Testing Cosmological Models with JWST High-Redshift Galaxies

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Talk based on:

"Dark energy, spatial curvature, and star formation efficiency from JWST photometric and spectroscopic high-redshift galaxies" [2604.13866]

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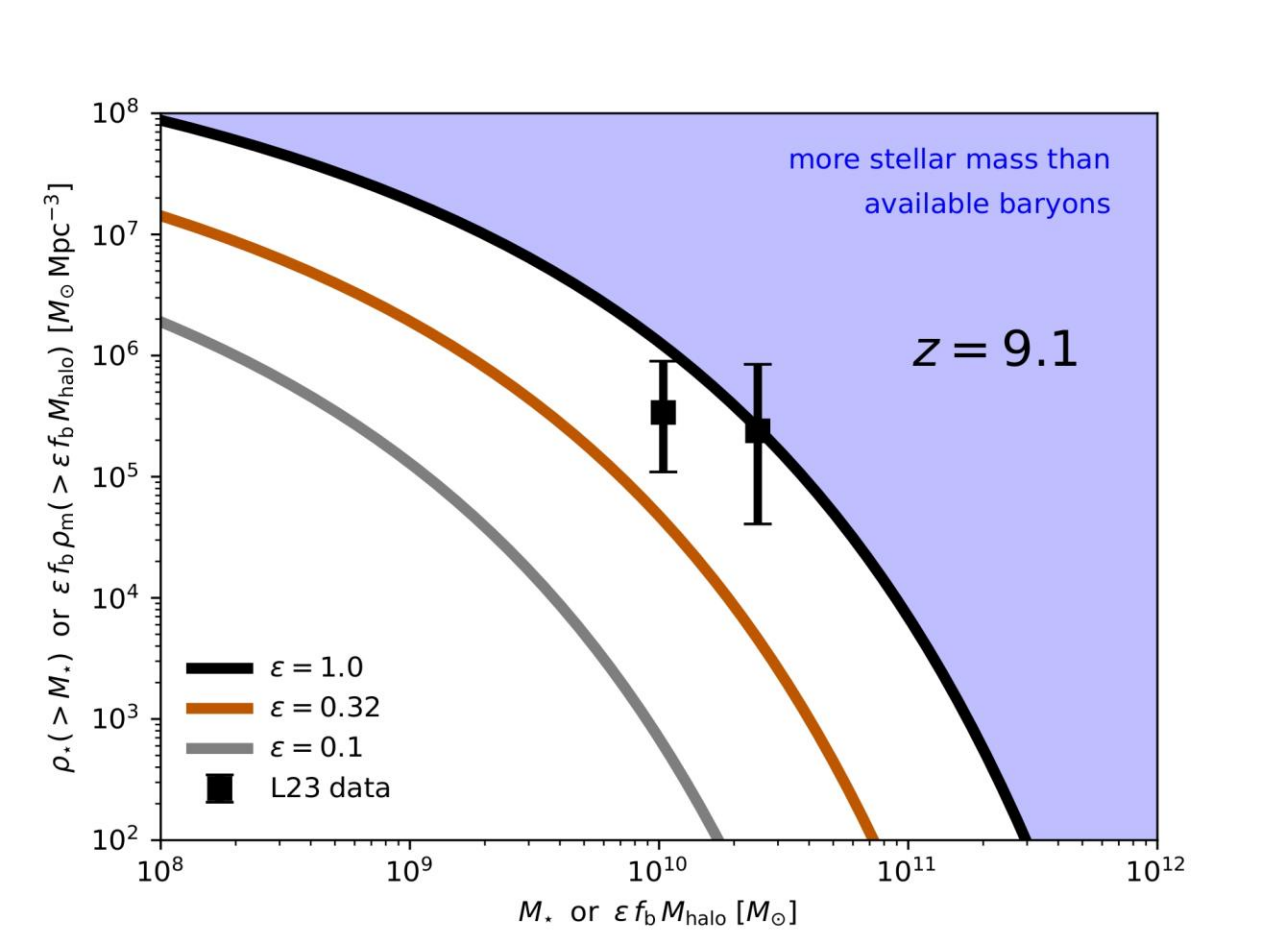
Tension with flat ΛCDM model

CEERS survey

FRESCO survey

- Too **many** galaxies
- Too **high-redshift**
- Too **massive**



CEERS data [2208.01611v2]

Goals

Can minimal extensions of ΛCDM explain the abundance of massive high-redshift galaxies observed by JWST?

Flat ΛCDM

$$(\Omega_m, \sigma_8, \epsilon)$$

Flat wCDM

$$(\Omega_m, \sigma_8, \epsilon, w)$$

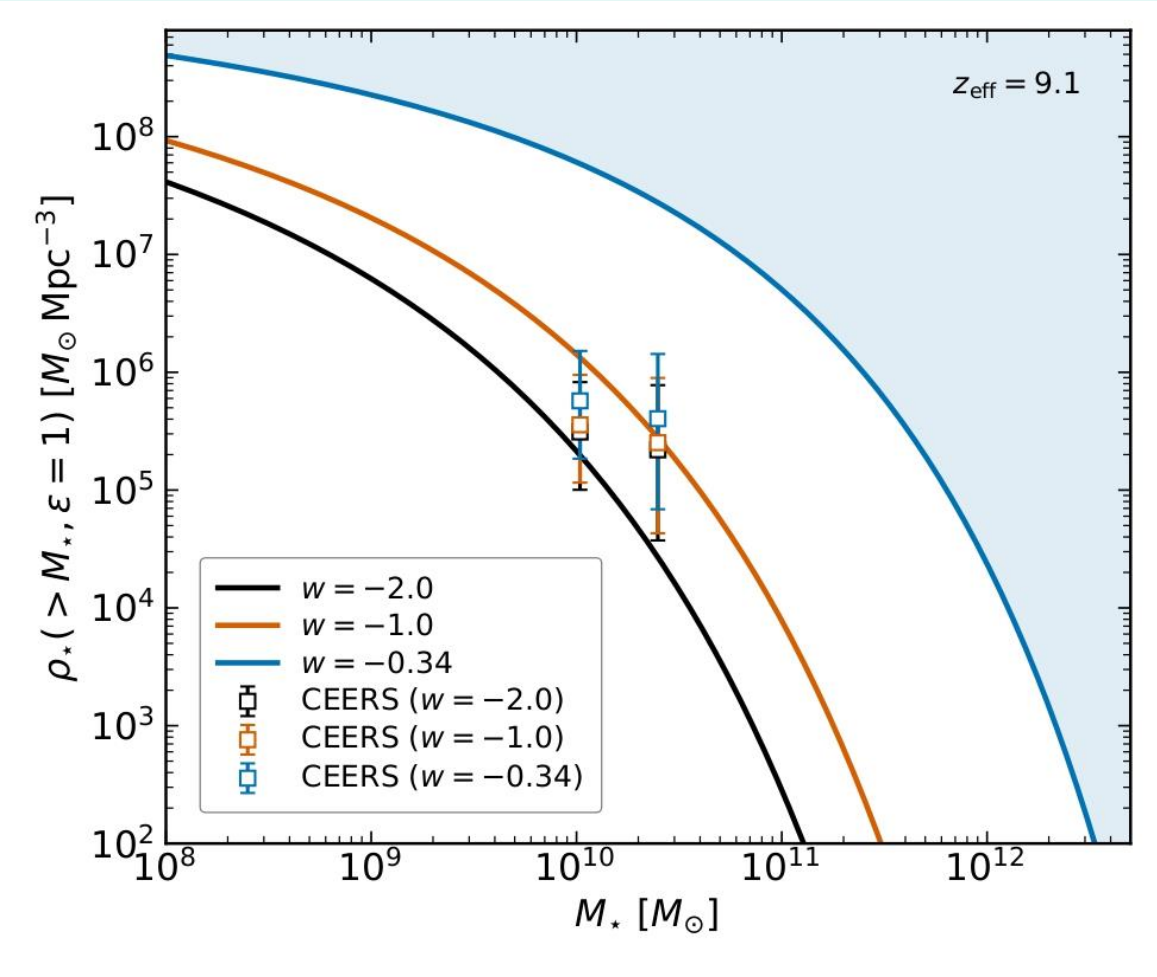
Non-flat ΛCDM

$$(\Omega_m, \sigma_8, \epsilon, \Omega_K)$$

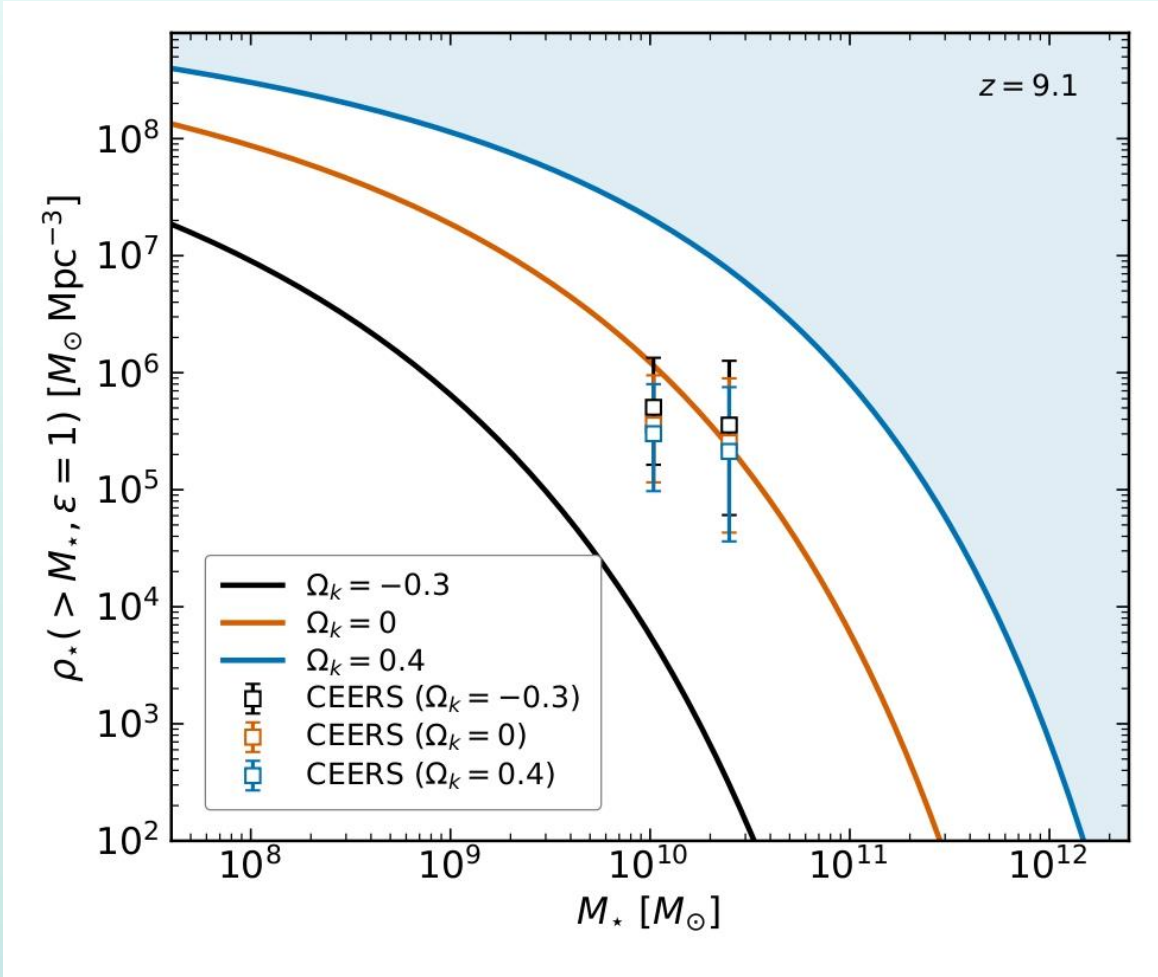
Non-flat wCDM

$$(\Omega_m, \sigma_8, \epsilon, w, \Omega_K)$$

Alternative cosmological models

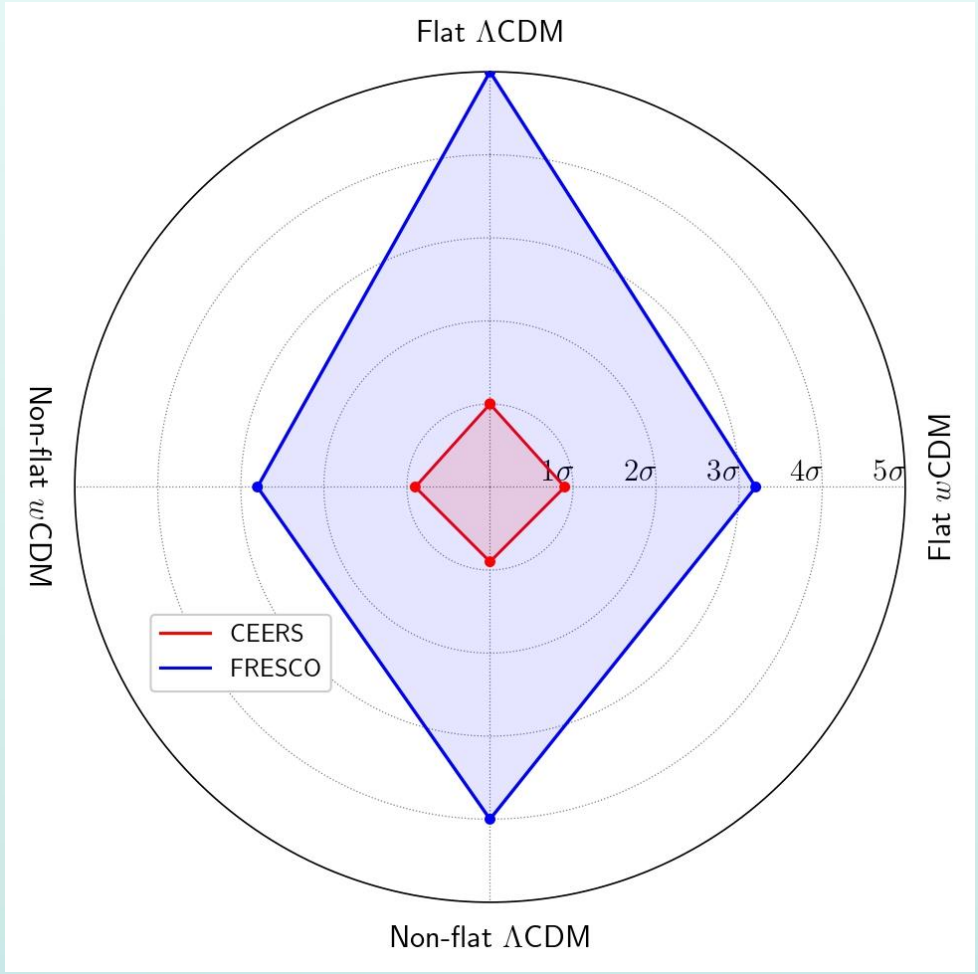


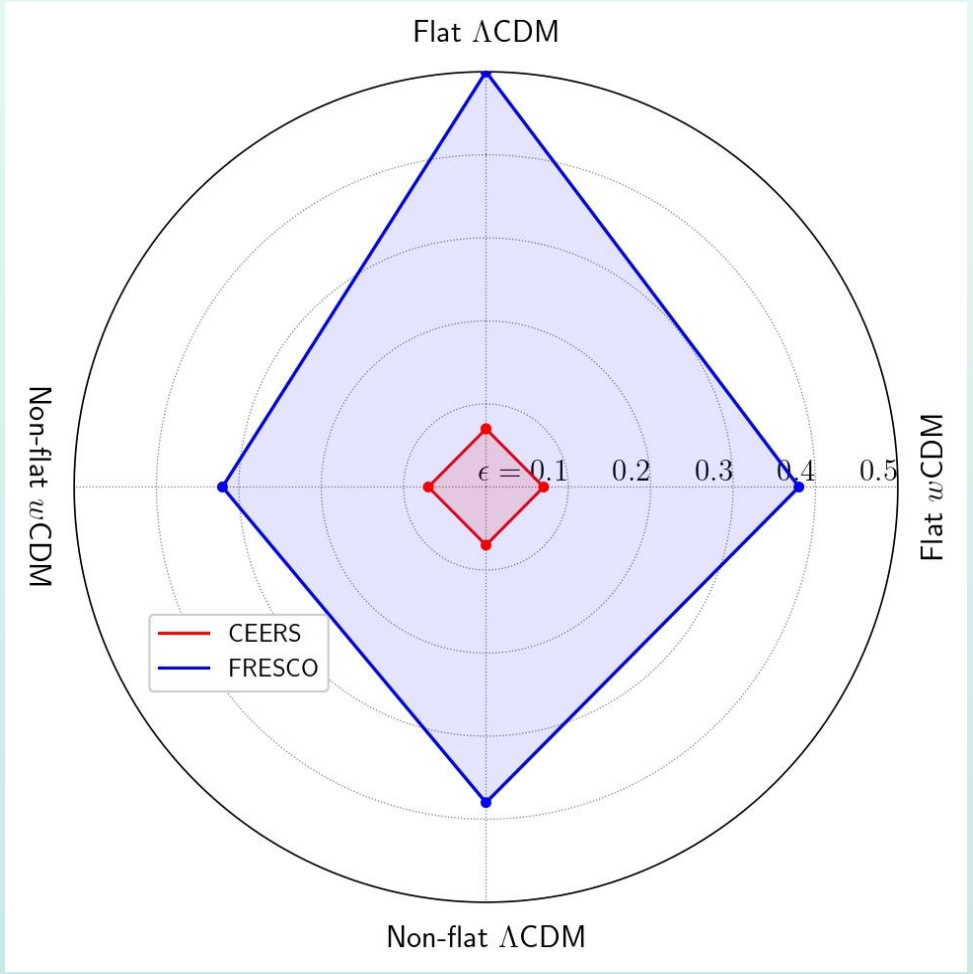
Flat wCDM



Non-flat ΛCDM

Results


Flat ΛCDM
Flat wCDM
Non-flat ΛCDM
Non-flat wCDM
1σ
2σ
3σ
4σ
5σ
CEERS
FRESCO


Flat ΛCDM
Flat wCDM
Non-flat ΛCDM
Non-flat wCDM
$\epsilon = 0.1$
0.2
0.3
0.4
0.5
CEERS
FRESCO

Conclusions

Does dark energy solve the tension?	**NO**
Does spatial curvature solve the tension?	**NO**
Is high ε still required?	**YES**
Is there evidence against ΛCDM?	**NO**

The JWST tension appears to be astrophysical rather than cosmological

Thank you
for your attention!

Semi-Gaussian Likelihood

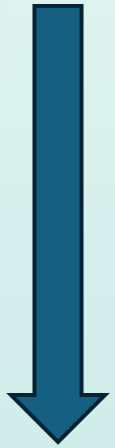
$$-2 \ln P(D|\theta) = \sum_{i=1}^{N} \begin{cases} \left(\frac{d_i - \mu}{\sigma_i}\right)^2 & \text{for } d_i > \mu \\ 0 & \text{for } d_i < \mu \end{cases}$$

- Predicting **too few galaxies** is inconsistent with observations
- Predicting **more galaxies than observed** is not penalized because current JWST samples are likely incomplete and affected by selection effects

Cumulative stellar mass density

Stellar mass: $M_\star = f_b \epsilon M_{\rm halo}$

- Efficiency of converting baryons into stars: ϵ

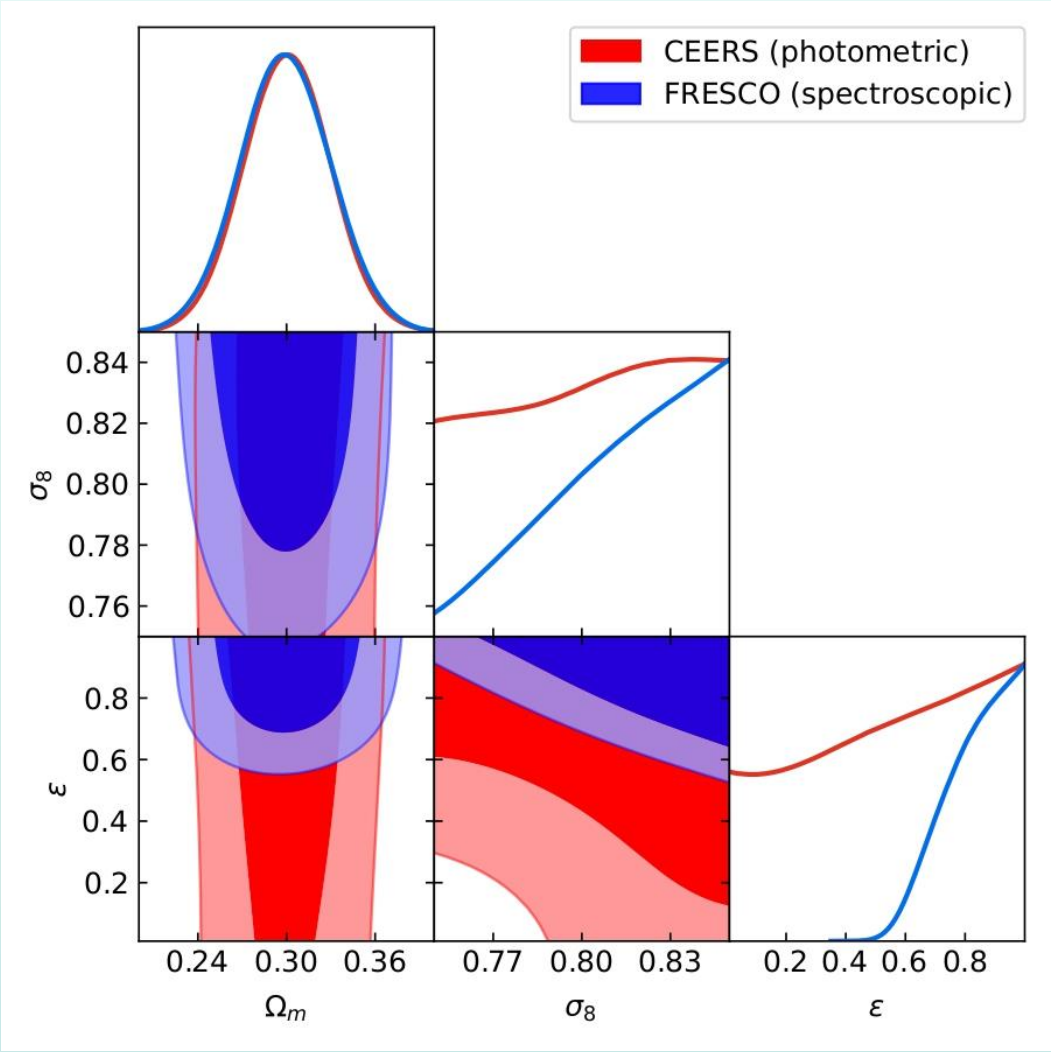


- Cosmic baryon fraction: $f_b = \dfrac{\Omega_b}{\Omega_m}$

Cumulative stellar mass density:

$$\rho_\star(>M_\star) = \epsilon f_b \int_{M_\star}^{\infty} {\rm d}M M \frac{{\rm d}n(M,z)}{{\rm d}M}$$

Results



- **CEERS:** weak constraints on ε due to large uncertainties
- **FRESCO:** requires **high star formation efficiency** ($\varepsilon \gtrsim 0.6$ in ΛCDM)

Minimal cosmological extensions relax the constraints only marginally

No statistically significant evidence for departures from ΛCDM