Cosmology from Home 2021

THE PROPERTIES OF HIGH-REDSHIFT GALAXIES

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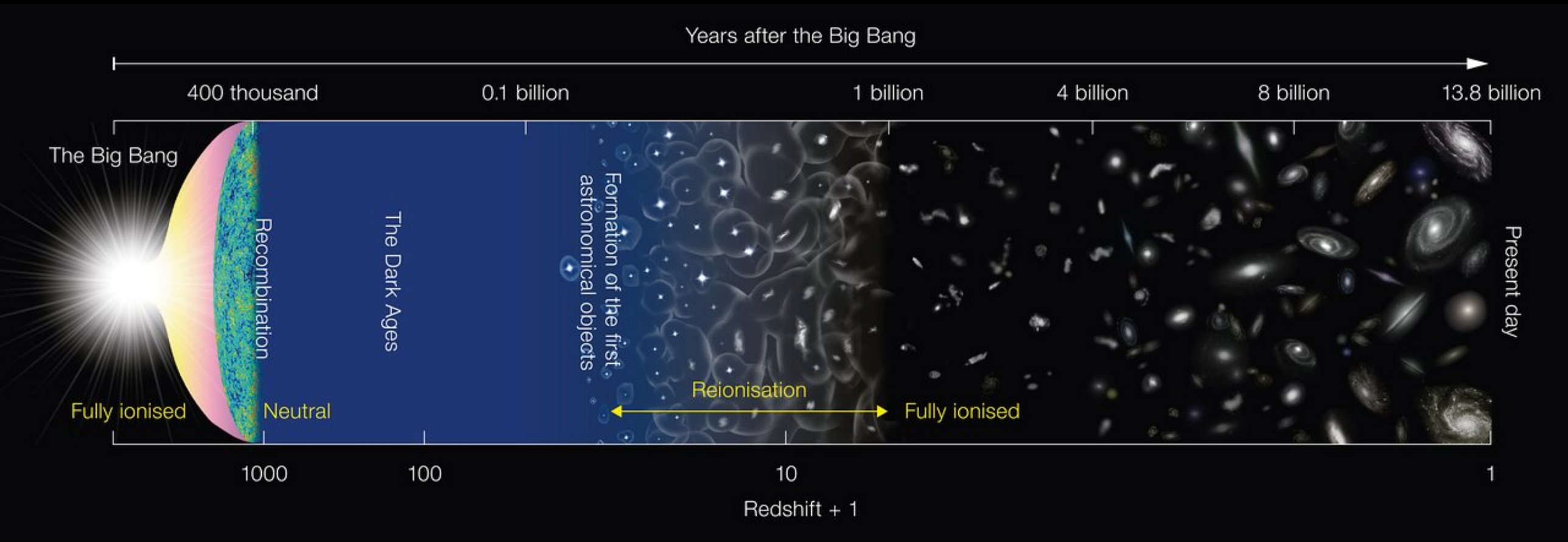
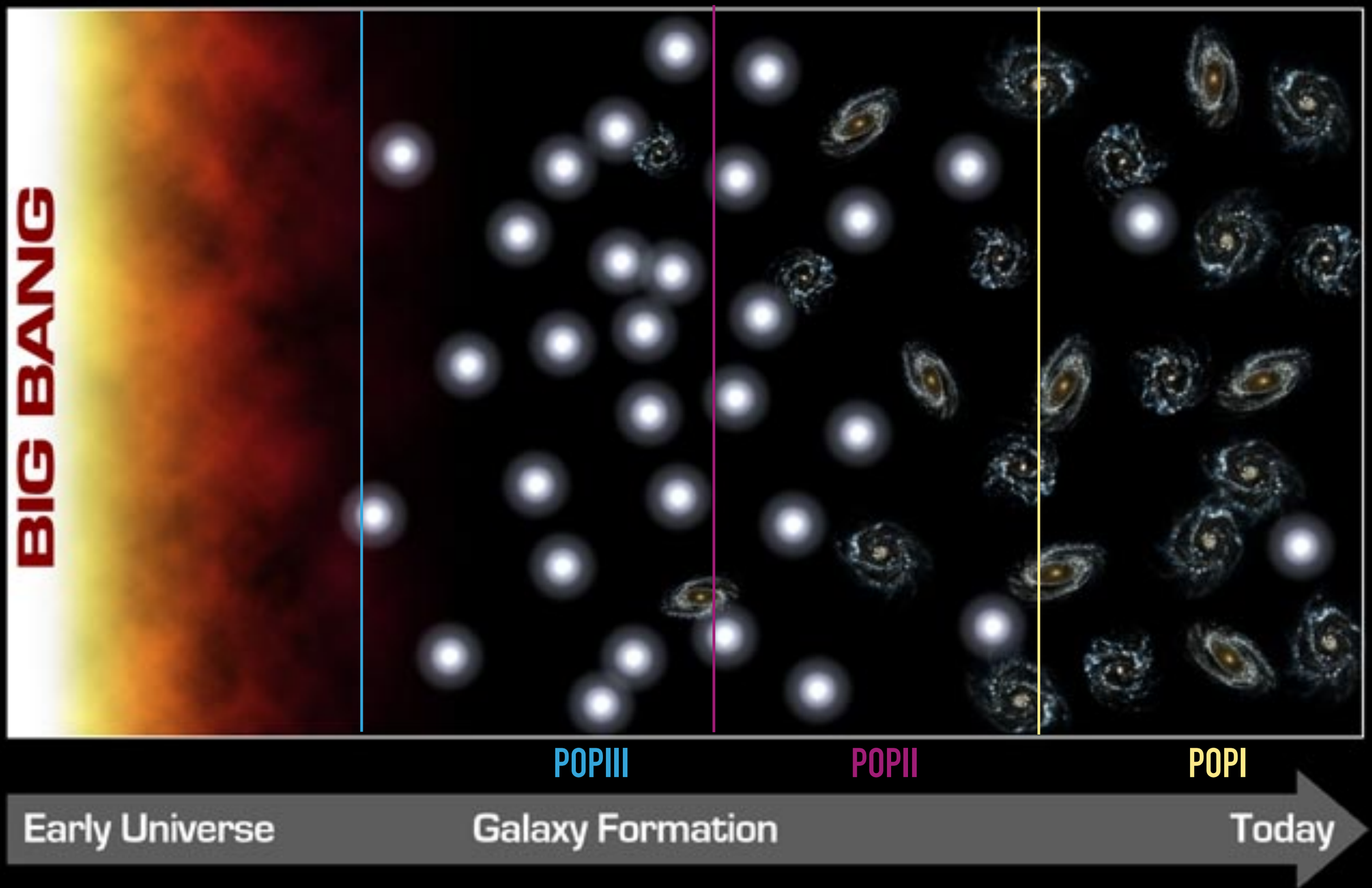
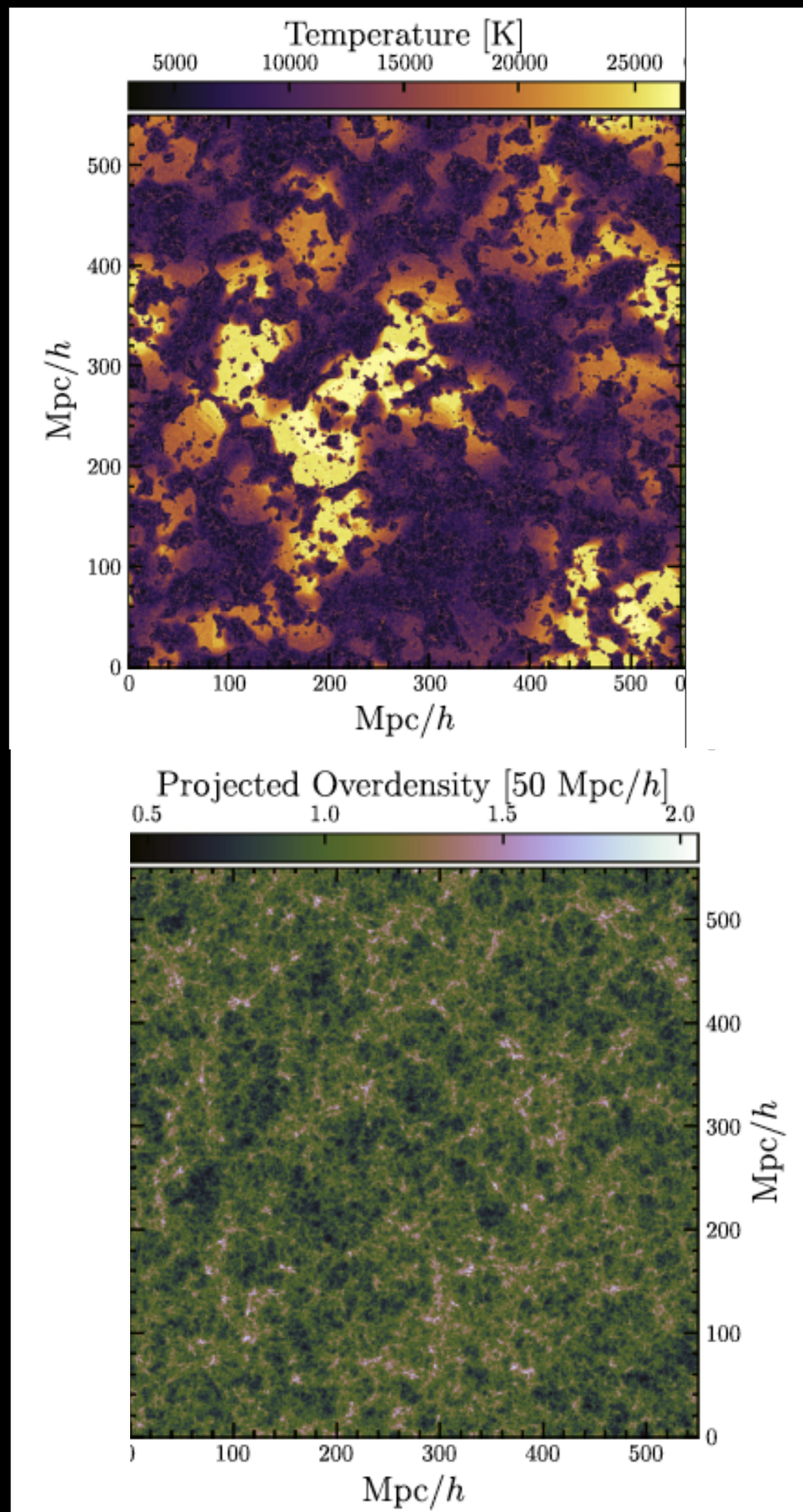
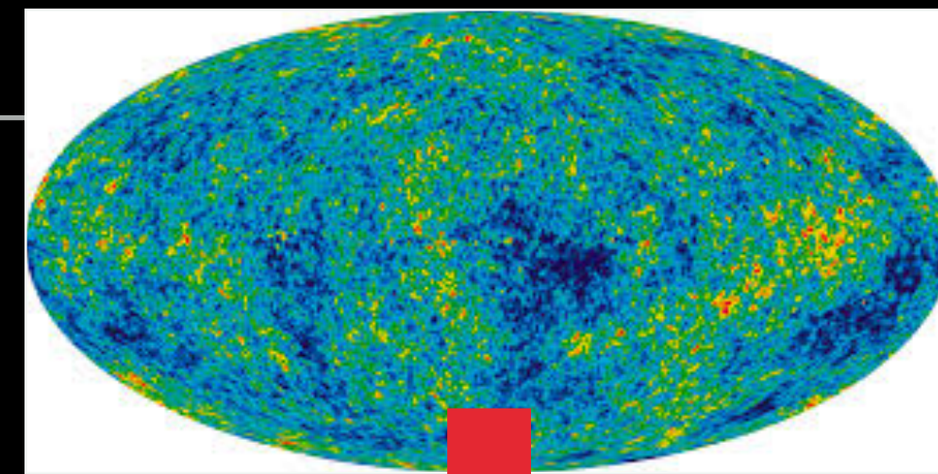
FORMATION OF STRUCTURE IN THE EARLY UNIVERSE

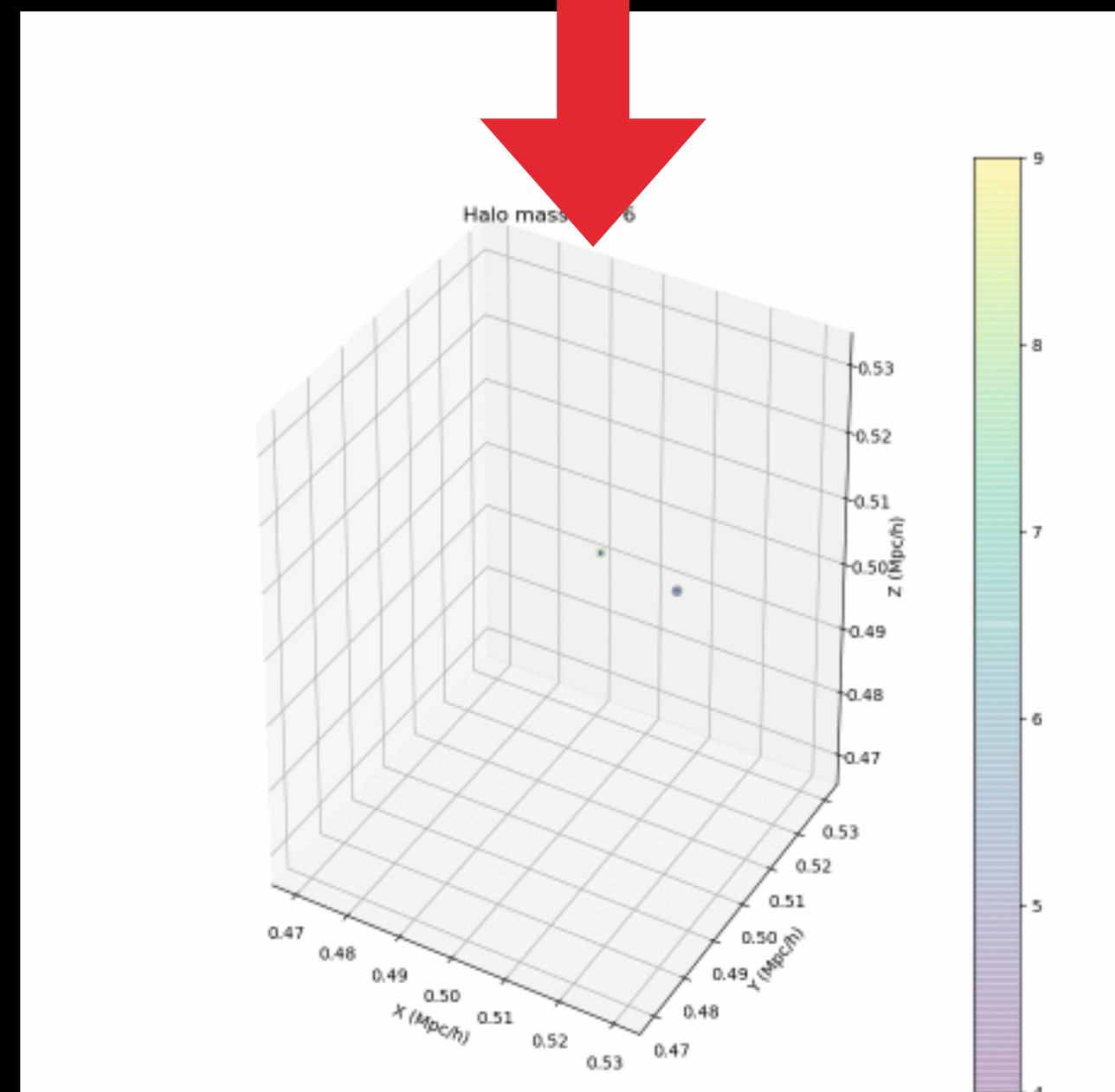


Timeline of the Universe









Becker et al 2018

RUN HIGH-RESOLUTION SIMS

Simulation	Box size (cMpc/h)	Comoving softening (ckpc/h)	Δz	Molecular cooling
Ch 18 512 MDW	**18**	**1.5**	**4.0 – 8.0**	
Ch 18 512 MDW mol	18	1.5	4.0 – 8.0	✓
Ch 18 512 EDW	18	1.5	4.0 – 8.0	
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Ch 12 512 MDW mol	12	1.0	2.2 – 8.0	✓
Ch 25 512 MDW mol	25	2.0	3.6 – 8.0	✓

P-GADGET3 (XXL) that includes self-consistent star formation and metal enrichment.

Flat Λ-CDM model is assumed with cosmological parameters from Planck 2015.

MDW / EDW: momentum / energy driven winds.

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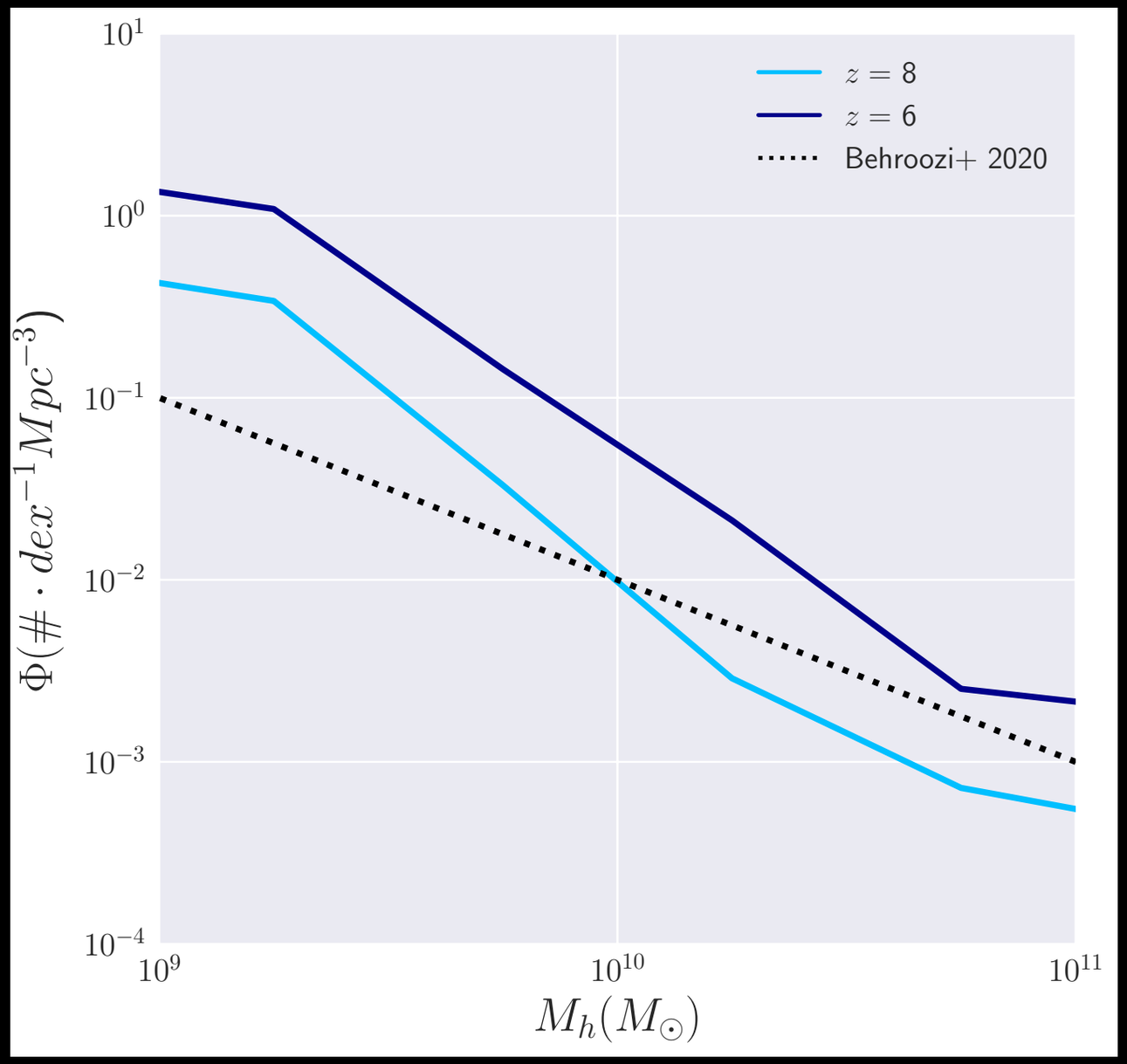
Initial conditions at z = 125

Feedback prescriptions

Metal enrichment

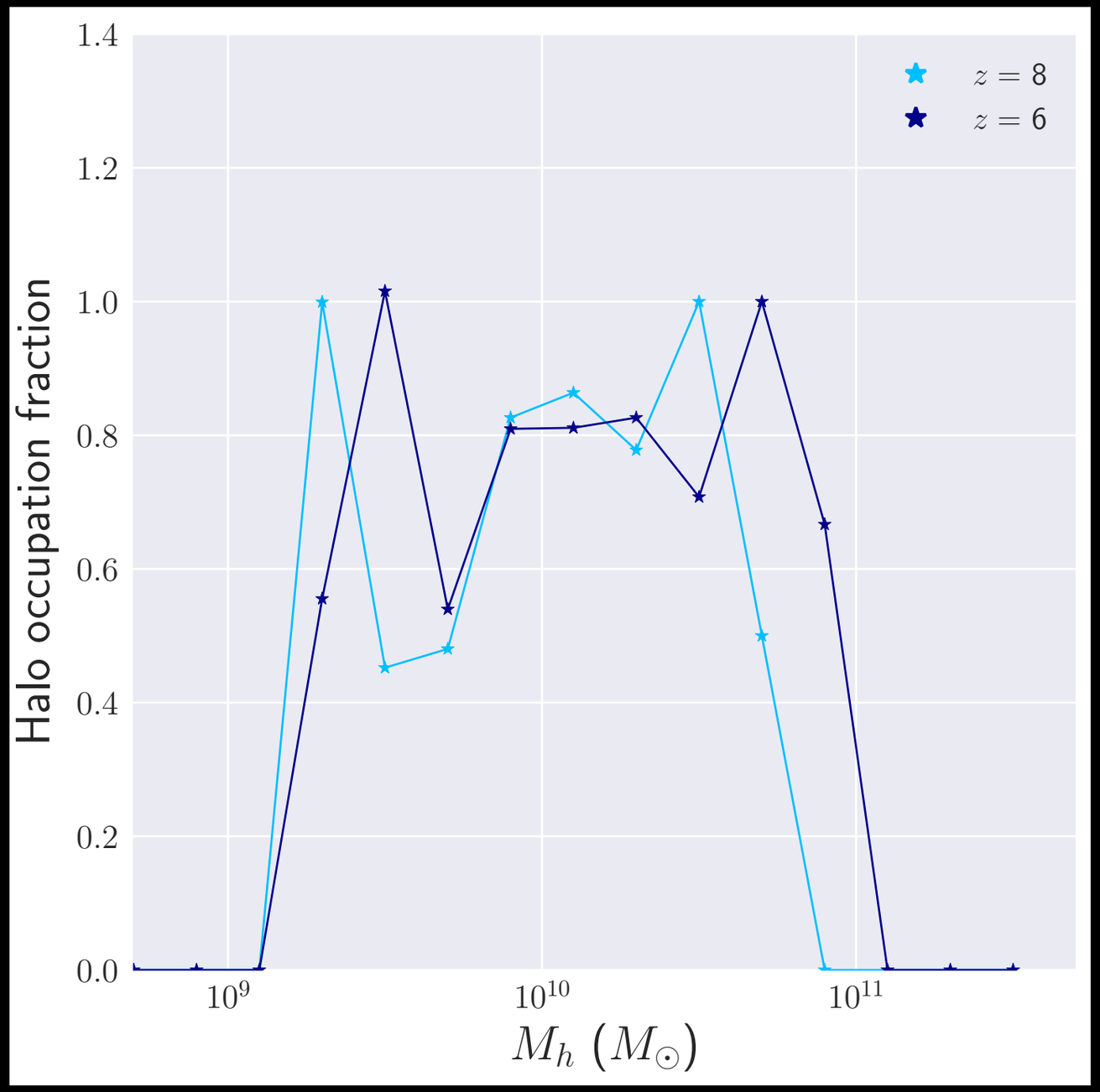
Molecular cooling

HALO MASS FUNCTION VS. HALO VIRIAL MASS



García submitted

HALO OCCUPATION FRACTION

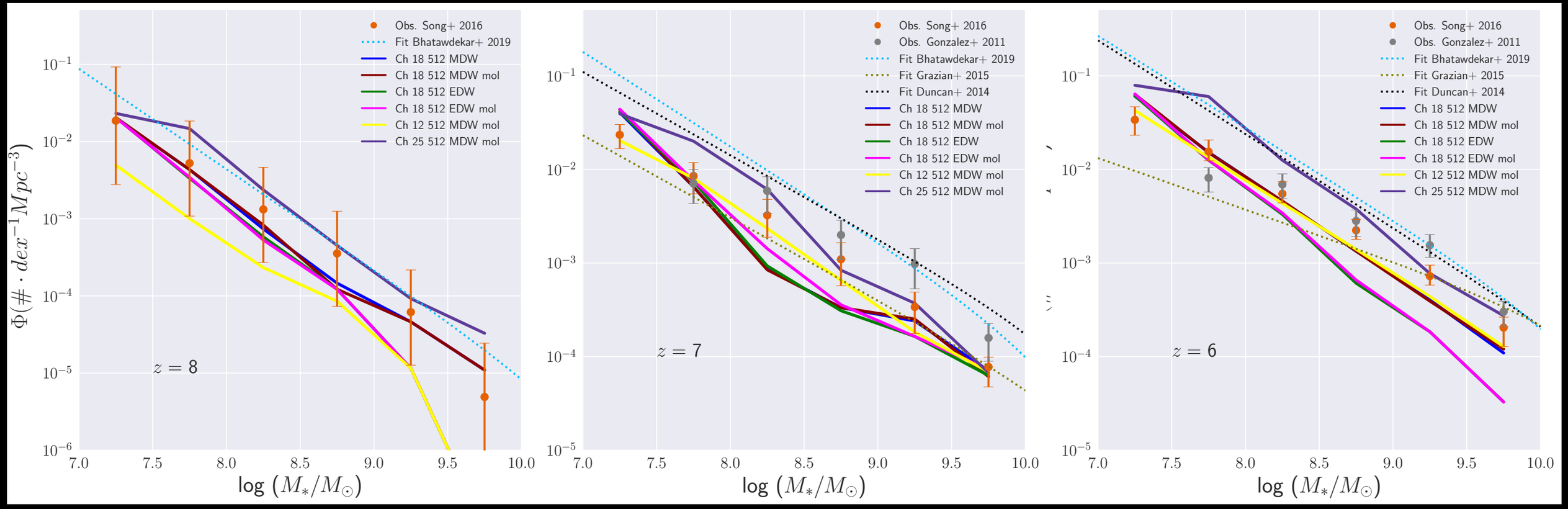


García submitted

SIMULATED GALAXY STELLAR MASS FUNCTION

$$\Phi(M) = \ln(10)\Phi^* 10^{(M-M_*)(\alpha+1)} e^{-10(M-M_*)}$$

	$\log_{10}M_*$	α	Φ^* (10^{-5}Mpc^{-3})
$z \sim 6$			
Bhatawdekar et al. (2019)	$10.35^{+0.50}_{-0.50}$	$-1.98^{+0.07}_{-0.07}$	$6.05^{+8.96}_{-3.49}$
Grazian et al. (2015)	$10.49^{+0.32}_{-0.32}$	$-1.55^{+0.19}_{-0.19}$	$6.91^{+13.5}_{-4.57}$
Duncan et al. (2014)	$10.87^{+1.13}_{-0.54}$	$-2.00^{+0.57}_{-0.40}$	$1.4^{+41.1}_{-1.4}$
$z \sim 7$			
Bhatawdekar et al. (2019)	$10.27^{+0.60}_{-0.67}$	$-2.01^{+0.17}_{-0.13}$	$3.9^{+9.2}_{-2.85}$
Grazian et al. (2015)	$10.69^{+1.58}_{-1.58}$	$-1.88^{+0.36}_{-0.36}$	$0.57^{+59.68}_{-0.56}$
Duncan et al. (2014)	$10.51^{+0.36}_{-0.32}$	$-1.89^{+1.39}_{-0.61}$	$3.60^{+3.01}_{-0.35}$
$z \sim 8$			
Bhatawdekar et al. (2019)	$10.54^{+1.00}_{-0.94}$	$-2.30^{+0.51}_{-0.46}$	$0.095^{+0.56}_{-0.08}$



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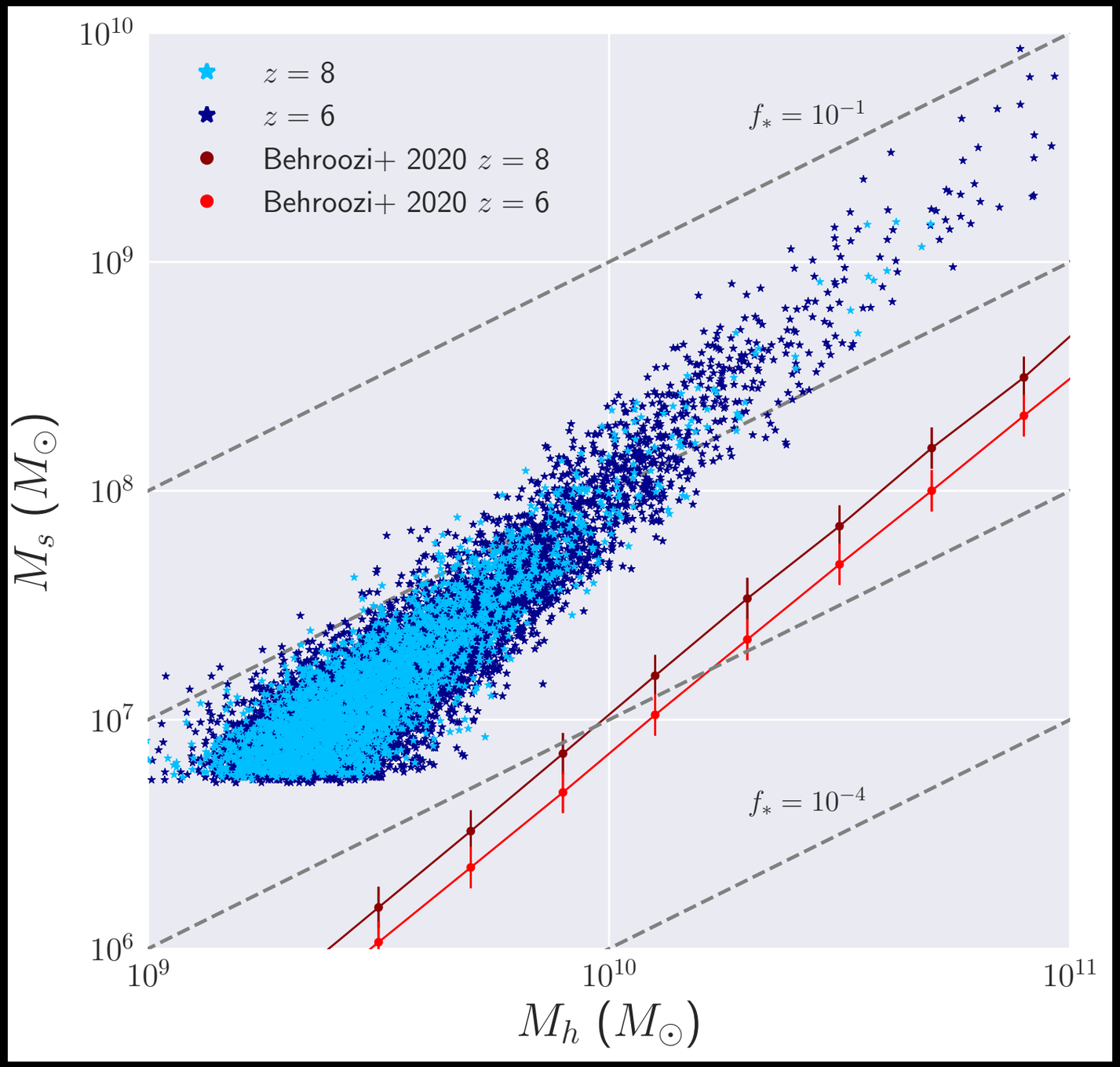
GALAXY STELLAR MASS TO HALO VIRIAL MASS FUNCTION



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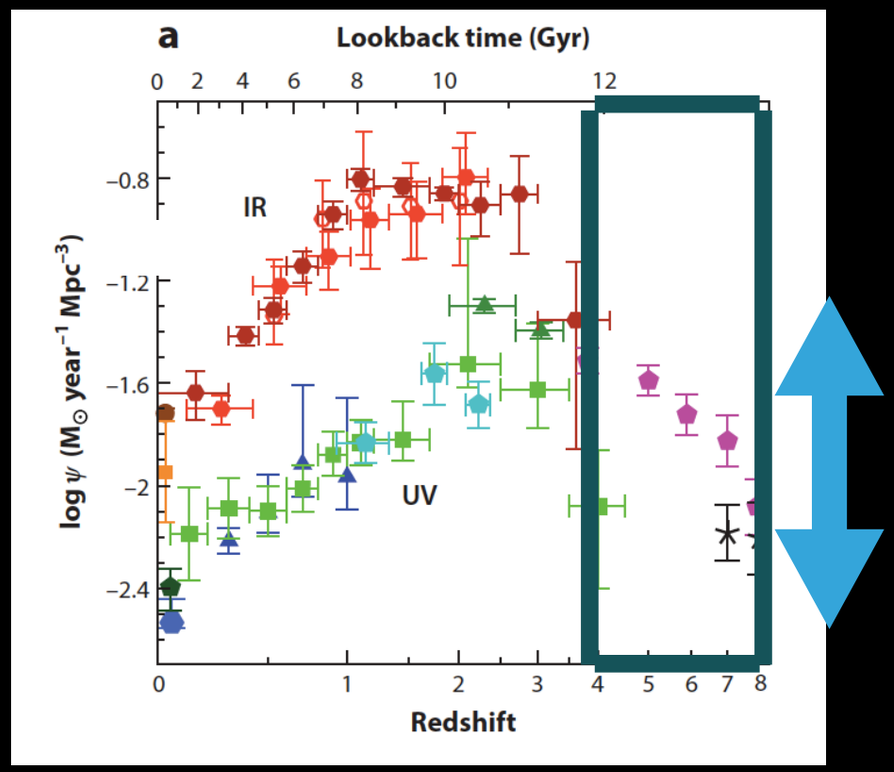
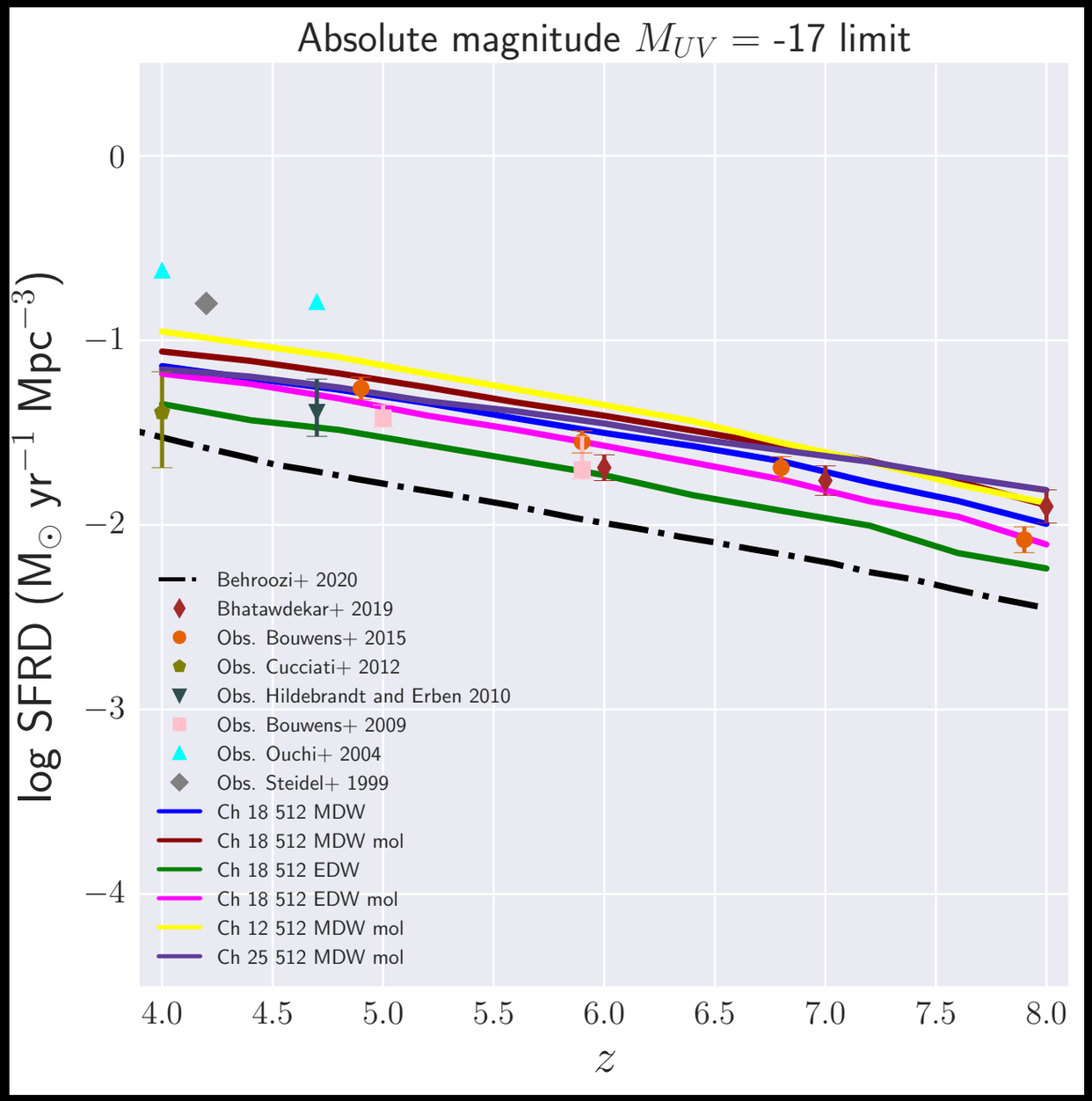
COSMIC STAR FORMATION RATE



Madau et al. 2014



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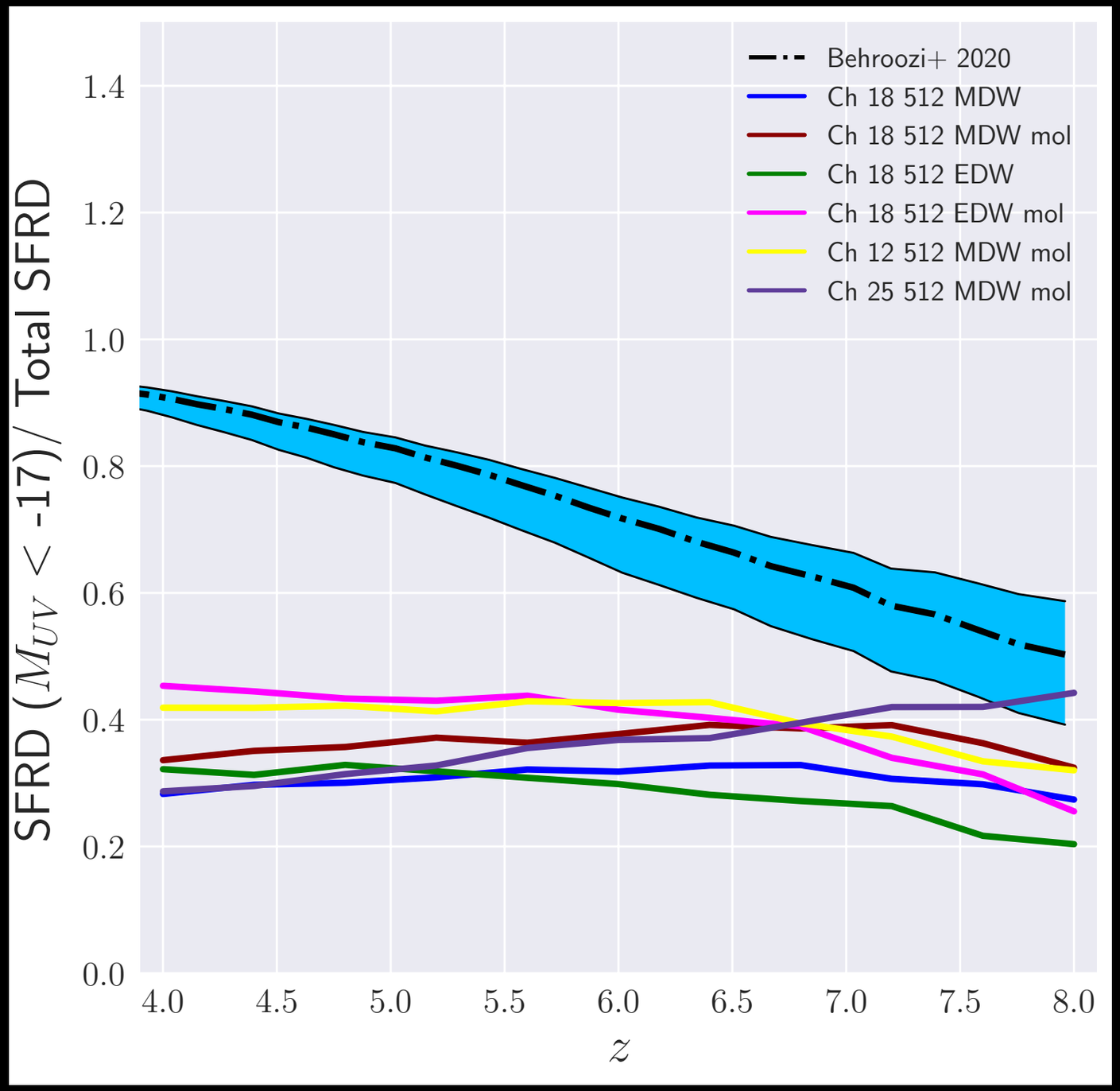
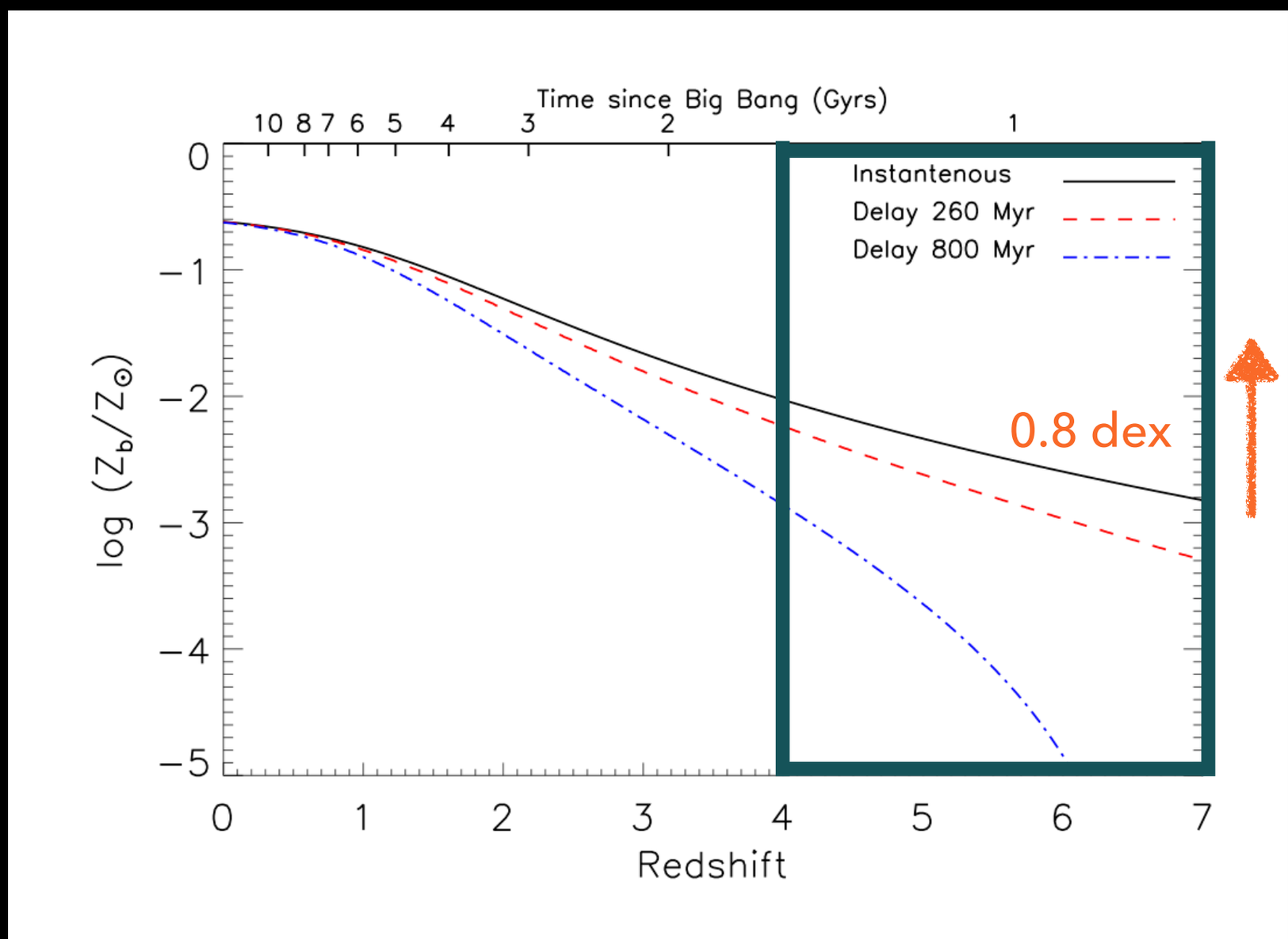
STAR FORMATION RATE RATIO



García submitted

CHEMICAL ENRICHMENT



$$Z_b(z) \equiv \frac{y\rho_*(z)}{\rho_b}$$

Mean metallicity of the Universe:

y: amount of heavy metals

$\rho_*(z)$

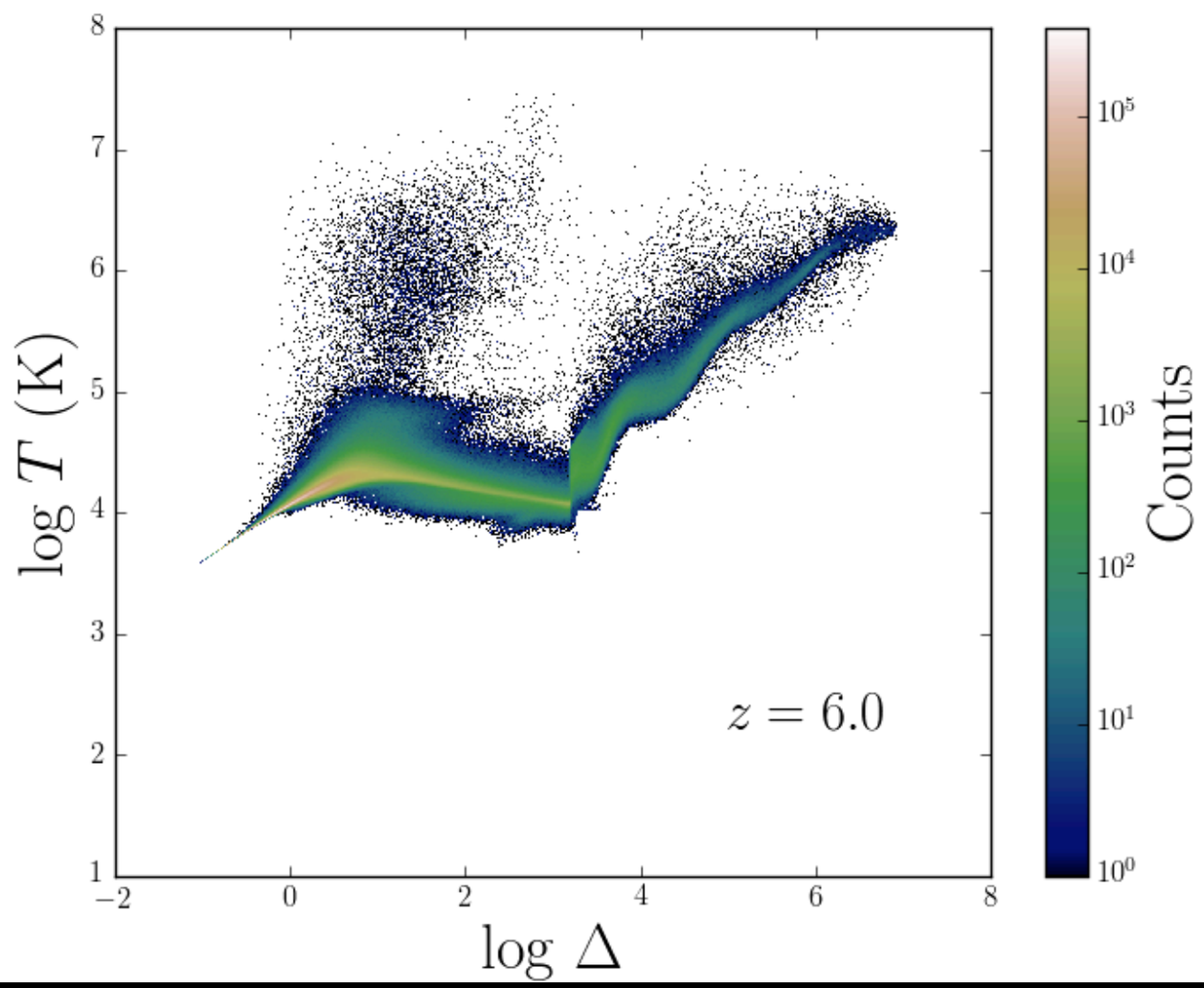
model SFR

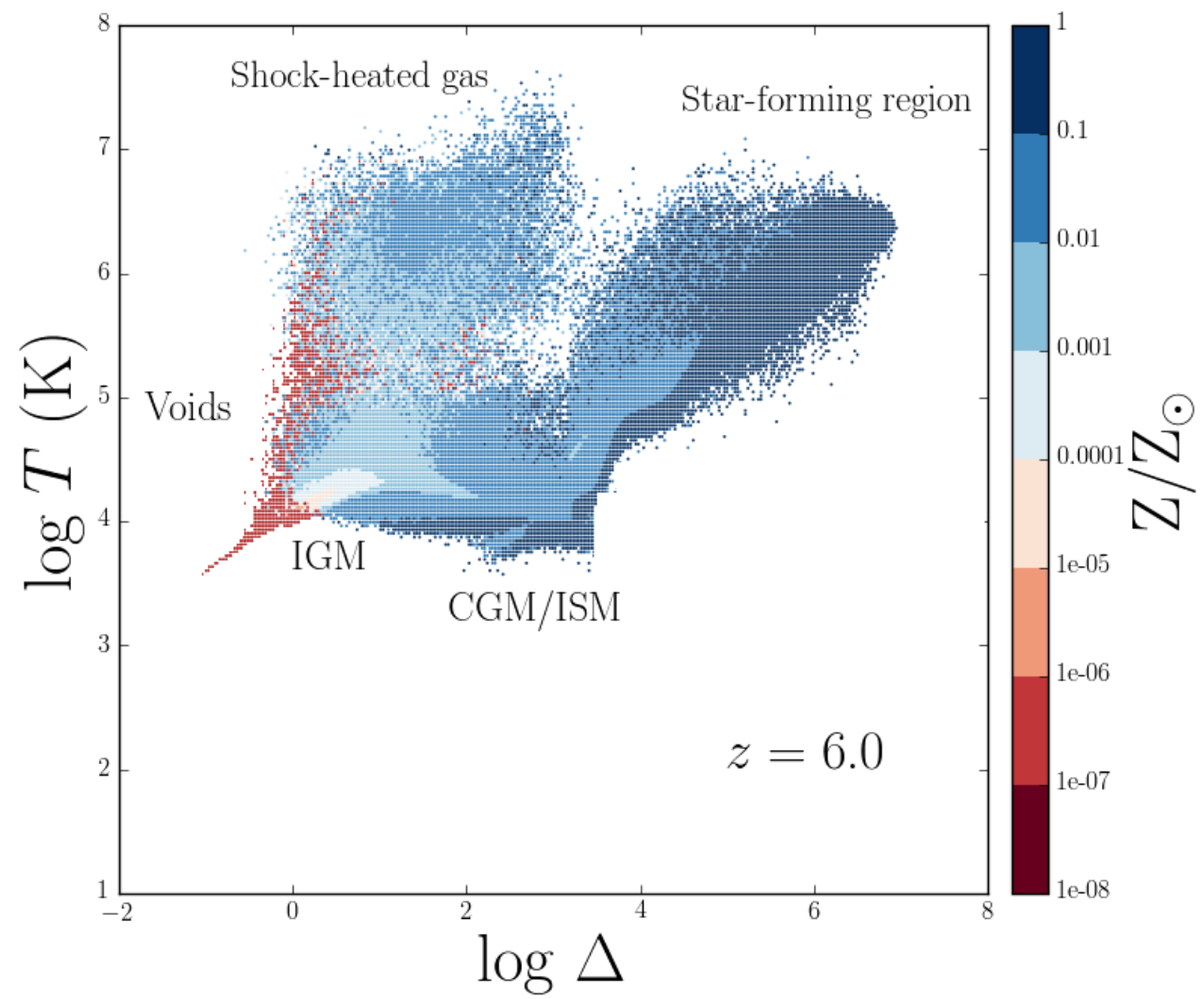
IMF

stellar yields

Díaz et al. in prep

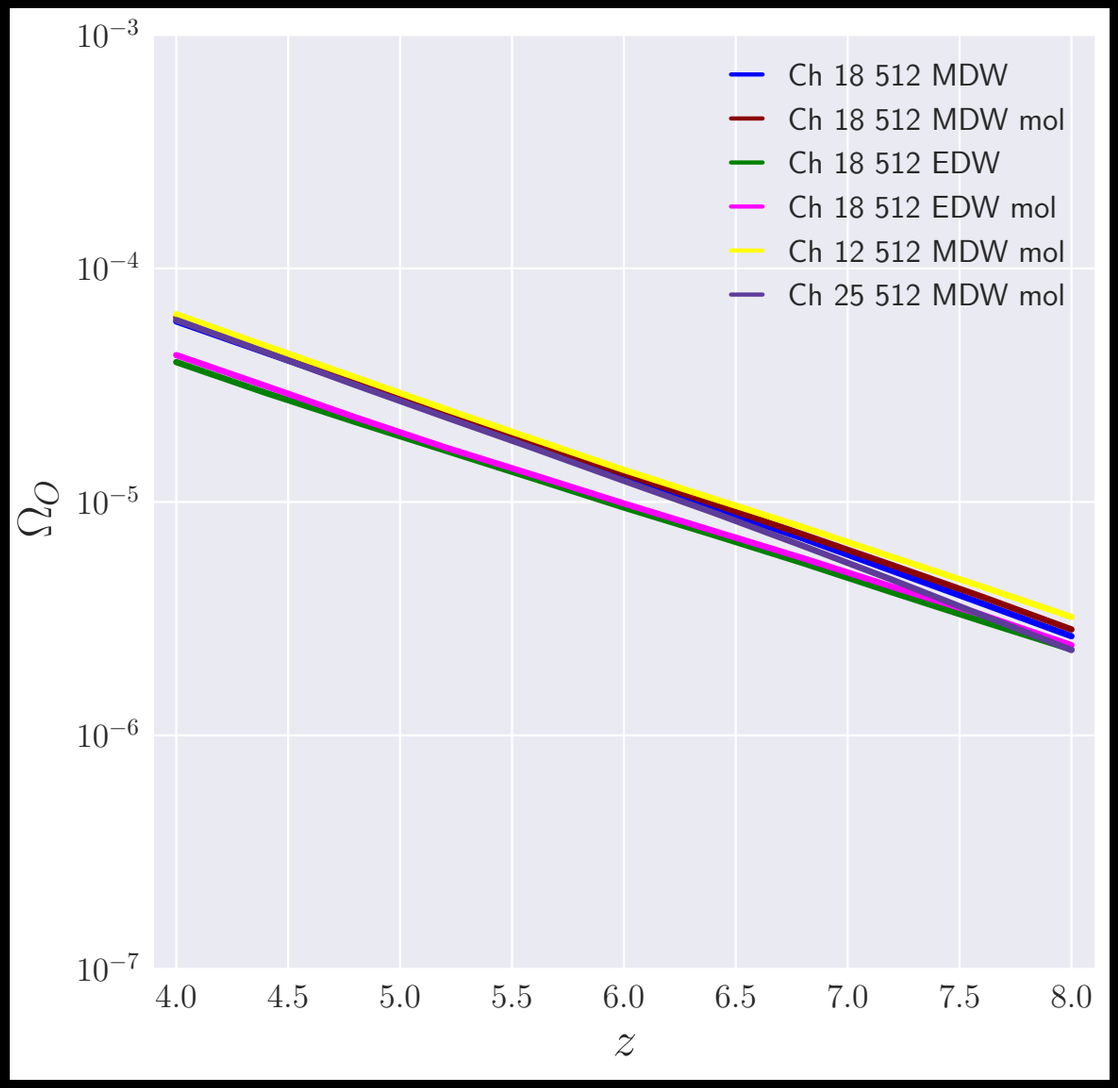
MULTIPHASE GAS - METALLICITY

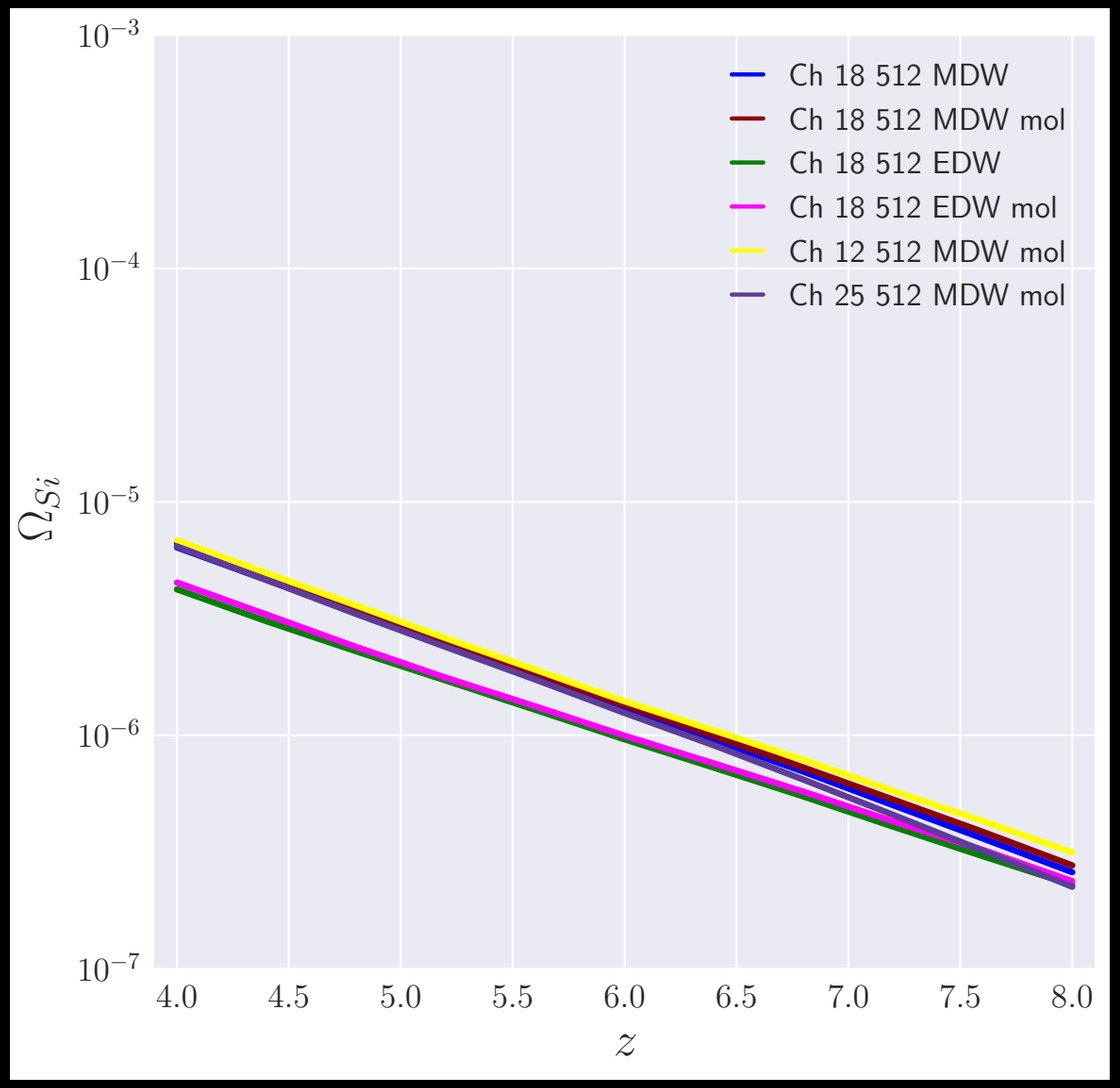




García et al 2017b

CHEMICAL ENRICHMENT





García submitted

TAKE-AWAY MESSAGES

* The main goal of the study is to describe the evolution of galaxy properties and their connection with the dark matter halos that host these galaxies at the tail of Reionization.

* The proposed models agree well with the observed galaxy stellar mass function at z = 8, 7, and 6, and the cosmic star formation rate at 4 < z < 8.

* These results are consistent with other simulations that account for modules with diverse physical processes, including Renaissance, Astraeus, CROC and UNIVERSEMACHINE.

* There is a correlation between the cosmic star formation history and the metal enrichment of the intergalactic medium, and both processes are regulated by the galaxy and supernova feedback prescriptions in the simulations.

* A comparison with UNIVERSEMACHINE models leads to an inferred constant power-law slope a = -2, at l = 8 - 6. This last conclusion will be tested and constrained by JWST shortly.

Thank you very much!

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