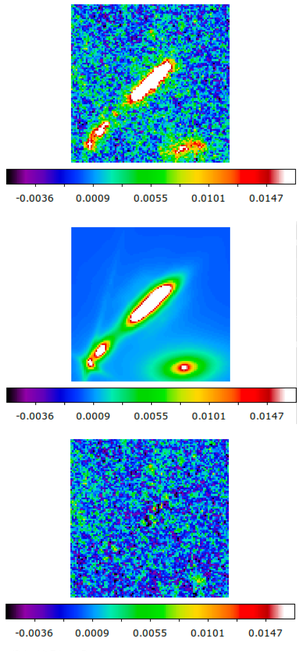


(Schmidt-Eder in Prep)

Pictured to the left is a PSF representing how light was spread out through our telescope. Creating a PSF helps to correct against the distance added by spread when we go to model our galaxies. We averaged the light of 14 stars to create this specific PSF.

The GALFIT fitting process:

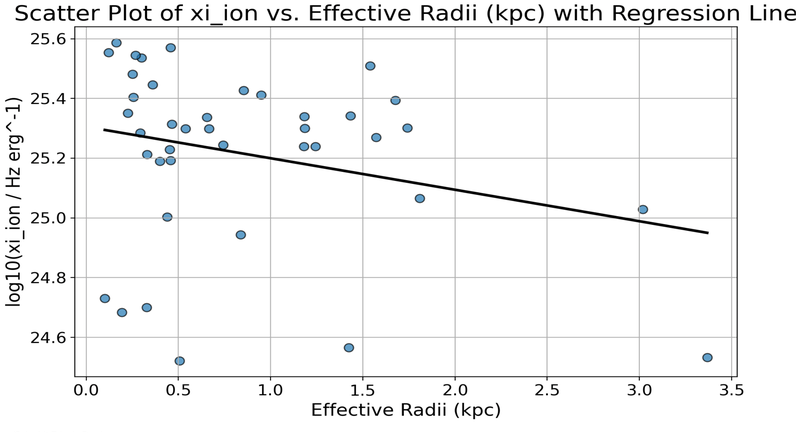
- Pictured right is our science image. This is what our galaxy was originally observed to look like prior to attempting to model it with GALFIT. This particular galaxy is significantly extended.
- GALFIT creates a model galaxy after performing least-squares minimization. This model galaxy allows us to analytically determine the effective radius of our galaxy.
- The residual image is the science image minus the model. If the noise looks around the same as before, our fit is correctly approximating the observed galaxy.



(Schmidt-Eder in Prep)

Potential Implications and Future Work:

Current implications are that size either is or isn't related to efficiency. While our linear fit shows evidence of a negative trend, we perform a Spearman's correlation test to yield a p-value of 0.183, indicating a lack of significant correlation. Should further analyses confirm this lack of correlation, compact galaxies could still be recognized as crucial to reionization due to their high escape fractions, though perhaps not as primary drivers. Moving forward, we plan to include more filters and extend the sample size, potentially including data from the CEERS survey, to refine our understanding.



(Schmidt-Eder in Prep)

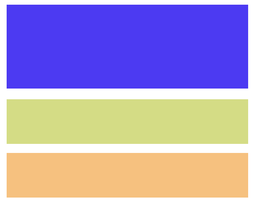
Style Cheat Sheet

Background:
Your background should always be white with pops of your accent color.

Selecting Colors
When selecting colors for you poster, pick an accent color, then stick within one color family.

Right

Wrong

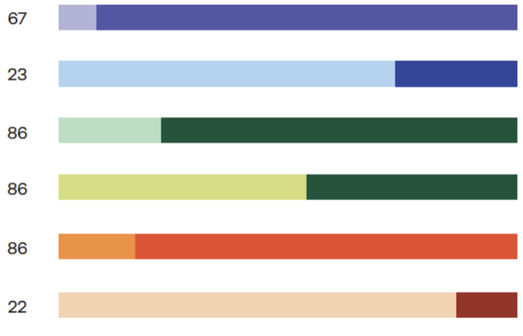


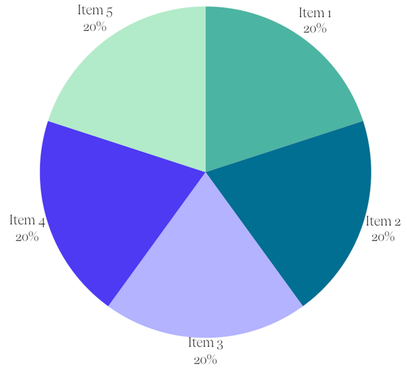
Text Box: If you need another color for a textbox or similar, pick only one of the tertiary colors.

Color on color? Always use colors on black or white backgrounds, never put colors directly next to or on top of other colors UNLESS you're making a chart.

Wrong

Right





Charts and graphs: You can use two or more color families.

Core Colors

White	Black	Galaxy Purple	Ocean Atmosphere	Northern Lights Teal	Grass Green	Bronze Brown	Gold Yellow
R: 255	R: 0	R: 76	R: 57	R: 74	R: 116	R: 218	R: 255
G: 255	G: 0	G: 58	G: 131	G: 182	G: 192	G: 129	G: 199
B: 255	B: 0	B: 242	B: 255	B: 163	B: 95	B: 80	B: 15
#ffffff	#000000	#4c3af2	#3983ff	#4ab6a3	#74c05f	#da8150	#ffc70f
C: 0	C: 0	C: 78	C: 72	C: 68	C: 58	C: 12	C: 0
M: 0	M: 0	M: 75	M: 49	M: 5	M: 0	M: 58	M: 22
Y: 0	Y: 0	Y: 0	Y: 0	Y: 44	Y: 84	Y: 76	Y: 98
K: 0	K: 100	K: 0	K: 0	K: 0	K: 0	K: 0	K: 0
		Pantone 2368 C	Pantone 2727 C	Pantone 7465 C	Pantone 2269 C	Pantone 2433 C	Pantone 7548 C

Secondary Colors

Think accent colors!

Extended Color Palette

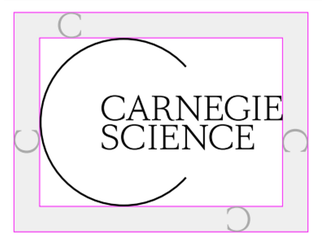
Tertiary Colors

Cosmos Purple	Deep Ocean Blue	Nebula Teal	Leaf Green	Clay Brown	Lava Orange
R: 42	R: 0	R: 0	R: 16	R: 181	R: 255
G: 13	G: 37	G: 113	G: 84	G: 65	G: 125
B: 131	B: 193	B: 147	B: 58	B: 11	B: 0
#2a0d83	#0025c1	#007193	#10543a	#b5410b	#ff7d00
C: 98	C: 94	C: 90	C: 88	C: 21	C: 0
M: 100	M: 86	M: 47	M: 41	M: 86	M: 63
Y: 11	Y: 0	Y: 28	Y: 82	Y: 100	Y: 100
K: 9	K: 0	K: 5	K: 40	K: 12	K: 0
Pantone 3542 C	Pantone 286 C	Pantone 7705 C	Pantone 343 C	Pantone 1525 C	Pantone 151 C

Cosmic Dust Purple	Sky Blue	Uranus Teal	Opal Green	Sand Brown	Gemstone Yellow
R: 178	R: 168	R: 177	R: 211	R: 255	R: 255
G: 180	G: 213	G: 237	G: 219	G: 190	G: 229
B: 255	B: 255	B: 196	B: 120	B: 115	B: 155
#b2b4ff	#a8d5ff	#b1edc4	#d3db78	#ffbe73	#ffe59b
C: 28	C: 30	C: 29	C: 20	C: 0	C: 1
M: 27	M: 7	M: 0	M: 3	M: 29	M: 8
Y: 0	Y: 0	Y: 31	Y: 67	Y: 62	Y: 47
K: 0	K: 0	K: 0	K: 0	K: 0	K: 0
Pantone 270 C	Pantone 2717 C	Pantone 2253 C	Pantone 6192 C	Pantone 2016 C	Pantone 2001 C

Pro Tip: You can use the eyedrop tool to pull colors from this chart.

Always make sure the Carnegie Science logo has clear space to breathe



Reminder

If you have any questions, please reach out to a member of the communications team.