Similarity between compact extremely-red objects discovered with JWST in cosmic dawn and blue-excess dust-obscured galaxies known in cosmic noon

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Spatially compact objects with extremely red color in the rest-frame optical to near-infrared (0.4–1.0 μm) and blue color in the rest-frame ultraviolet (UV; 0.2–0.4 μm) have been discovered at 5 < z < 9 using the James Webb Space Telescope (JWST). These extremely red objects (JWST-EROs) exhibit spectral energy distributions (SEDs) that are difficult to explain using a single component of either star-forming galaxies or quasars, leading to two-component models in which the blue UV and extremely red optical are explained using less-dusty and dusty spectra of galaxies or quasars, respectively. In this poster, we report the remarkable similarity in SEDs between JWST-EROs and blue-excess dust-obscured galaxies (BluDOGs) identified at 2 < z < 3. BluDOGs are a population of active galactic nuclei (AGNs) with black hole masses of ~10^{8-9} $M_\odot$, which are 1 order of magnitude larger than those in some JWST-EROs. The Eddington ratios of BluDOGs are 1 or higher, whereas those of JWST-EROs are in the range of 0.1–1. Therefore, JWST-EROs are less massive, less active, and more common counterparts in higher-z of BluDOGs in cosmic noon. Conversely, JWST-EROs have a significantly higher fraction of those with blue excess than DOGs.

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1. Introduction

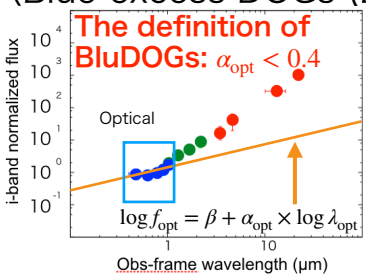
⟨Dust-Obscured Galaxies (DOGs)⟩

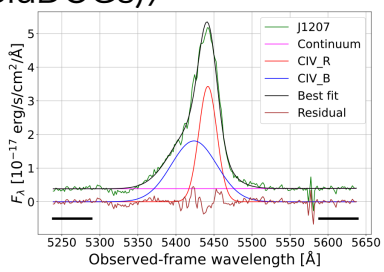
very red — **definition**
R - [24] ≥ 14.0 [vega mag] Dey+08
i - [22] ≥ 7.0 [AB mag] Toba+15

rare — **number density**
logφ = − 6.59 ± 0.11 [Mpc^{-3}] Toba+15

far — **redshift**
z = 1 - 2 Dey+08, Toba+15

⟨Blue-excess DOGs (BluDOGs)⟩

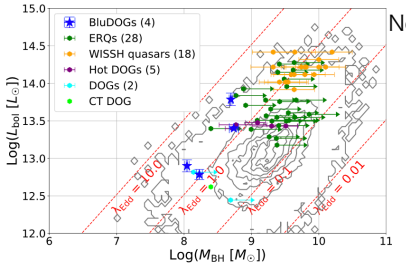




Recent results (Noboriguchi+22)

(1) CIV lines of the BluDOGs have blue-tails, suggesting that there is an outflow in a nucleus region.

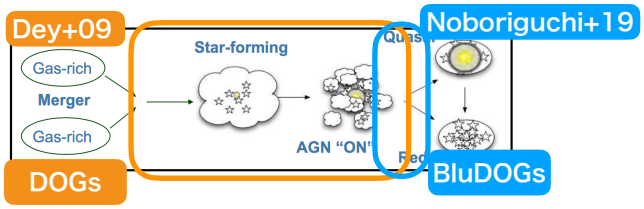
(2) the super massive blackhole (SMBH) mass (M_{SMBH}) of the BluDOGs is about 10^8 $M_\odot$, and the Eddington ratio is greater than one.



Noboriguchi+22

- Extremely red quasar (ERQs; Perrotta+19)
- WISSH quasar (Bischetti+17)
- Hot DOGs (Wu+18)
- DOGs (Melbourne+11,12)

⟨Gas-rich major merger scenario⟩



The results of optical spectroscopic observations support the gas-rich major merger scenario.

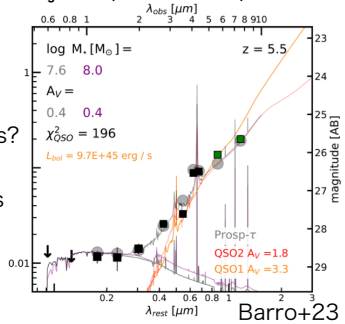
⟨This work⟩

Recently, JWST found the extremely red objects (JWST-EROs).

JWST-EROs features
- very red color between NIR-MIR.
- blue color in NIR bands.

-> JWST-EROs could be high-z BluDOGs?

We compare the SEDs and properties of JWST-EROs with high-z BluDOGs and we propose that JWST-EROs are high-z BluDOGs.



Barro+23

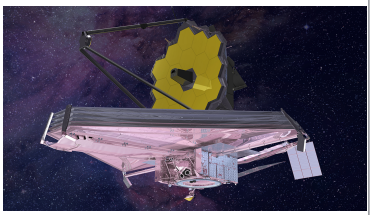
2. Data

We utilize JWST-EROs photometric data and physical parameter data from Barro+23 and Matthee+23, respectively.

JWST (James Webb Space Telescope)

Photometric bands (NIRCAM & MIRI)

NIRCAM	F115 (1.15 μm)
	F150 (1.50 μm)
	F200 (2.00 μm)
	F277 (2.77 μm)
	F356 (3.56 μm)
	F444 (4.44 μm)
MIRI	F560 (5.60 μm)
	F770 (7.70 μm)

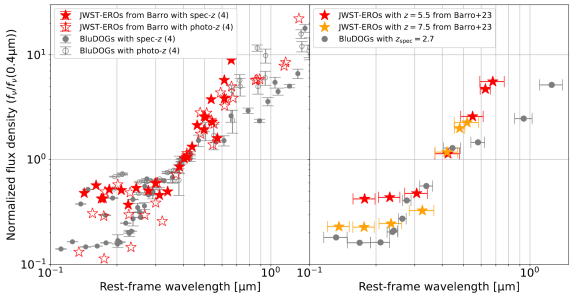


https://webbtelescope.org/contents/media/images/2017/28/4051-Image?Category=08-webb-mission&page=4&filterUUID=91dfa083-c258-4f9f-bef1-8f40c26f4c97

3. Results

Comparing SEDs of BluDOGs with that of JWST-EROs

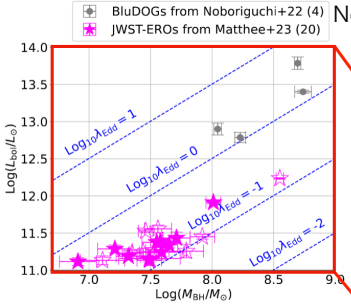
SEDs show that
- red color (0.4–1.0)
- blue color (0.2–0.4)



The shapes of the SEDs are very similar.

Noboriguchi+23

SMBH mass, bolometric luminosity, & Eddington ratio



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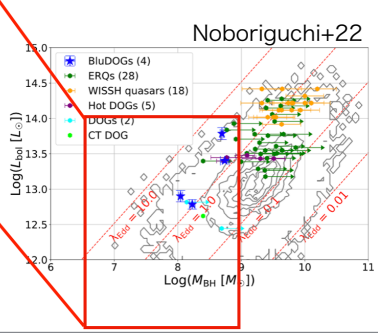
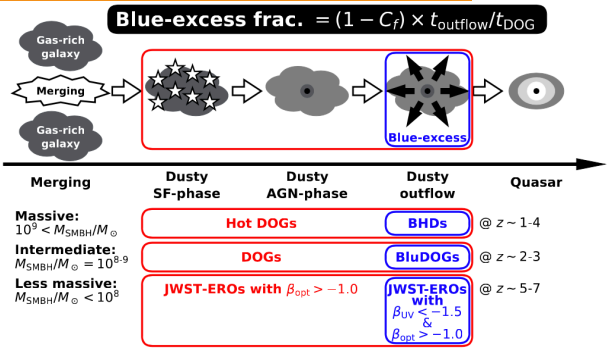


Noboriguchi+22

JWST-EROs
- Small SMBH masses
- Faint bolometric luminosity

4. Discussion & Conclusion

Blue-excess frac. $= (1 - C_f) \times t_{outflow}/t_{DOG}$



One of the idea is that the dusty AGNs are in the gas-rich major merger scenario, and the blue-excess objects in each dusty AGN samples are in the outflow phase.