# The highest-redshift AGN?





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### A triply-imaged point-source

The object is detected with JWST/ NIRCam as a point-source triply imaged by the strong lensing cluster Abell 2744. Both its gravitational lensing geometry and it's HST/ACS-dropout nature firmly place it at  $z_{\text{geo}} > 7$ . The flux ratios of all three images concur with the magnification ratios across all bands, which confirms the detection to be genuine. This discovery is published in Furtak et al. 2022b.

#### The UNCOVER survey

The public UNCOVER survey (Bezanson et al. 2022) observed Abell 2744 with JWST and represents the deepest imaging of a lensing cluster to date. It reaches  $5\sigma$ -depths of 30 AB per filter. These incredible depths and the wide field-of-view enabled the discovery of numerous new strong lensing features in the cluster outskirts. We used these to publish a new and extended strong lensing mass model of Abell 2744 (Furtak et al. 2022a).

#### Extremely red colors!

Our object has extremely red colors in the four reddest NIRCam filters, about one half of a magnitude redder than typical JWST-detected galaxies at the same redshift.

## Spectroscopy coming soon!



### Extremely faint and compact!

Folding-in the lensing magnification, we measure a very faint UV luminosity of  $M_{\rm IIV} \simeq -17$ . More importantly, the unresolved point-source nature of all three multiple images yields an upper limit on the size of  $r_{\rho} < 30$  pc! Such a compact morphology cannot originate from a galaxy. This object is smaller by an order of magnitude than typical galaxies of similar UV luminosity. It resembles GNz7q, a red high-redshift quasar recently discovered by Fujimoto



SED-fitting

We fit the JWST and HST photometry both with galaxies and type-II AGN using BEAGLE (Chevallard et al. 2016) and its newly-developed templates (Feltre et al. 2016; Vidal-García et al. 2022).

The emission line-driven AGN-templates fit the red colors of our object better than the continuum-dominated SF galaxy templates. A non-detection in dustcontinuum also rules out a red SF galaxy.

JWST/NIRCam composite-color image of Abell 2744 and our object, A2744-QSOI. The critical curves of our lensing model (Furtak et al. 2022a) are shown in blue and red for a source at  $z_s = 1.7$  and  $z_s = 7.5$ . The point-like red multiple images in cyan squares are the images of our  $z_{phot} \simeq 7.7$  AGN candidate (Furtak et al. 2022b). The orange squares highlight the Zitrin et al. (2014) triply-imaged  $z \sim 10$  galaxy in Abell 2744, which was recently spectroscopically confirmed at z = 9.76 with JWST (Roberts-Borsani et al. 2022).

#### Want to know more about this object?

Photometry and size measurements? Gravitational lensing modeling? Detailed SED-fitting? In-depth discussion of exotic sources? Then please check-out our recent papers:

Furtak et al. 2022a, arXiv:2212.04381

#### et al. 2022.



#### A more exotic source?

We also explore and discuss if this object's peculiar emission features could originate from a new type of hitherto unobserved source such as: a cluster of supermassive, Population III or dark stars, a Pop. III hyper-nova, or a direct-collapse black hole.



Furtak et al. 2022b, arXiv:2212.10531

Of these possibilities, both a cluster of supermassive stars and a direct-collapse black hole are consistent with the observed colors and lensing time delays.

#### References

Bezanson et al. 2022, arXiv:2212.04026; Chevallard et al. 2016, MNRAS, 462, 1415; Feltre et al. 2016, MNRAS, 456, 3354; Fujimoto et al. 2022, Nature, 604, 261; Roberts-Borsani et al. 2022, arXiv:2210.15639; Vidal-García et al. 2022, arXiv:2211.13648; Zitrin et al. 2014, ApJL, 793, L12

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