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The JWST EXCELS survey: Too much, too young, too fast? Ultra-massive quiescent galaxies at 3 < z < 5

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1. Introduction

Many detections of Hi-z massive galaxies by JWST

- => Are they too massive/early/numerous within the Λ -CDM framework?
- => Quenched galaxies (QGs) are more common at z>3 than expected

5.1 117560 & 109760

- z=4.62, pair
- deep Balmer absorption + Ha+N2 emission (but non-broad)
- Deep NaI absorption : cold ISM gas
- SFH : z_fomr=7.8 / 9.4, t_quench=7.1 / 6.7
- Metallicity : Challenging due to α-enhancement : Z=-1e0.35 Msun/ 1e-0.41Msun : significant difference, different evolutional path?. 109760 may have formed in shallower potential well>
- SIze : re=0.61kpc/0.33kpc, very compact
- + σ : 360km/s / 140km/s , dynamical mass consistent with photometric

mass

Table 3. Derived parameters for our 4 EXCELS ultra-massive quiescent galaxies from the BACPUPES full-spectral-fitting analysis described in Section 4.3.1, as well as the morphological analysis described in Section 4.4. The definitions of the parameters in our full-spectral-fitting

Spectroscopy of QGs provide us their SFH

- => e.g. Carnall+23c :
- z=4.7 QG, z_quench=6.5, M*=1e10.58Msun
- Very compact : r_e<200pc
- AGN (broad Ha) M_BH=1e9Msun
- => Glazebrook+24
- z=3.2 QG, z_quench=11, M*=1e11.26Msun
- strong tension with Λ -CDM cosmology?

Questions to be soloved

- a. What is the mechanism to cause early shutdown of massive galaxies?
- b. The high number density of massive QGs at z>3 requires revision of galaxy formation model or Λ−CDM cosmology?
- 2., Observing Strategy and 3. Sample Selection

Early eXtragalactic Continuum and Emission Line Science (EXCELS)

- : NIRSpec spec. survey of z=3-5 QGs
- 4hrs in G140M, G235M, and 5hrs in G395M / 1-5um, R[~]1000
 => Rest-optical wavelength coverage (~3500-7500A)
- 3 MSA setups / 401 targets
- Selected from VANDELS / PRIMER-UDS
 - 4 of them has M*>1e11Msun
 - Two are a pair of z=4.62 QGs, separated by 860pkpc (ZF-UDS-7329)
- 4. Methods
- 4.3 spectrophotoemtric fitting
- spectra+JWST/HST photometric points (3540-7350A)
- BAGPIPES code => SFH M*, age, metallicity...

5. Results

Only 4 QGs in this paper









Figure 4. Star-formation histories for our 4 ultra-massive quiescent galaxies at 3 < z < 5 from full spectral fitting. To the left the SFR as a function of time is shown, whereas to the right the total mass in stars as a function of time is shown. Results for GS-9209 (Carnal et al. 2023) at z = 45.8%, which is 20 - 4 - 5 dete ses massive than the other galaxies; are also shown in grey. Three of the new galaxies

6. Discussion

 Λ -CDM limit : M_halo * f_baryon(0.16) * f_star < M* of galaxies in halo Note that M* is sensitive to IMF

6.1 Extreme Value Statistics

Just assume f_star=1.0

Fig 8 : left, fiducial SFH model, right, f*=1 model

=> high stellar fraction are required, but no strong tension with Λ -CDM

cosmology



Figure 7. A comparison of the SFHs we derive for our 3 oldest ultra-massive quiescent galaxies with predictions for the most-massive