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UV continuum slopes at $6.5 < z < 13$ using wideband JWST/NIRCam imaging

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Prime Extragalactic Areas for Reionization and Lensing Science
PEARLS

PI: Rogier Windhorst, Proposal IDs: 1176; 2738

Read the paper here

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IN THIS TALK…

1. Overview of the EPOCHS high-z galaxy sample
2. Calculating UV continuum slopes and the search for exotic systems
3. A look at the dust content in early galaxies using β
4. Implications for reionization

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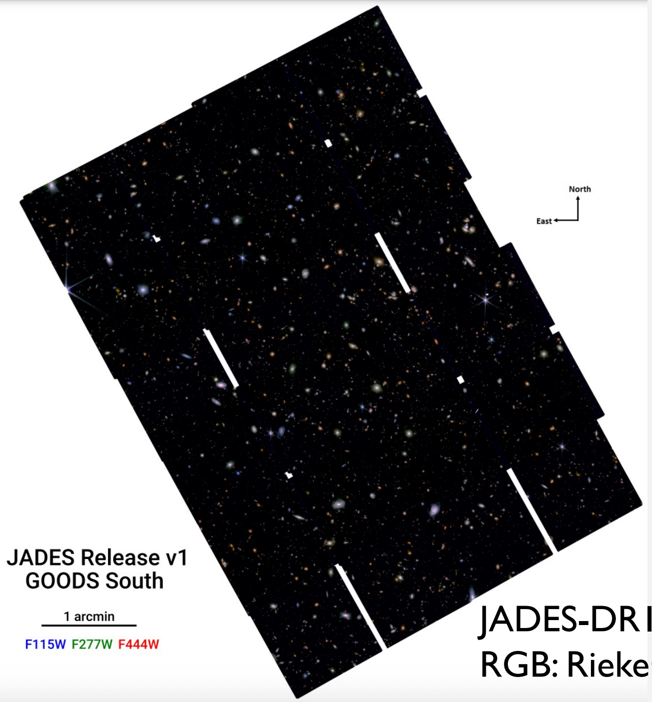
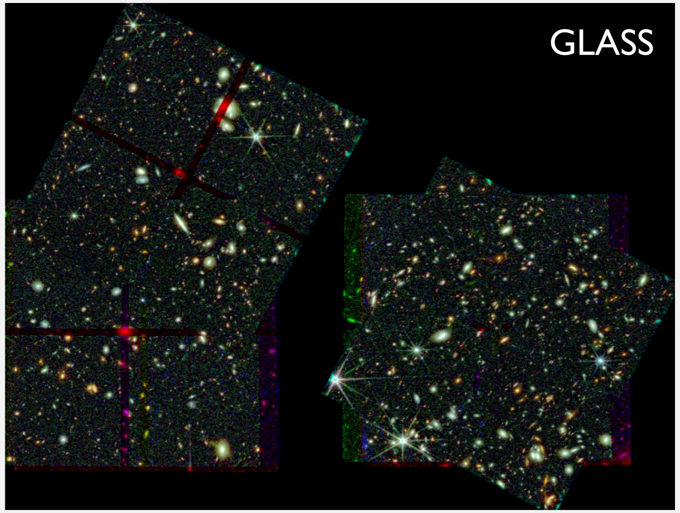
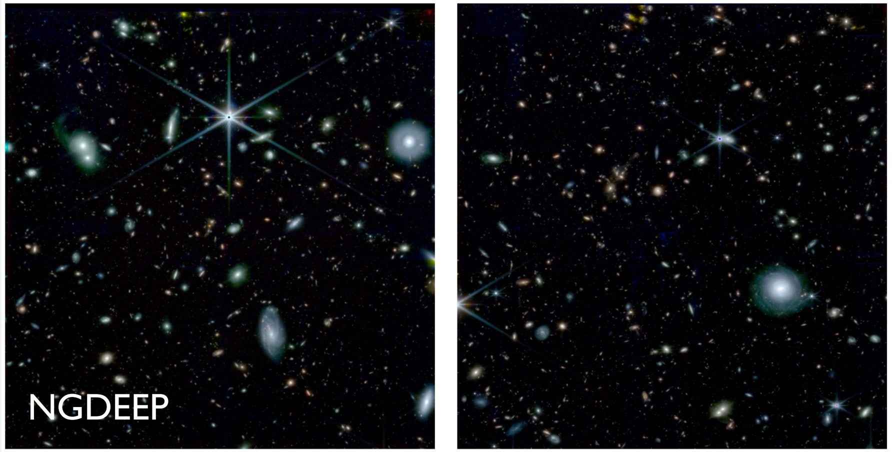
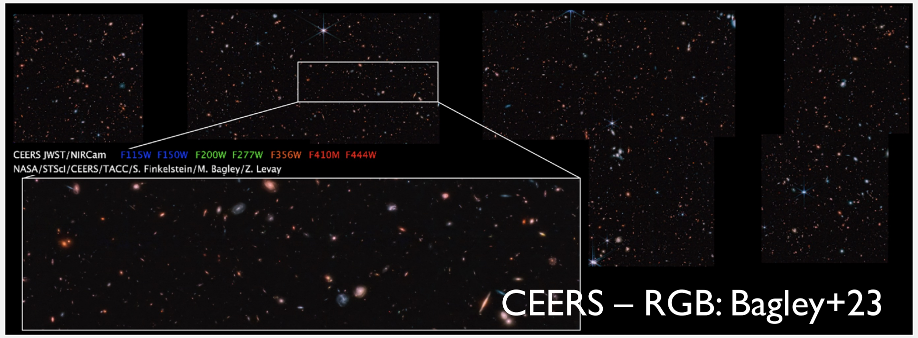
DATA

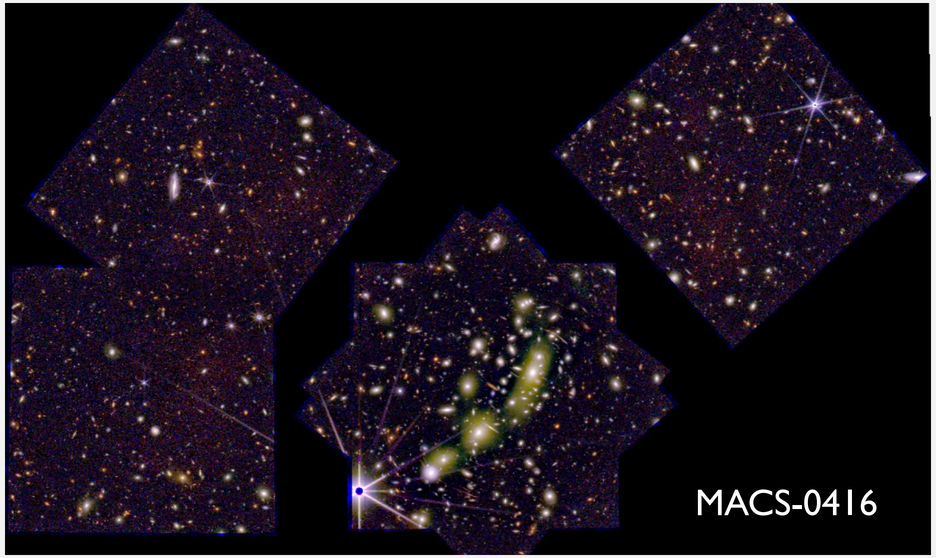


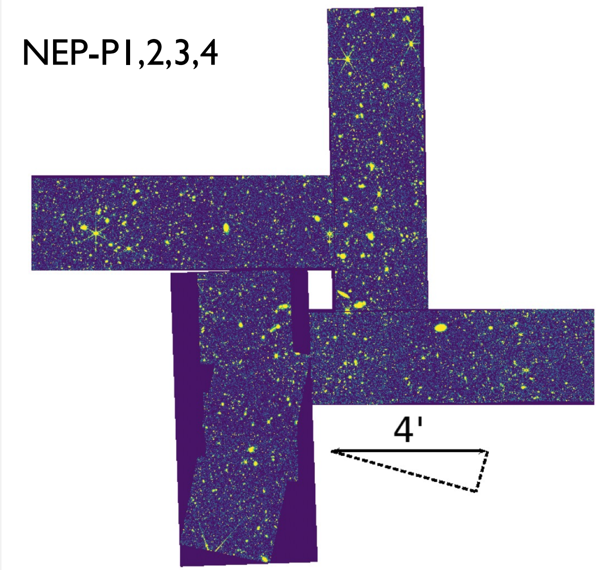
JADES-DR1 –
RGB: Rieke+23











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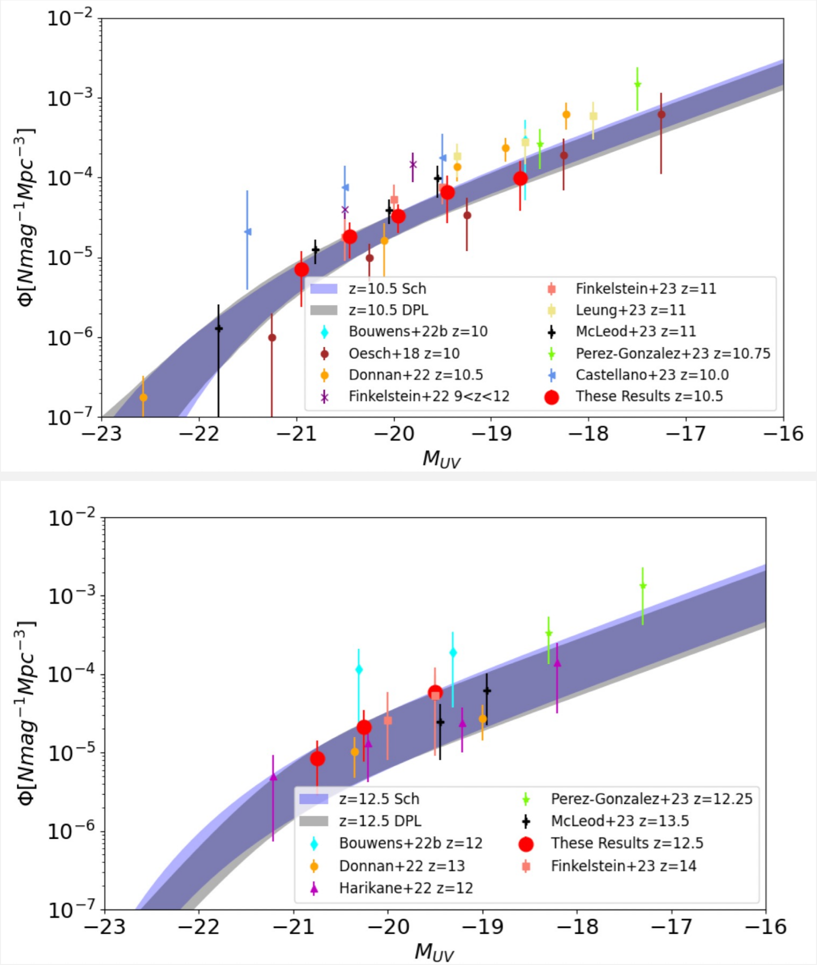
DATA SAMPLE: OVERVIEW

- $m_{\mathrm{AB,\,F277W}} = 29.0 - 30.3$ (0.32as apertures)
- 1011 $6.5 < z < 13$ SFGs over ~179 sq. arcmin of unmasked area, with photo-z's from EAZY (Brammer+08, Larson+22) using the Larson+22 template set and M_* from Bagpipes (Carnall+19)
- 59 brown dwarfs (Sonora+18 templates)
- 34 LRDs (Kokorev+24 selection)
- EPOCHS-I: Conselice in prep. (overview paper)
- EPOCHS-IV: Harvey+24 (stellar mass function)



EPOCHS-II: Adams+23 (UVLF)

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WHY STUDY β?

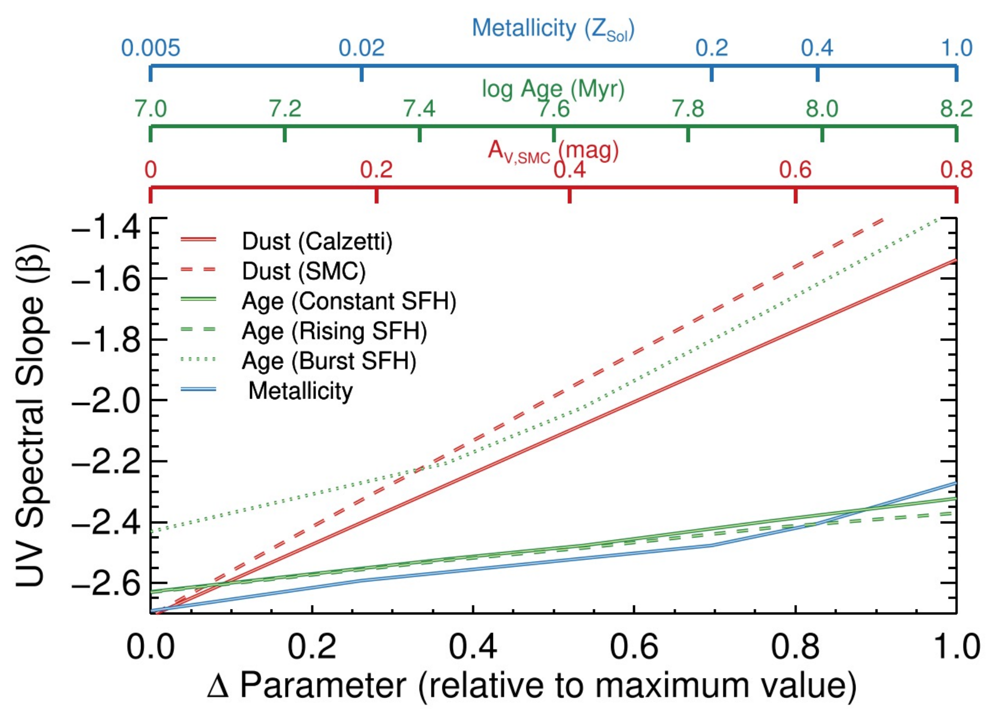


Fig. 6: Tacchella et al. 2022

- β traces the dust – can study the build up of dust at high-z
- $\beta < -3$ could indicate metal poor Pop. III stellar populations

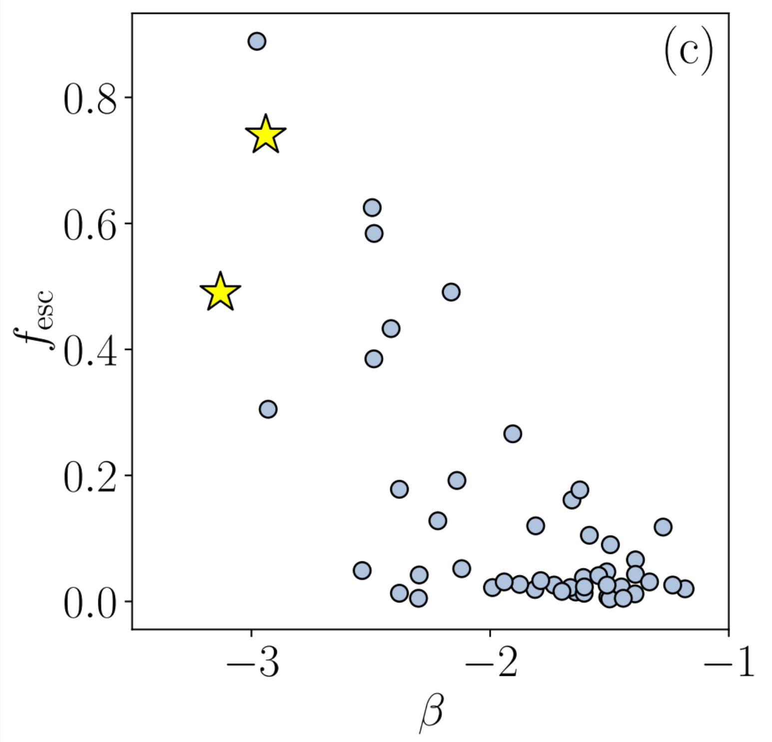
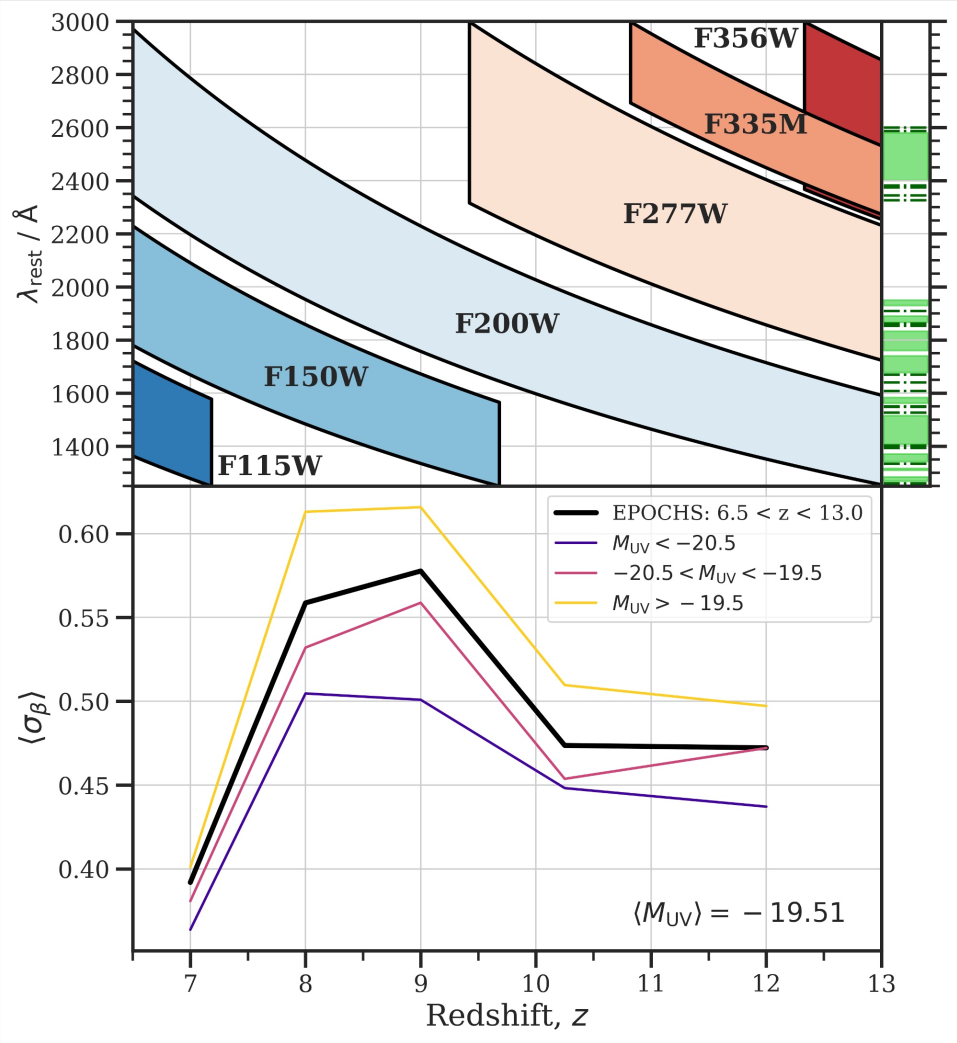
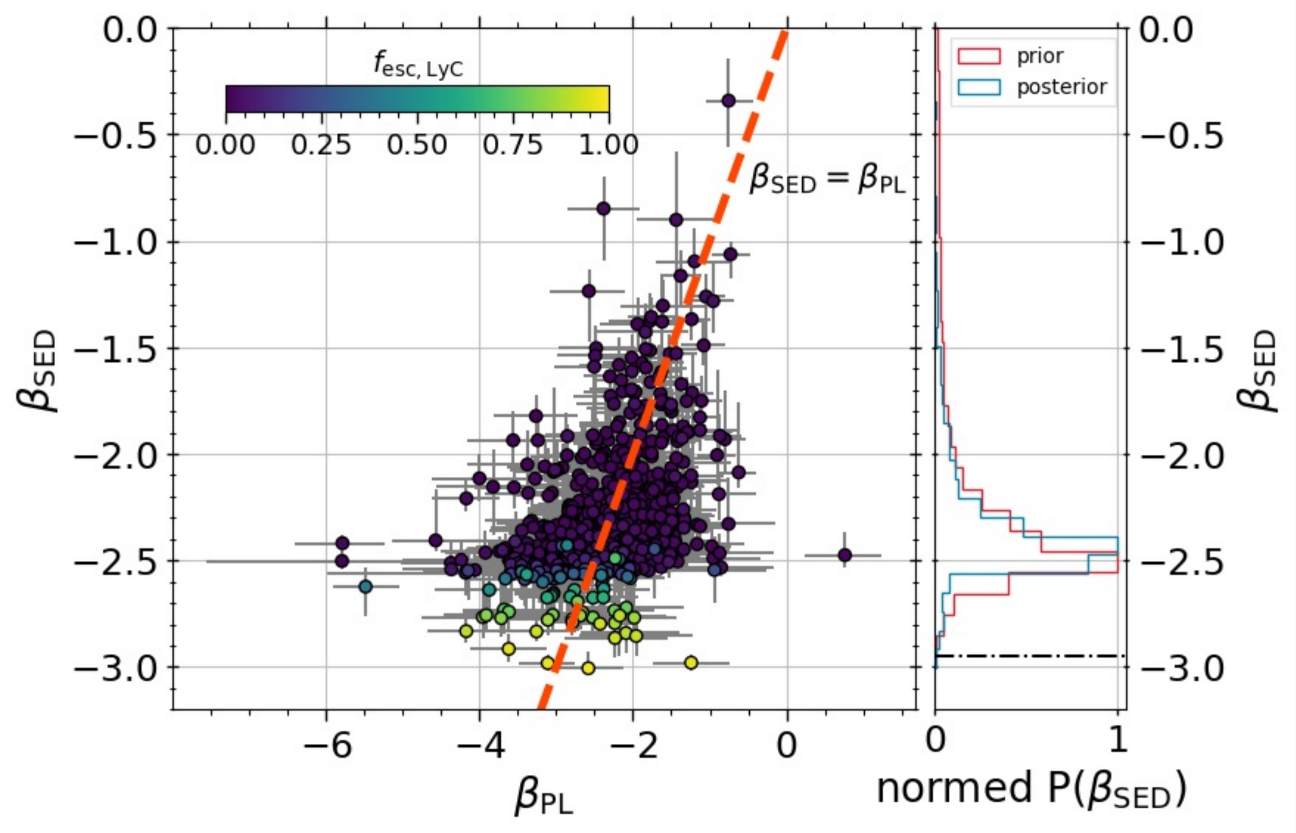


Fig. 8: Topping et al. 2022

- Ultra blue $\beta < -2.8$ requires high escape fractions and are potential Lyman continuum leakers

CALCULATING UV CONTINUUM SLOPES, β



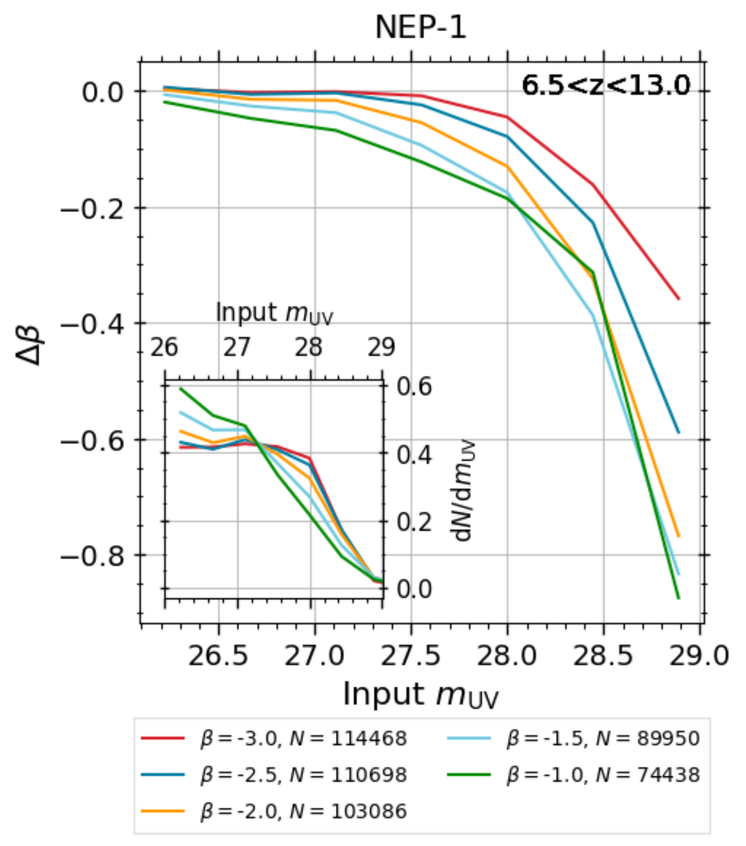


Calzetti et al. 1994

(1250Å < λ_{rest} < 3000Å)

$$f_\lambda \propto \lambda^\beta$$

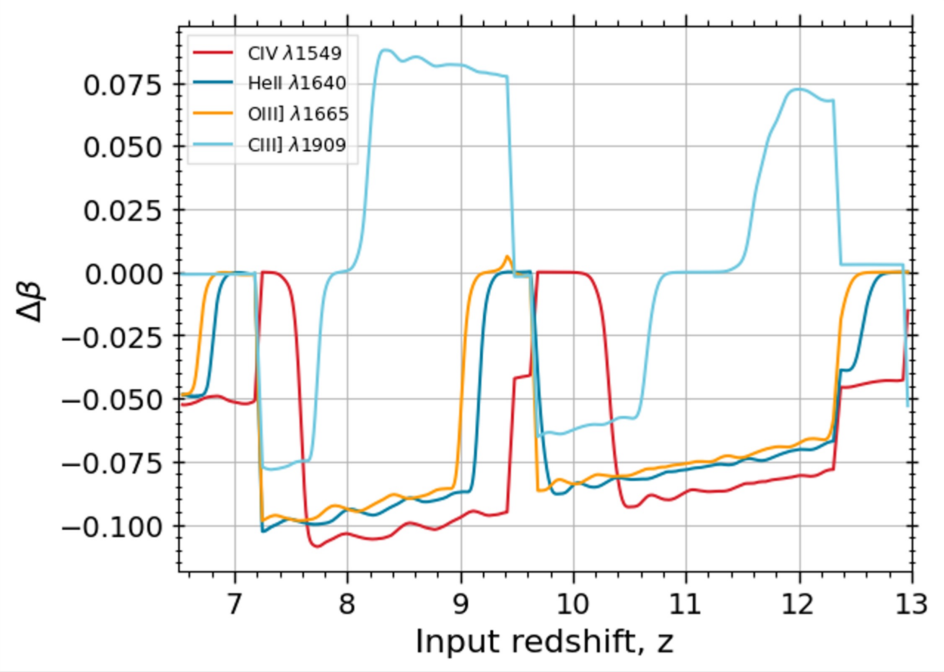
CALCULATING PHOTOMETRIC BETA BIASES



$$\langle \Delta\beta \rangle = -0.06^{+0.06}_{-0.10}$$

$$\Delta\beta_{\min} = -0.54; \Delta\beta_{\max} = 0.24$$

UV line bias per 10Å EW



$$\Delta\beta(\mathrm{EW_{rest}}) = \mathrm{EW_{rest}} \frac{\Delta\beta(\mathrm{EW_{rest}} = 10\ \text{Å})}{10}$$

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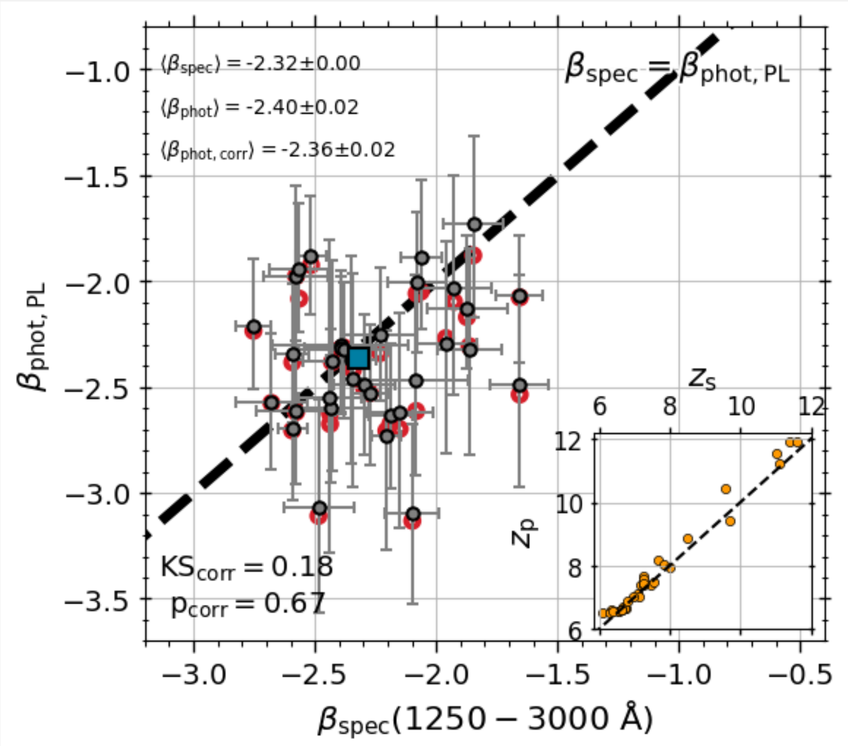
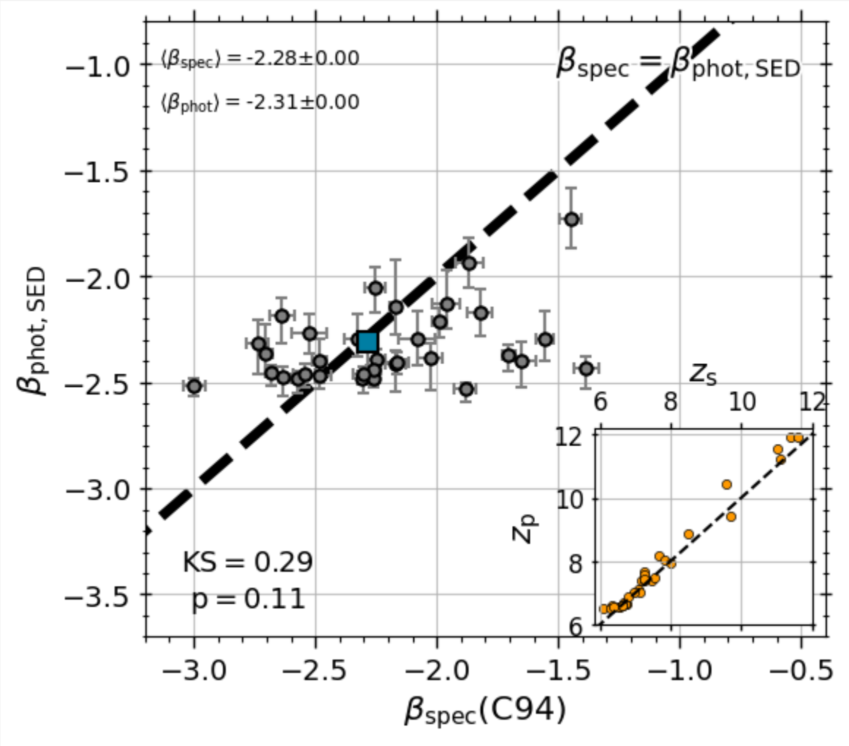
A COMPARISON WITH SPECTROSCOPY

Power law β



SED β



UV continuum $\mathrm{SNR} > 3$: 39 NIRSpec/PRISM spectra obtained from Dawn JWST Archive (DJA)

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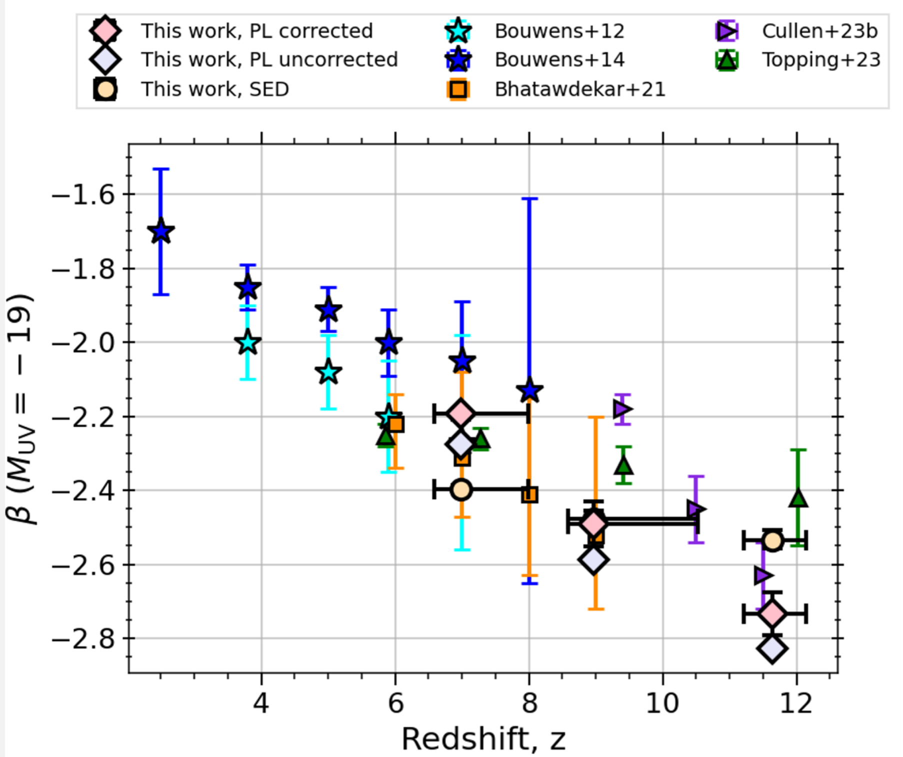
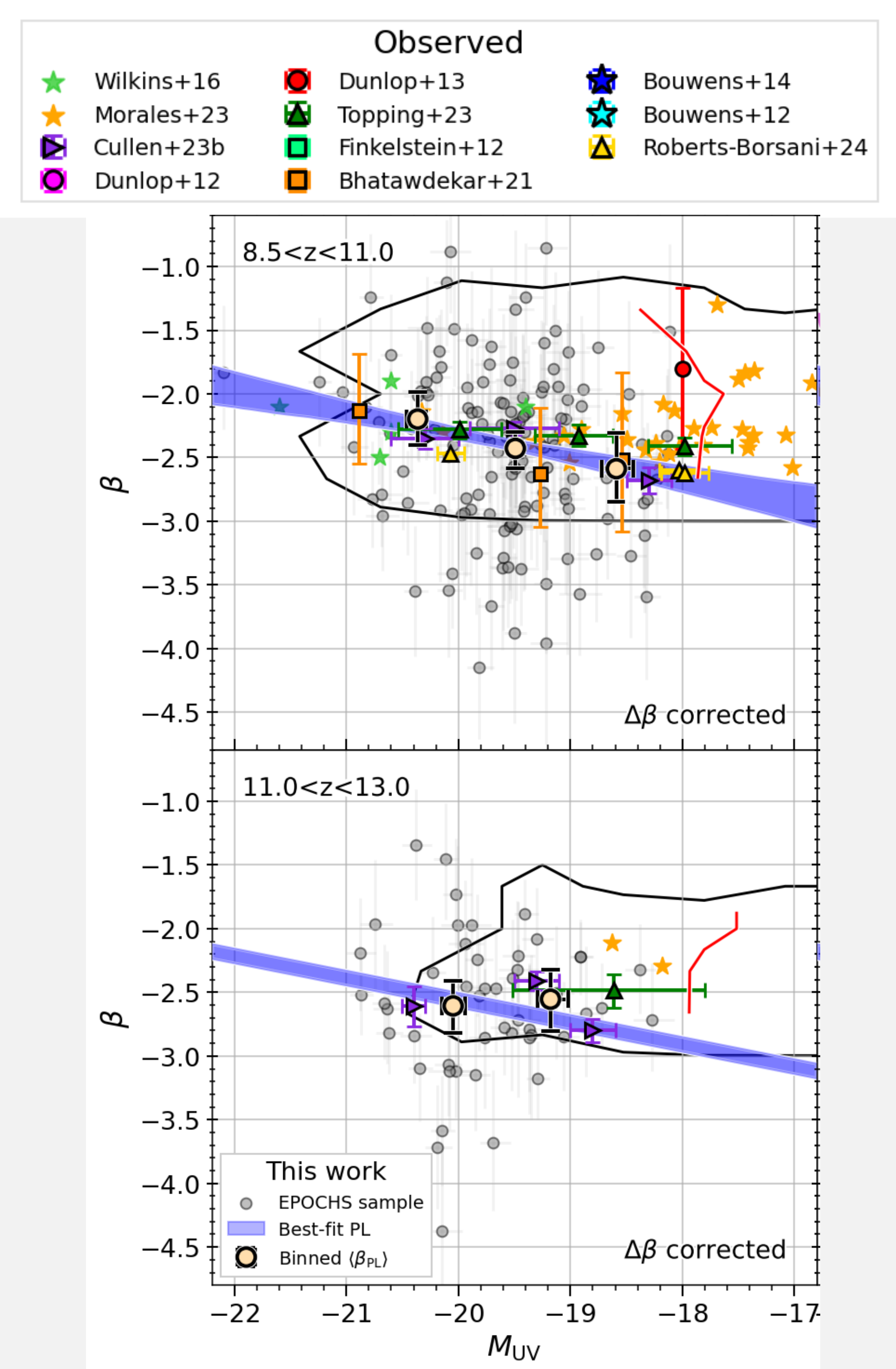
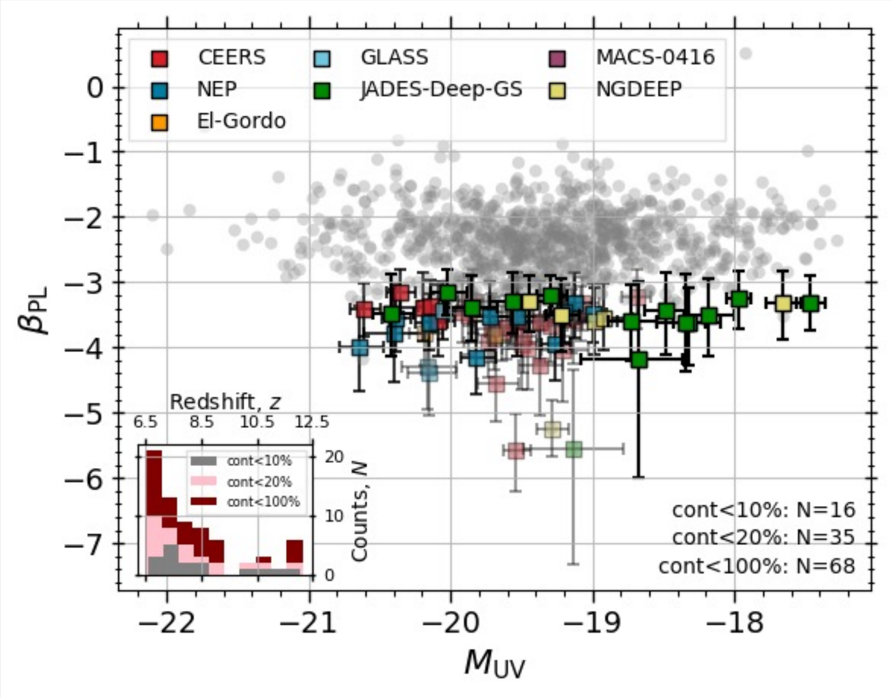
BETA VS M_{UV}



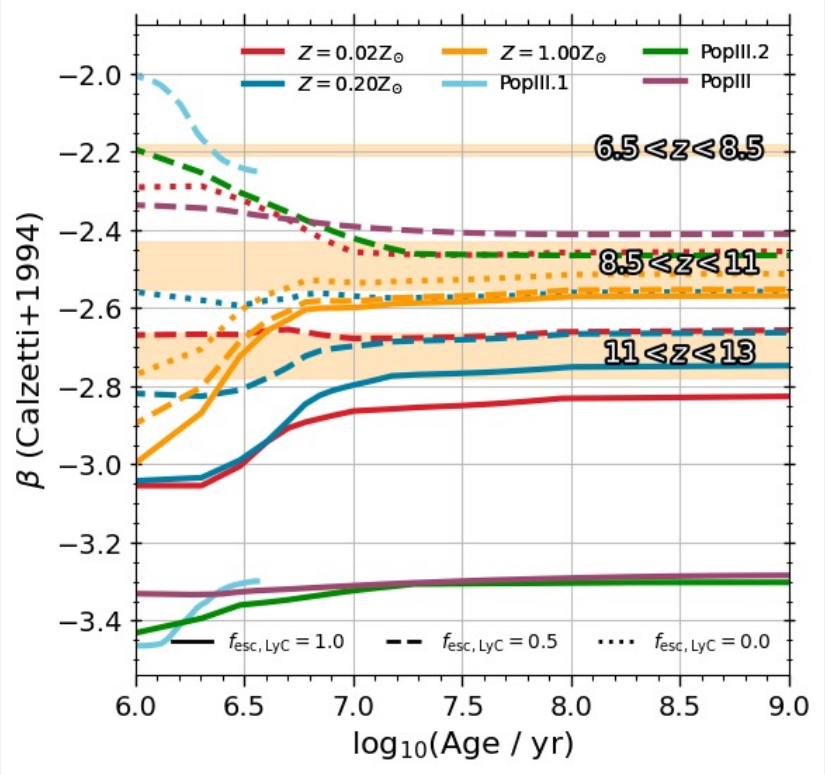
Ultra-blue $\langle\beta\rangle = -2.73 \pm 0.06$
at $11 < z < 13$



EVIDENCE FOR ULTRA-BLUE EXOTIC STELLAR POPULATIONS?



68 potential $\beta + \sigma_\beta < -2.8$ candidates



$\langle\beta\rangle$ consistent with low-metallicity dust free systems at $11 < z < 13$

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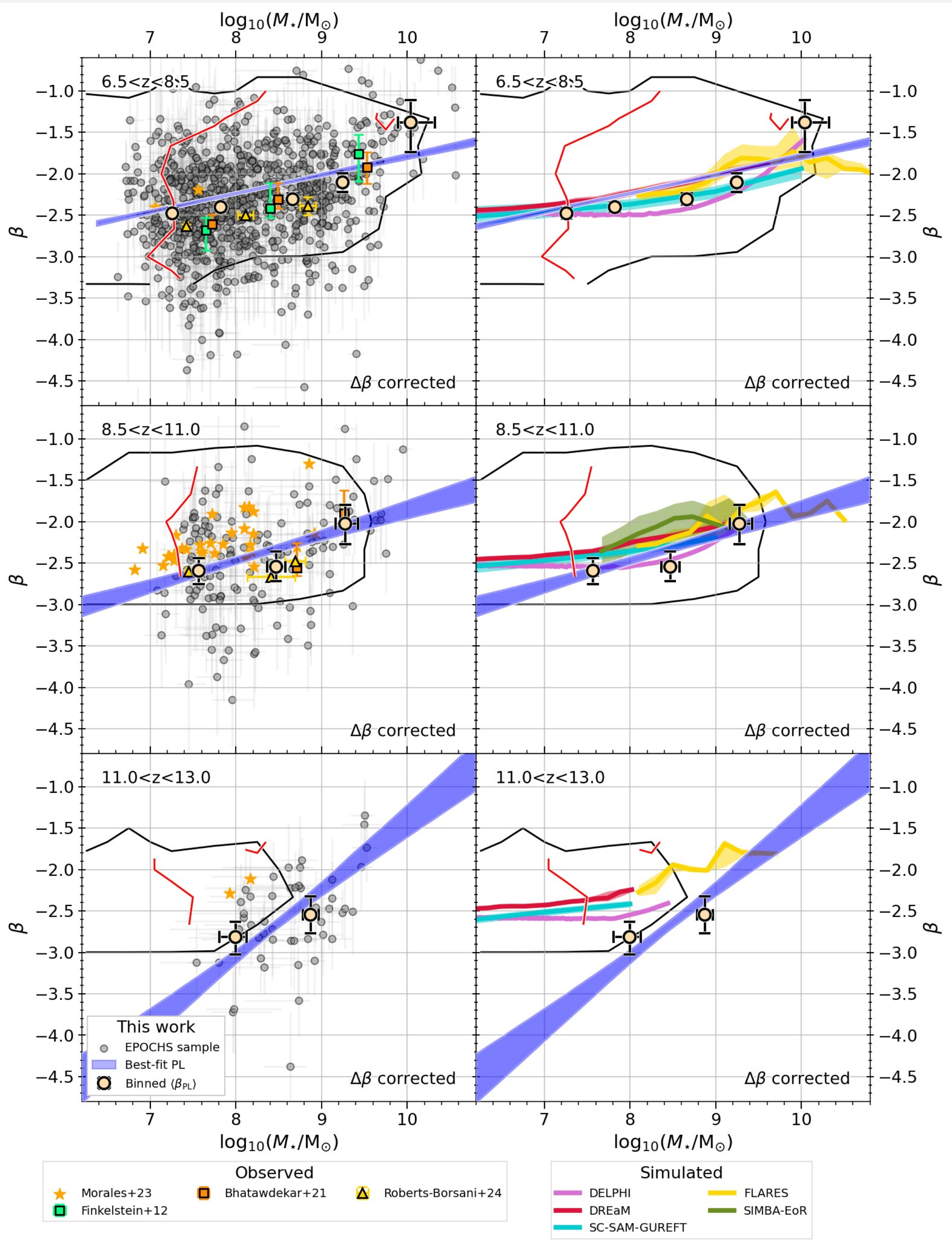
BETA VS MASS



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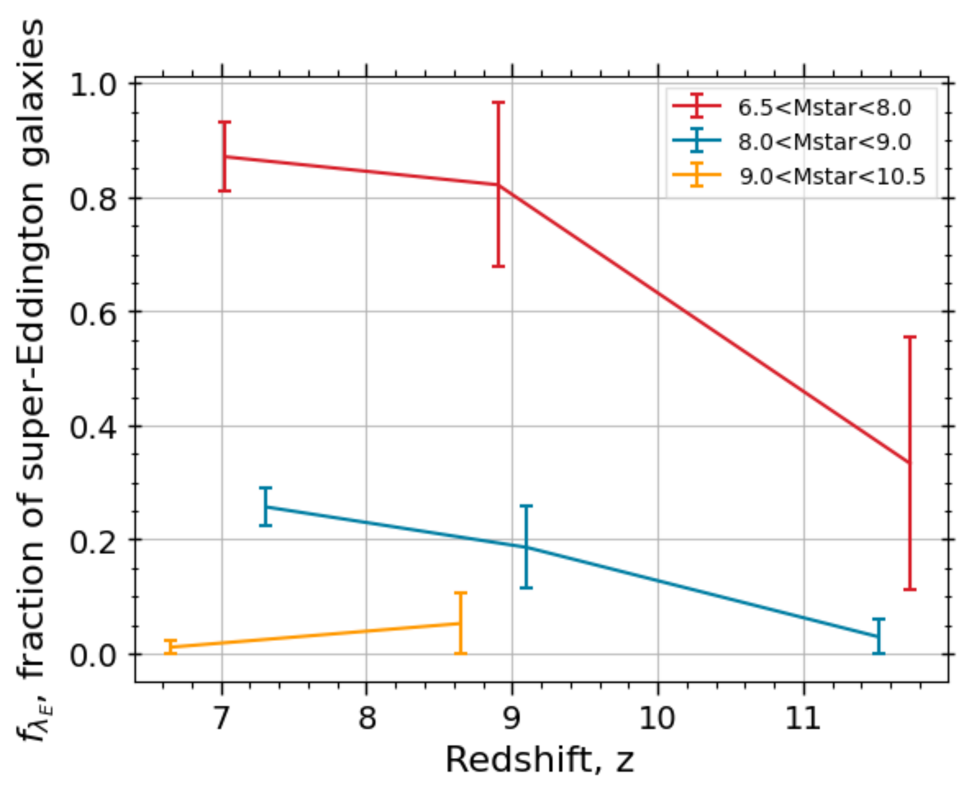
WHAT HAPPENS TO DUST IN LOW MASS GALAXIES AT $z > 11$?

1. UV radiation pressure induced outflows in super-Eddington galaxies (Ferrara+23)
2. Dust is spatially segregated from UV emitting regions in giant molecular clouds (Ziparo+23)
3. Enhanced dust destruction processes e.g. ISM grain-grain/shattering processes in SNe reverse shocks (Kirchschlager+22)



$$f_{\lambda_E} = \frac{N(\mathrm{sSFR} > 25\mathrm{Gyr}^{-1})}{N_{\mathrm{tot}}}$$

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CONCLUSIONS

1. EPOCHS sample: 1011 $6.5 < z < 13$ SFGs over ~179 sq. arcmin at depth $m_{\mathrm{AB,F277W}} = 29.0 - 30.3$

2. 68 candidate LyC leakers with $\beta + \sigma_\beta < -2.8$

3. Ultra-blue $\langle\beta\rangle = -2.73 \pm 0.06$ at $11 < z < 13$

   → Galaxies are *on average* dust free at these redshifts

4. Chisholm+22: $\langle f_{esc}\rangle = 0.28$ at $11 < z < 13$

   $\langle f_{esc}\rangle = 0.14$ at $8.5 < z < 11$

   → Perhaps favours early and slow reionization models

   → Highlights need for multivariate models of f_{esc}