The Bimodal Formation Time Distribution of Infall Dark Matter Halos and Its Effect on Galaxies

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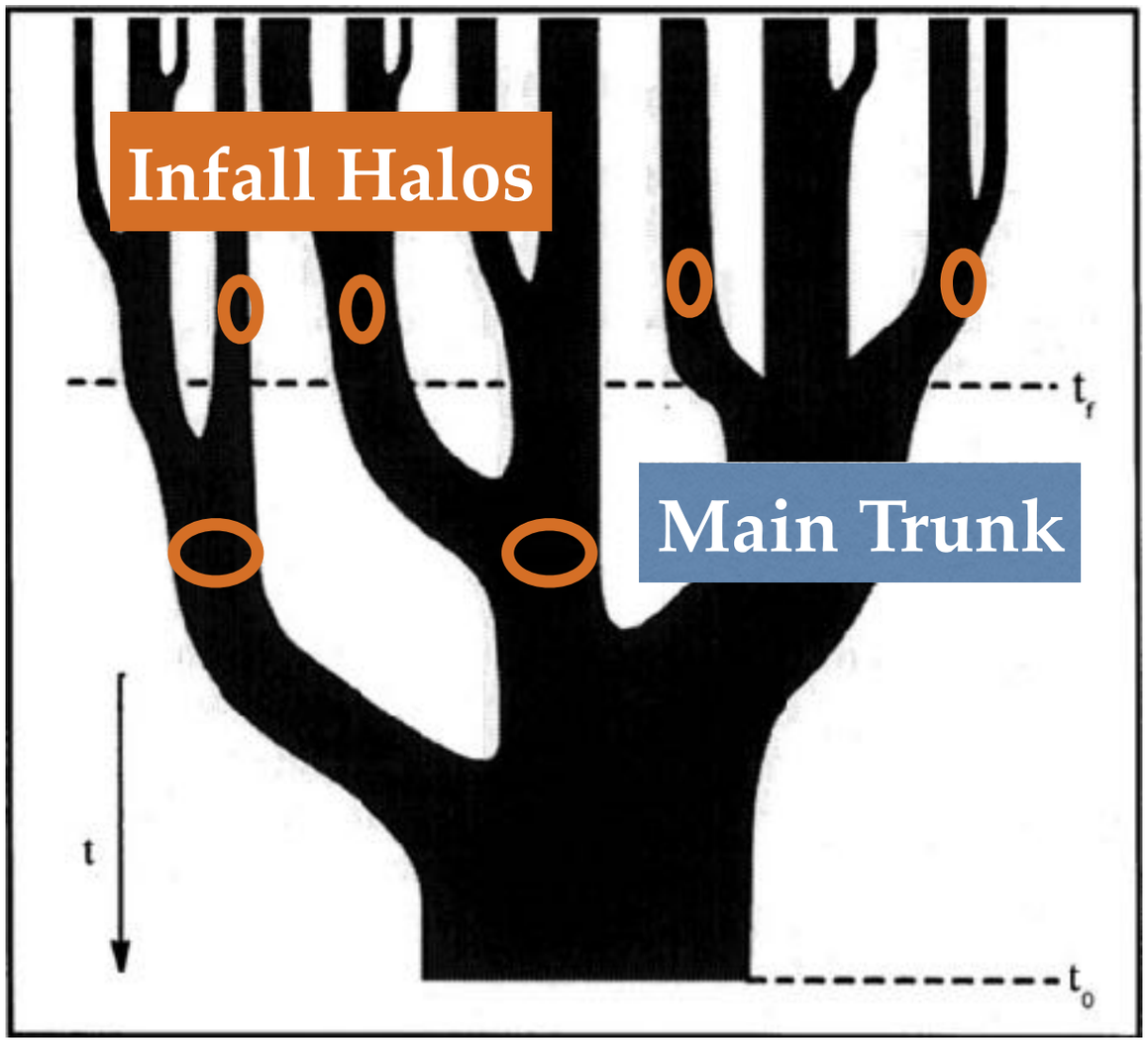
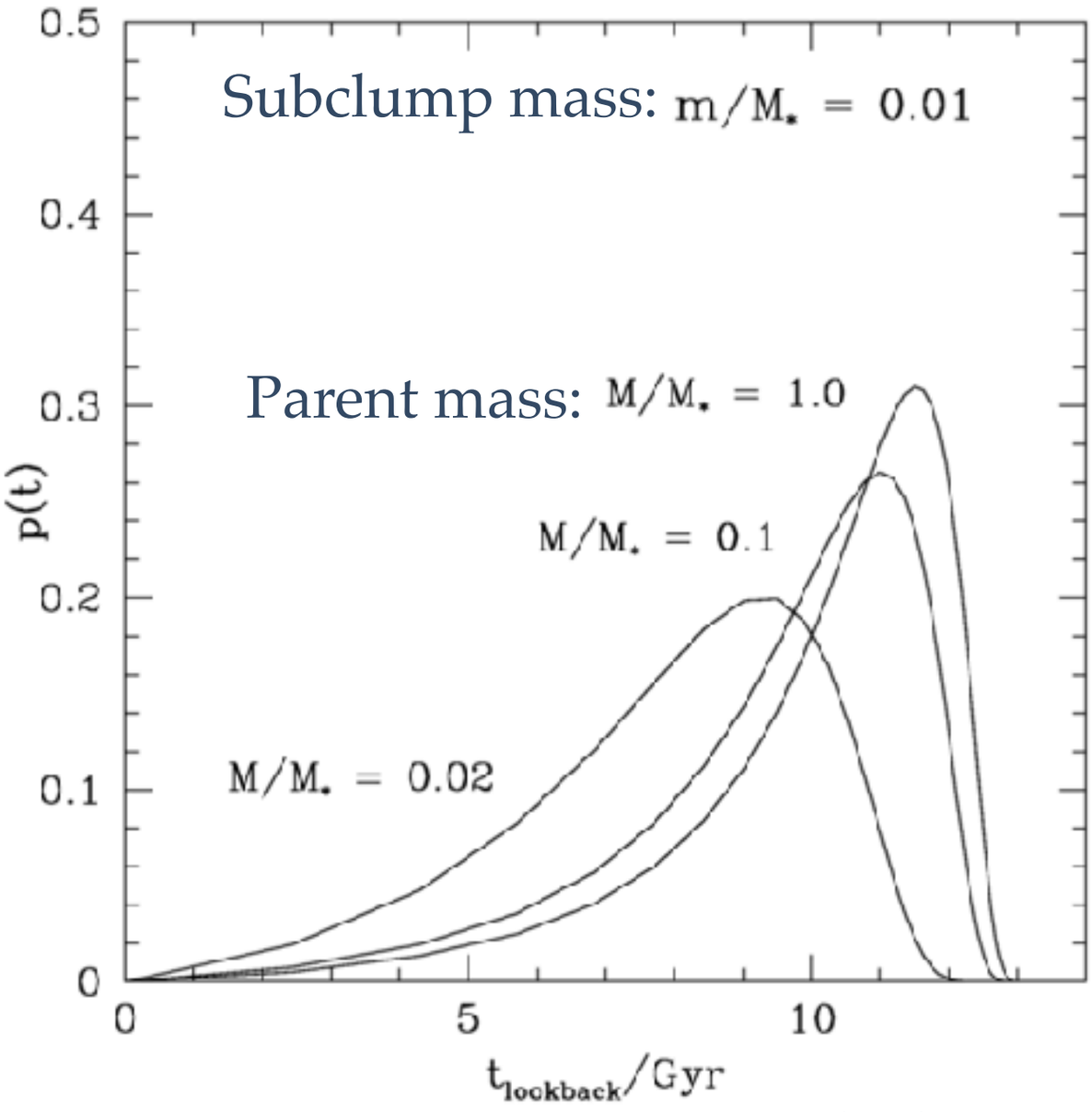
Motivation



Lacey & Cole 1993

Formation time distribution of subhalos:

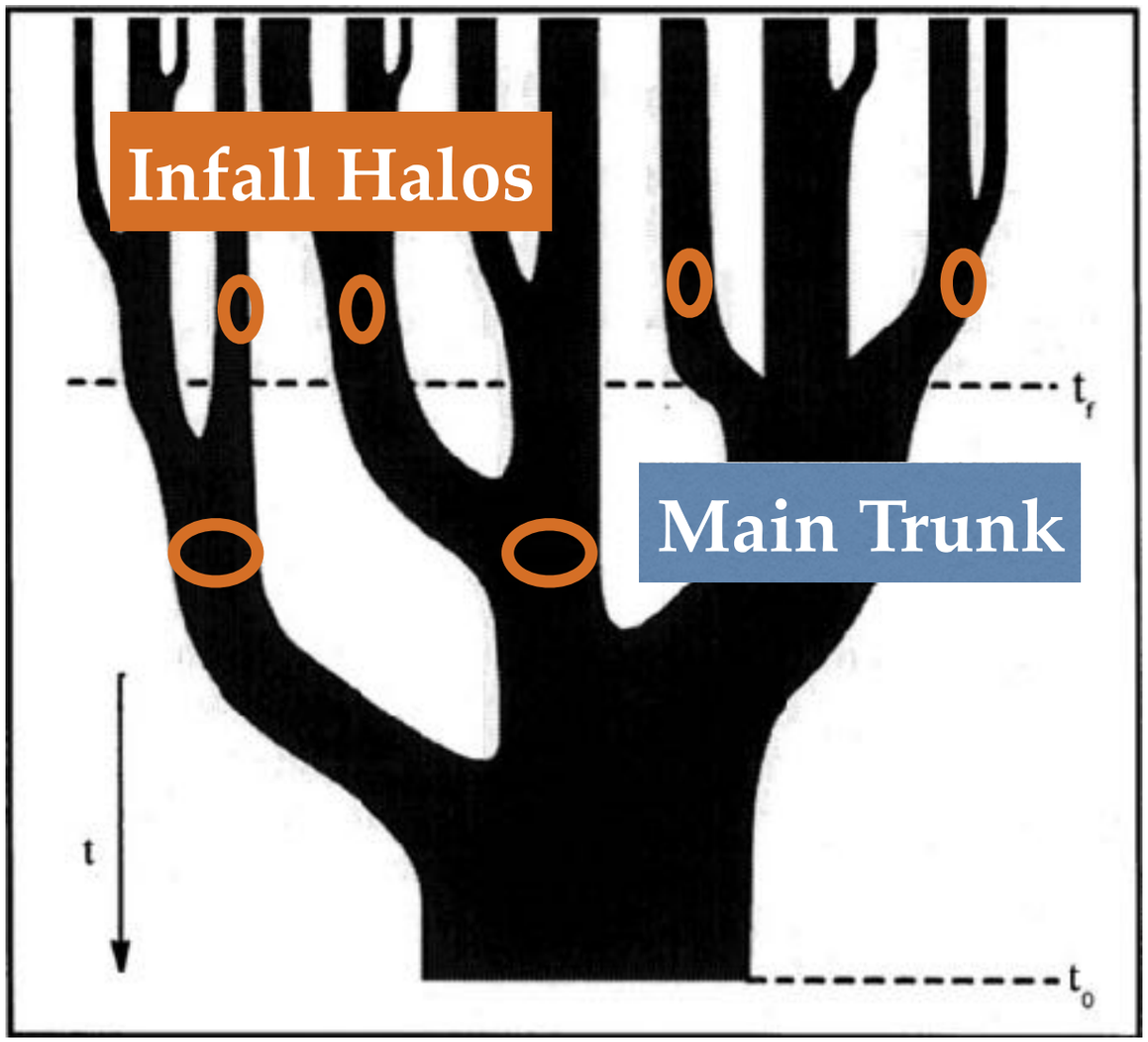


Sheth 2003

Motivation

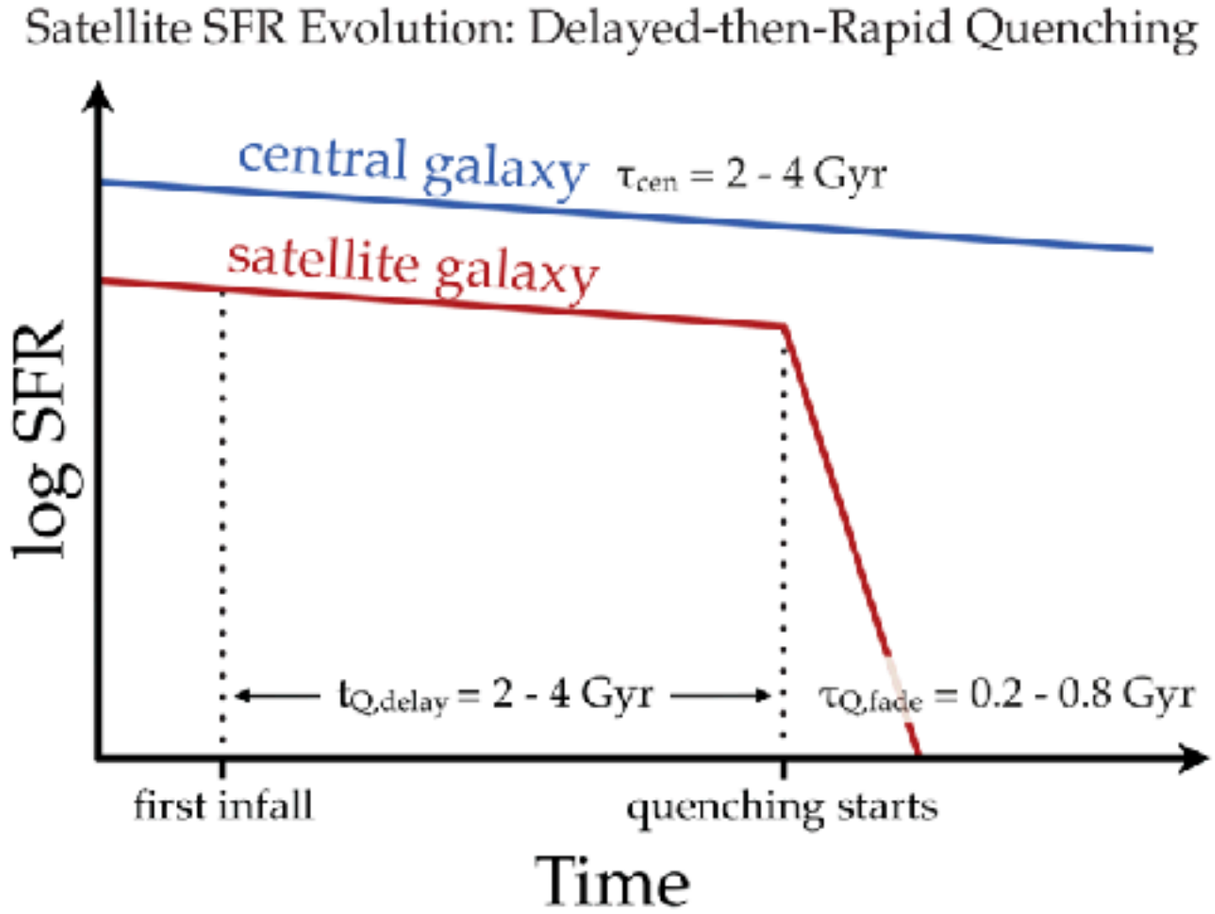
A. Does subhalo share a similar accretion history as the host halo?

B. What is the pre-accretion phase of subhalo looks like? and How is it related with the galaxy properties lying inside?



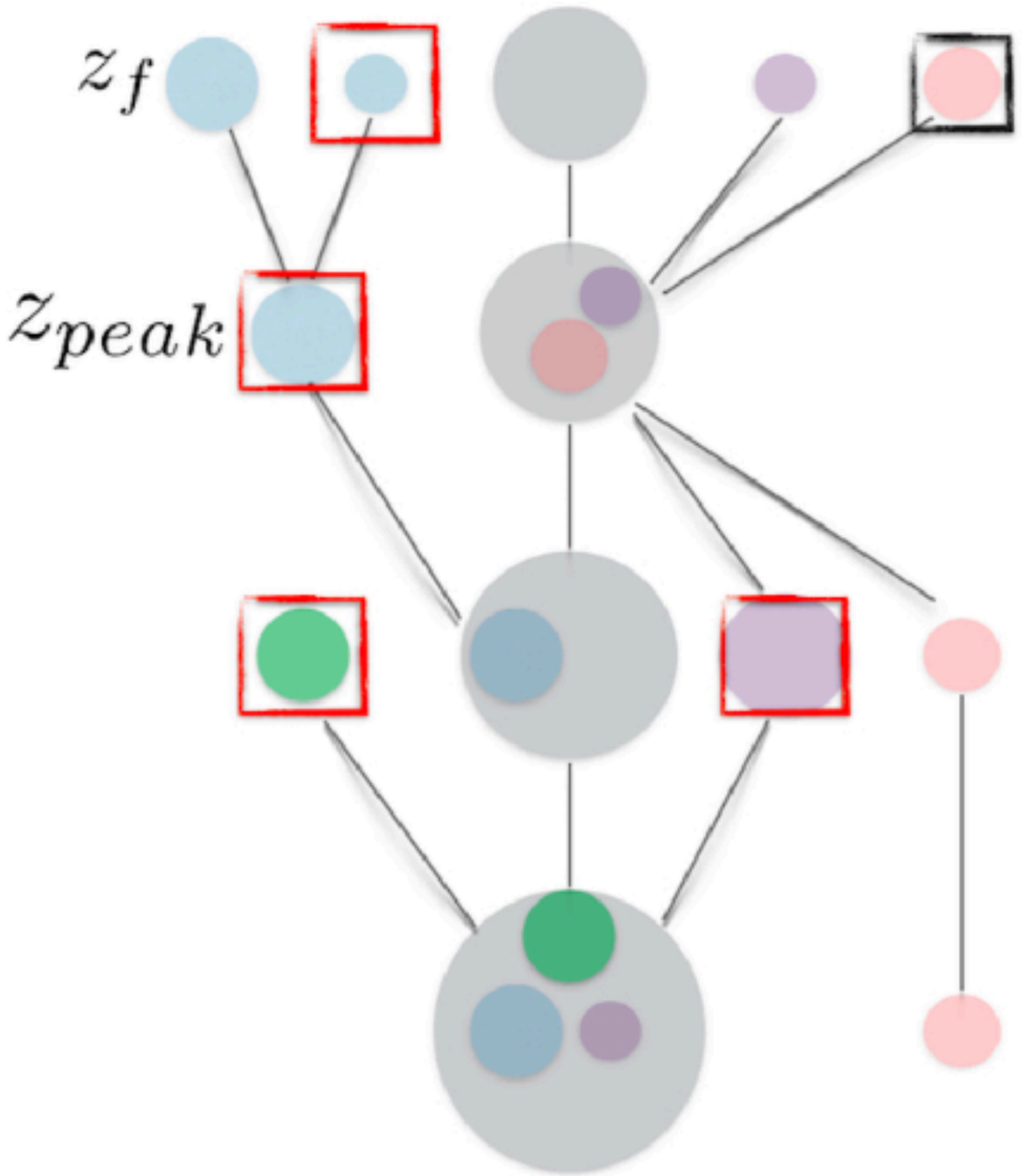
Lacey & Cole 1993

Satellite Quenching:



Wetzel et. al. 2013

Merger trees and simulations:



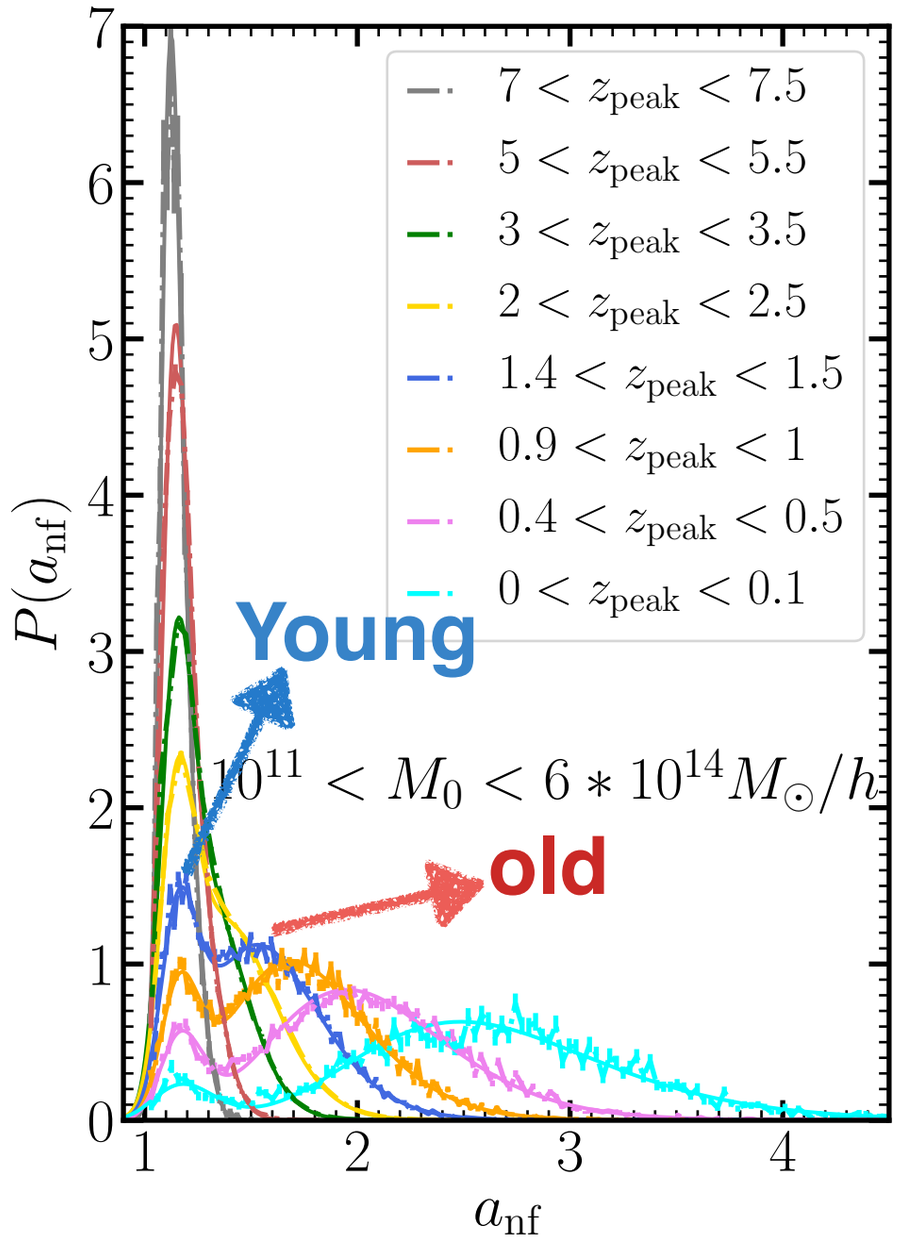
Simulations

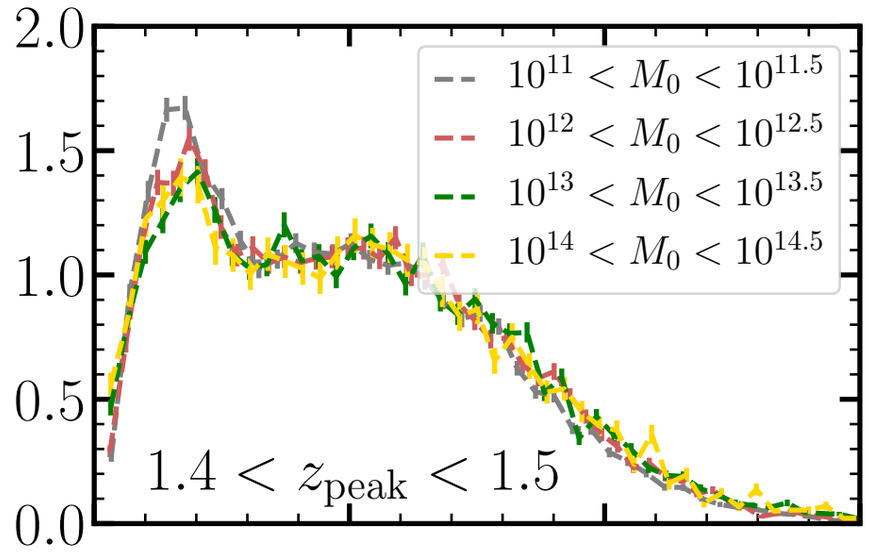
- Gadget-2 (Springel 2005)
- WMAP9 Cosmology (Hinshaw 2013)
- $N_p = 2048^3$, $L = 200h^{-1}Mpc$, $m_p = 7.29 \times 10^7 h^{-1} M_\odot$
- 100 snapshots from $z = 20$ to $z = 0$

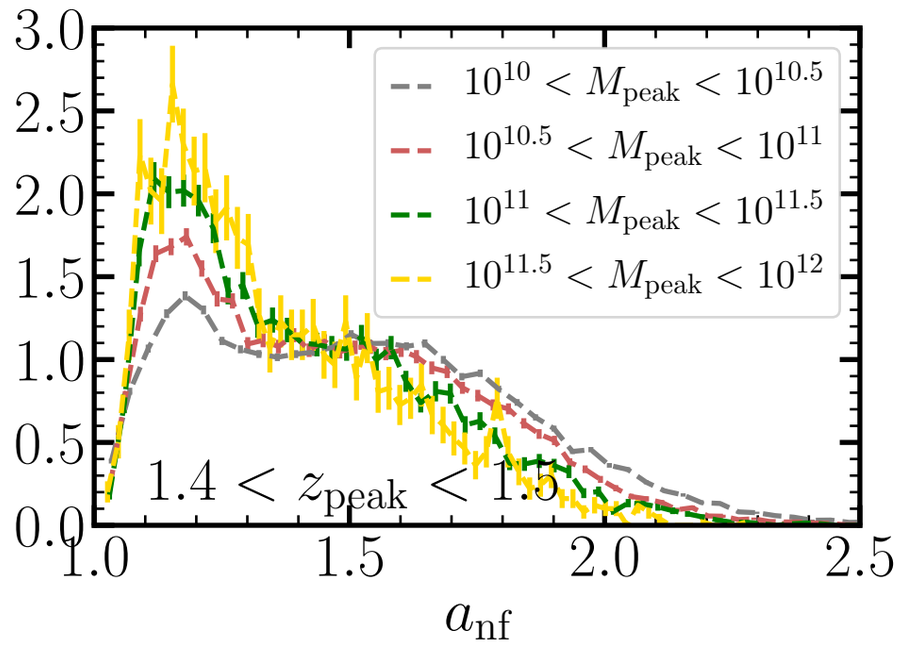
Characteristic Time Definition

- Accretion time z_{peak}: M_{peak}
- Formation time z_f: $M_{peak}/2$

$$a_{\rm nf} \equiv \frac{1+z_{\rm f}}{1+z_{\rm peak}}$$



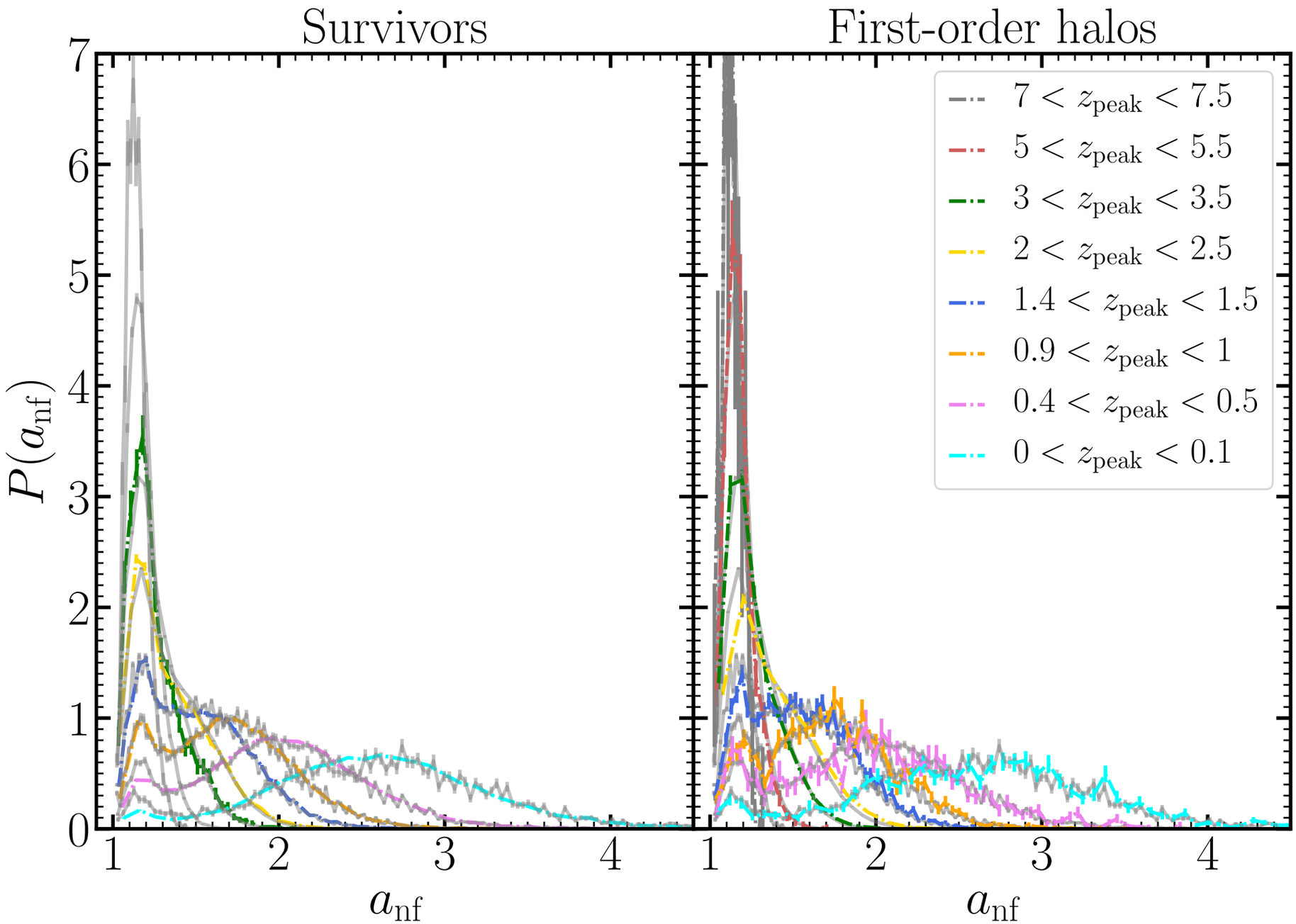




The bimodal formation time distribution of infall DM halos

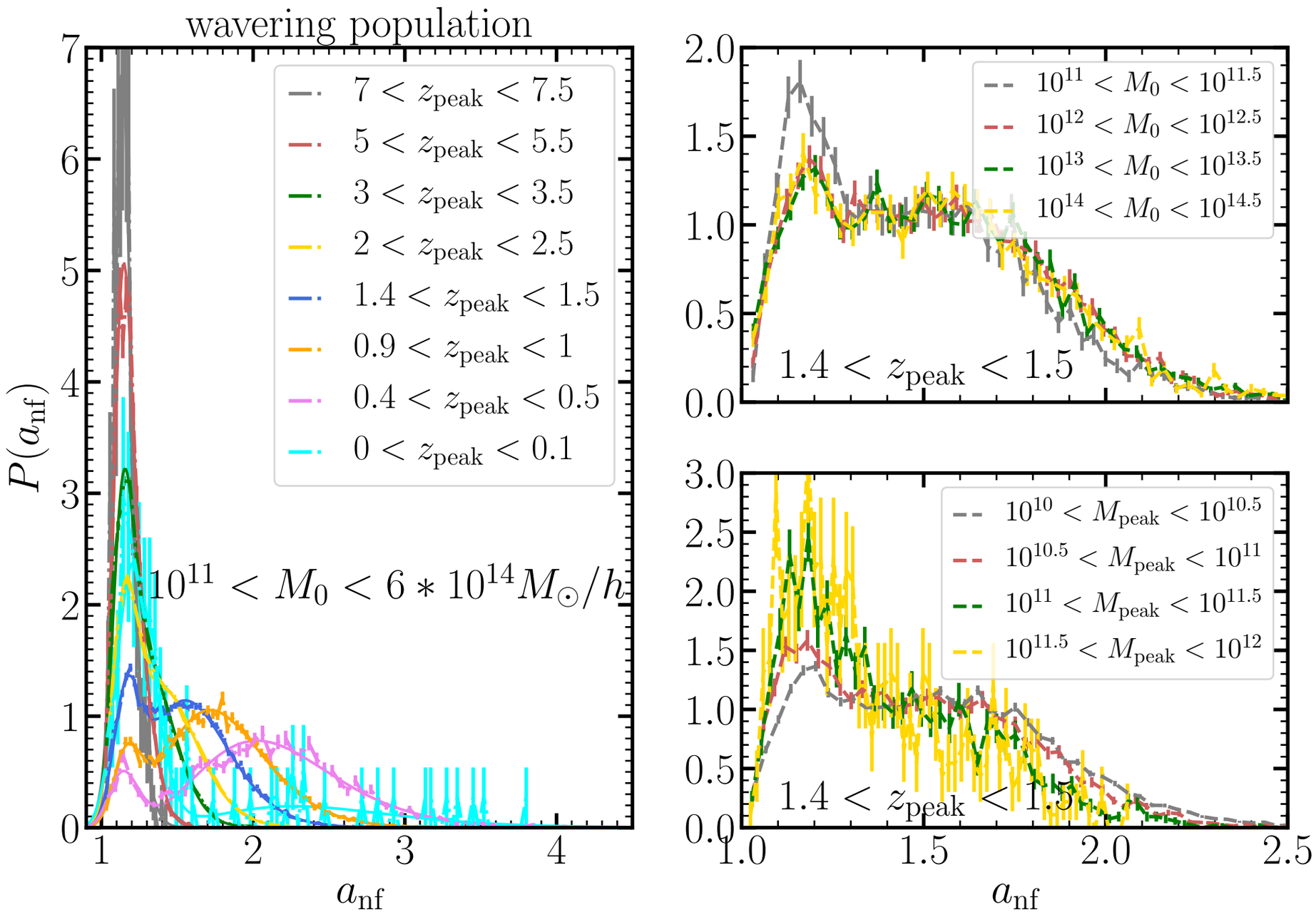
Shi et al. (2018)

Survivors and First-order accreted halos



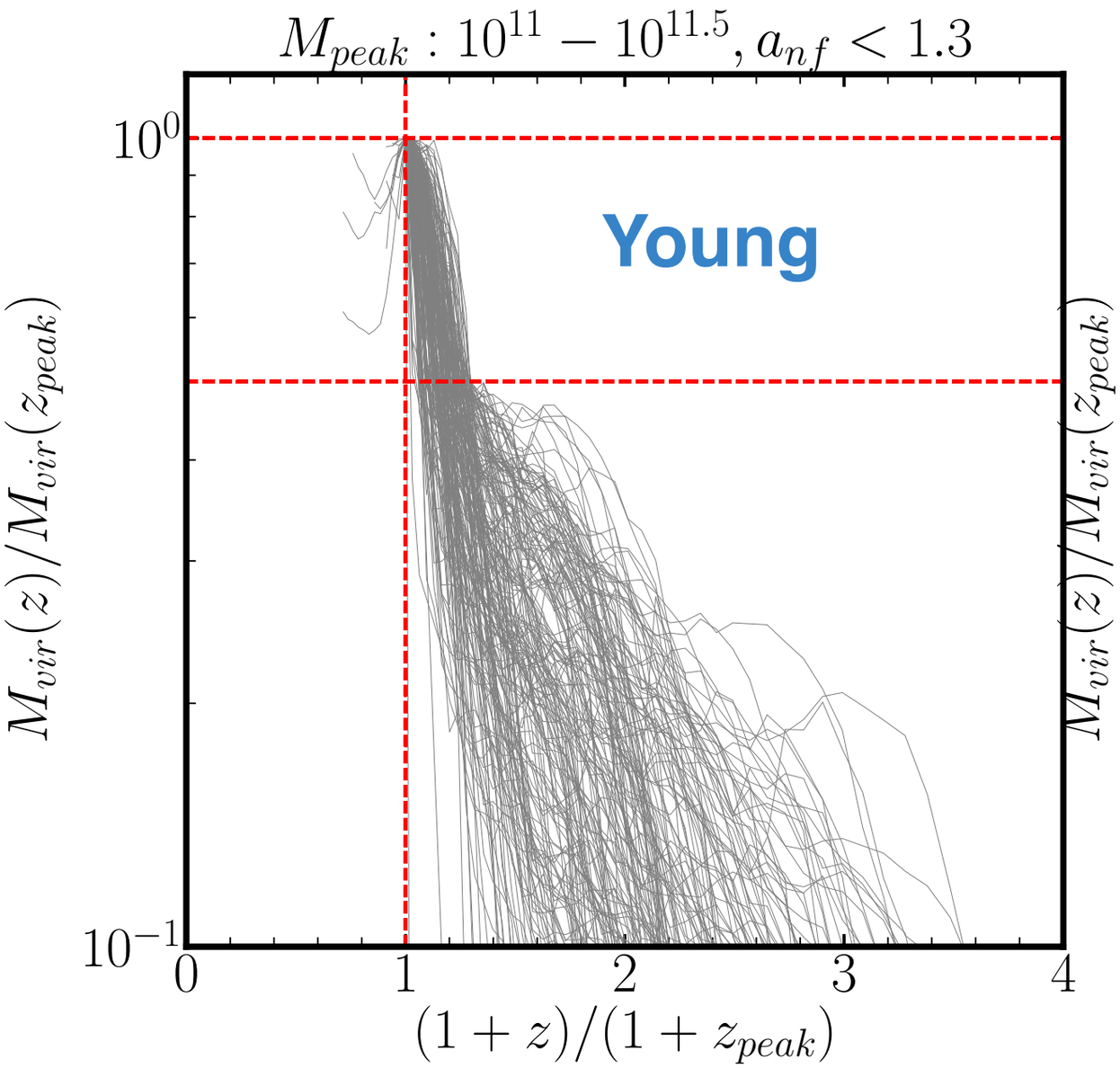
Shi et al. (2018)

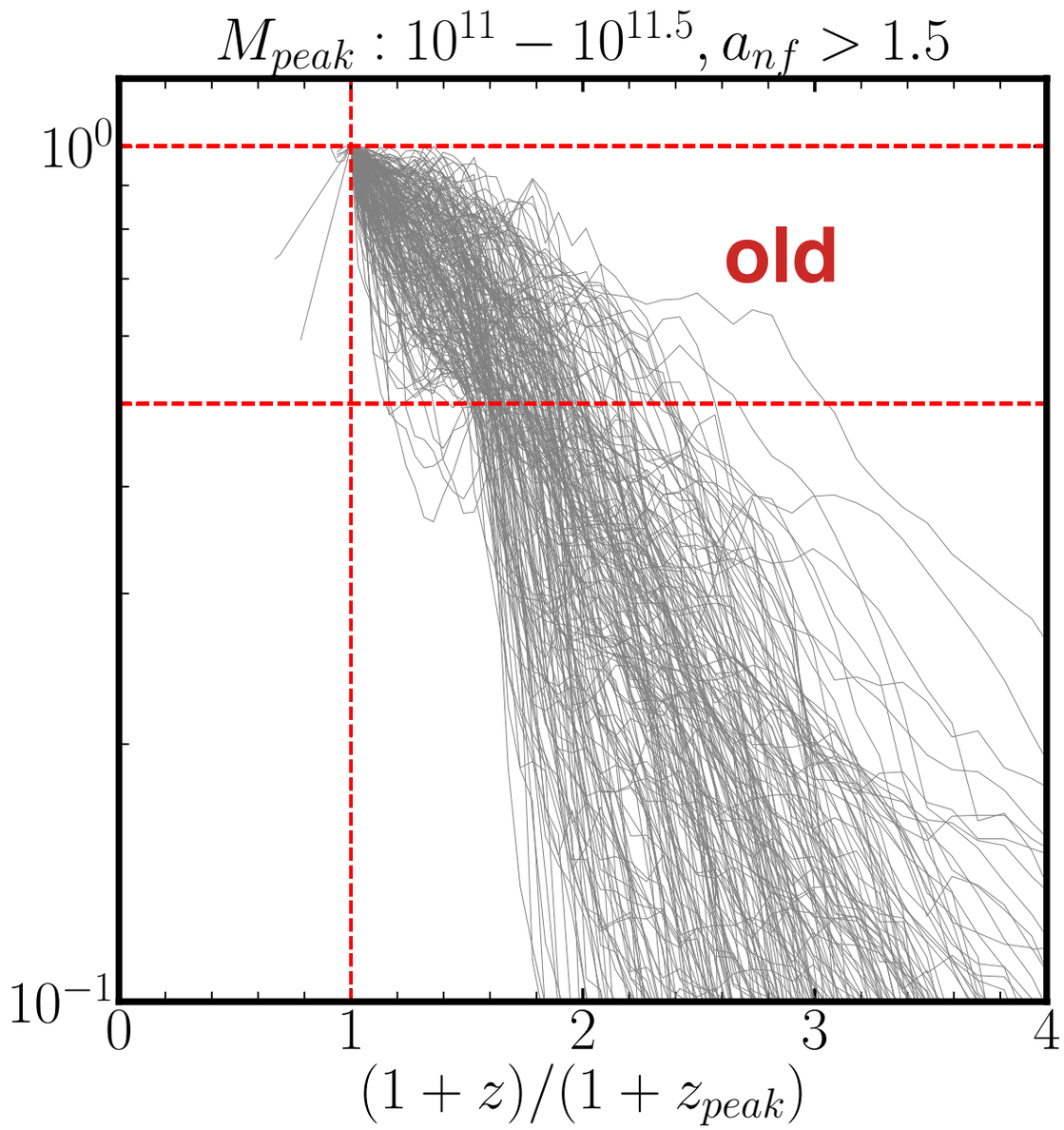
Wavering population



Shi et al. (2018)

Mass accretion history

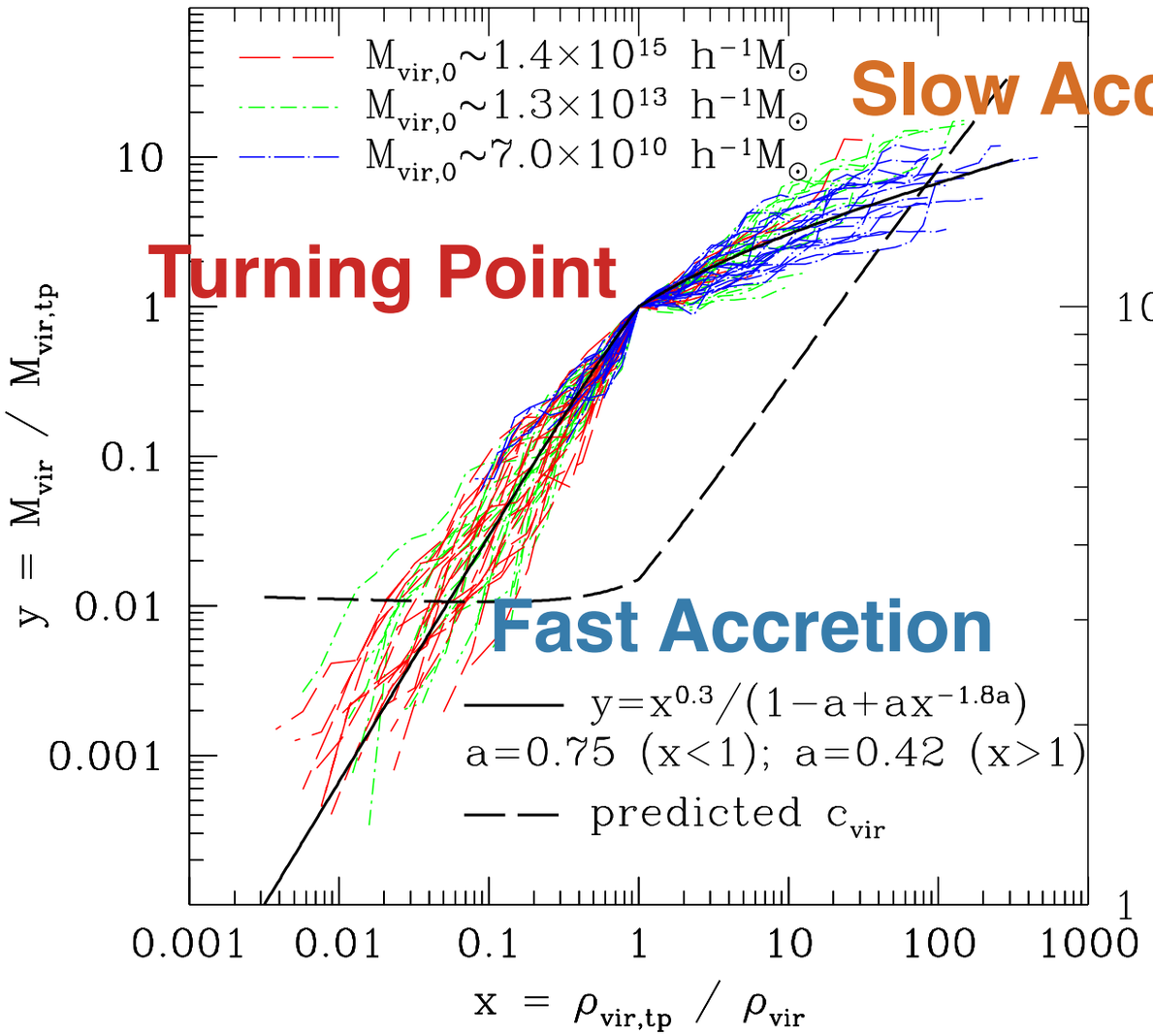


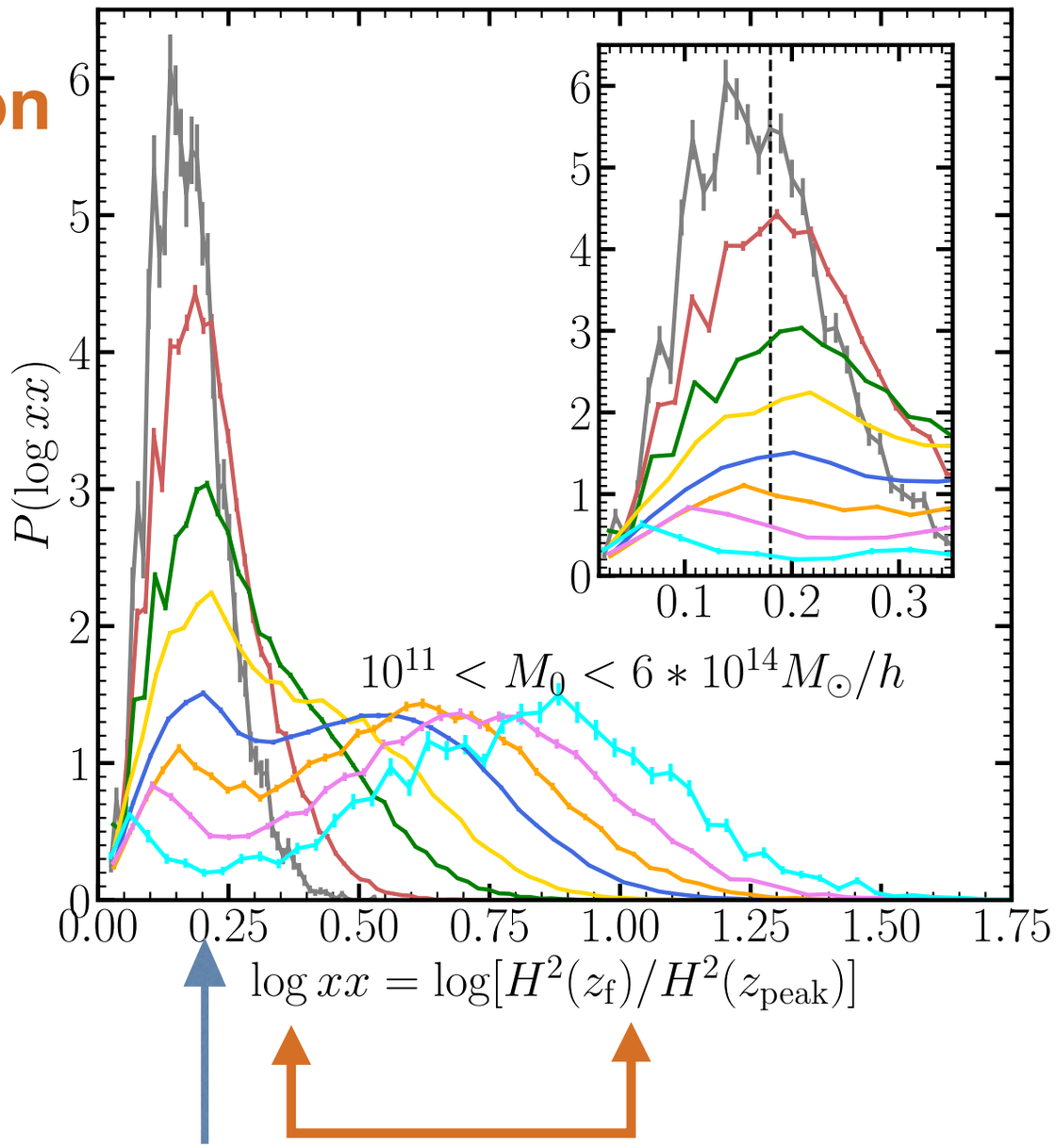


Shi et al. (2018)

Two-Phase Mass accretion history

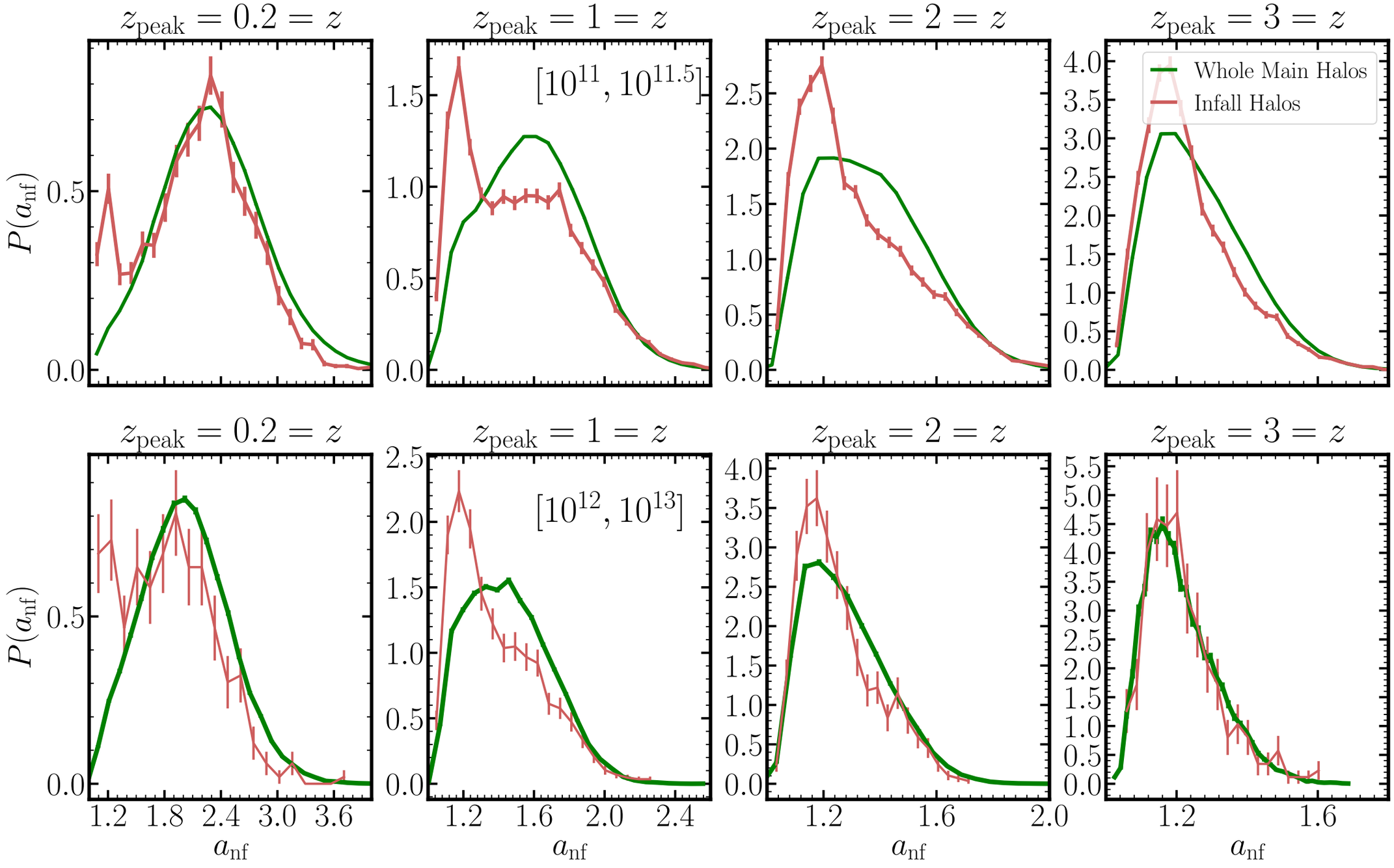
Shi et al. (2018)





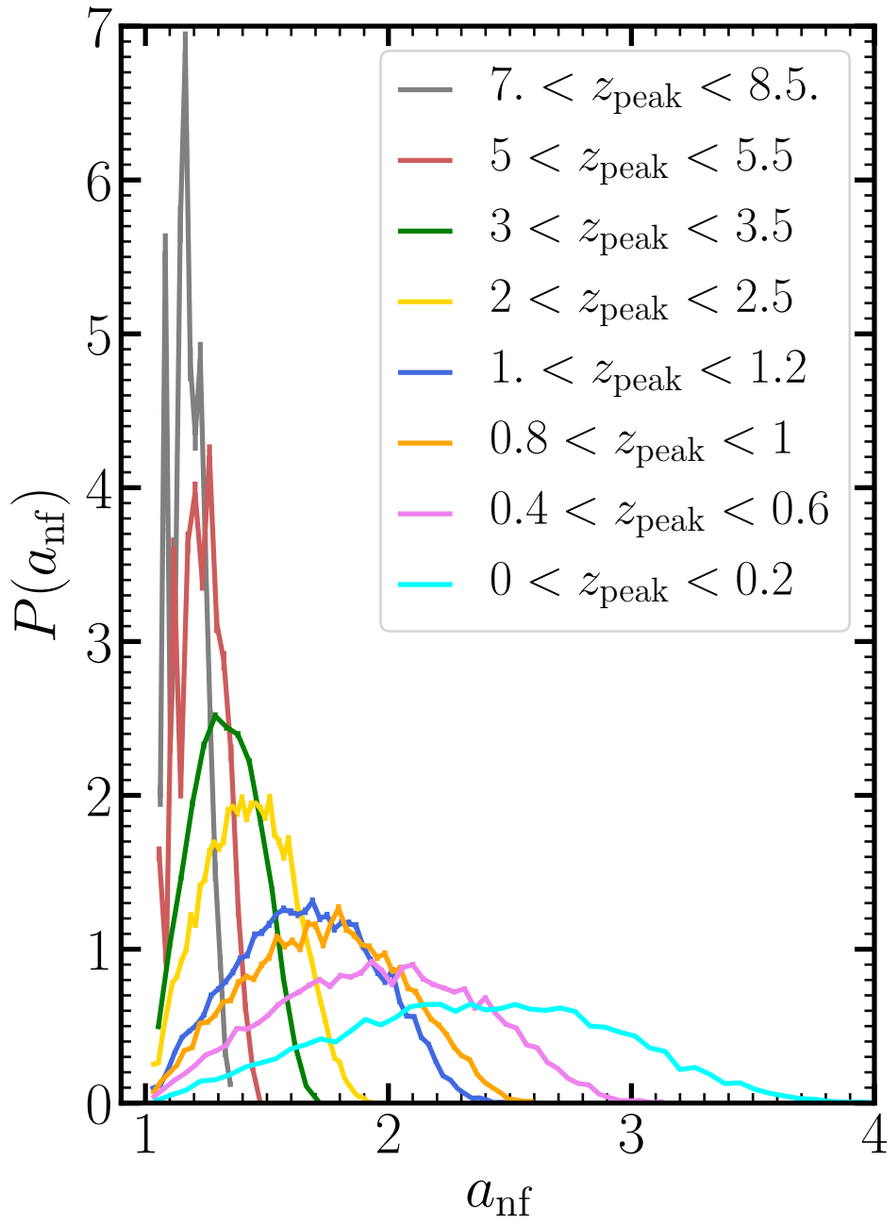
Zhao et al. (2003)

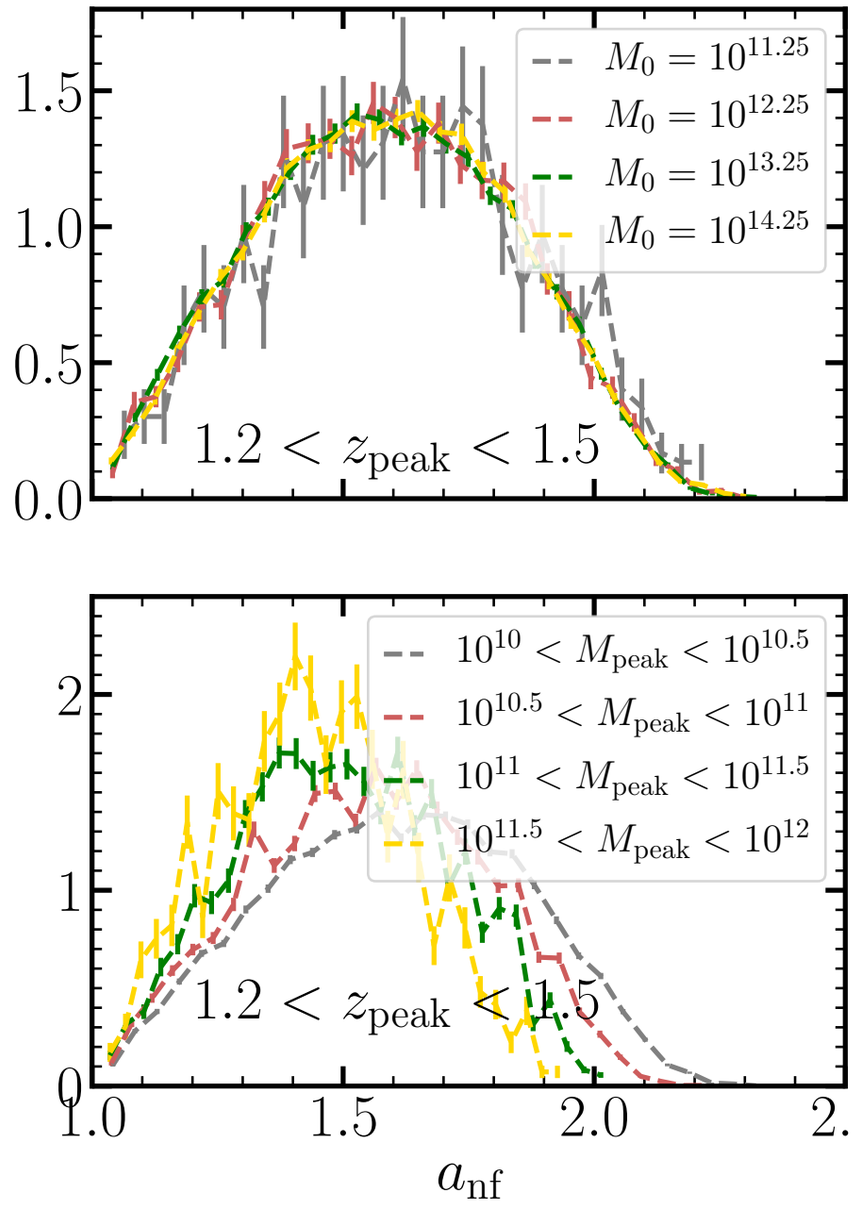
Infall halos versus Normal halos



Shi et al. (2018)

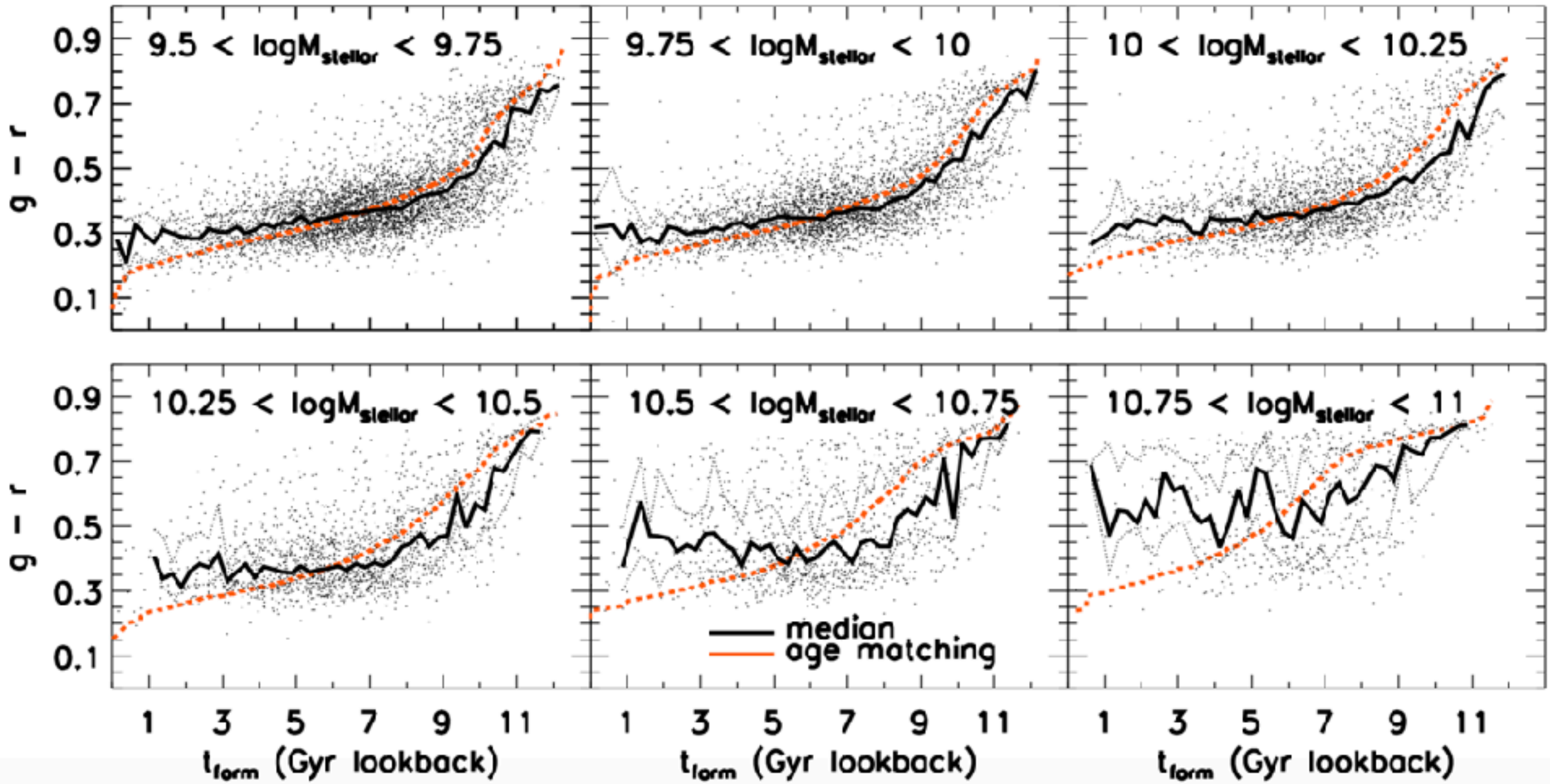
EPS merger tree results



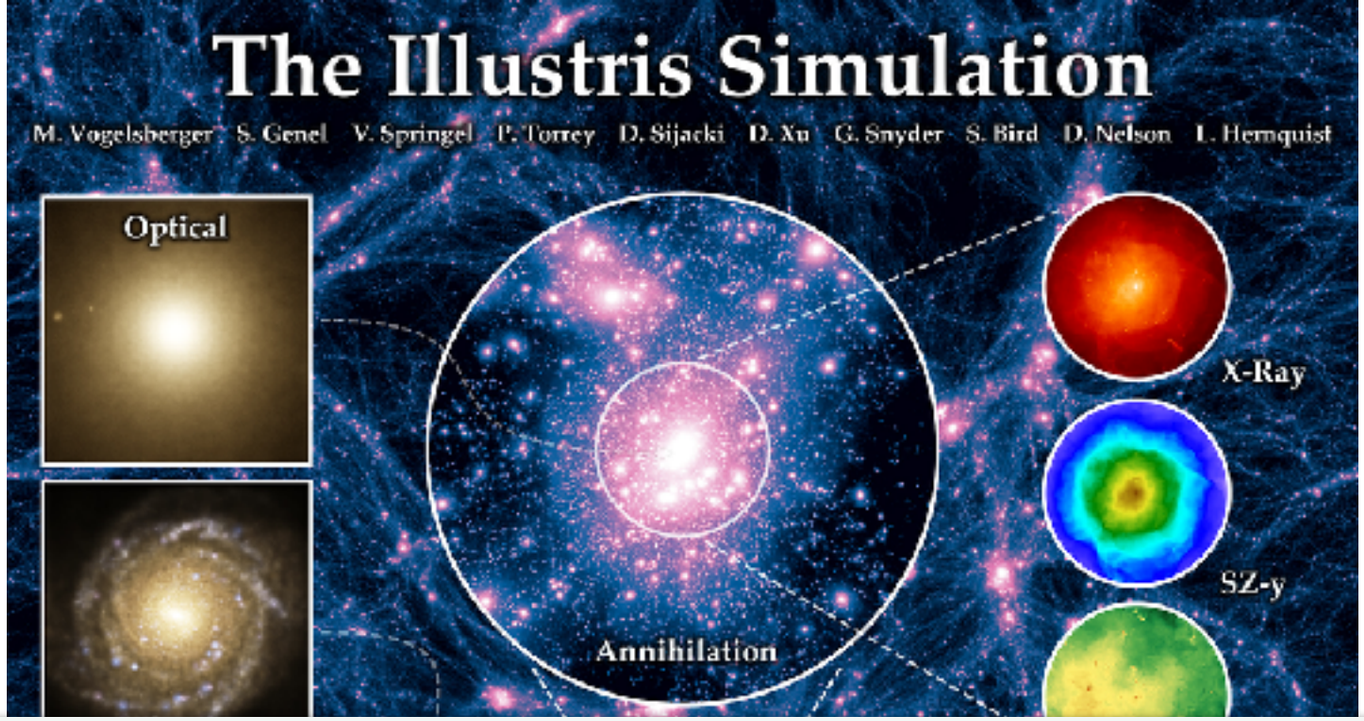


Shi et al. (2018)

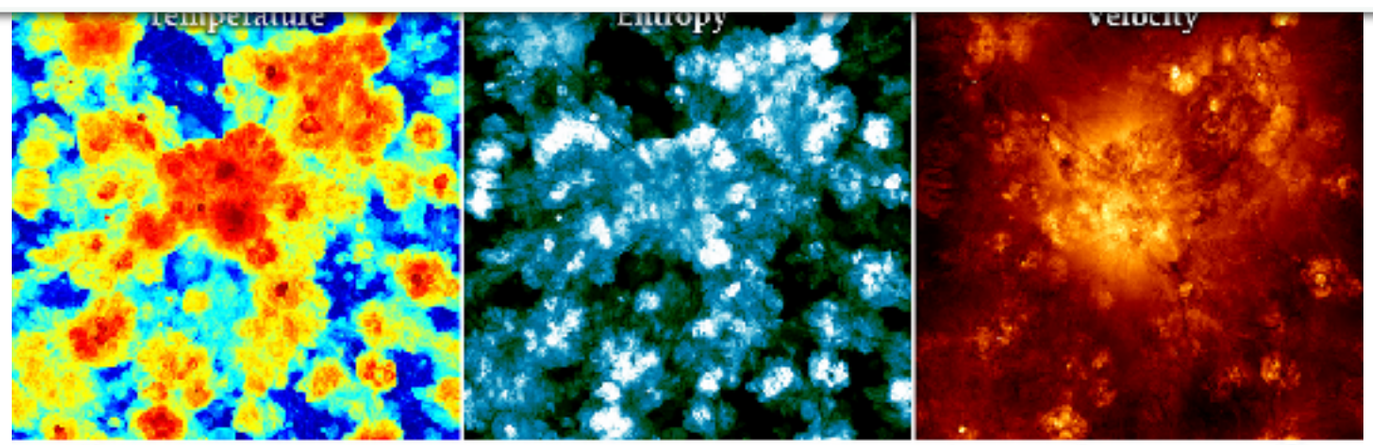
Connection between halo age and galaxy color



Bray et al. (2016)

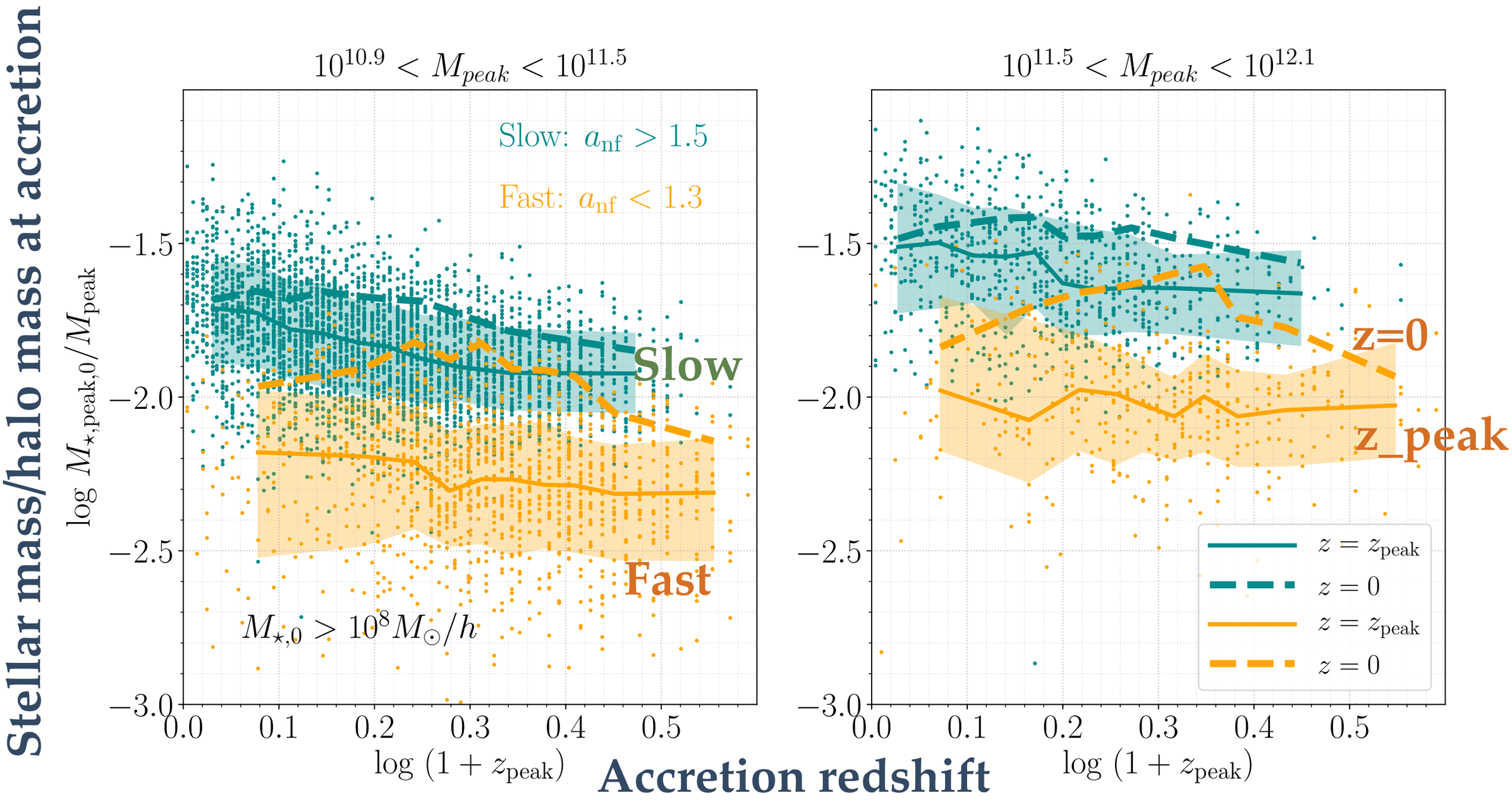


Run Name	Alt. Name	Volume [Mpc^3]	$L_{\rm box}$ [Mpc/h]	$N_{\rm GAS}$	$N_{\rm TR}$	$N_{\rm DM}$	$\epsilon_{\rm baryon}$ [kpc]	ϵ_{DM} [kpc]	m_{baryon} [M$_\odot$]	m_{DM} [M$_\odot$]
Illustris-1	L75n1820FP	106.5^3	75	1820^3	1820^3	1820^3	0.7	1.4	1.6×10^6	6.3×10^6
Illustris-2	L75n910FP	106.5^3	75	910^3	910^3	910^3	1.4	2.8	1.0×10^7	5.0×10^7
Illustris-3	L75n455FP	106.5^3	75	455^3	455^3	455^3	2.8	5.7	8.0×10^8	4.0×10^8
Illustris-1-Dark	L75n1820DM	106.5^3	75	0	0	1820^3	-	1.4	-	7.6×10^6
Illustris-2-Dark	L75n910DM	106.5^3	75	0	0	910^3	-	2.8	-	6.0×10^7
Illustris-3-Dark	L75n455DM	106.5^3	75	0	0	455^3	-	5.7	-	4.8×10^8



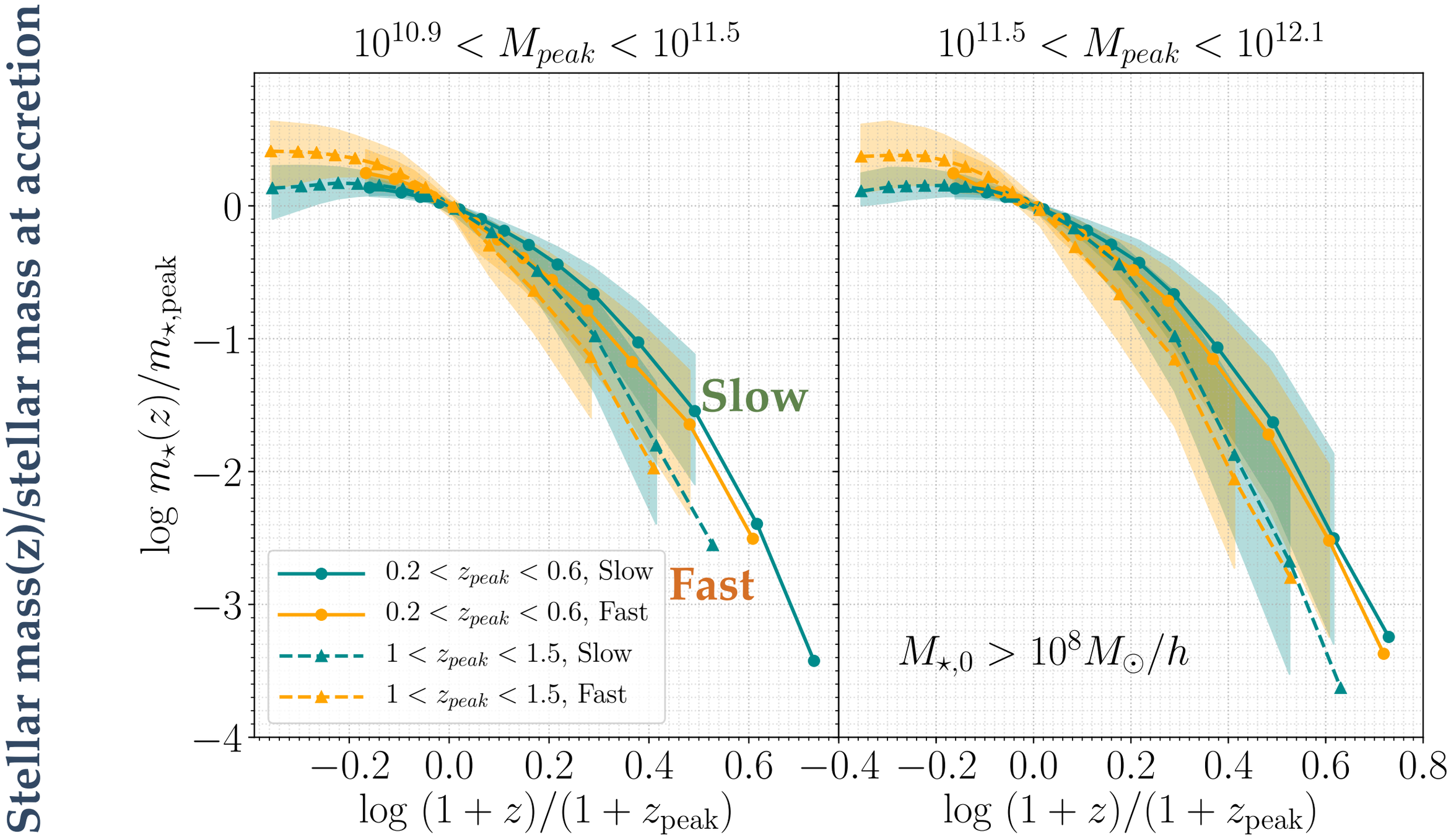
Nelson et al. (2015)

Stellar mass at accretion time and z=0



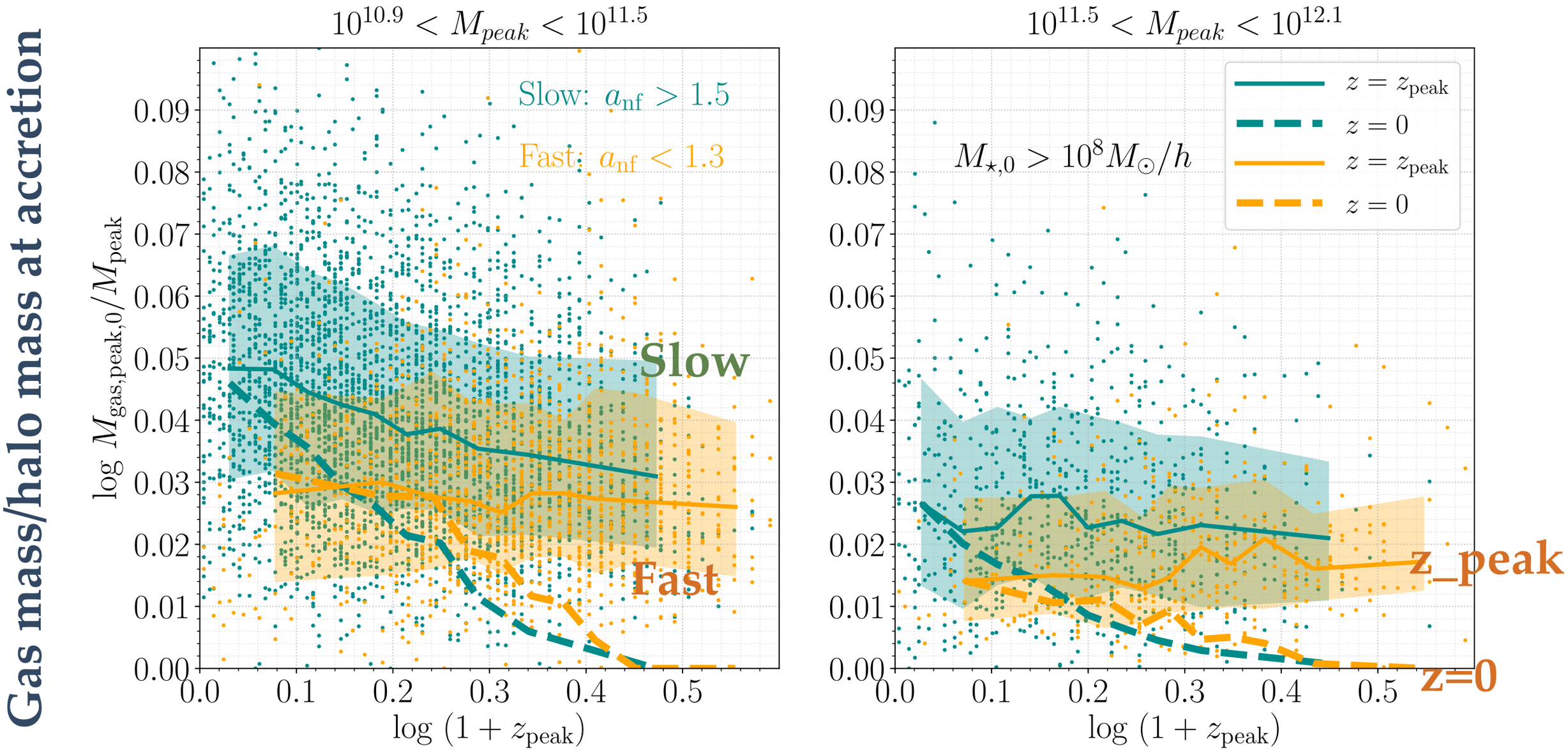
Shi et al. (2018), in preparation

Stellar mass evolution



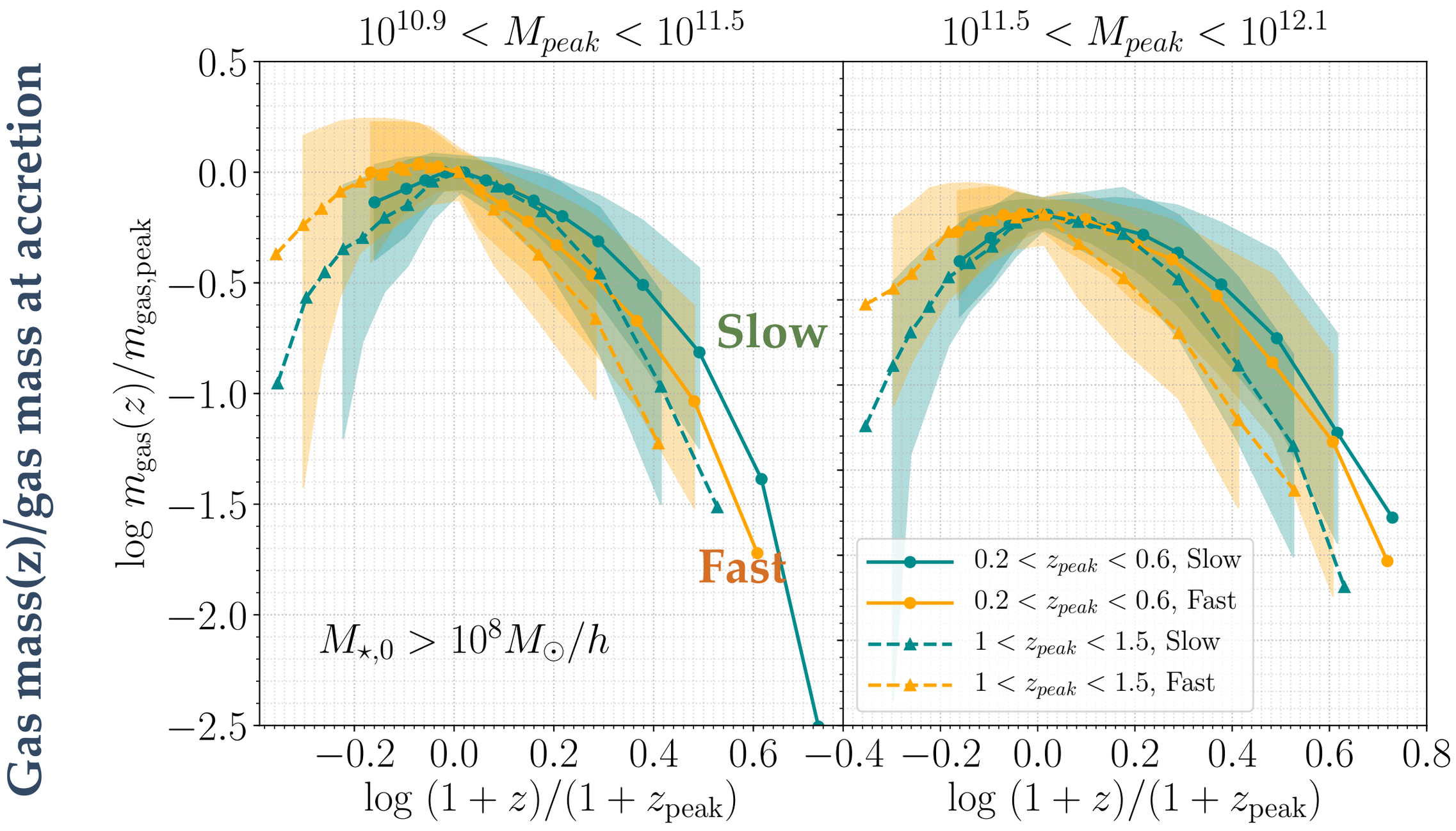
Shi et al. (2018), in preparation

Gas mass at accretion time and z=0



Shi et al. (2018), in preparation

Gas mass evolution



Shi et al. (2018), in preparation

Summary

- At given accretion time, the formation time distribution of infall halos is bimodal
- Comparing to the normal halos, the infall halos are younger
- The stellar mass, gas mass is higher for the satellite galaxies lying in the slow accretion phase halo than those lying in the fast accretion phase halo at accretion time
- At z=0, the stellar mass of the satellites in the slow accretion phase halo is higher, however their gas mass is lower
- The stellar mass continues to grow even after accretion happens; the satellites in the fast accretion phase halo even continues the gas accretion
- Our work can help to better constrain the satellite quenching process and the galaxy-halo connection