Background: NASA, ESA, CSA, Brant Robertson (UC Santa Cruz), Ben Johnson (CfA), Sandro Tacchella (Cambridge), Marcia Rieke (University of Arizona), Daniel Eisenstein (CfA)

JADES JWST ADVANCED DEEP EXTRAGALACTIC SURVEY

Implications for early star formation from the JADES UV luminosity function at z~9–15

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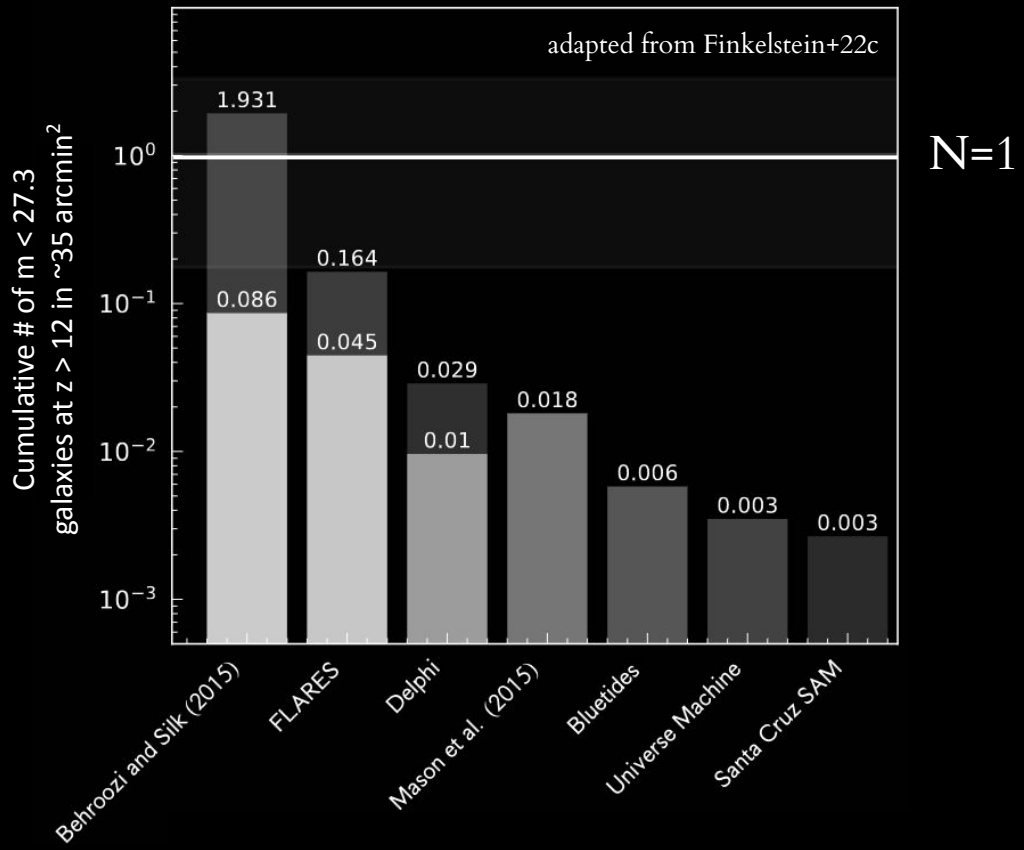
Cosmic Dawn at High Latitudes – June 28, 2024

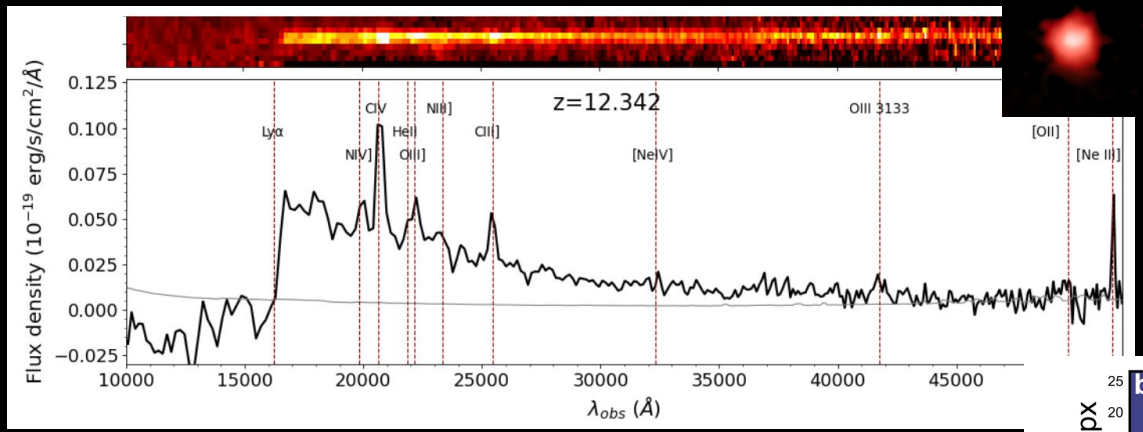
Pre-JWST theory and lower redshift observations: ≪ **one bright** (M_{UV} ~ –20) **galaxy expected at z ~ 12** in the areas of early JWST fields

M_{AB} ~ –20.2 at z = 10
M_{AB} ~ –20.4 at z = 12



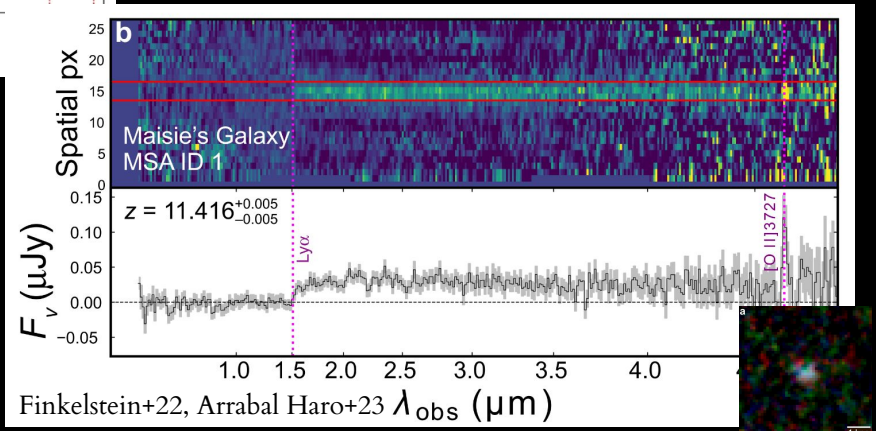
Early JWST observations: several individual bright z ~ 11 – 12 objects → an **unexpectedly large bright galaxy population at z ≥ 10**

GHZ2/GLASS-z12, z=12.34, M_{UV} ~ -20.5

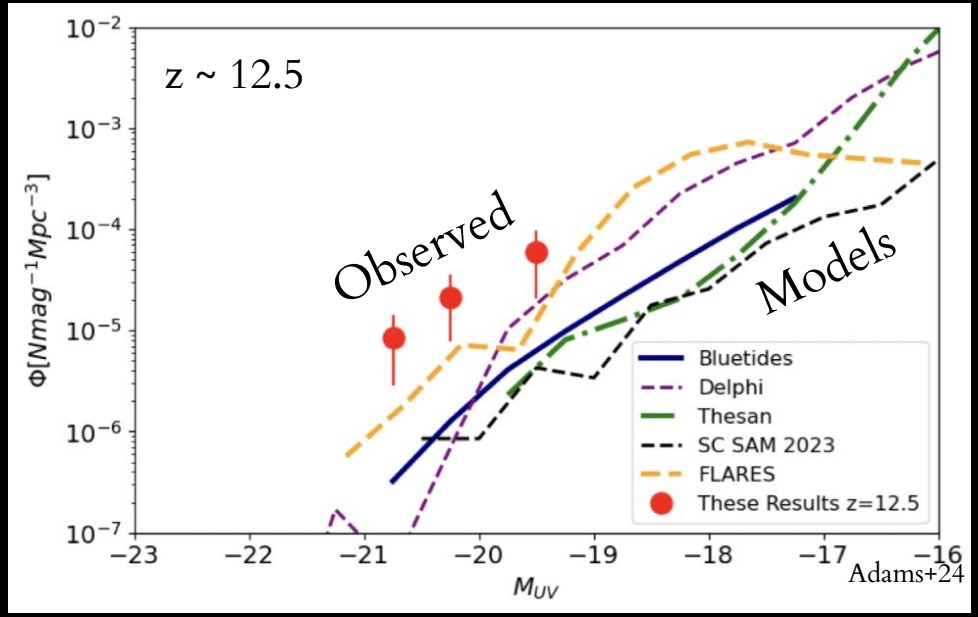


Castellano+22,+24, Naidu+22

Maisie's Galaxy, z=11.42, M_{UV} ~ -20.1



Statistical JWST measurements of the **UV luminosity function up to z ~ 12 support a large population of bright galaxies**, in tension with models



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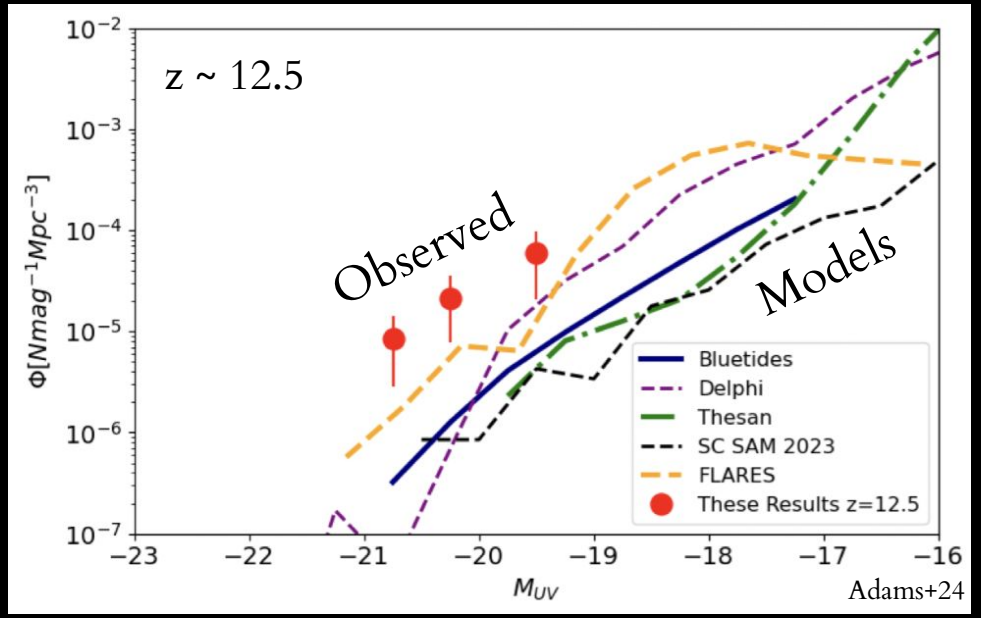
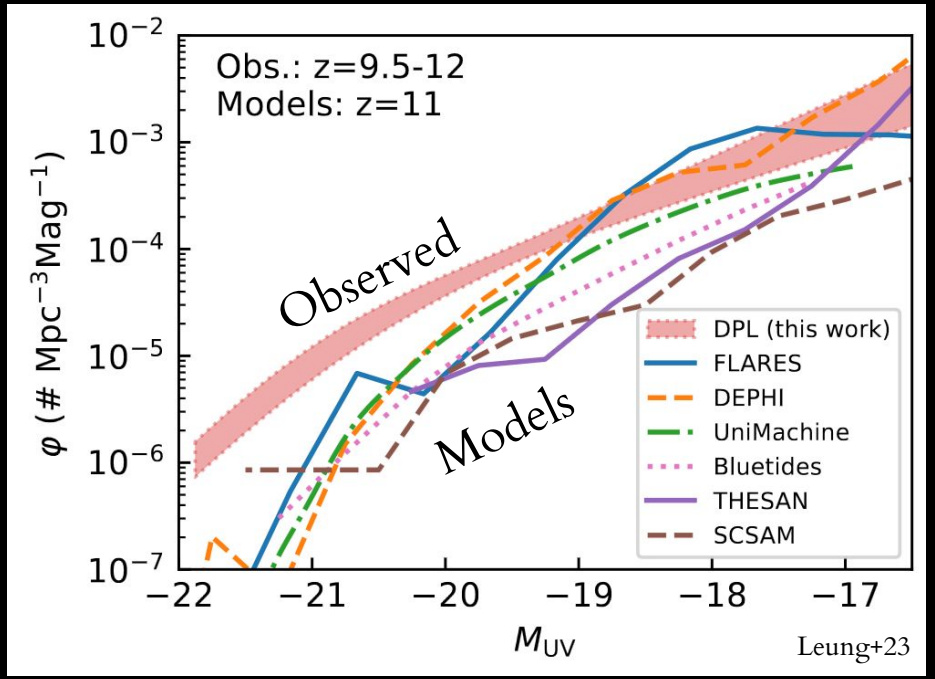




Is there a similar tension for fainter systems? What about higher redshifts?

Along with the bright galaxy population, **are faint galaxies ($-19 \lesssim M_{UV} \lesssim -17$) also more abundant than expected?**

How long does the steady evolutionary trend observed at $z \sim 10-12$ continue? How do the luminosity function and cosmic UV luminosity density evolve up to $z \sim 14$?

The JADES luminosity function data: **~160 arcmin²** in GOODS-N and GOODS-S with **several tiers of depth**

F090W, F115W, F150W, F200W, F277W, F356W, F410M, and F444W + HST/ACS

+ most of the NIRCam medium bands and F070W from JADES, JEMS (Williams+23), FRESCO (Oesch+23), and program 3215 (Eisenstein+23b)

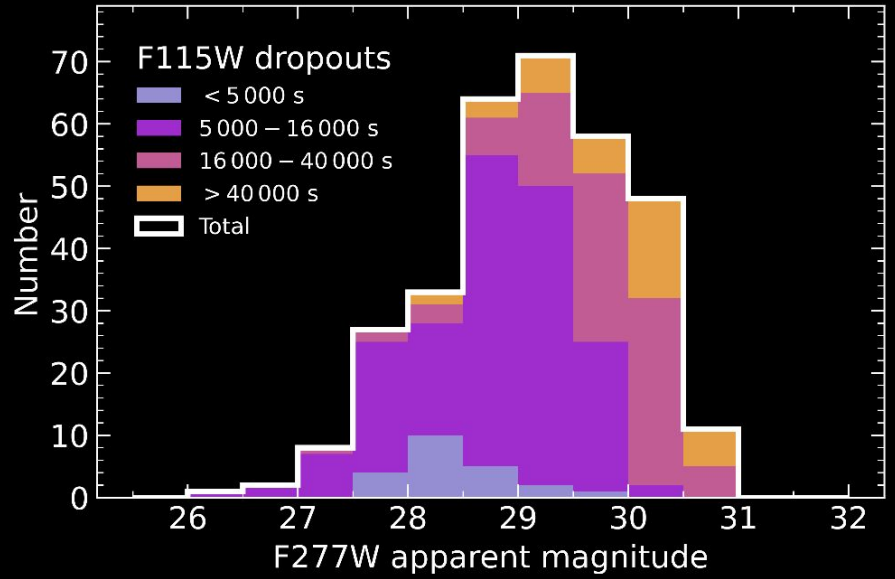
NIRCam 5σ depths down to m_{AB} ~ 30.8 (~1.7 nJy)

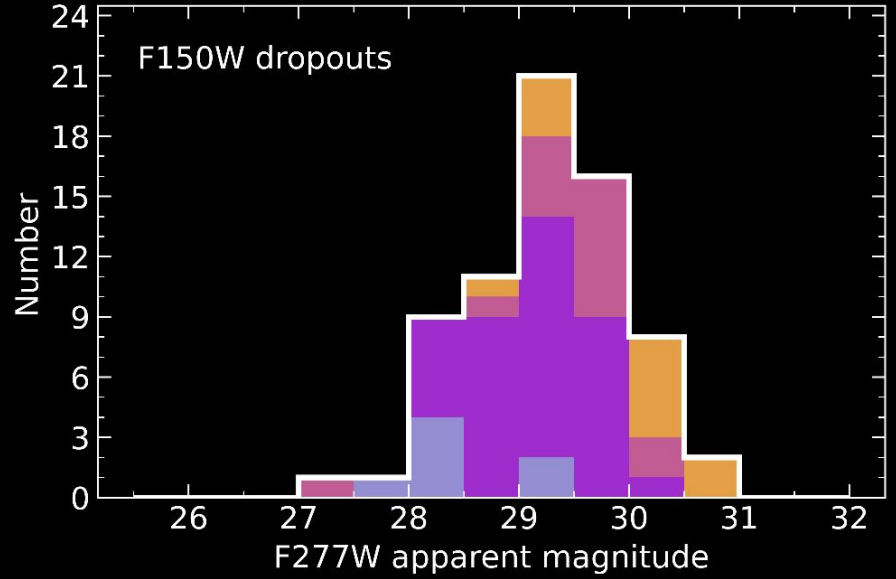
M_{AB} ~ -16.7 at z = 10

M_{AB} ~ -17.2 at z = 14

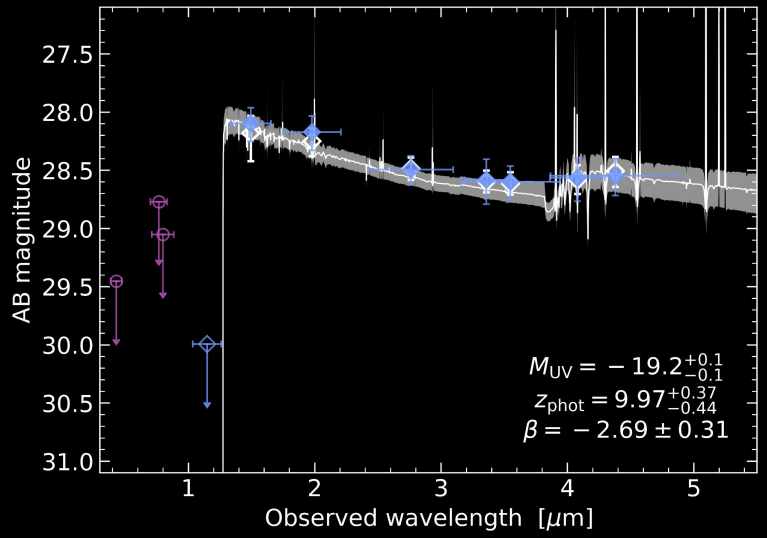
Three color-selected dropout samples

	Number	F277W apparent magnitude	Redshift
F115W dropouts	324	26–31 AB mag	8.7–11.7
F150W dropouts	69	27–30.6 AB mag	11.3–15.1
F200W dropouts	1	30.6 AB mag	17.9





A robust sample of candidates with properties consistent with expectations for the high redshift galaxy population



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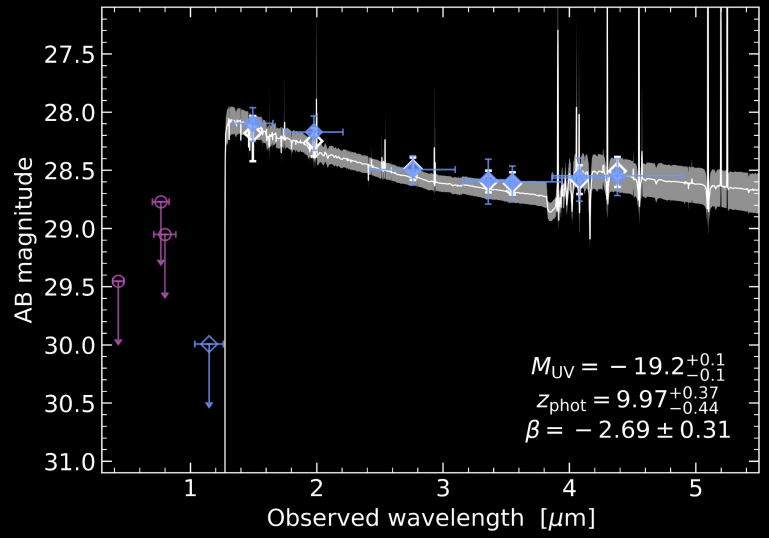

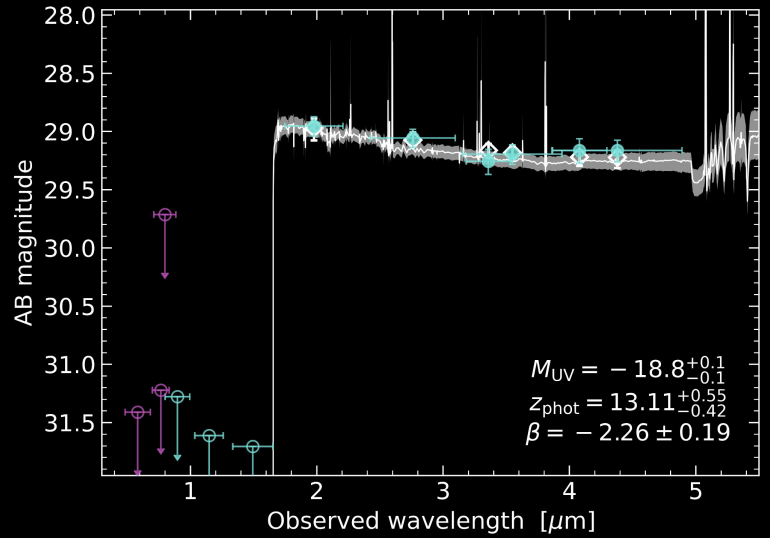

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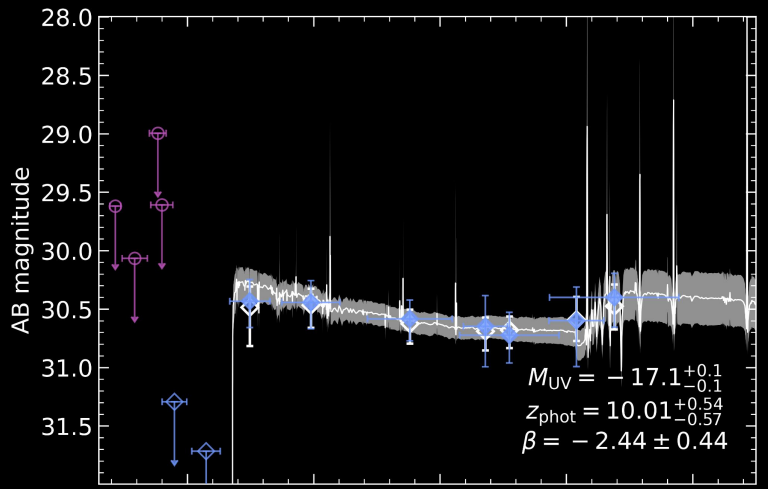
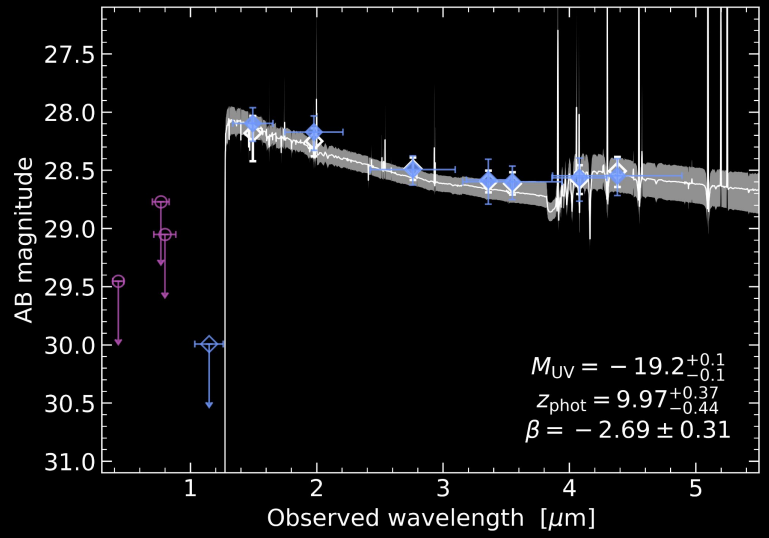
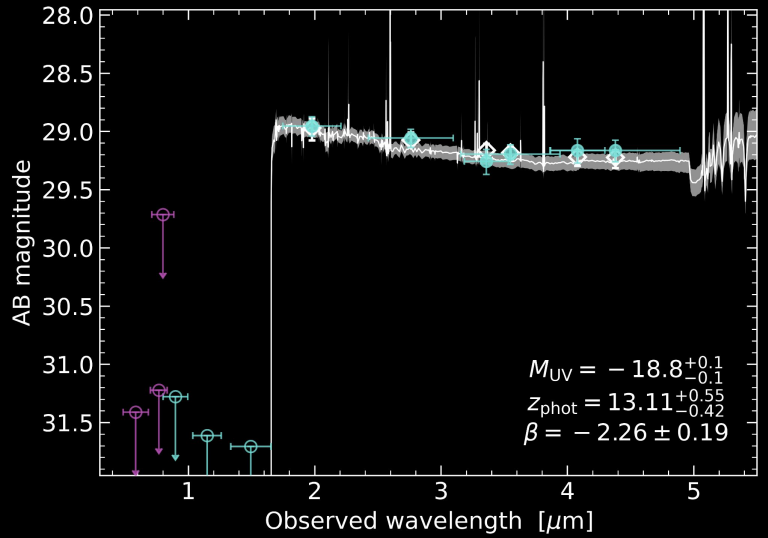
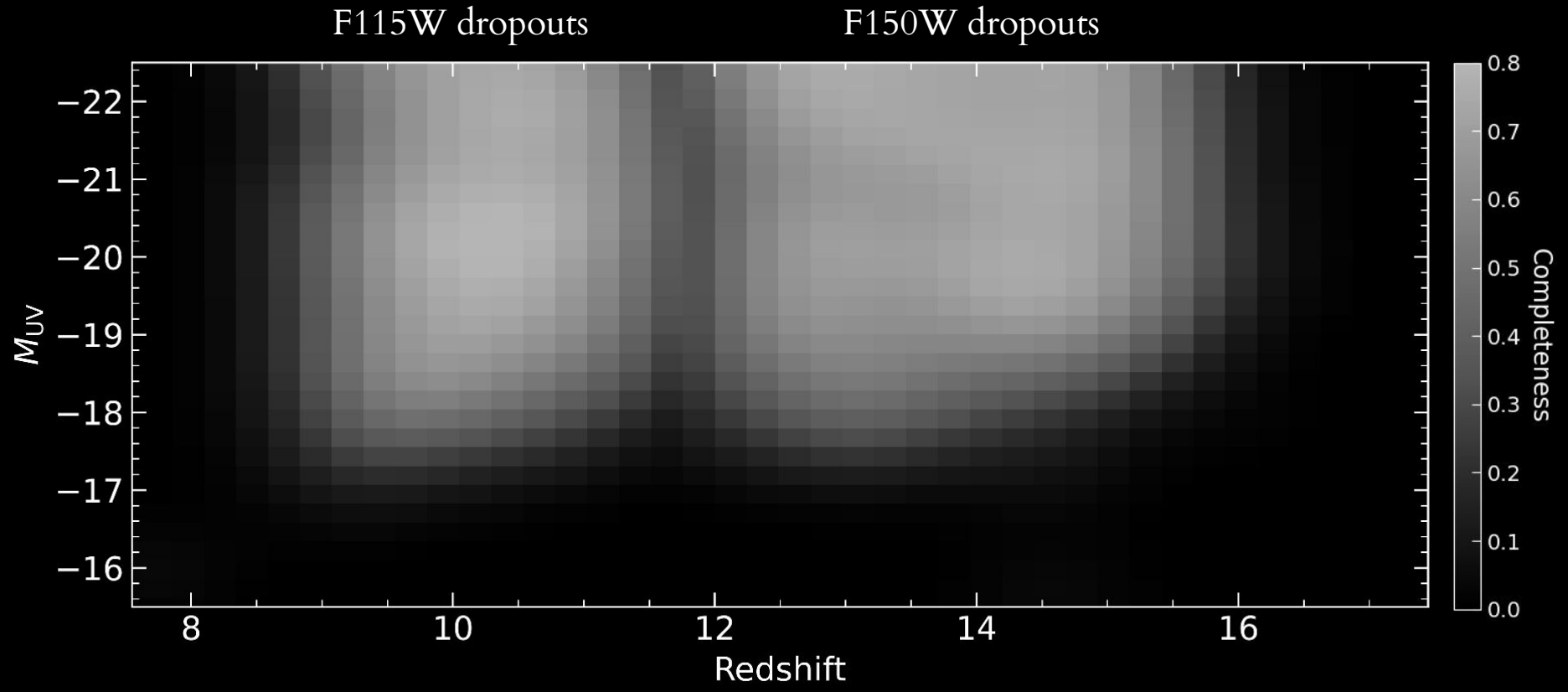






The selection functions: **end-to-end source injection simulations**



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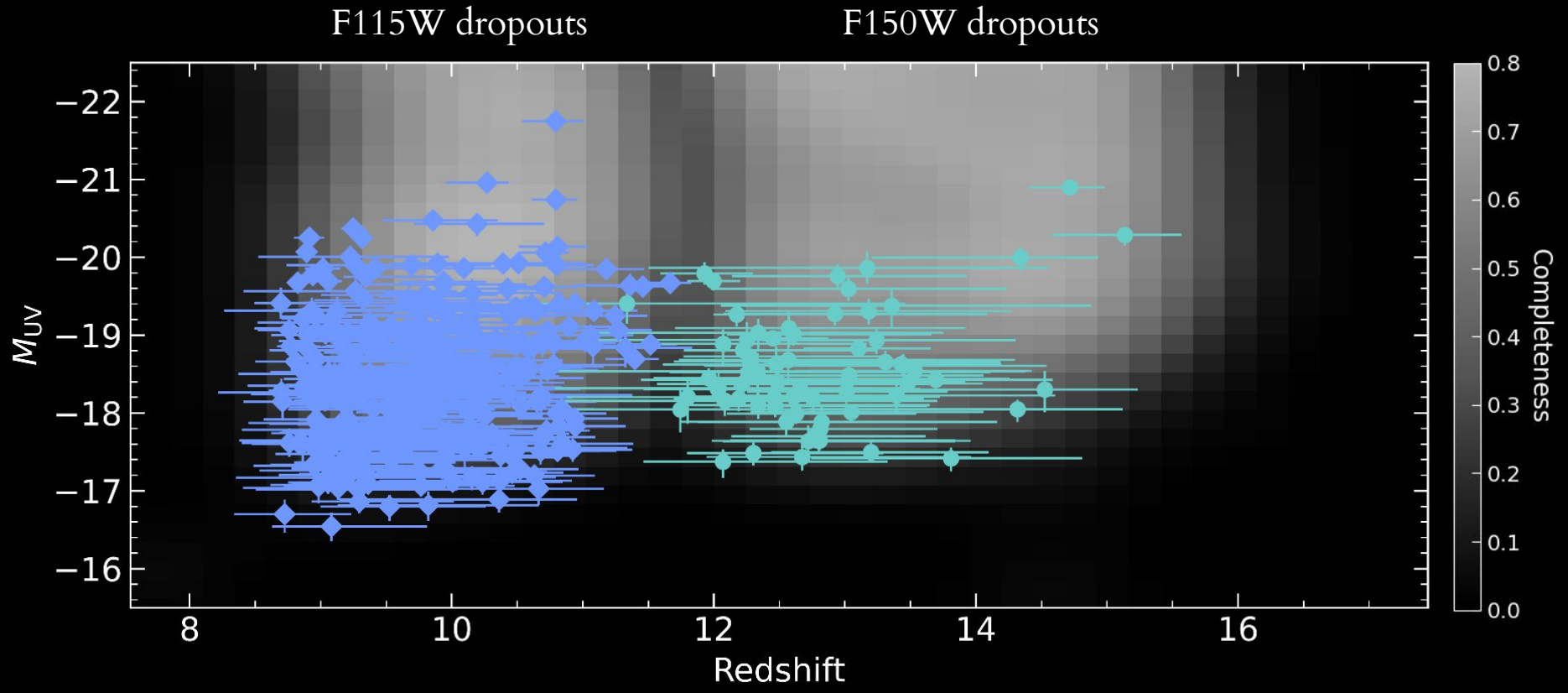
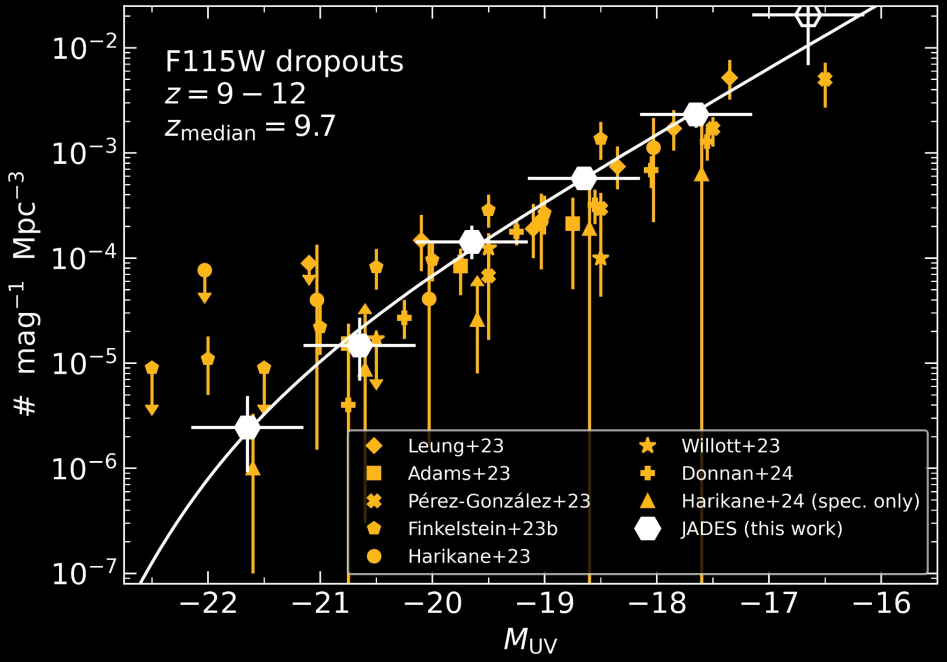
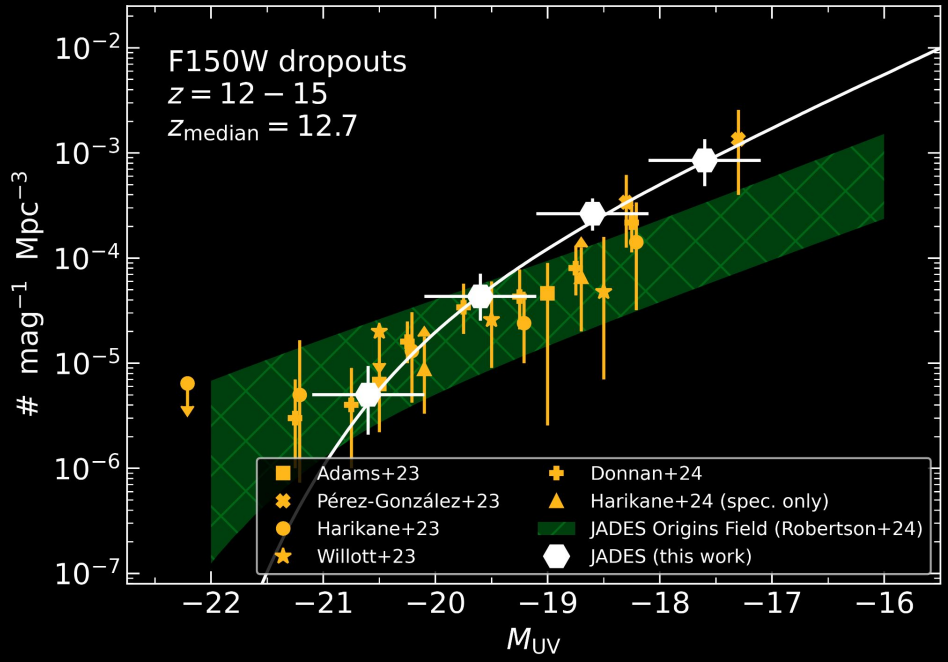
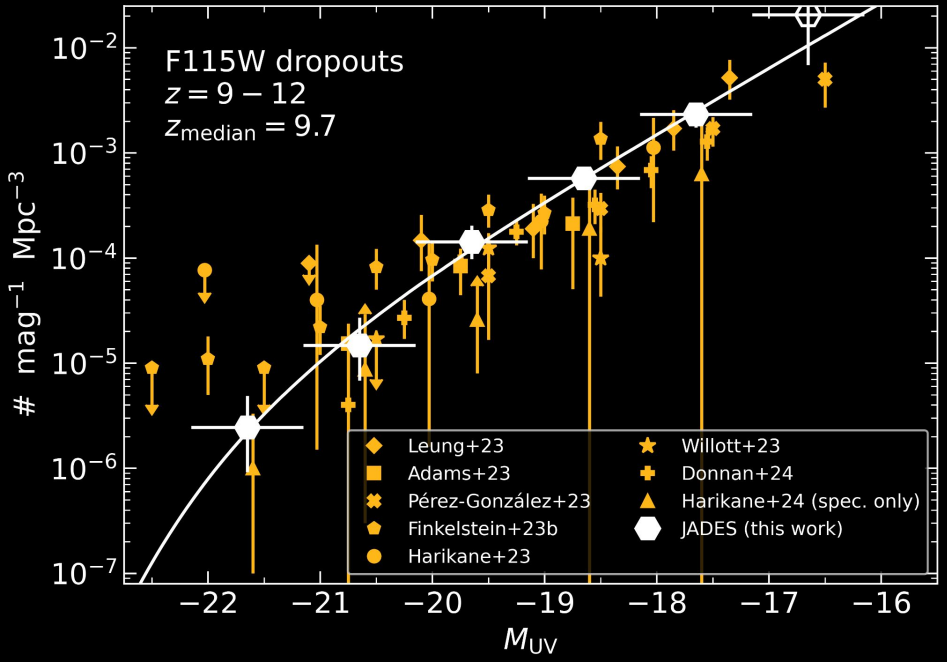


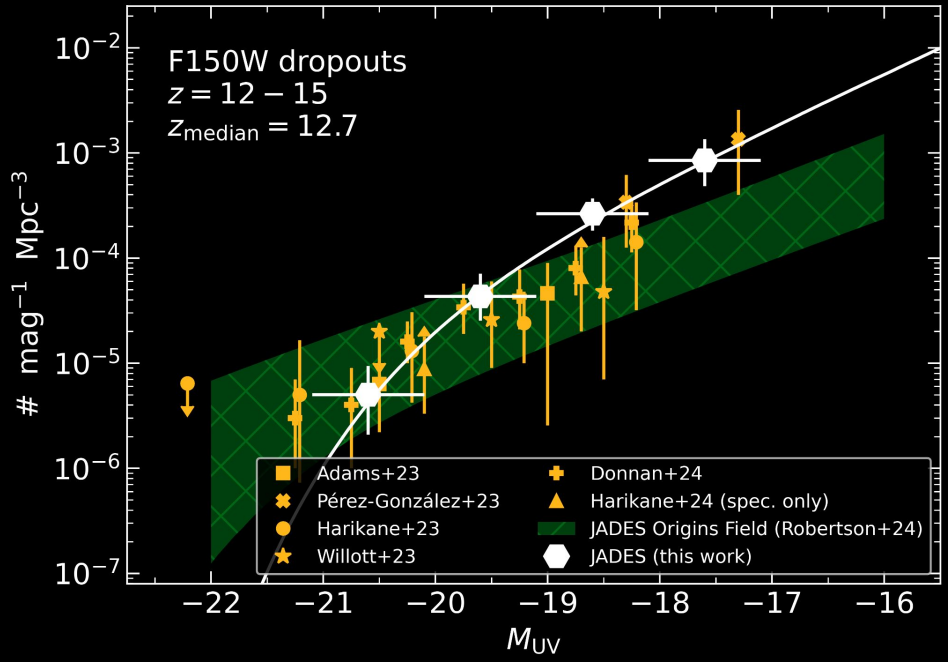
The JADES UV luminosity functions at z~9–15



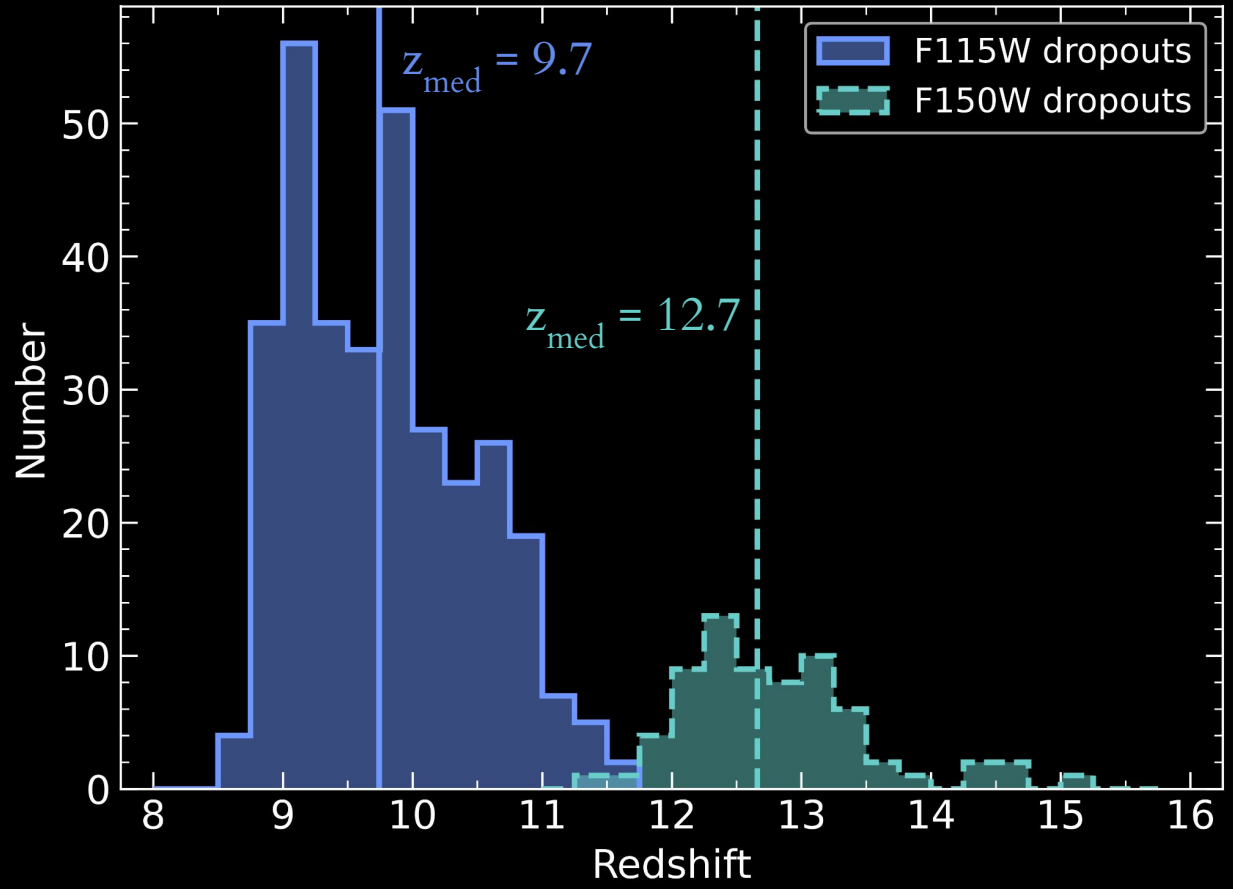


The JADES UV luminosity functions at z~9–15*





* the samples are weighted towards the lower redshifts of the selection functions



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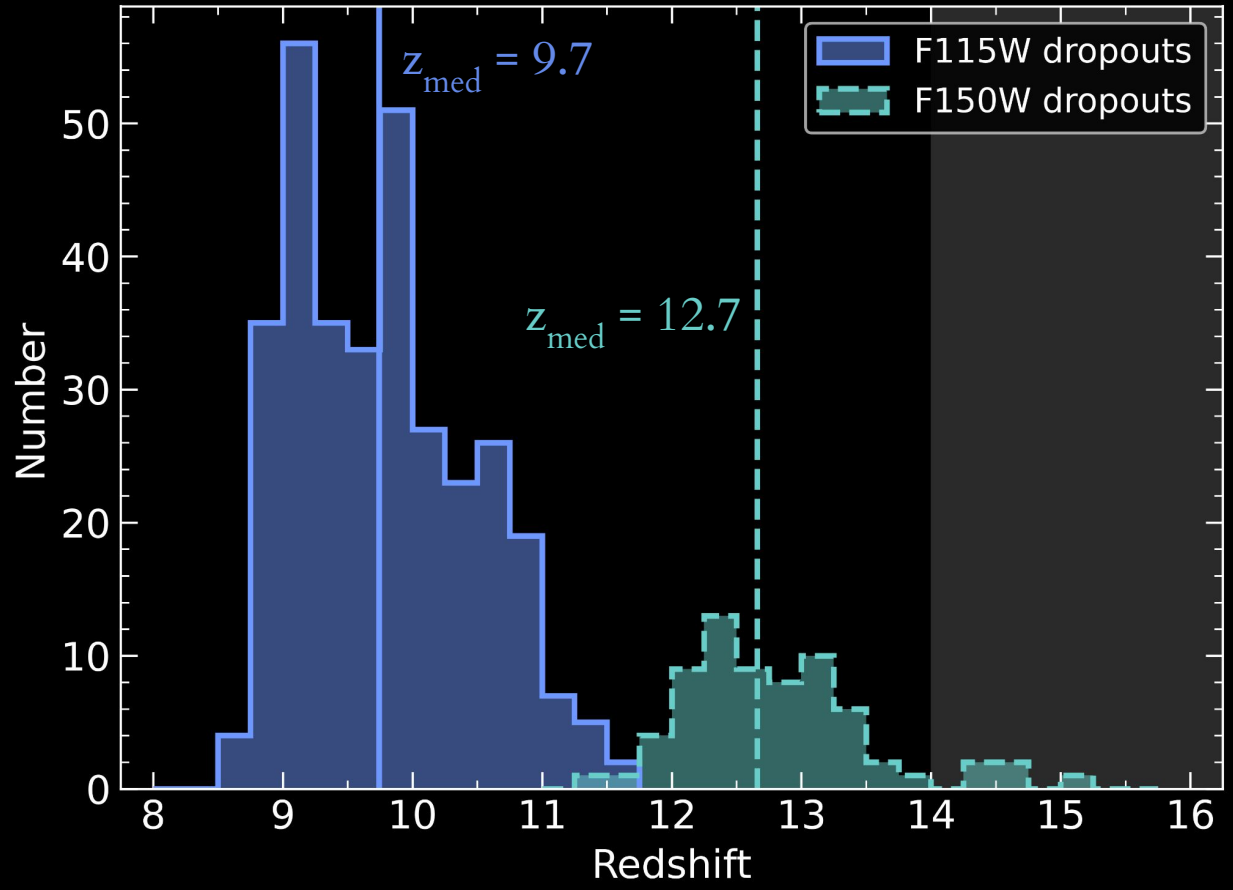
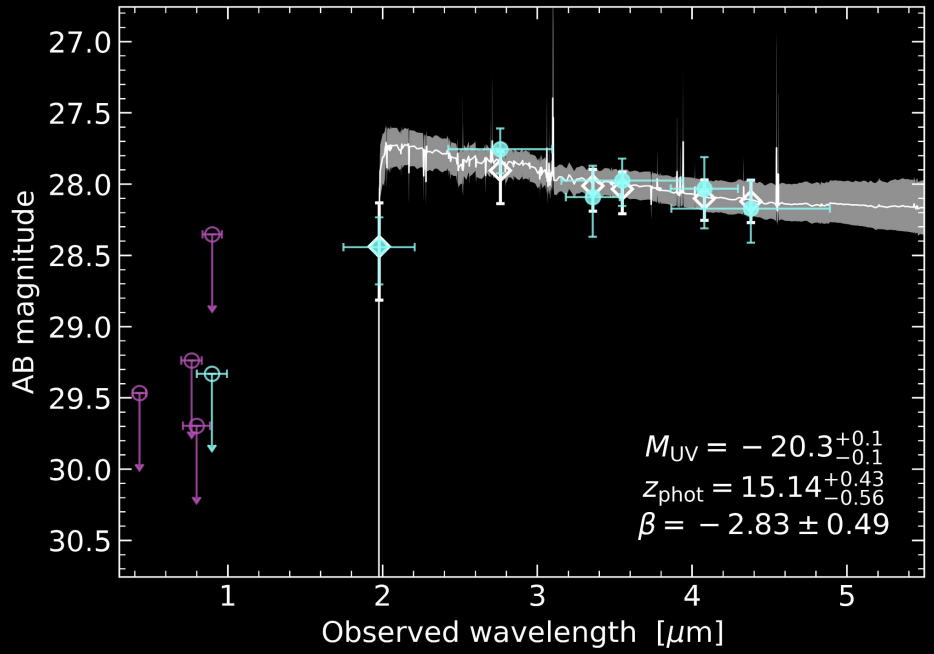
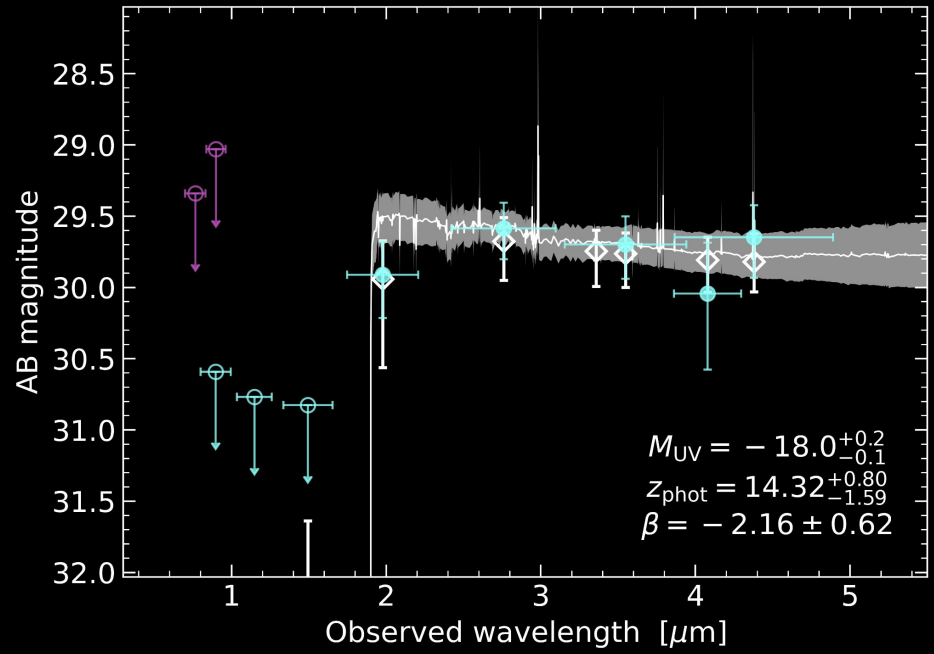


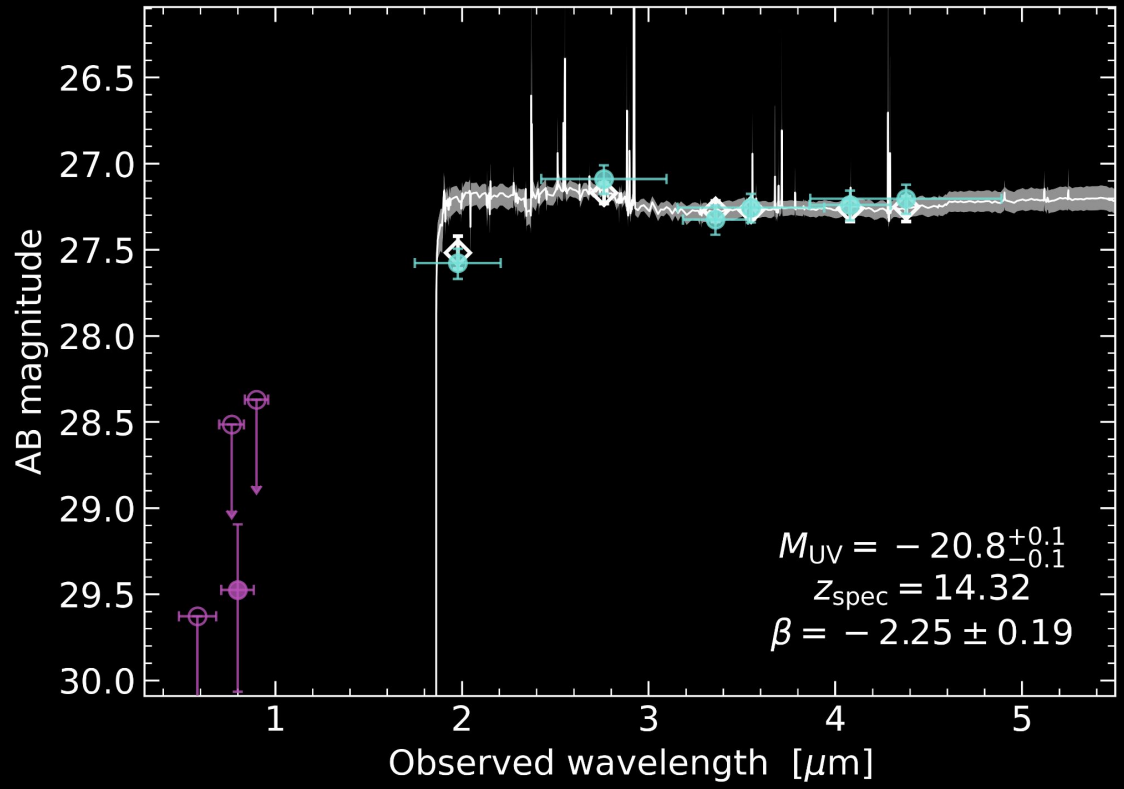
Investigate z~14 by **isolating the subset of the F150W dropout sample at $z_{phot} \geq 14$**

Five candidates with photometric redshifts at z ≥ 14





Five candidates with photometric redshifts at z ≥ 14 including GS-z14-0 at z_{spec} = 14.32



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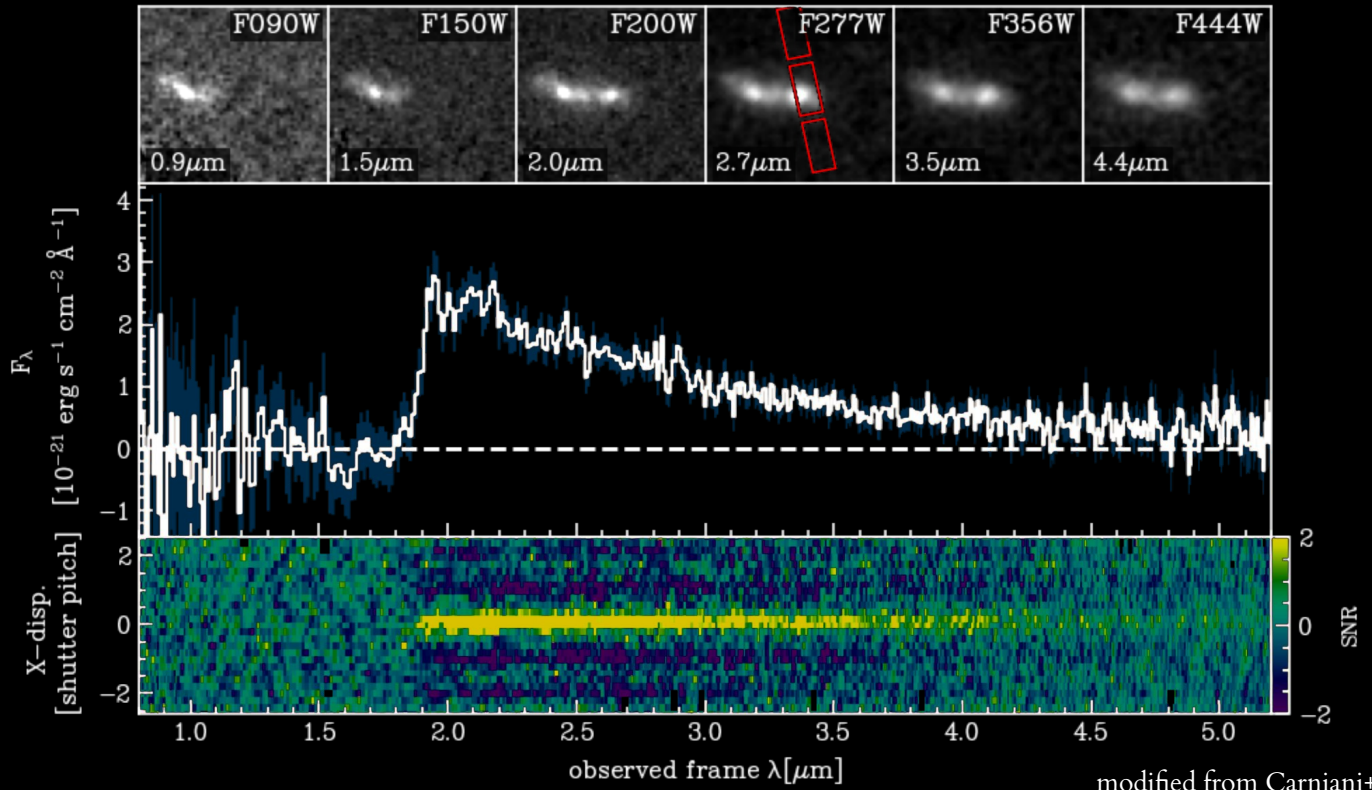
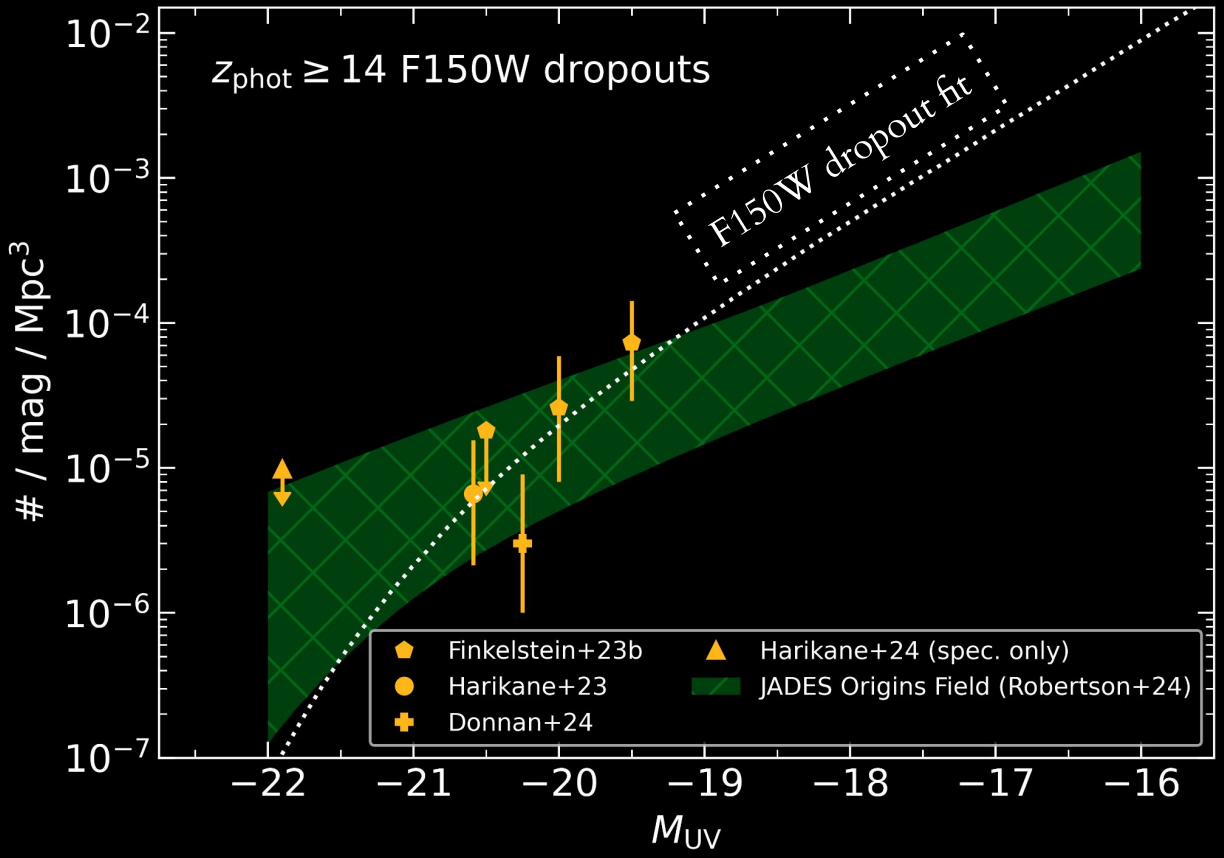


modified from Carniani+24, also see Helton+24

Little evolution between the entire F150W dropout **(z~12–15)** luminosity function and **z~14–15**



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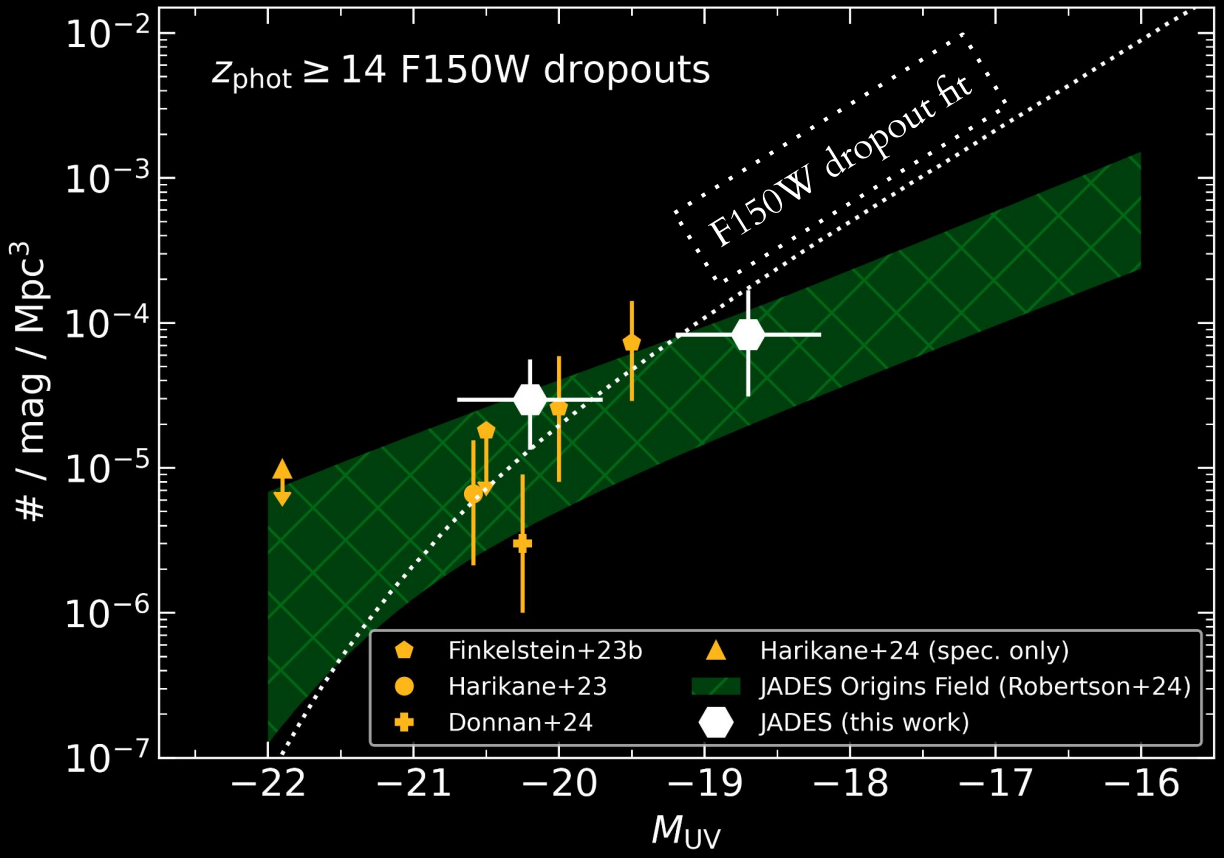
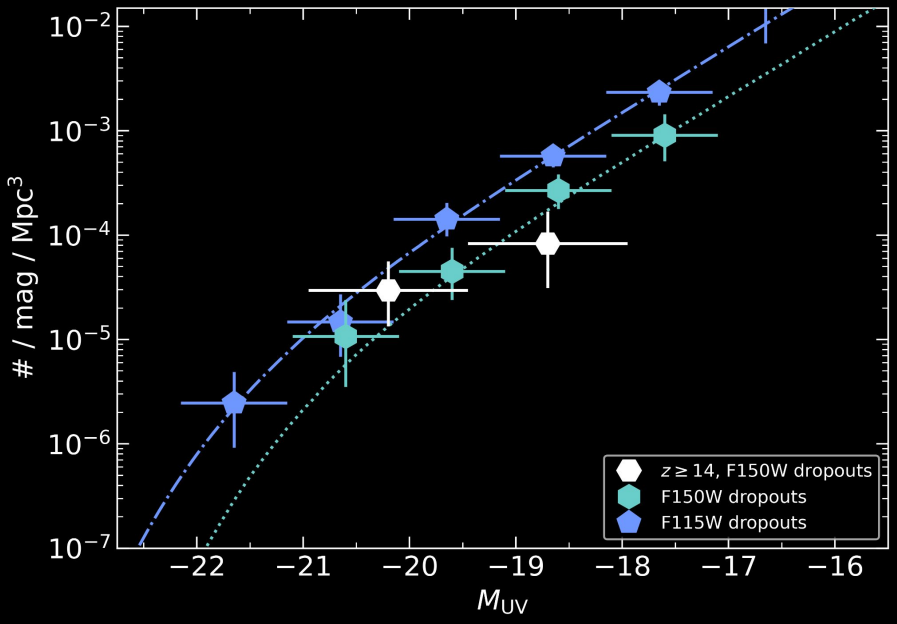
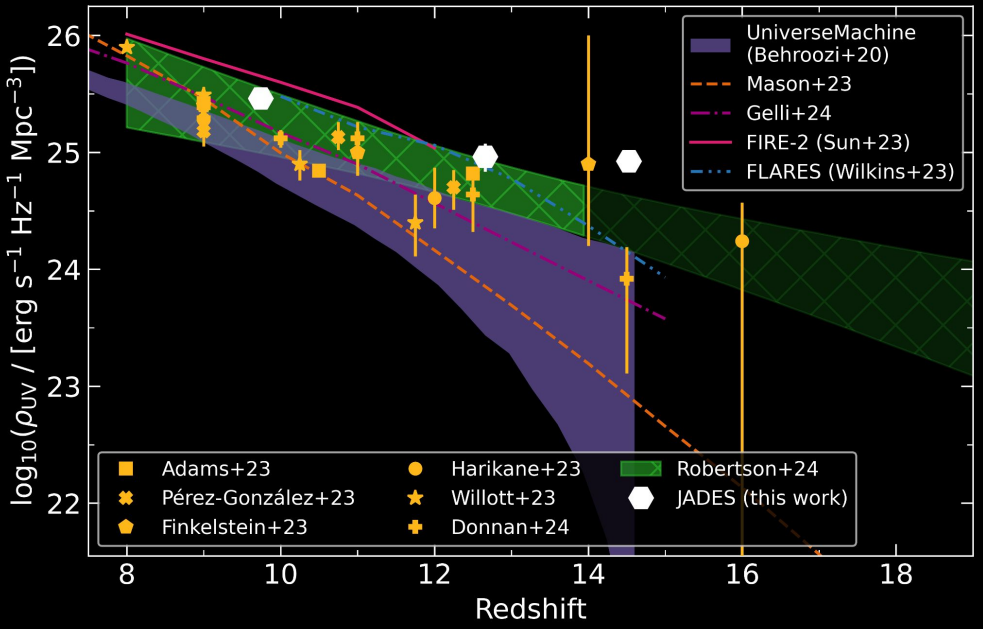
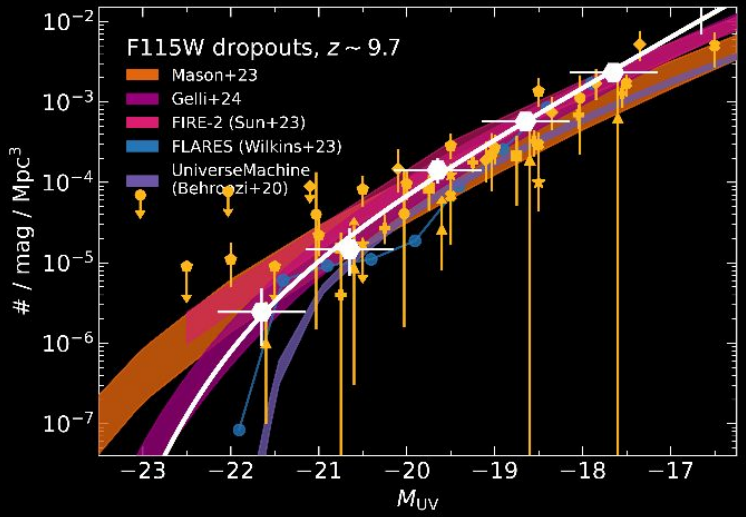


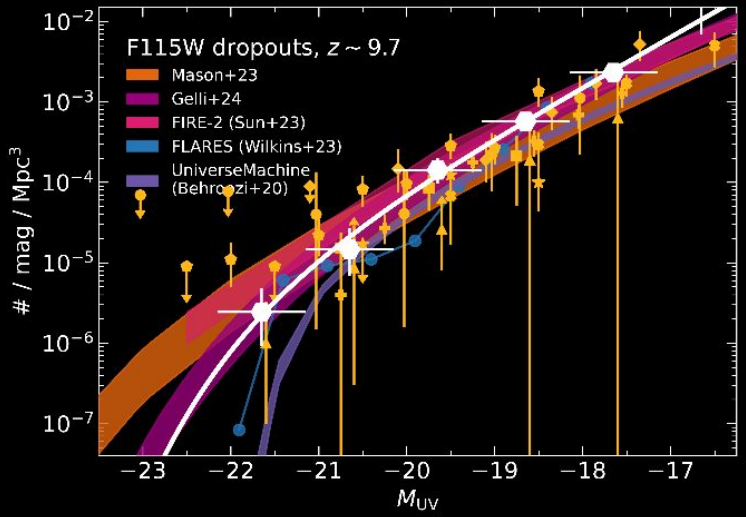
And an overall **slow evolution of ρ_{UV} with redshift**

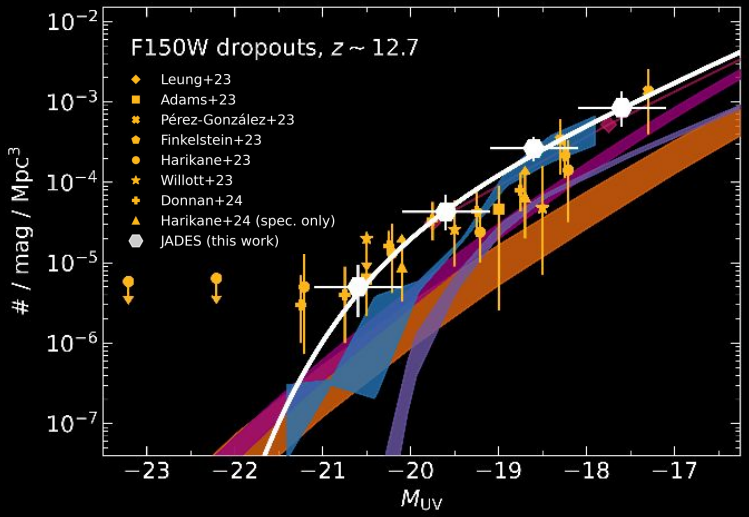






Increasingly strong tension with models at increasingly high redshifts, **even at the faint end**





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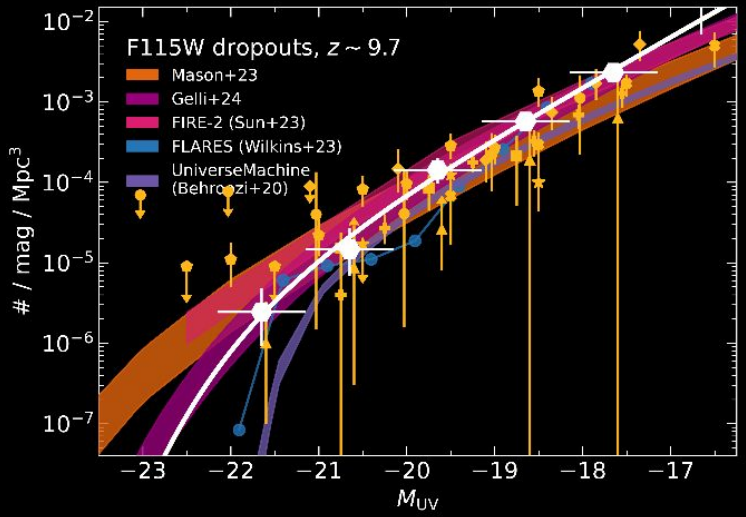
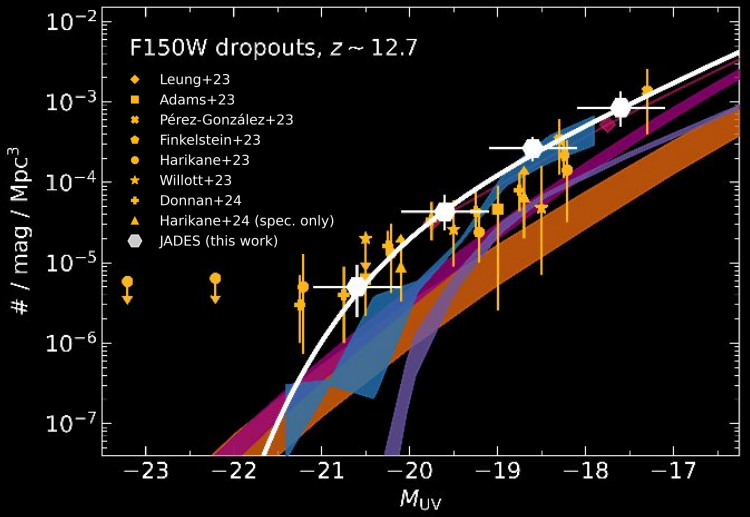
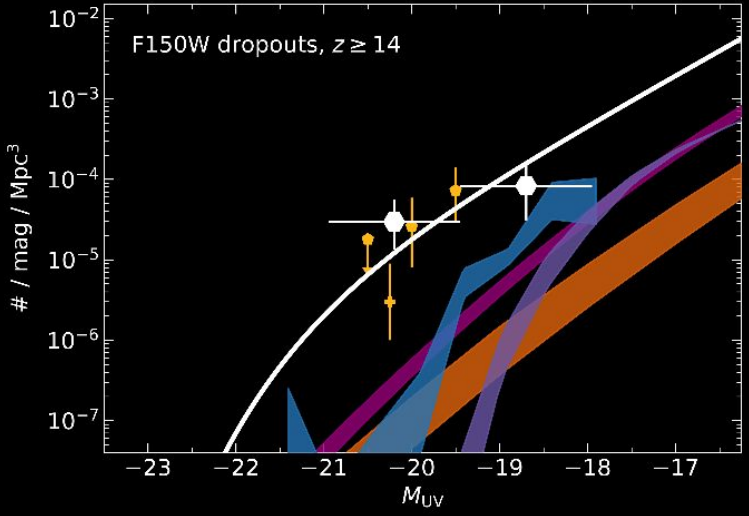
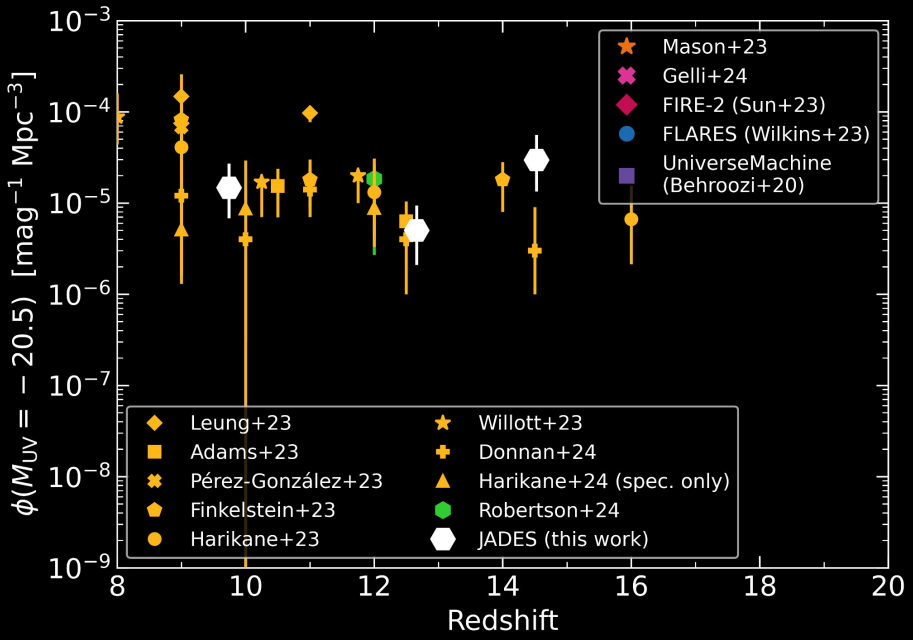




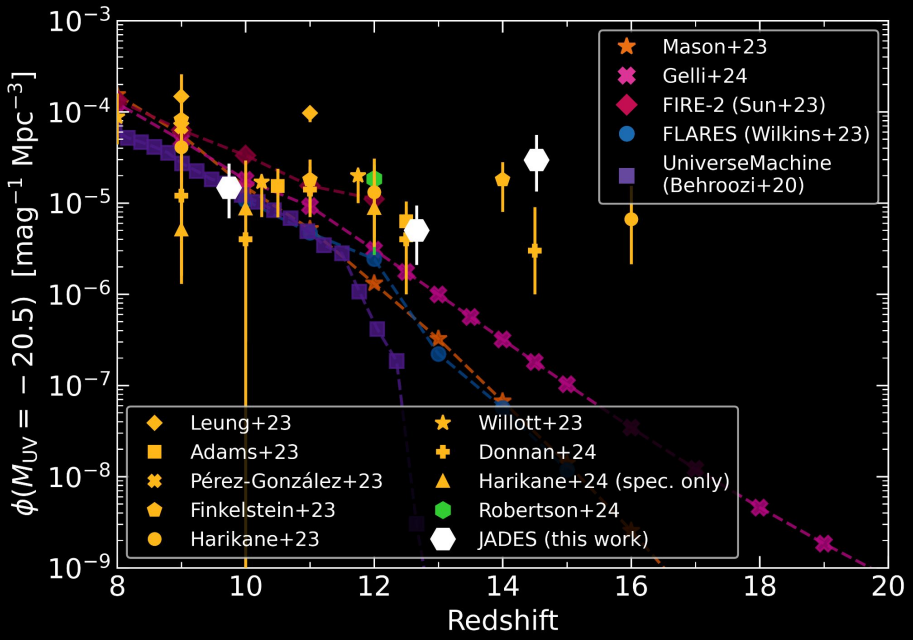


Increasingly strong tension with models at increasingly high redshifts, **even at the faint end**

Confirmation of **slow evolution in the bright galaxy population at least out to z~14**



Confirmation of **slow evolution in the bright galaxy population at least out to z~14**, well above model predictions



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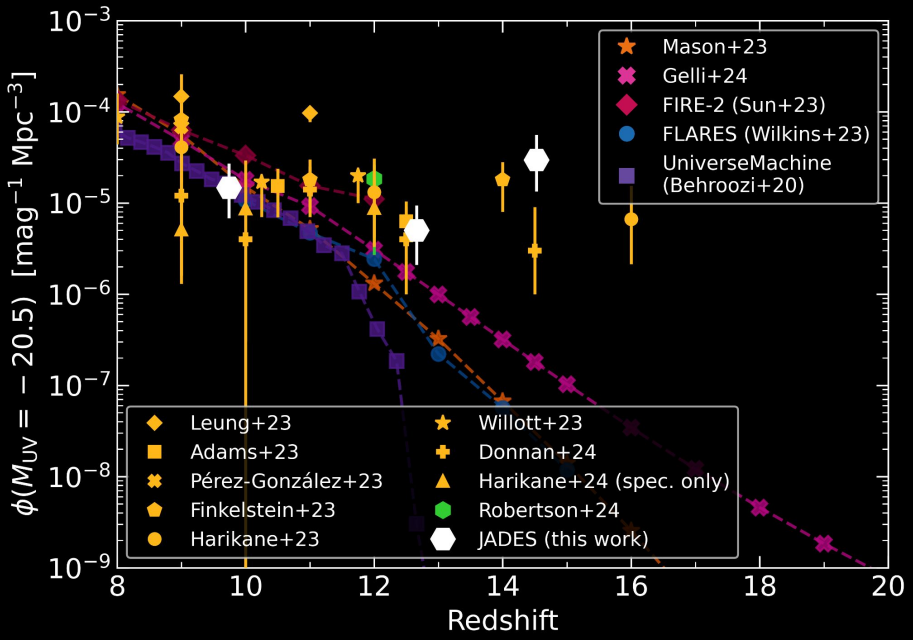

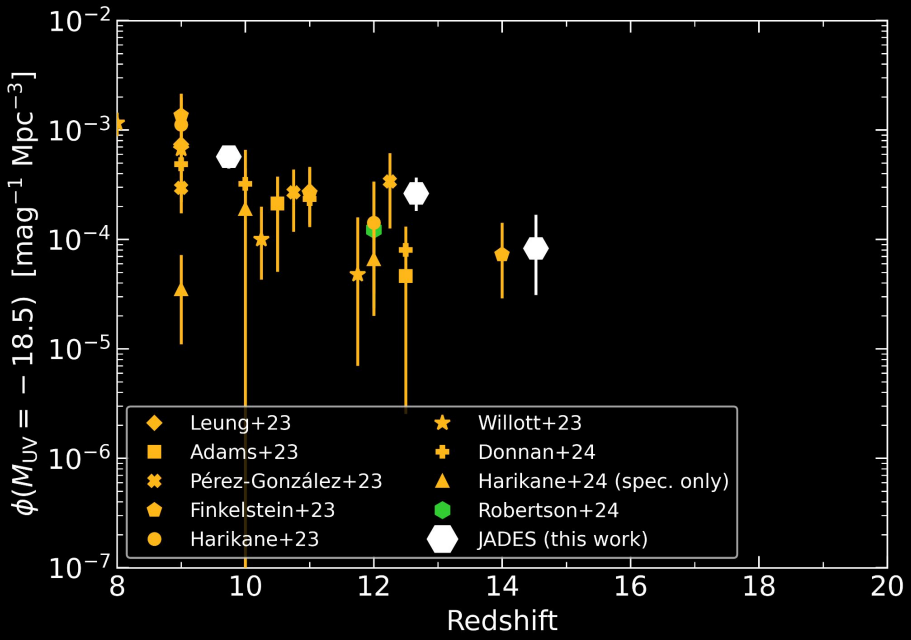

And potentially a similar, if weaker, trend for the faint population

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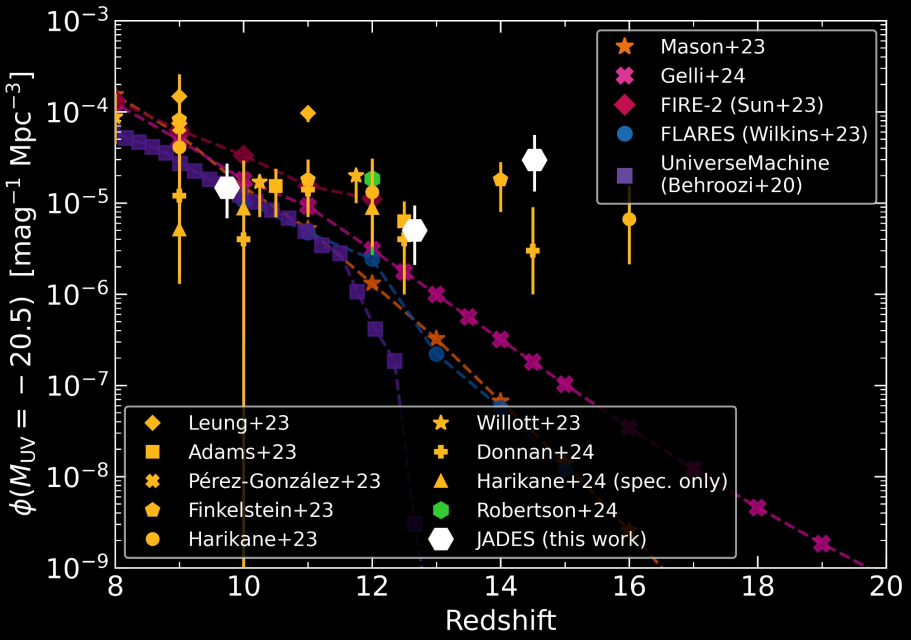

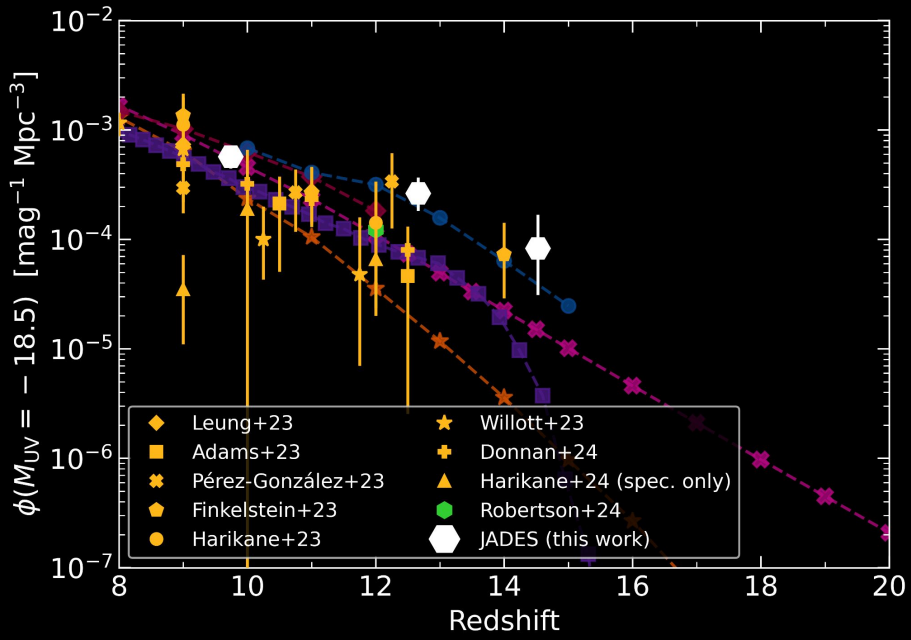

And potentially a similar, if weaker, trend for the faint population

Summary

JADES is well suited to probe both very faint galaxies and galaxies at the highest redshifts

~160 arcmin^2 of imaging

regions that reach depths of ~30.8 AB mag

~400 color selected dropout candidates robustly probe redshifts of z~9-15
and have properties consistent with expectations for high redshift galaxies

The UV luminosity function measured with
JADES data is consistent with other JWST measurements

The z~14 luminosity function estimated using five $z_{phot} \geq 14$
candidates continues to show a significant excess over models

Fainter ($-19 \lesssim M_{UV} \lesssim -17$) galaxies also display an excess over
some predictions, notably constant star formation efficiency models

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