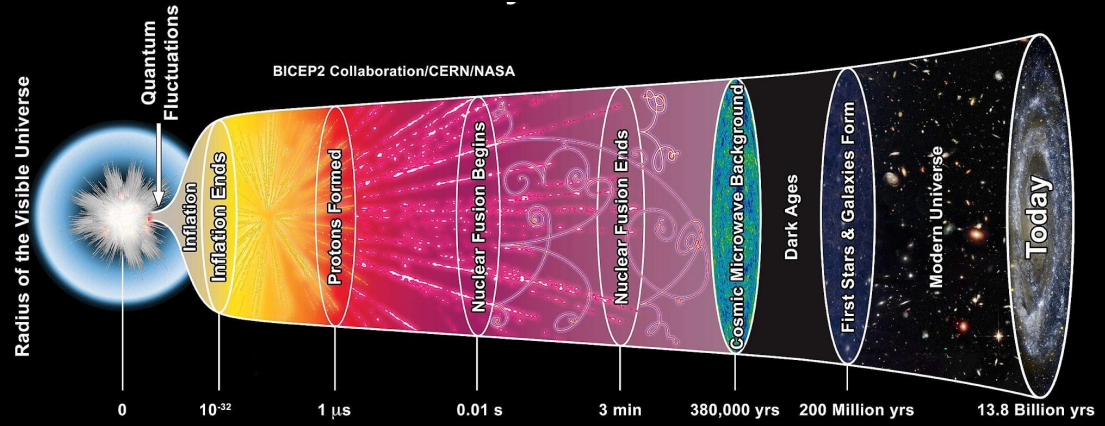
Is the JWST Hinting Towards a Cosmological Model Beyond the Standard?

Sambit Giri

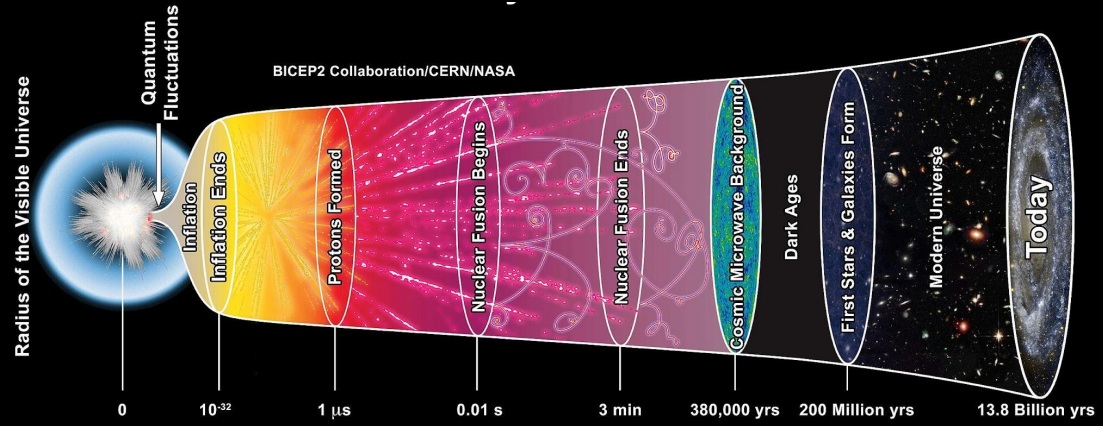
NORDITA fellow

18 Oct 2023

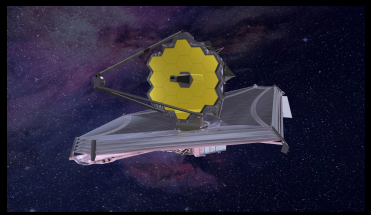
History of our Universe



History of our Universe

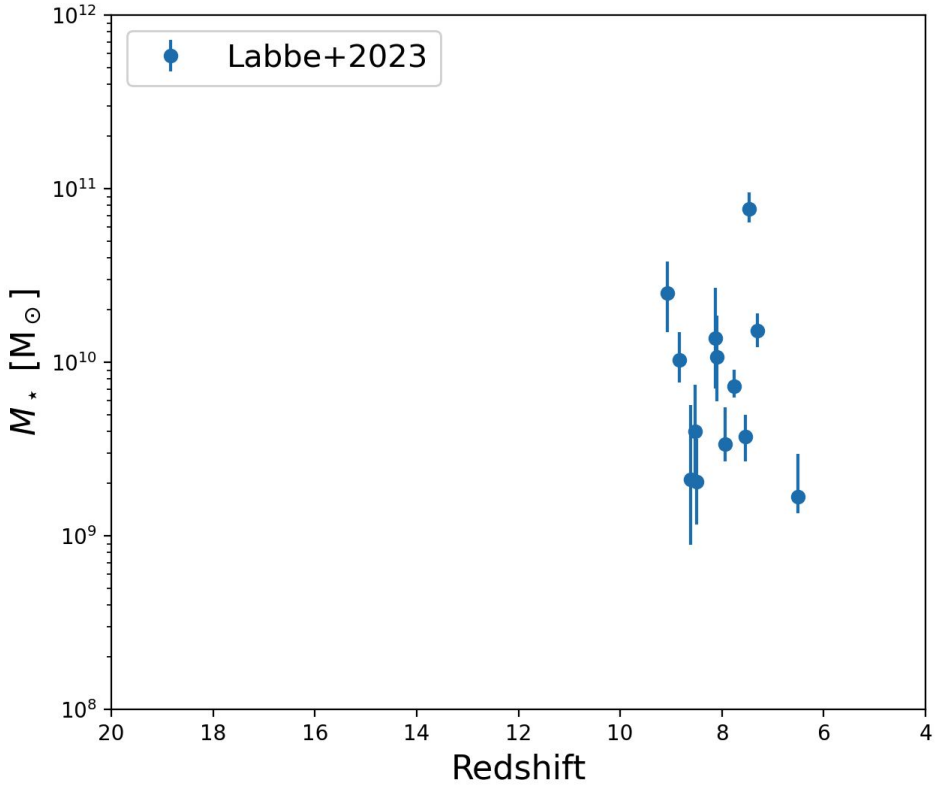


First generation of galaxies



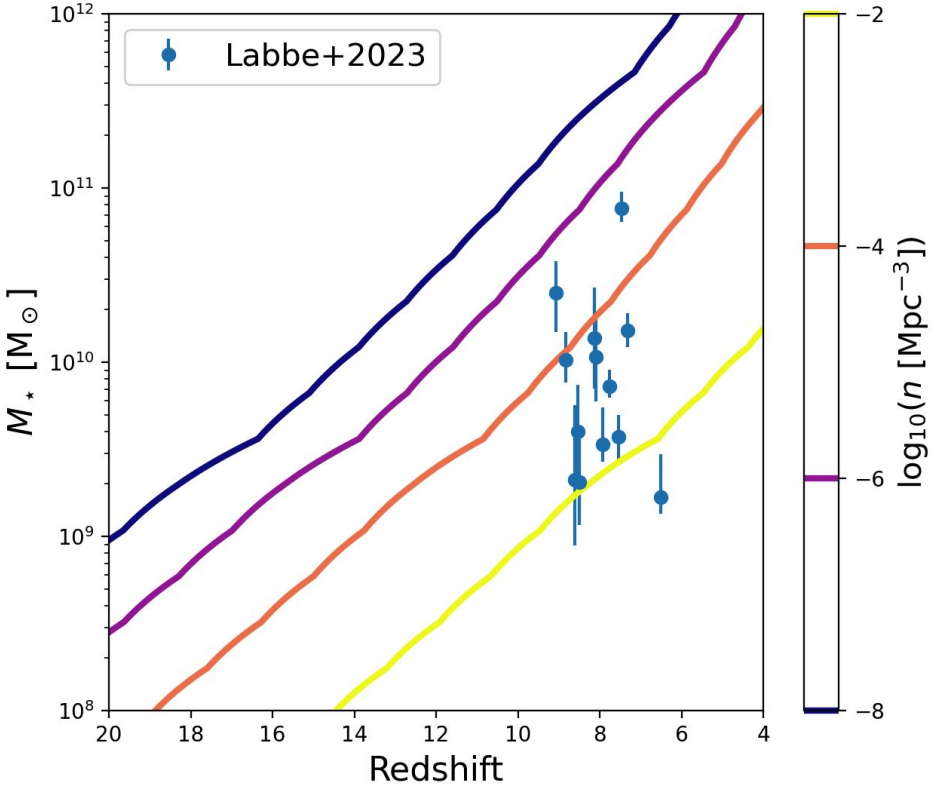
James Webb Space Telescope (JWST)

Massive Early Galaxies



$$M_\star = \frac{\Omega_b}{\Omega_m} \varepsilon M_{\rm halo}$$

Massive Early Galaxies

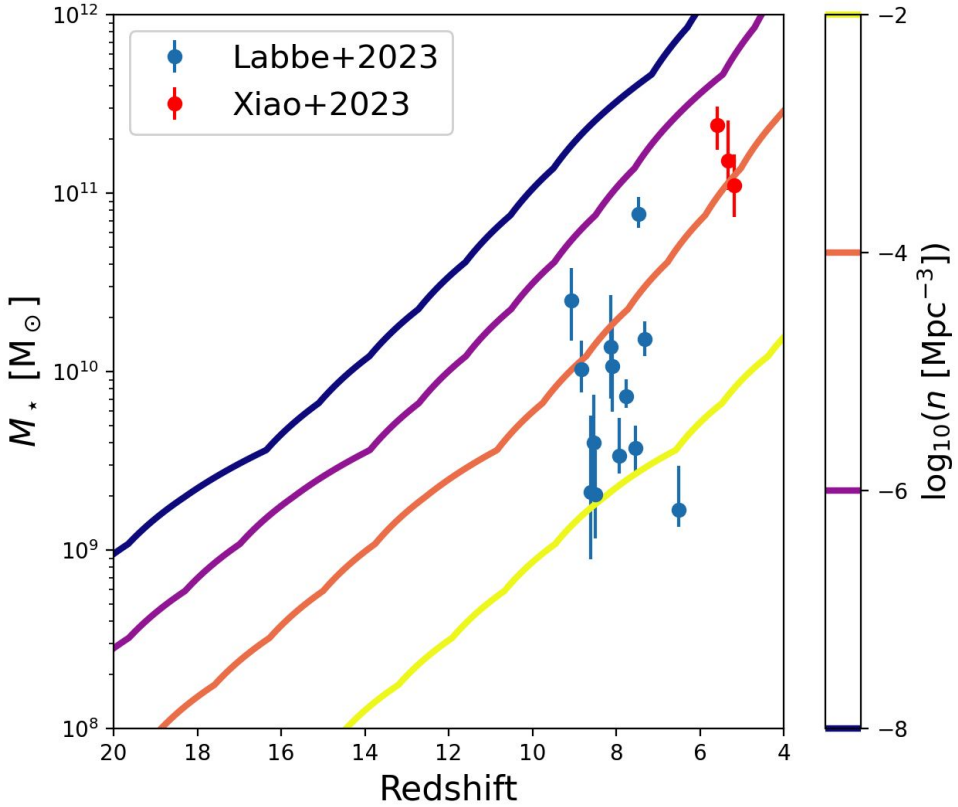


$$M_\star = \frac{\Omega_b}{\Omega_m} \varepsilon M_{\rm halo}$$

$$n(> M_\star) = \frac{\Omega_b}{\Omega_m} \varepsilon \int_{M_{\rm halo}}^{M_{\rm max}} dM \frac{dn}{dM}$$

Analysis similar to **Boylan-Kolchin (2023)**

Massive Early Galaxies with spectroscopic data

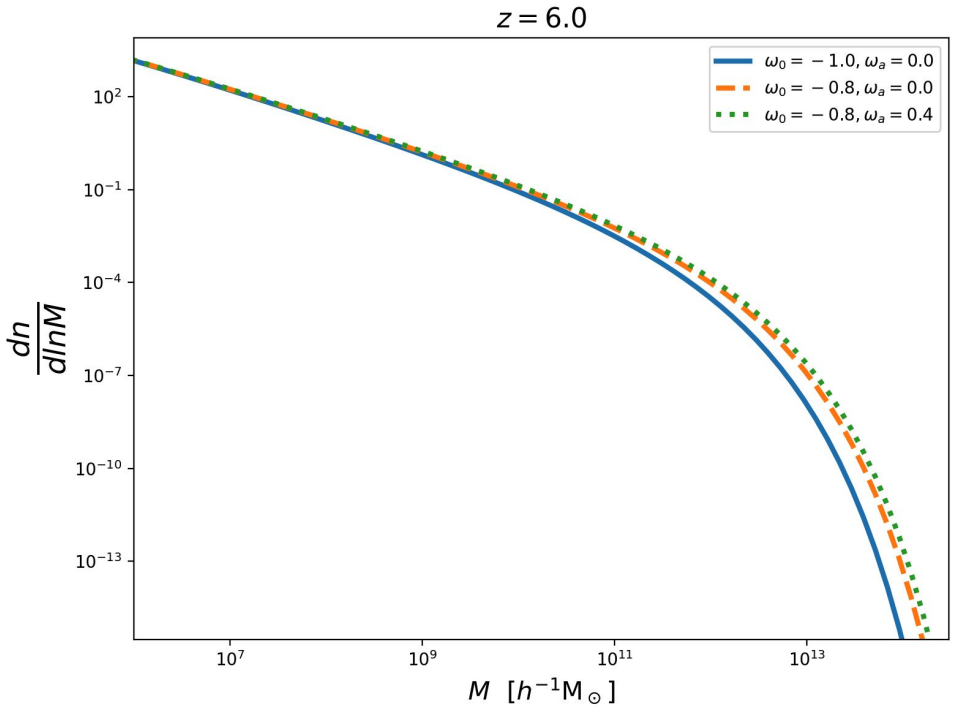


$$M_\star = \frac{\Omega_b}{\Omega_m} \varepsilon M_{\rm halo}$$

$$n(> M_\star) = \frac{\Omega_b}{\Omega_m} \varepsilon \int_{M_{\rm halo}}^{M_{\rm max}} dM \frac{dn}{dM}$$

Analysis similar to **Boylan-Kolchin (2023)**

Dynamic Dark Energy - HMF

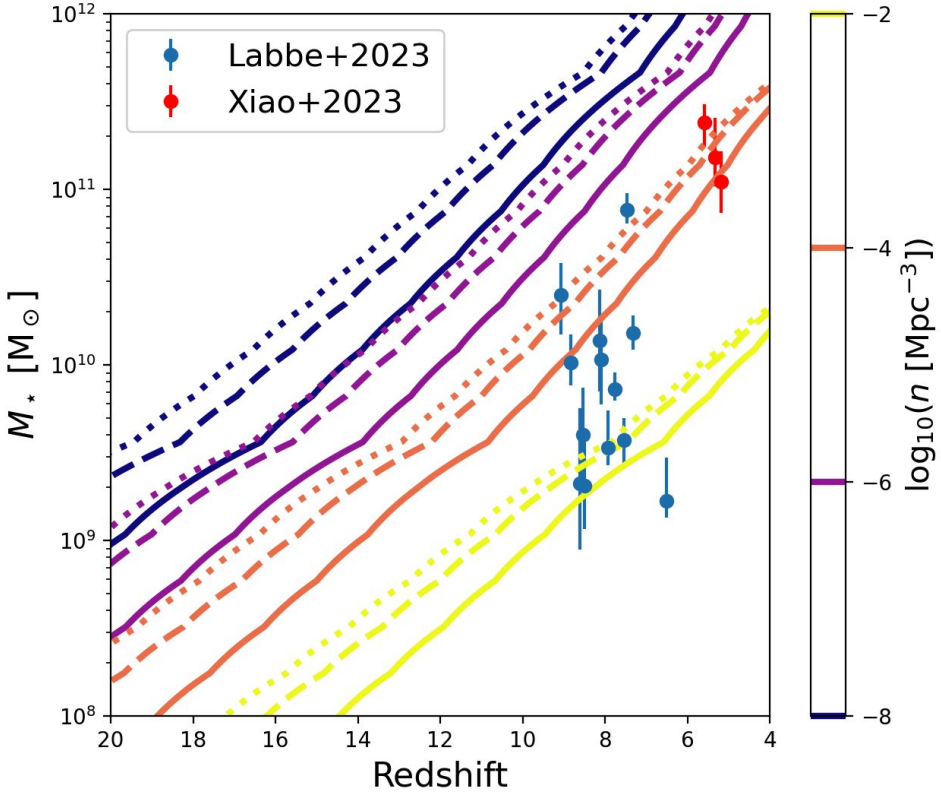


CPL

$$\left(\frac{H(z)}{H(0)}\right)^2 = \Omega_\gamma(1+z)^4 + \Omega_m(1+z)^3 + \Omega_\Lambda(1+z)^{3(1+\omega_0+\omega_a)} \exp\left(\frac{-3\omega_a z}{1+z}\right)$$

Preliminary Work with **Suhail Dhawan**

Dynamic Dark Energy



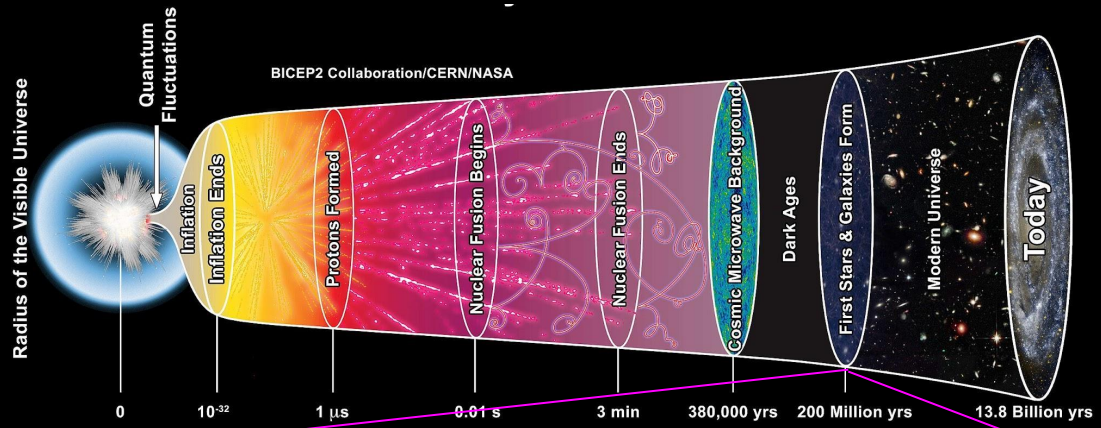
CPL

$$\left(\frac{H(z)}{H(0)}\right)^2 = \Omega_\gamma(1+z)^4 + \Omega_m(1+z)^3 + \Omega_\Lambda(1+z)^{3(1+\omega_0+\omega_a)} \exp\left(\frac{-3\omega_a z}{1+z}\right)$$

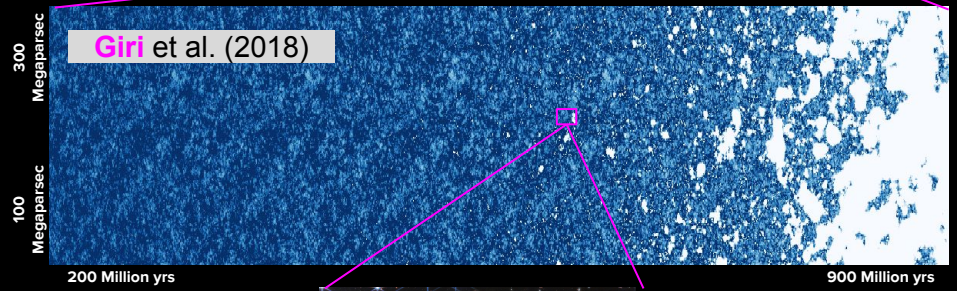
$\omega_0 = -1.0, \omega_a = 0.0$
$\omega_0 = -0.8, \omega_a = 0.0$
$\omega_0 = -0.8, \omega_a = 0.4$

Preliminary Work with **Suhail Dhawan**

History of our Universe

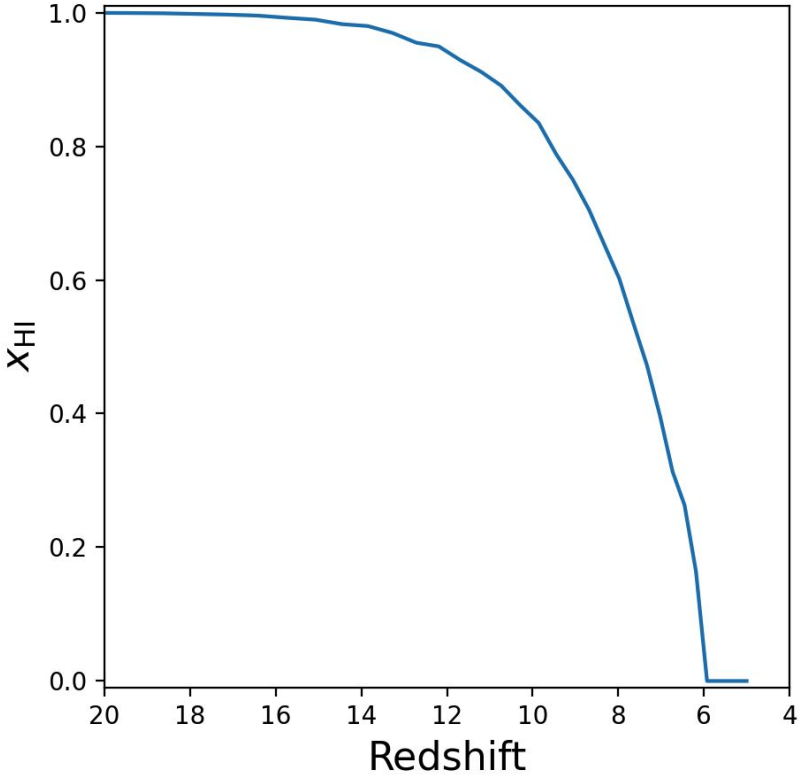


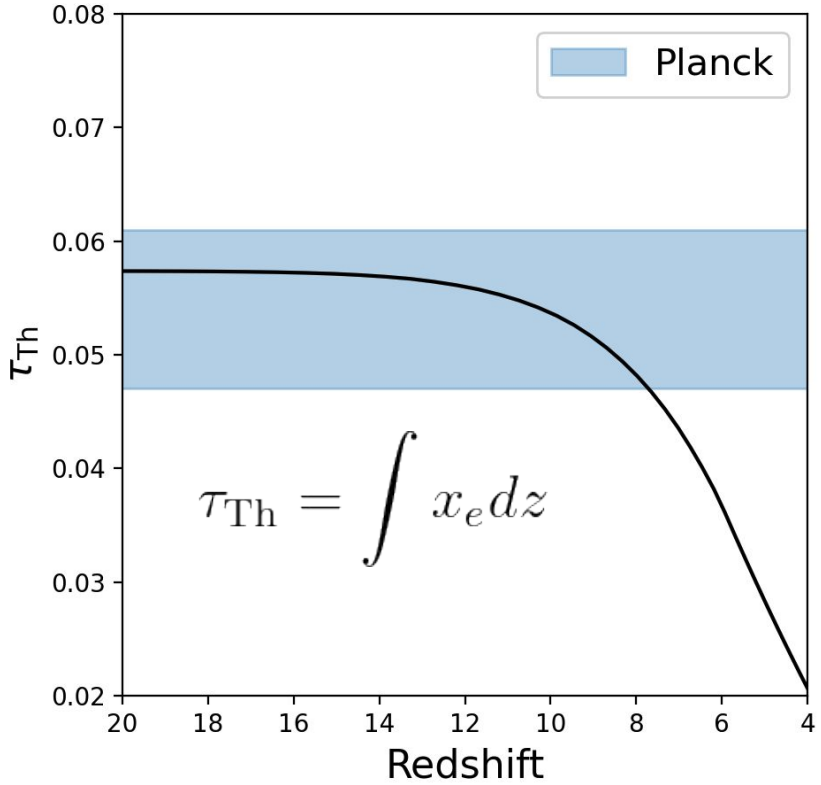
Intergalactic neutral hydrogen gas



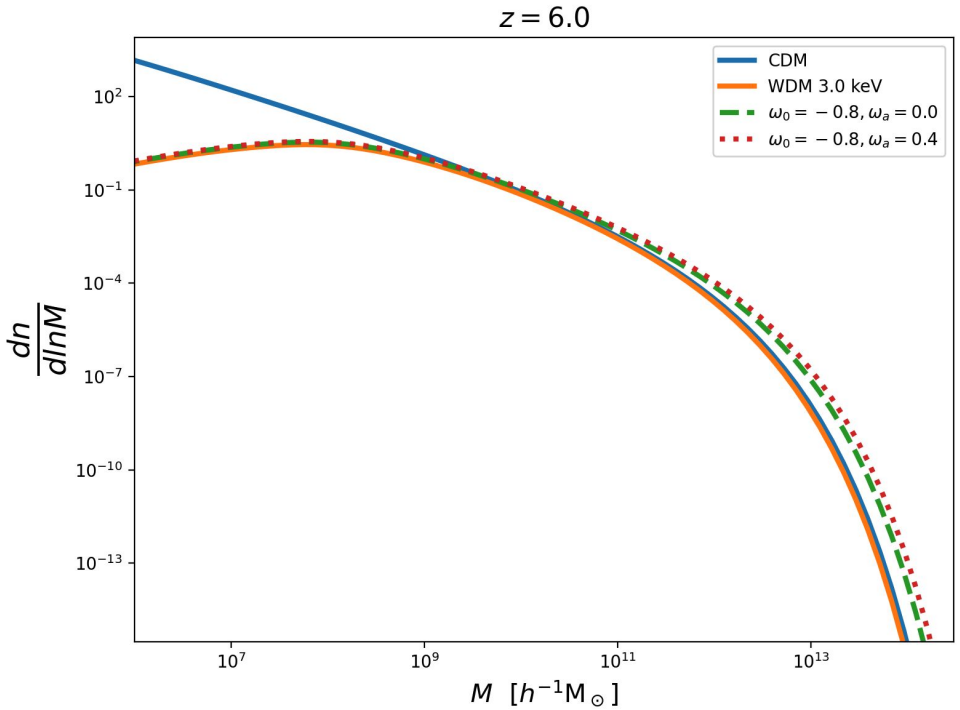
First generation of galaxies

Implications on cosmic reionization





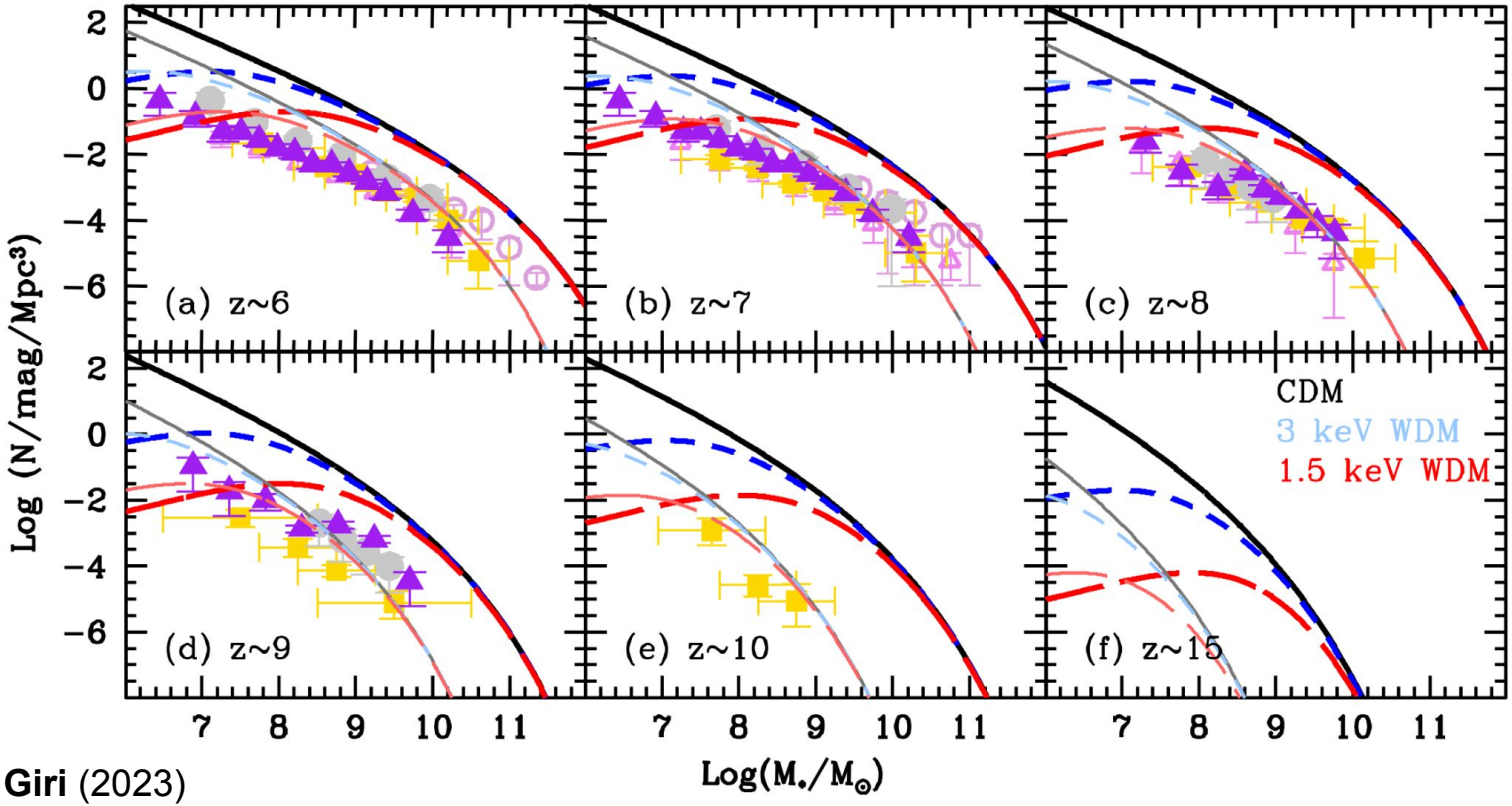
Dynamic Dark Energy & non-Cold Dark Matter



CPL

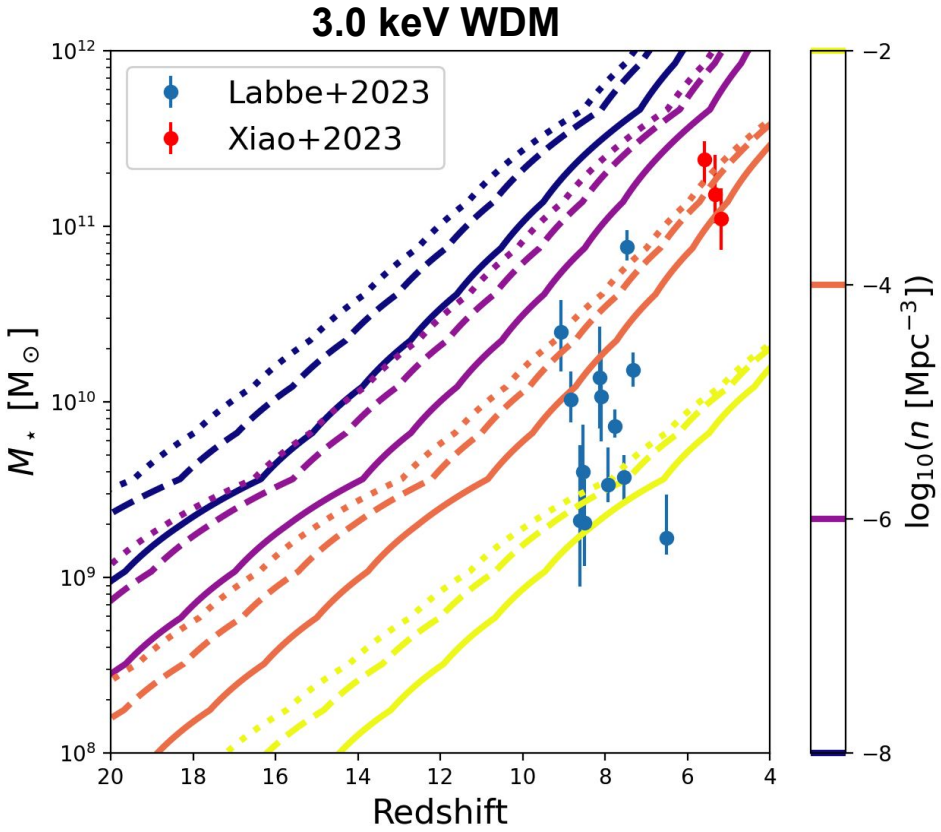
$$\left(\frac{H(z)}{H(0)}\right)^2 = \Omega_\gamma(1+z)^4 + \Omega_m(1+z)^3 + \Omega_\Lambda(1+z)^{3(1+\omega_0+\omega_a)} \exp\left(\frac{-3\omega_a z}{1+z}\right)$$

Testing WDM with JWST

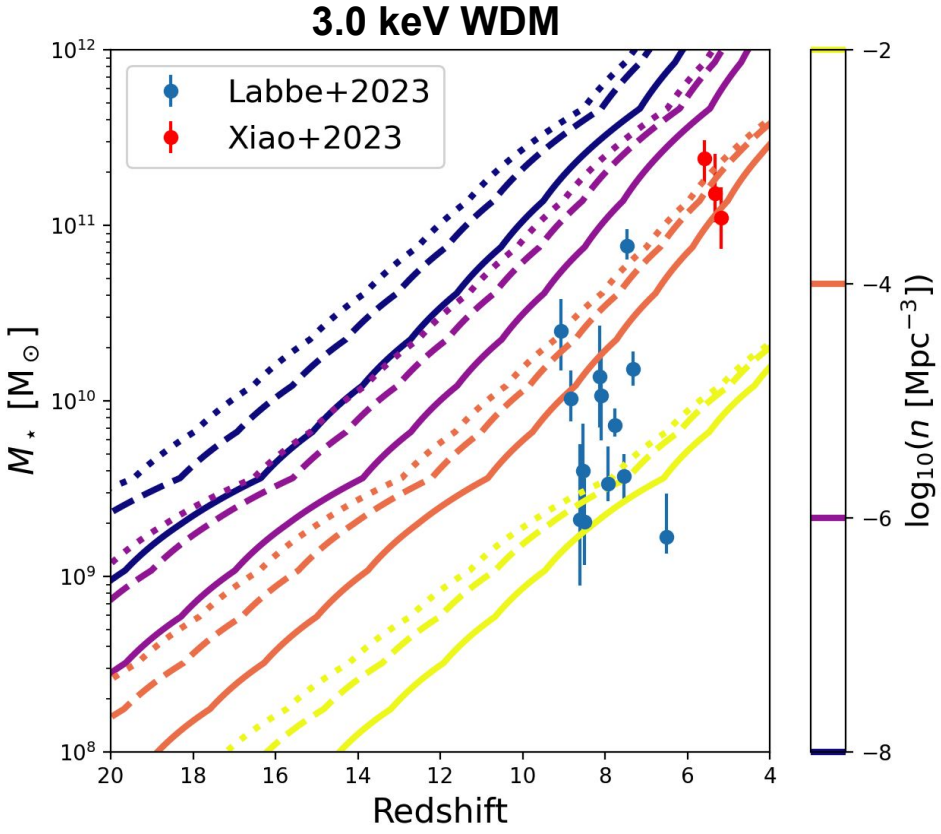


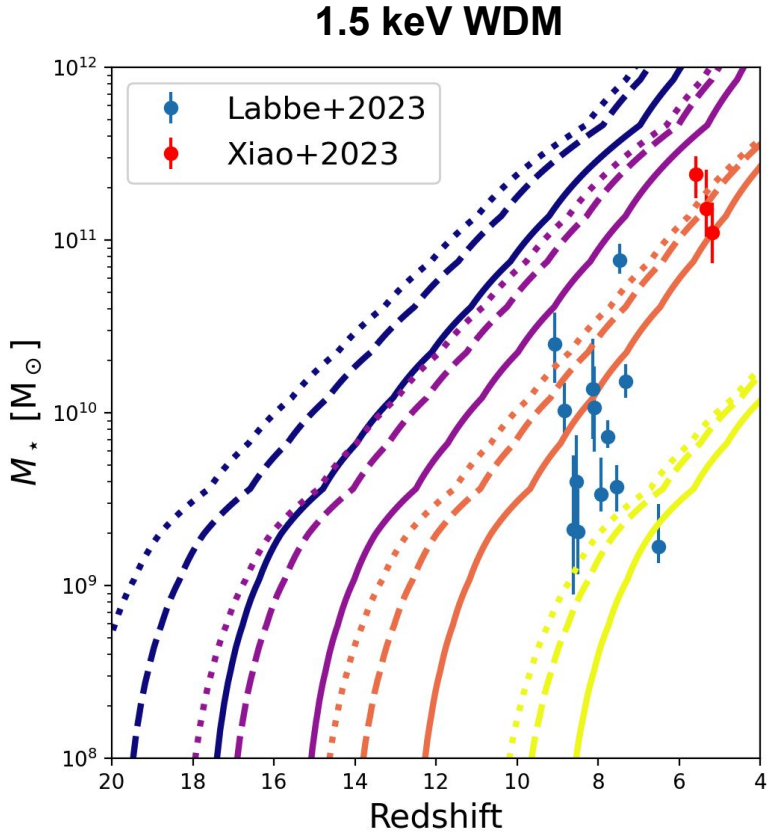
Dayal & **Giri** (2023)

Dynamic Dark Energy & non-Cold Dark Matter



Dynamic Dark Energy & non-Cold Dark Matter





Summary

- JWST suggests that either
  - **structure formation began earlier**, or
  - **galaxy formation was very efficient at early times**
- **Dynamic Dark Energy with non-Cold Dark Matter** is a plausible explanation for early structure formation