Characteristic masses in the galaxy population

- The mass at the "knee"of the luminosity/stellar mass function
- The mass at the maximum of the stellar mass/halo mass relation
- The mass above which most galaxies are quenched
- The mass above which all galaxies have central supermassive BH

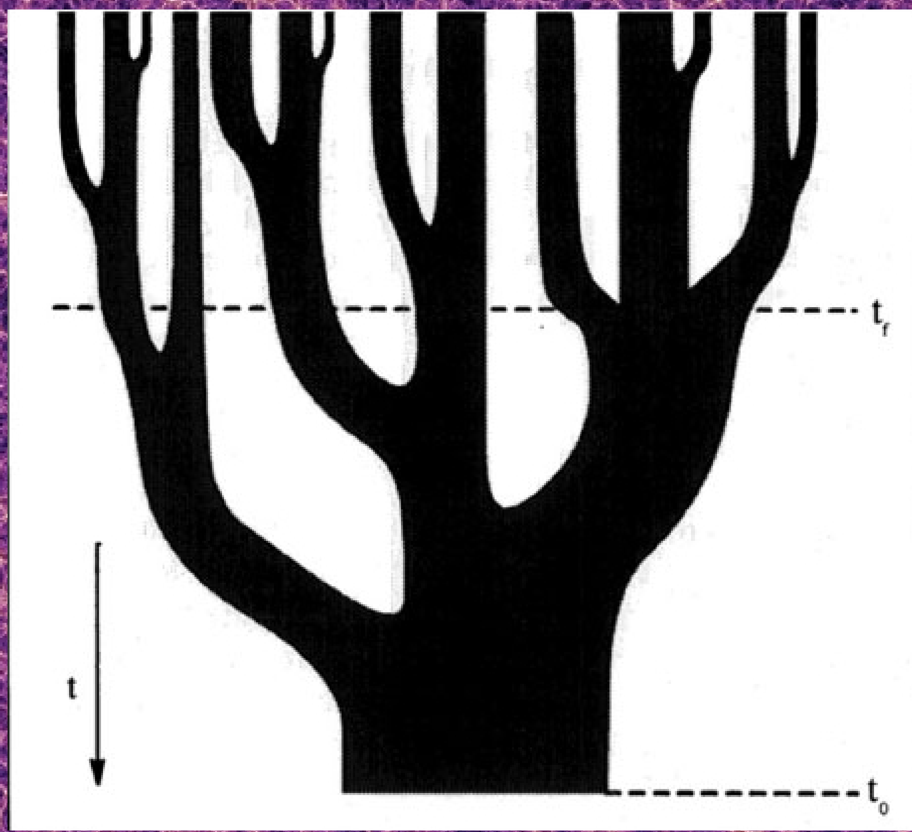
- Why are all these masses (approximately) the same?
- Why do they evolve so little with redshift?

Henriques et al 2018

N-body codes can simulate the evolution of the abundance, internal structure and clustering of dark halos at high precision

Galaxies correspond to self-bound *subhalos* within halos, rather than to the halos themselves

The information relevant to galaxy formation is encoded in *sub*halo merger trees



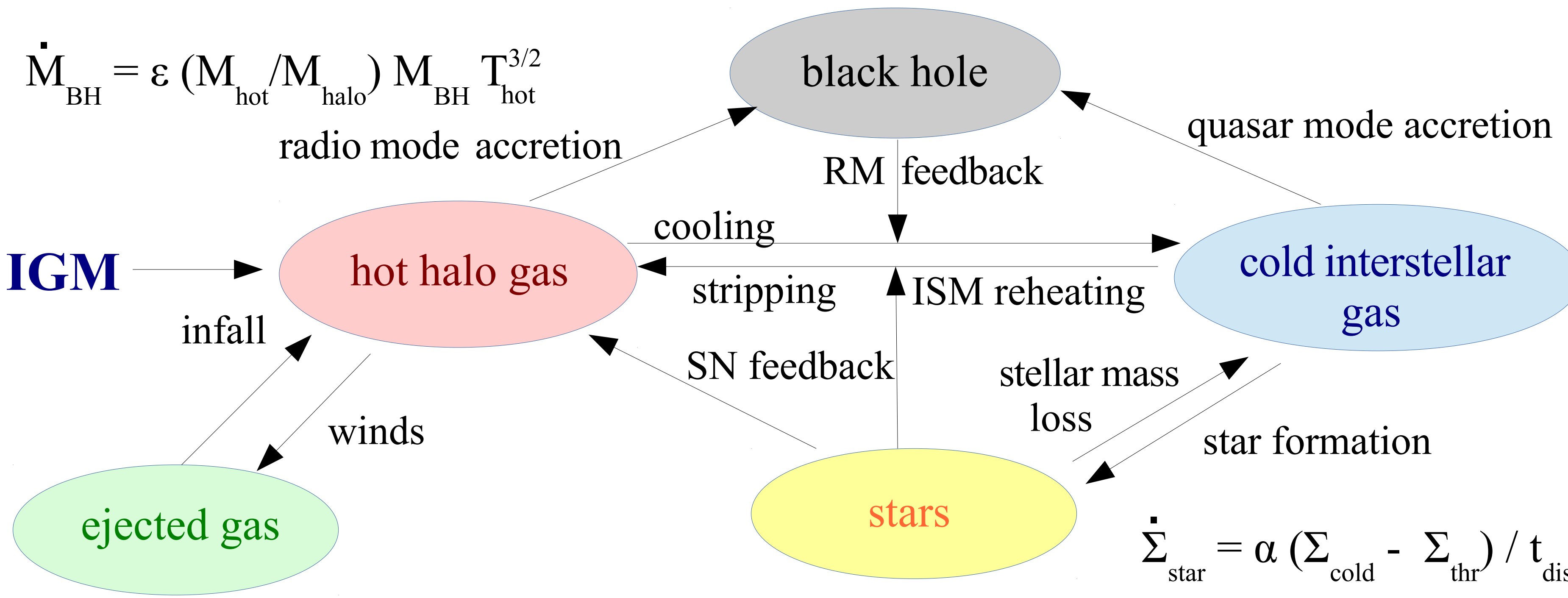
Most stars are in galaxies similar in mass to the Milky Way
Dark matter is *much* more broadly distributed across halos

→ Halo to galaxy mass ratio varies *strongly* with mass

Star formation efficiency is reduced at both low *and* high halo mass

$$(\Omega_b / \Omega_m)\, M_{halo} = M_{hot} + M_{cold} + M_{ejecta} + M_{star} + M_{BH}$$

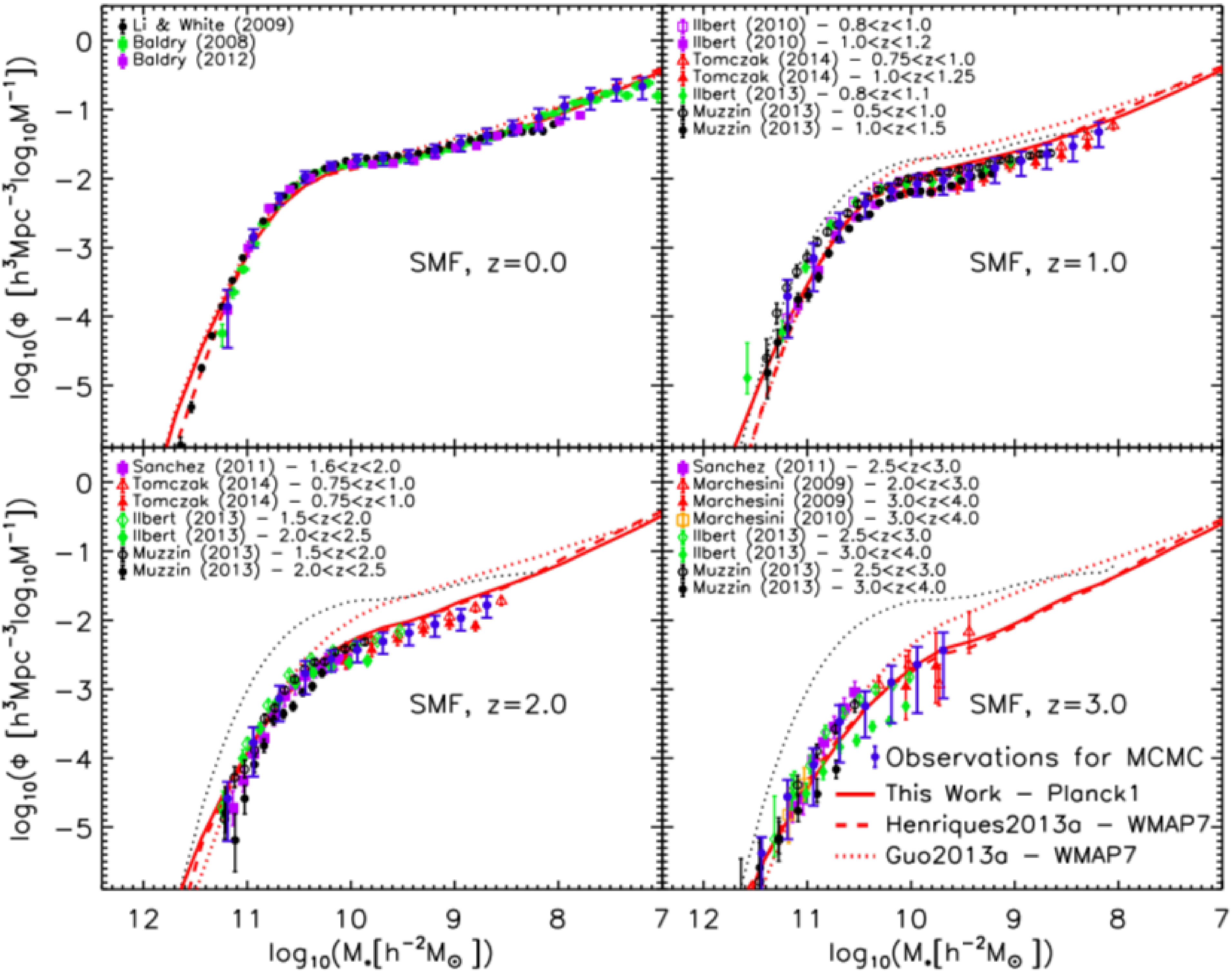
$$\dot{M}_{BH} = \varepsilon\, (M_{hot}/M_{halo})\, M_{BH}\, T_{hot}^{3/2}$$

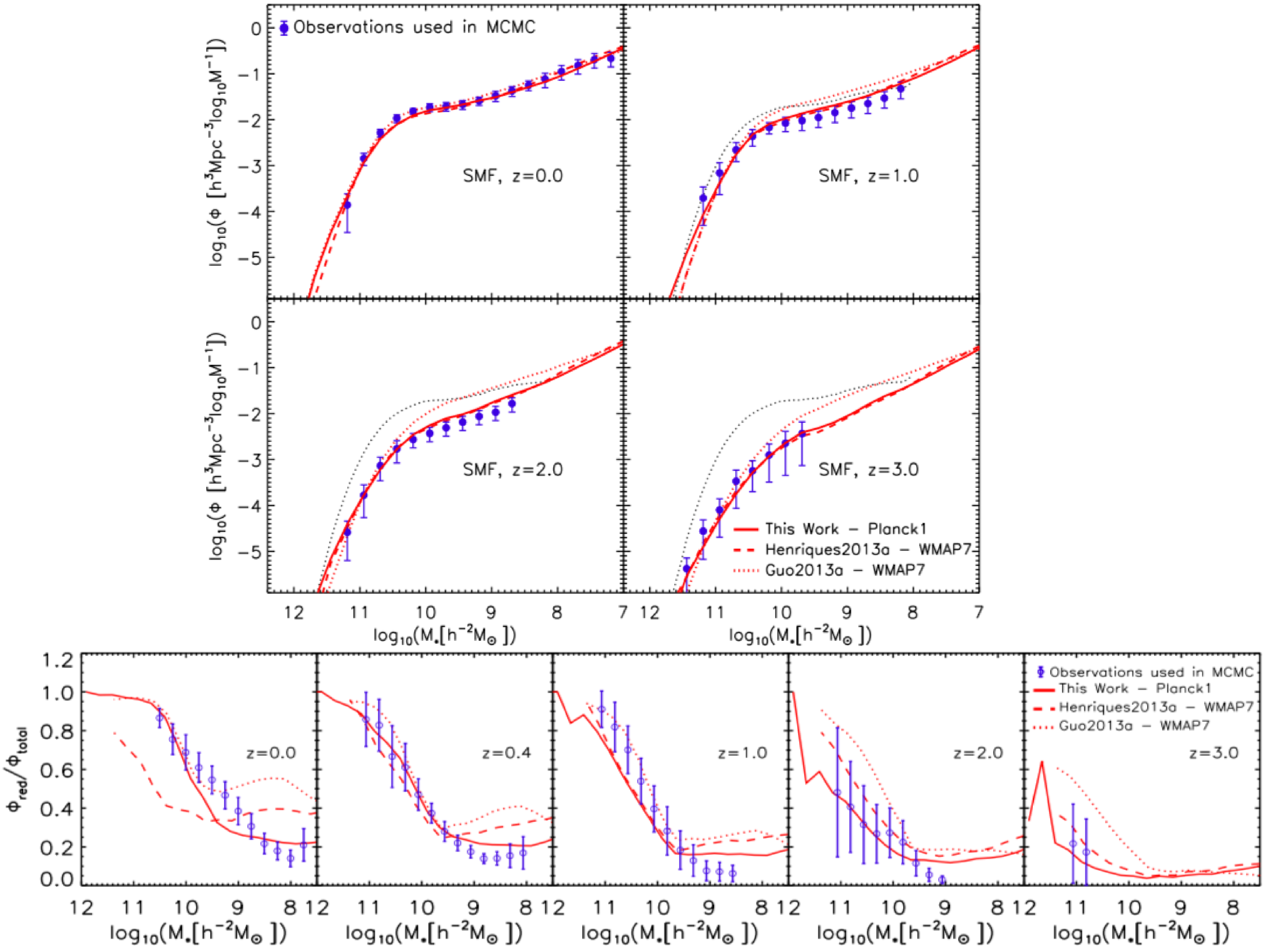


$$\dot{\Sigma}_{star} = \alpha\, (\Sigma_{cold} - \Sigma_{thr}) / t_{disk}$$

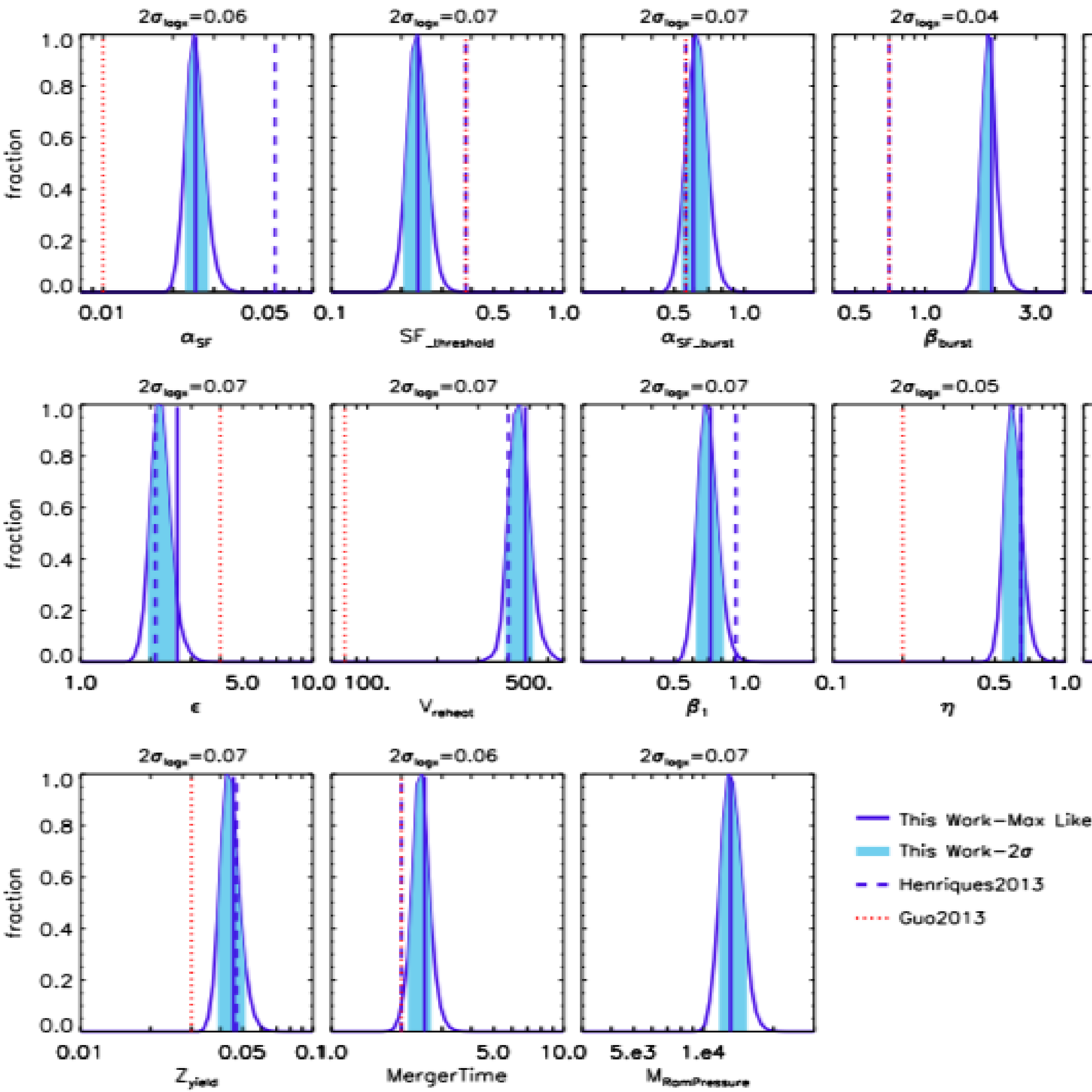
Table S1. Results from the MCMC parameter estimation. The best-fitting values of parameters and their "2-σ" confidence limits are compared with the values published in Henriques et al. (2013) and Guo et al. (2013).

	Guo13	Henriques13	New Best Fit	2σ lower	2σ upper	Units
$\alpha_{\rm SF}$ (SF eff - eq. S14)	0.011	0.055	0.025	0.021	0.029	
$M_{\rm crit,0}$ (Gas mass threshold - eq. S15)	0.38	0.38	0.24	0.20	0.27	$10^{10}\,{\rm M}_\odot$
$\alpha_{\rm SF,burst}$ (SF burst eff - eq. S33)	0.56	0.56	0.60	0.52	0.73	
$\beta_{\rm SF,burst}$ (SF burst slope - eq. S33)	0.70	0.70	1.9	1.7	2.0	
$k_{\rm AGN}$ (Radio feedback eff - eq. S24)	new eq	new eq	5.3×10^{-3}	4.6×10^{-3}	6.5×10^{-3}	${\rm M}_\odot\,{\rm yr}^{-1}$
$f_{\rm BH}$ (BH growth eff - eq. S23)	0.03	0.015	0.041	0.035	0.048	
$V_{\rm BH}$ (Quasar growth scale - eq. S23)	280	280	750	670	880	${\rm km\,s^{-1}}$
ϵ (Mass-loading eff - eq. S19)	4.0	2.1	2.6	1.9	2.6	
$V_{\rm reheat}$ (Mass-loading scale - eq. S19)	80	405	480	390	540	${\rm km\,s^{-1}}$
β_1 (Mass-loading slope - eq. S19)	3.2	0.92	0.72	0.60	0.82	
η (SN ejection eff - eq. S17)	0.18	0.65	0.62	0.53	0.68	
$V_{\rm eject}$ (SN ejection scale - eq. S17)	90	336	100	90	120	${\rm km\,s^{-1}}$
β_2 (SN ejection slope - eq. S17)	3.2	0.46	0.80	0.71	0.95	
γ (Ejecta reincorporation - eq. S22)	new eq	1.8×10^{10}	3.0×10^{10}	2.6×10^{10}	3.6×10^{10}	yr
$M_{\rm r.p.}$ (Ram-pressure threshold)	0.0	0.0	1.2×10^4	1.1×10^4	1.6×10^4	$10^{10}\,{\rm M}_\odot$
$R_{\rm merger}$ (Major-merger threshold)	0.30	0.30	0.1			
$\alpha_{\rm friction}$ (Dynamical friction - eq. S32)	2.0	2.0	2.5	2.1	2.8	
y (Metal yield)	0.03	0.047	0.046	0.038	0.053	


Li & White (2009)
Baldry (2008)
Baldry (2012)
SMF, z=0.0
Ilbert (2010) – 0.8<z<1.0
Ilbert (2010) – 1.0<z<1.2
Tomczak (2014) – 0.75<z<1.0
Tomczak (2014) – 1.0<z<1.25
Ilbert (2013) – 0.8<z<1.1
Muzzin (2013) – 0.5<z<1.0
Muzzin (2013) – 1.0<z<1.5
SMF, z=1.0
Sanchez (2011) – 1.6<z<2.0
Tomczak (2014) – 0.75<z<1.0
Tomczak (2014) – 0.75<z<1.0
Ilbert (2013) – 1.5<z<2.0
Ilbert (2013) – 2.0<z<2.5
Muzzin (2013) – 1.5<z<2.0
Muzzin (2013) – 2.0<z<2.5
SMF, z=2.0
Sanchez (2011) – 2.5<z<3.0
Marchesini (2009) – 2.0<z<3.0
Marchesini (2009) – 3.0<z<4.0
Marchesini (2010) – 3.0<z<4.0
Ilbert (2013) – 2.5<z<3.0
Ilbert (2013) – 3.0<z<4.0
Muzzin (2013) – 2.5<z<3.0
Muzzin (2013) – 3.0<z<4.0
SMF, z=3.0
Observations for MCMC
This Work – Planck1
Henriques2013a – WMAP7
Guo2013a – WMAP7
$\log_{10}(\Phi\ [h^3\mathrm{Mpc}^{-3}\log_{10}M^{-1}])$
$\log_{10}(M_*[h^{-2}M_\odot])$

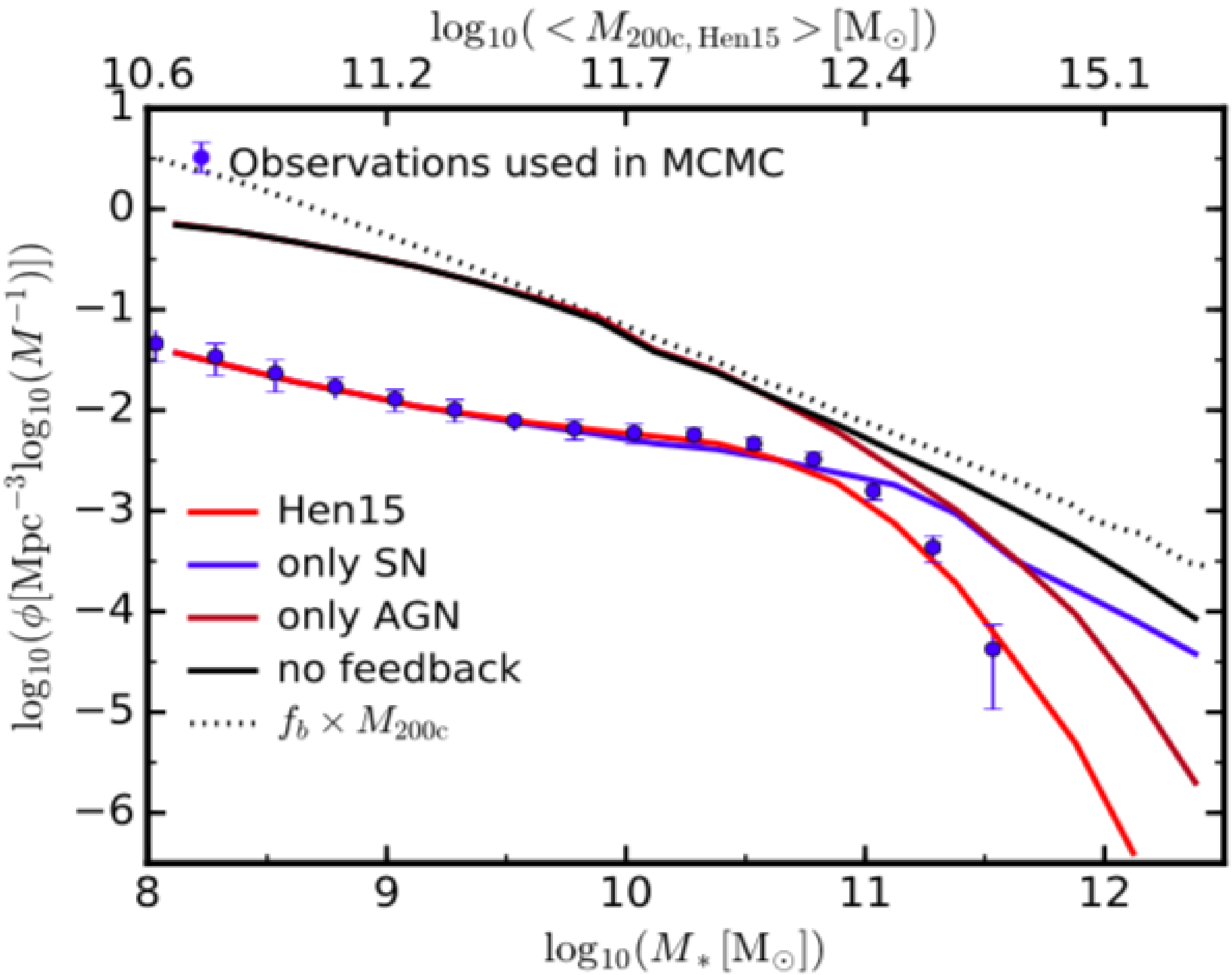


Observations used in MCMC
SMF, z=0.0
SMF, z=1.0
SMF, z=2.0
SMF, z=3.0
This Work – Planck1
Henriques2013a – WMAP7
Guo2013a – WMAP7
$\log_{10}(\Phi\ [h^3\mathrm{Mpc}^{-3}\log_{10}M^{-1}])$
$\log_{10}(M_*[h^{-2}M_\odot])$
Φ_{red}/Φ_{total}
z=0.0
z=0.4
z=1.0
z=2.0
z=3.0

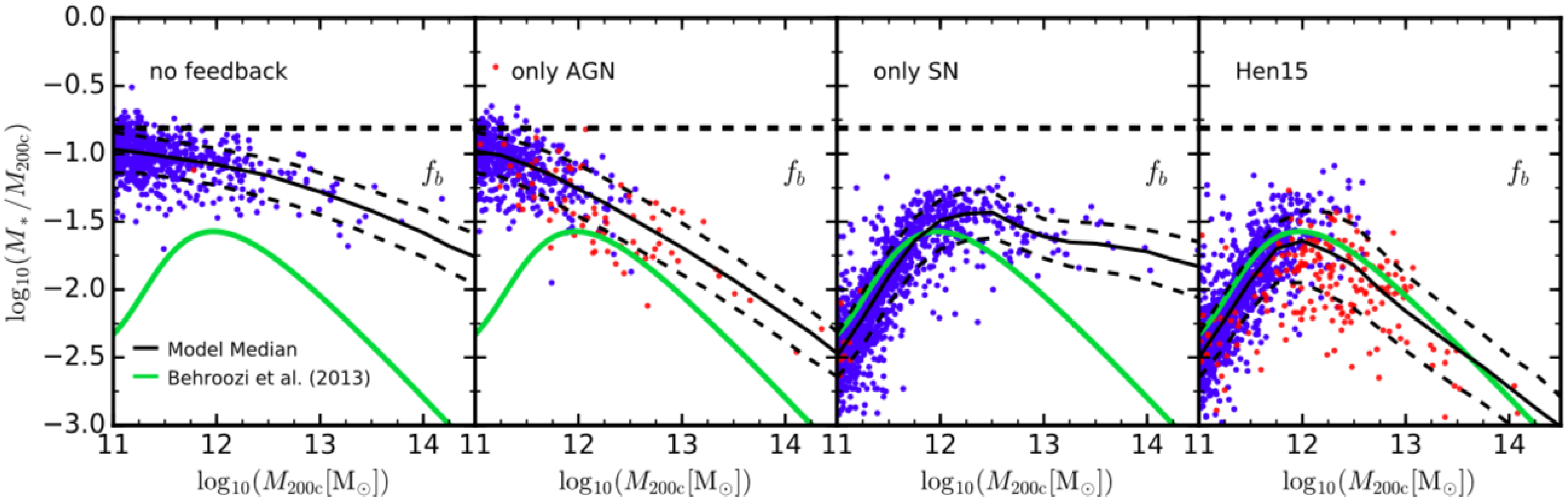


$2\sigma_{\log x}=0.06$
$2\sigma_{\log x}=0.07$
$2\sigma_{\log x}=0.04$
$2\sigma_{\log x}=0.05$
$2\sigma_{\log x}=0.08$
fraction
α_{SF}
SF_threshold
α_{SF_burst}
β_{burst}
K_{AGN}
f_{BH}
V_{AGN}
ϵ
V_{reheat}
β_1
η
V_{eject}
β_2
γ
Z_{yield}
MergerTime
$M_{RamPressure}$
This Work−Max Like
This Work−2σ
Henriques2013
Guo2013

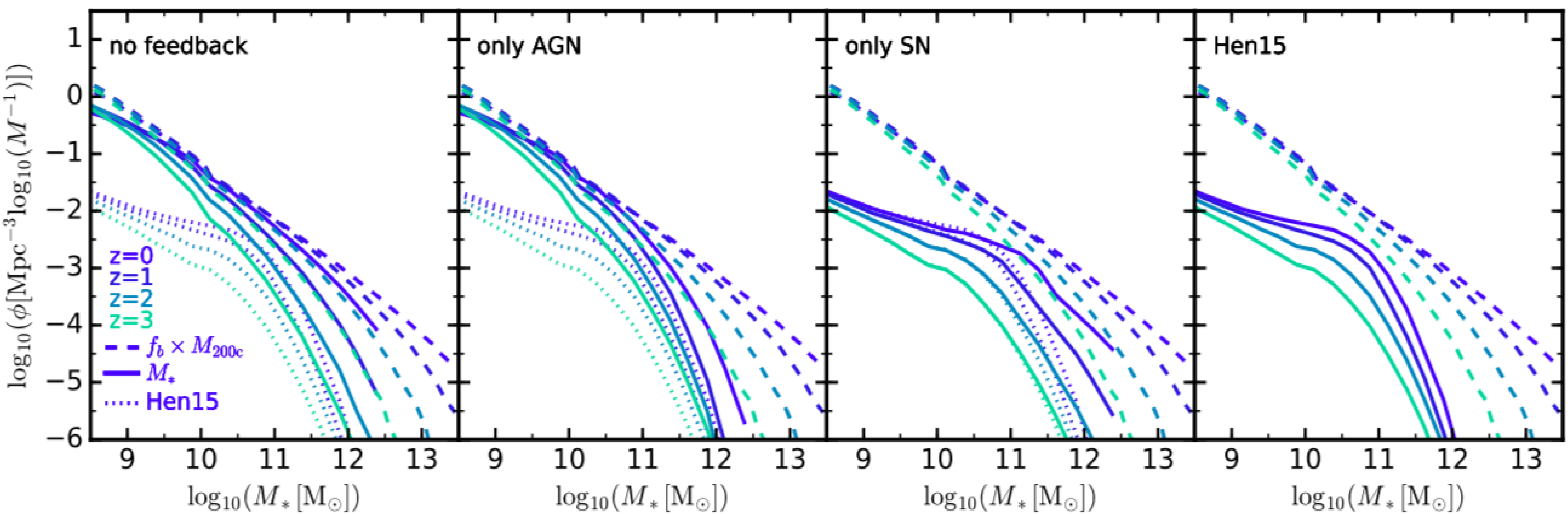
Effects of feedback on the stellar mass function



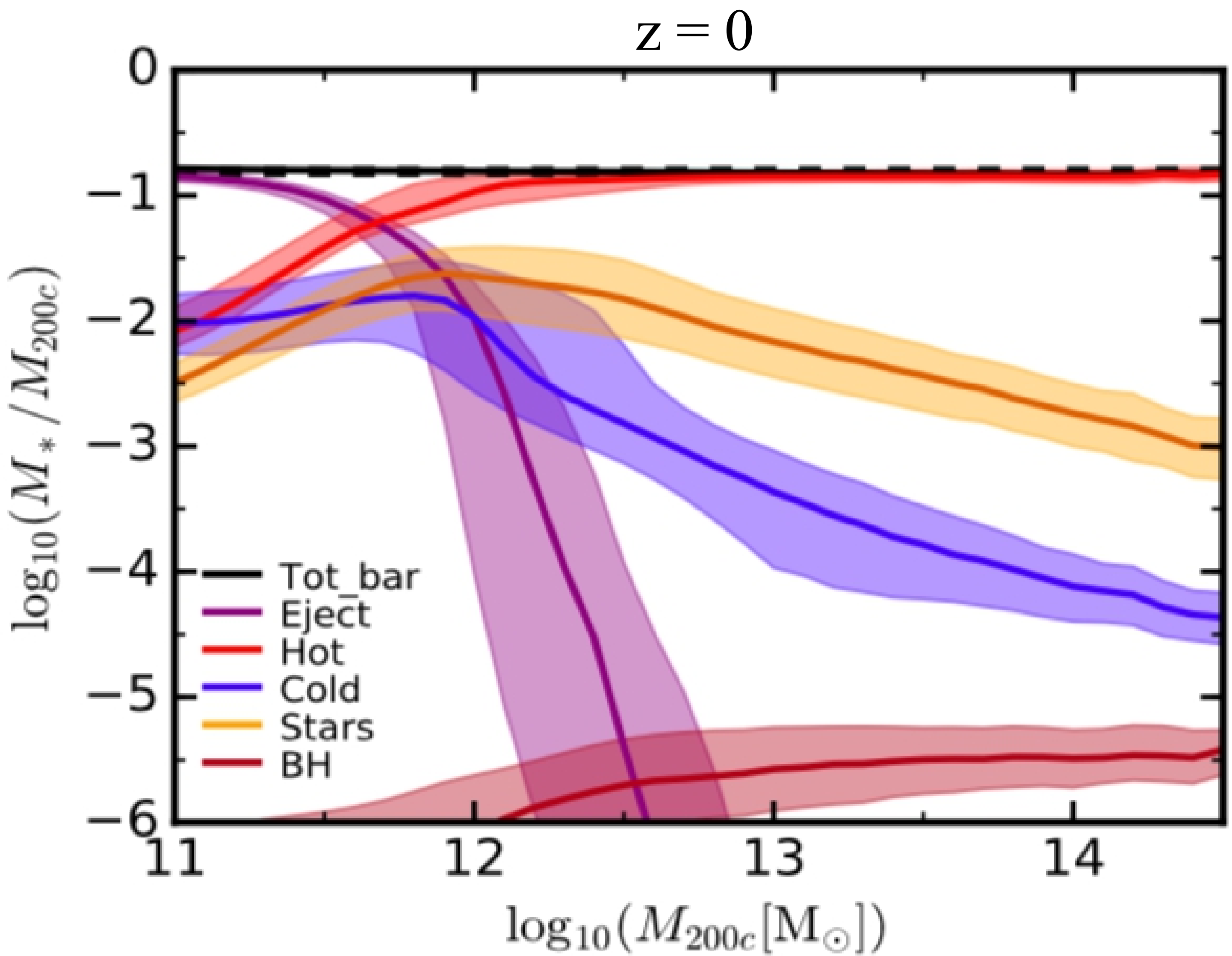
Central galaxy stellar mass – halo mass relation



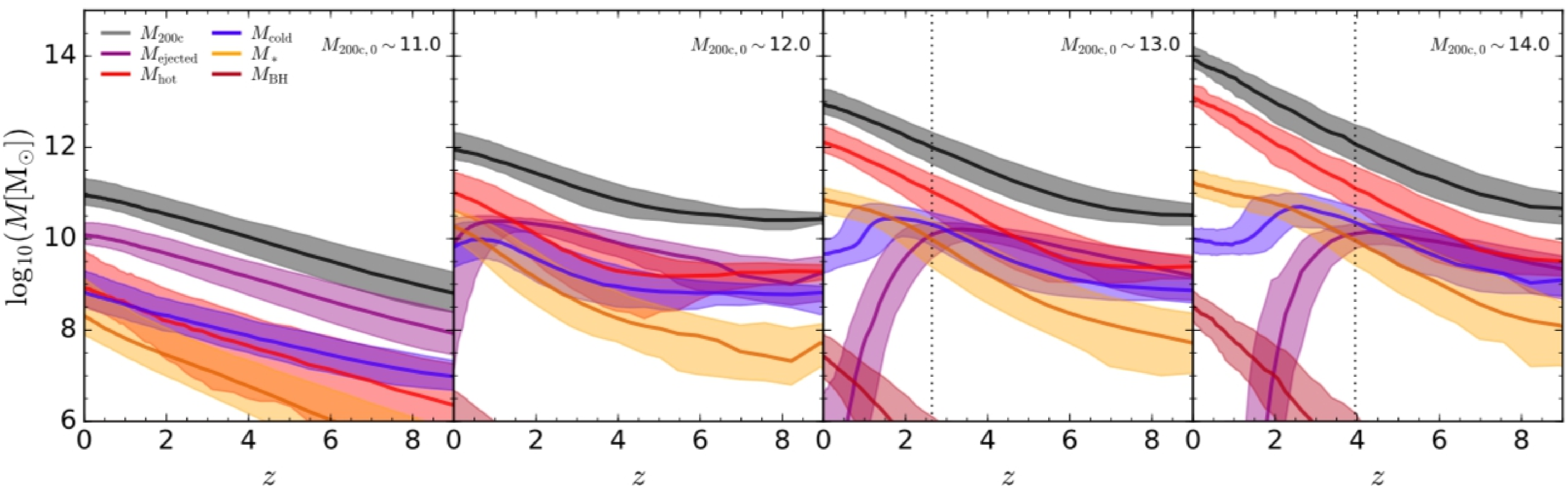
Stellas mass function evolution with/w.o feedback



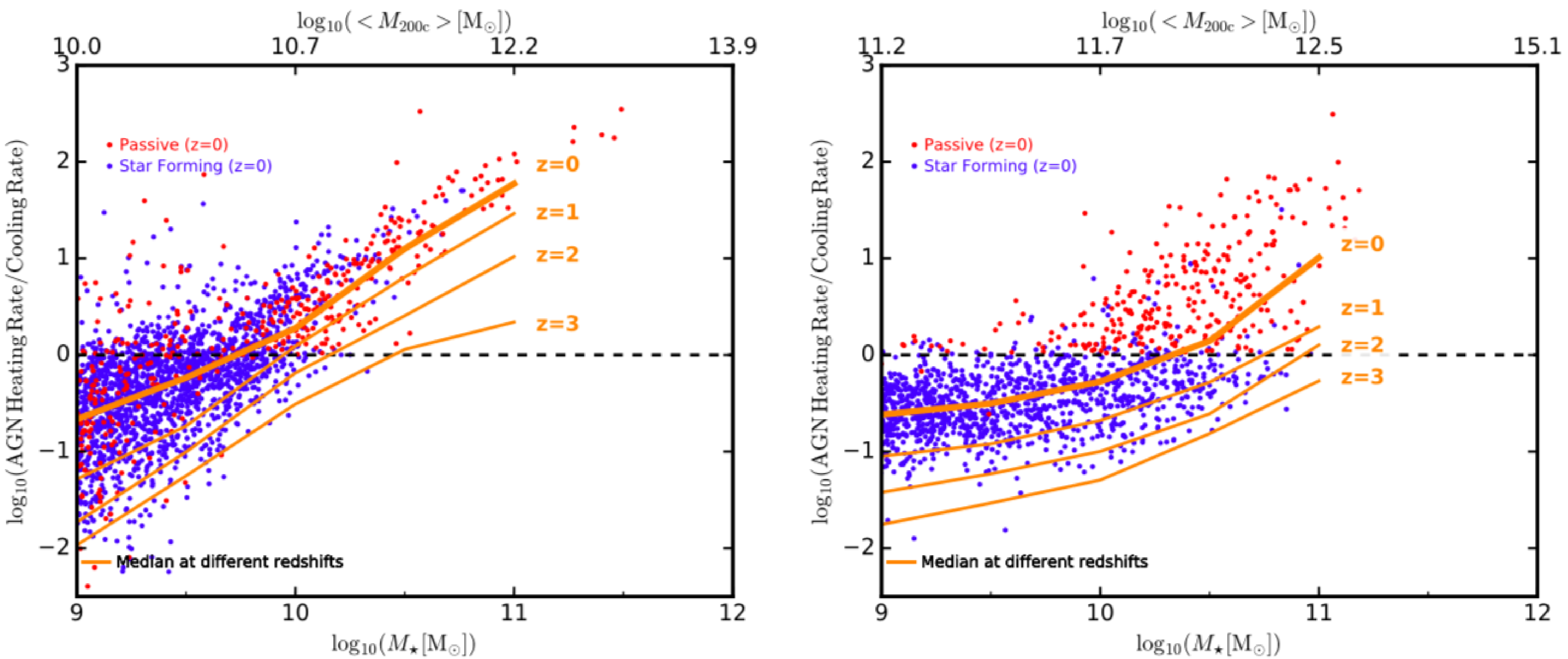
Repartition of mass between baryonic components



The evolution of the mass repartition in halos of differing present-day mass



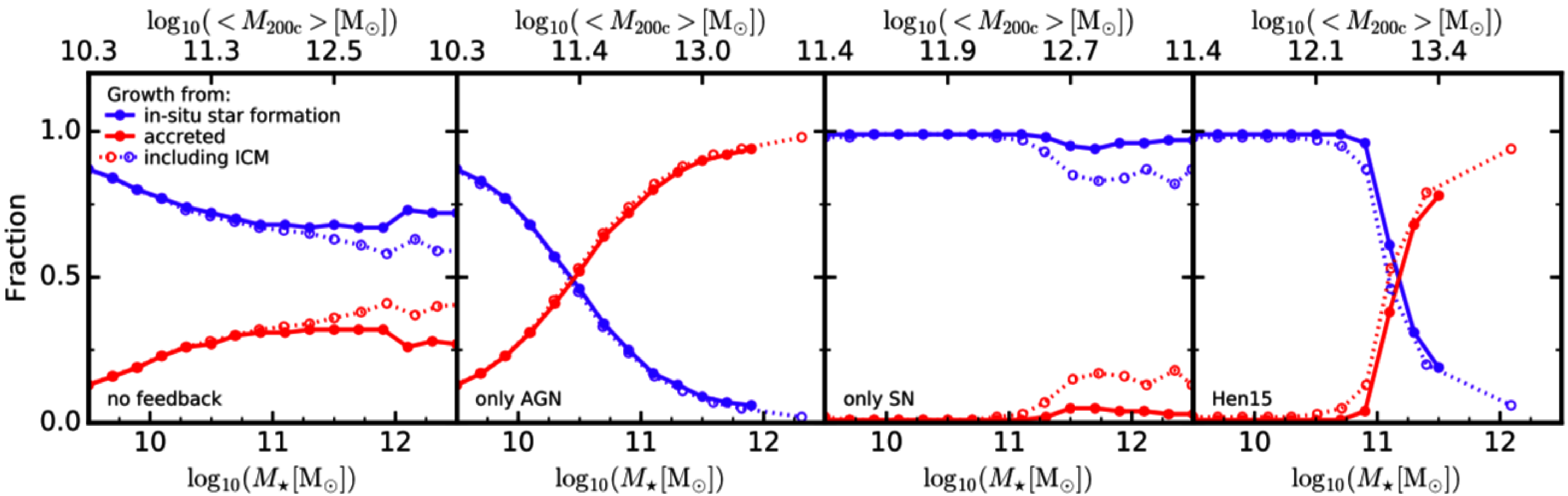
Balance between “AGN” heating and hot halo cooling



(a) AGN-feedback-only

(b) Henriques et al. (2015)

Mergers – *in situ*/accreted stellar fractions at z = 0



Evolution of a typical rich cluster BCG