Analysing LTG3 Simulations

Paramita Barai

Collaborators : Matteo Viel, …

(cosmo-IGM project)

Trieste 2012 Hydro-Simulation Workshop

9th Jan., 2012

Simulations with LTG3 code

- G30911_NOAGN_NOW :
  - Radiative Cooling (Wiersma et al. 2009, MNRAS, 399, 574)
  - Star Formation (Springel & Hernquist 2003, MNRAS, 339, 289)
  - Chemical Evolution (Tornatore et al. 2007, MNRAS, 382, 1050)

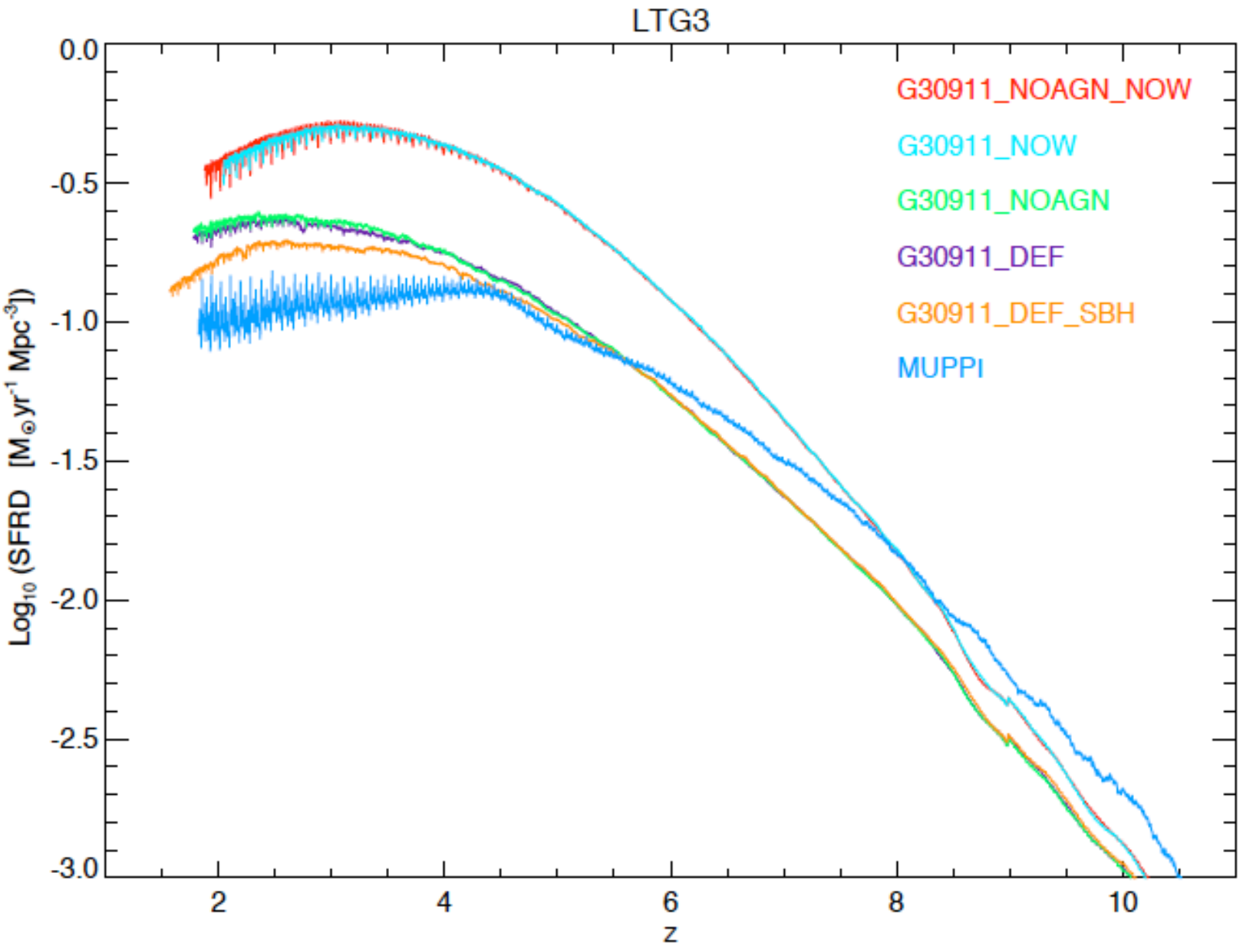
- G30911_NOAGN：Feedback from SN-driven galactic wind of velocity 350 km/s (SH03, T07)

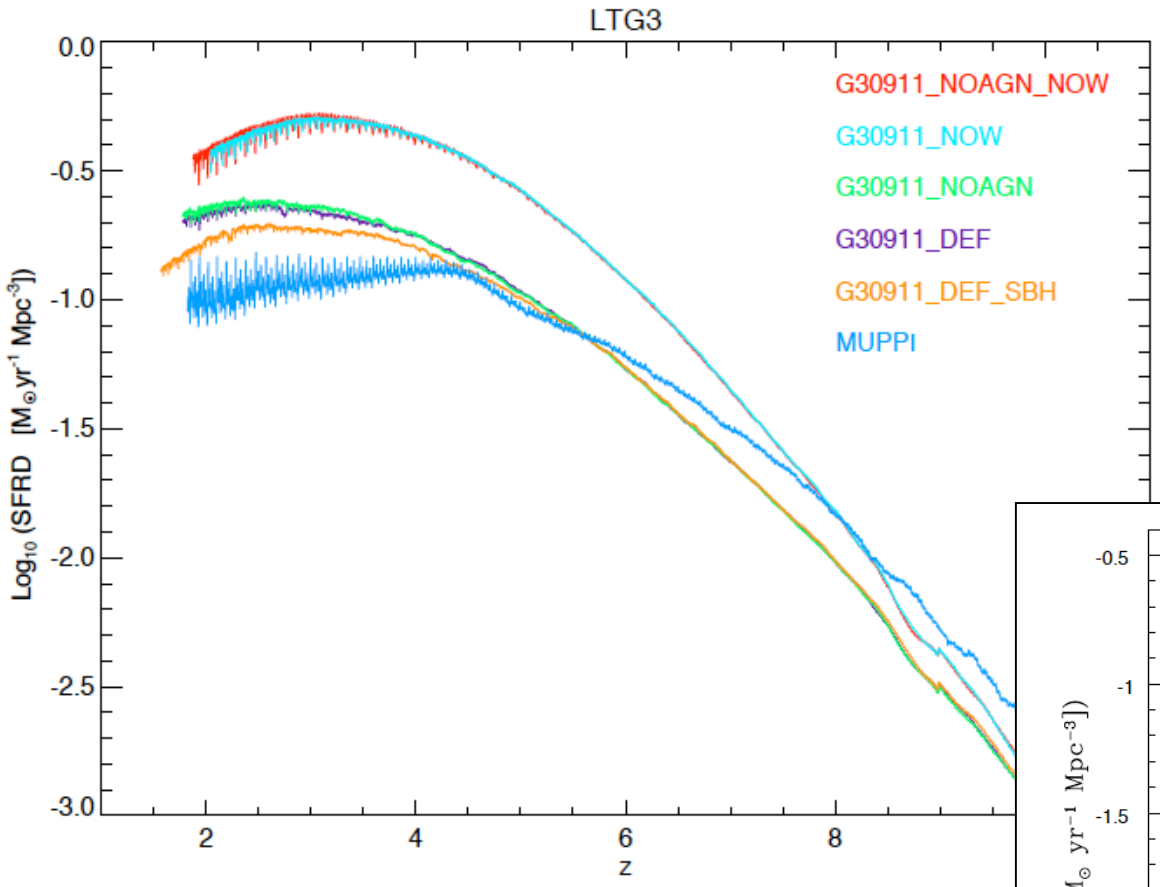
- G30911_NOW：Accretion onto SMBH & thermal feedback
  (Springel et al. 2005, MNRAS, 361, 776)
  (Fabjan et al. 2010, MNRAS, 401, 1670)

- G30911_DEF：Both Wind & AGN

$25/h$ Mpc box,
2×256^3 particles,
upto $z = 2$.

Star Formation Rate





- Comparable to Tescari et al. (2011, MNRAS, 411, 826)

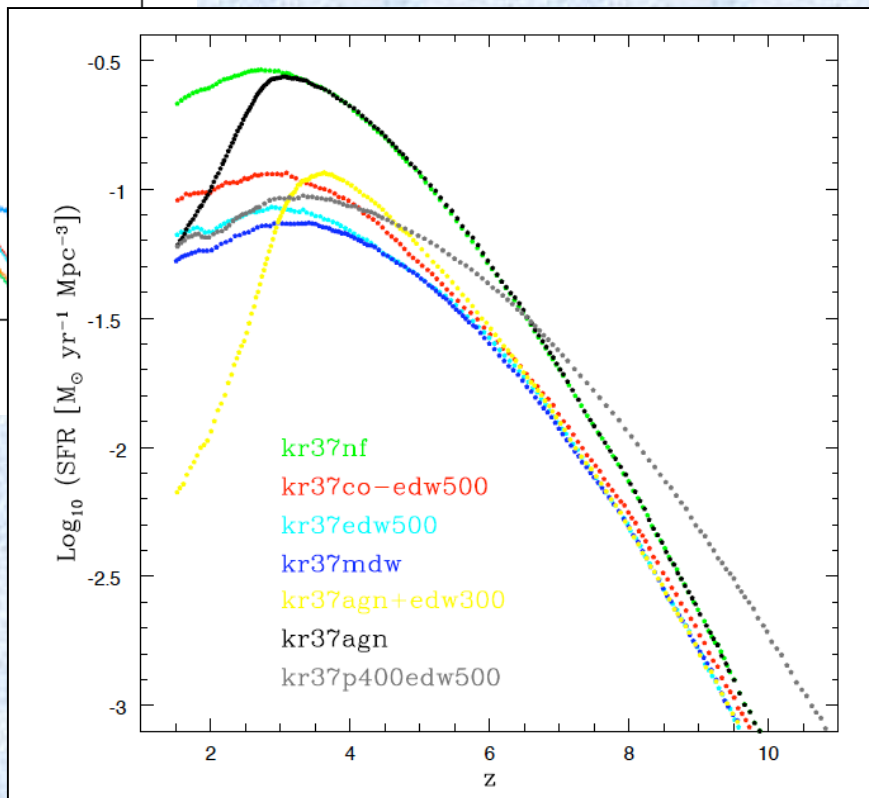
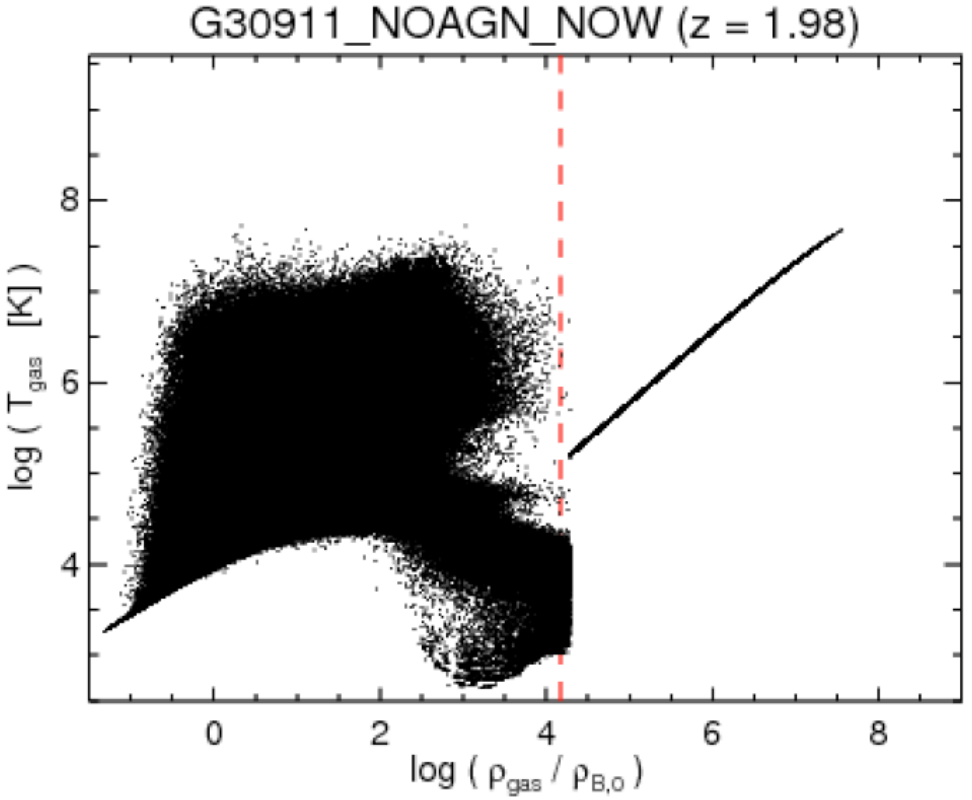


Figure 2. *Left Panel*: cosmic star formation rate (SFR) for some of the hyd function of redshift for all the hydrodynamic simulations of Table 2.

Phase Diagram



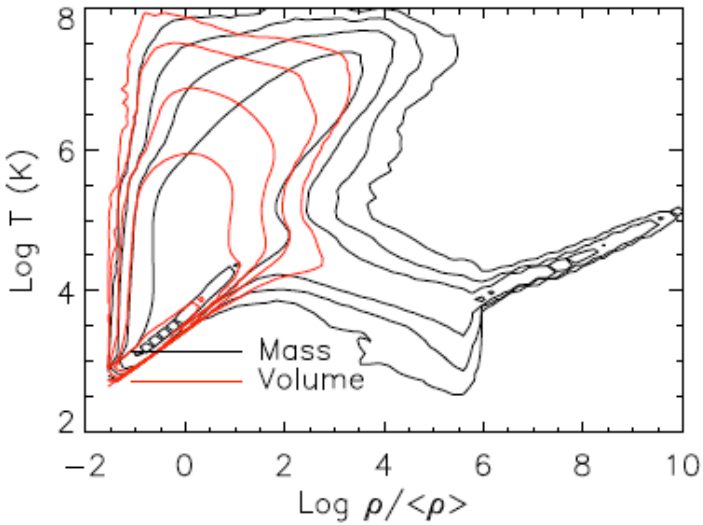


Figure 9. Gas distribution weighted by mass (*black*)

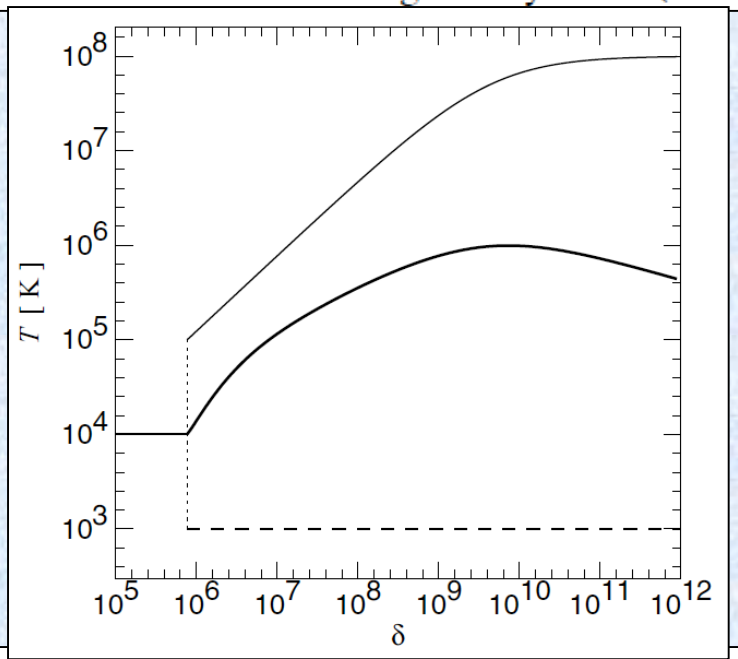
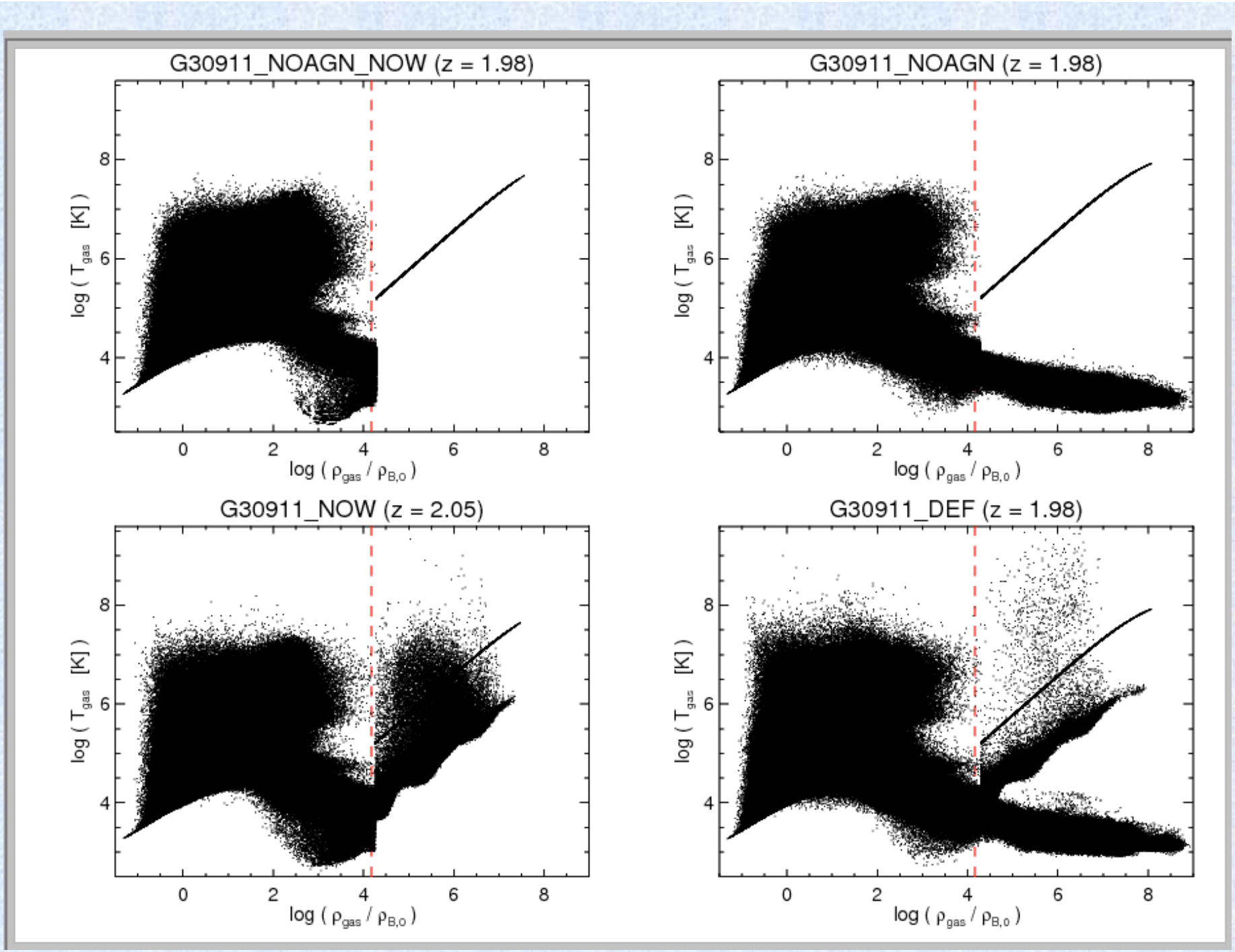
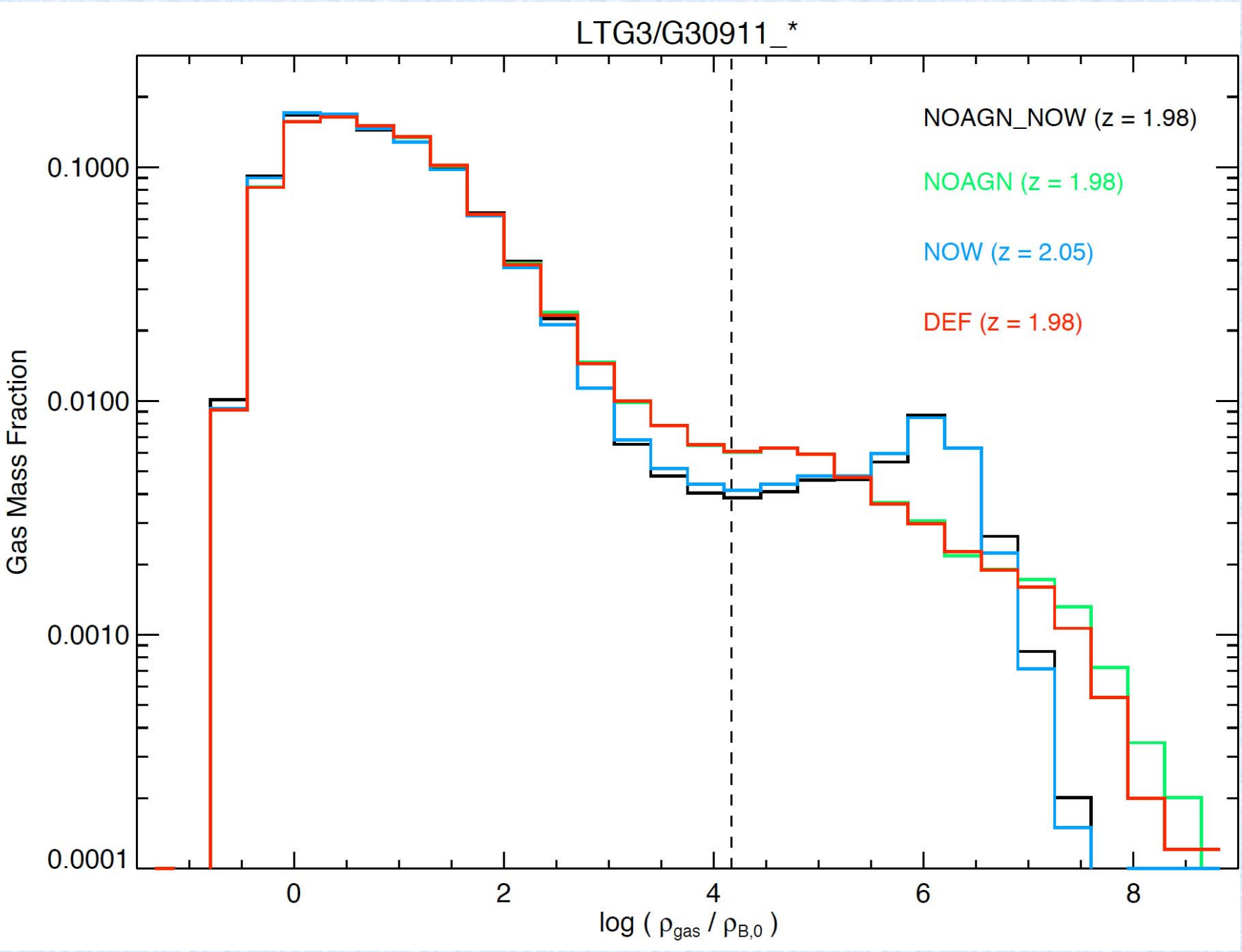
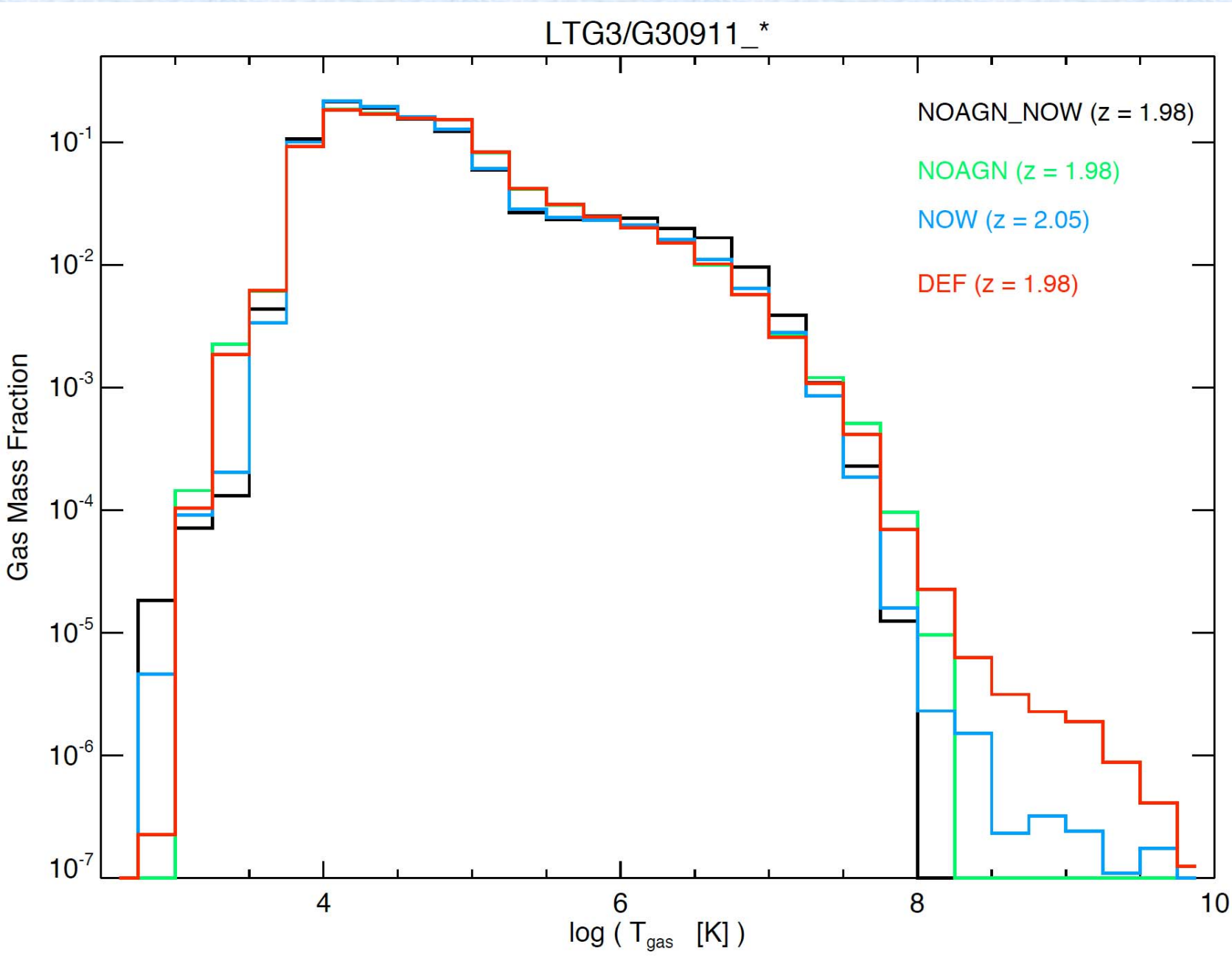


Figure 1. The top panel shows the temperature structure of the multiphase medium as a function of baryonic overdensity (assuming $\Omega_b = 0.04$). Below a density of $\delta \simeq 8 \times 10^5$, star formation does not occur and the gas is treated

- Fixed equation of state above $n_H = 0.1$ cm^{-3} is similar to Wiersma et al. (2009)
- But closer to the hot-phase T of Springel & Hernquist (2003)


G30911_NOAGN_NOW (z = 1.98)
G30911_NOAGN (z = 1.98)
G30911_NOW (z = 2.05)
G30911_DEF (z = 1.98)
log (T_gas [K])
log (ρ_gas / ρ_B,0)
4
6
8
0
2
4
6
8


LTG3/G30911_*
NOAGN_NOW (z = 1.98)
NOAGN (z = 1.98)
NOW (z = 2.05)
DEF (z = 1.98)
Gas Mass Fraction
0.1000
0.0100
0.0010
0.0001
0
2
4
6
8
log (ρgas / ρB,0)


LTG3/G30911_*
NOAGN_NOW (z = 1.98)
NOAGN (z = 1.98)
NOW (z = 2.05)
DEF (z = 1.98)
Gas Mass Fraction
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
4
6
8
10
log (T_gas [K])

Groups containing SMBHs

In LTG3/G30911_DEF/groups_010 :

- Min. group Stellar Mass for BH seeding, M_{Limit}
  = KD_SEED_STAR_MASS_FRACTION * MinFoFMassForNewSeed
  = 0.02 * 2.9 Unit_Mass = 8.2503558e+08 M_{sun}

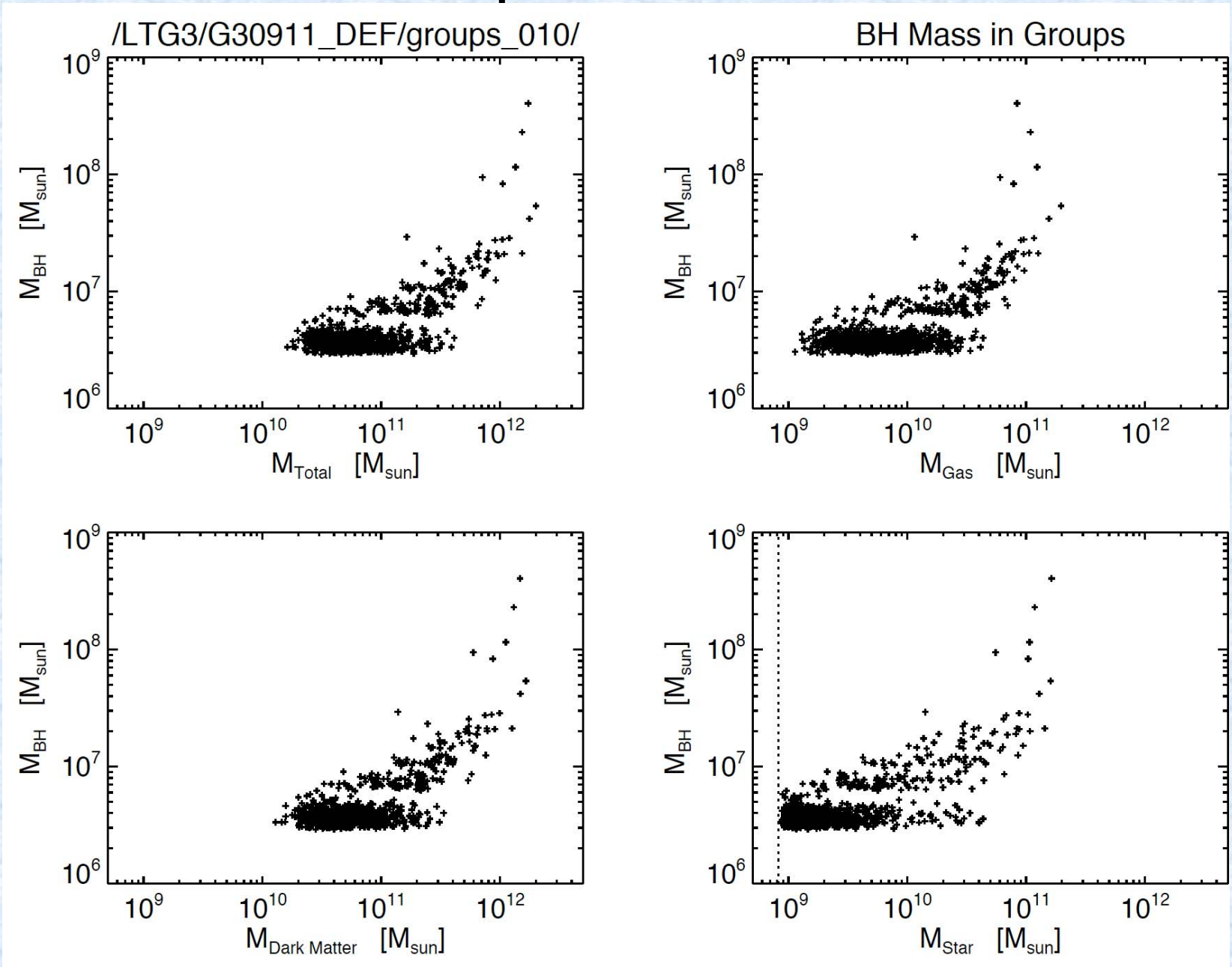
- Total no. of groups found by FoF = 10921
- No. of groups with positive Star Mass = 5698

- No. of groups having Star-Mass > M_{Limit} = 1035
- No. of groups having Star-Mass <= M_{limit} = 4663

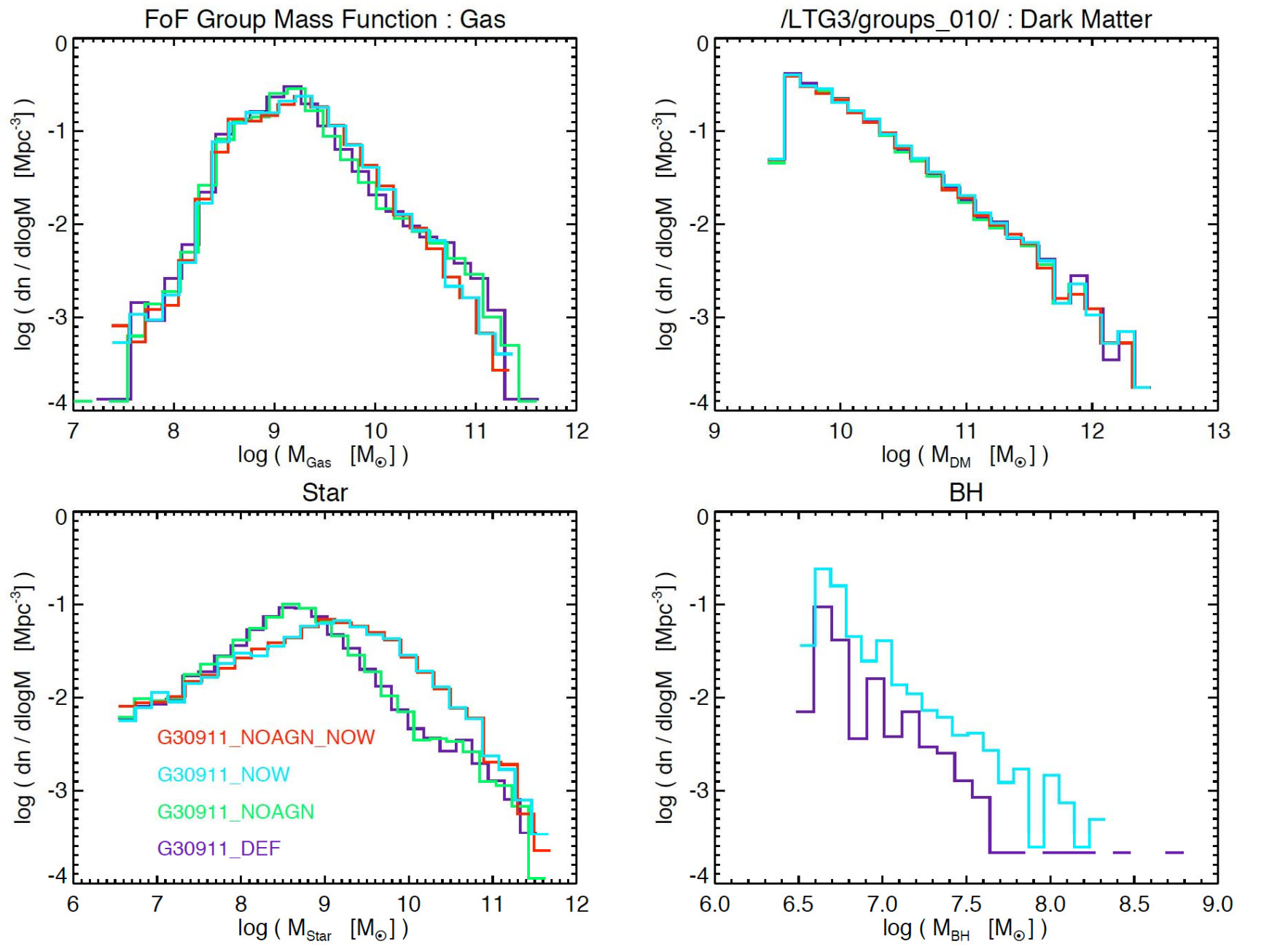
- No. of groups with positive BH Mass = 859

- Another choice : MinFoFMassForNewSeed = (2 - 3) * Min Stellar mass found by on-the-fly FoF

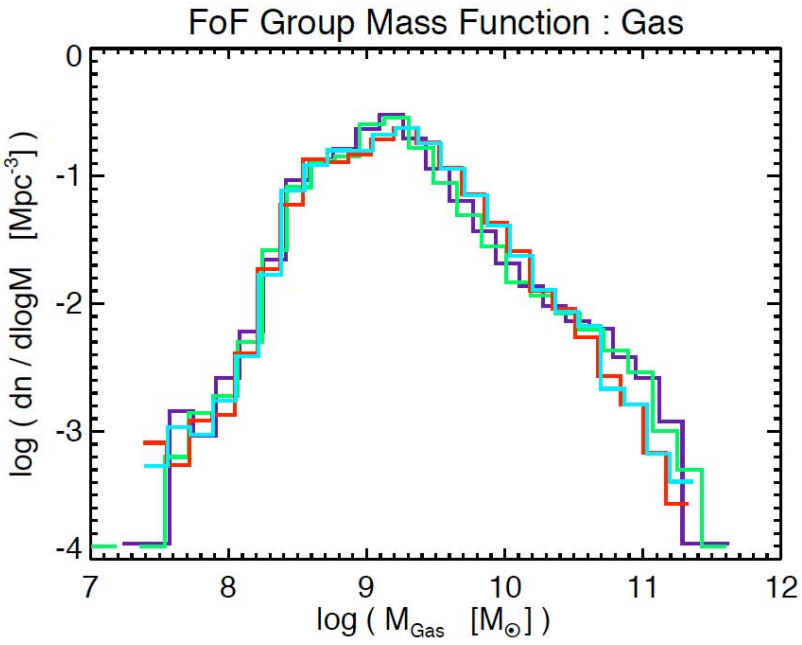
BH - Group Mass Correlation

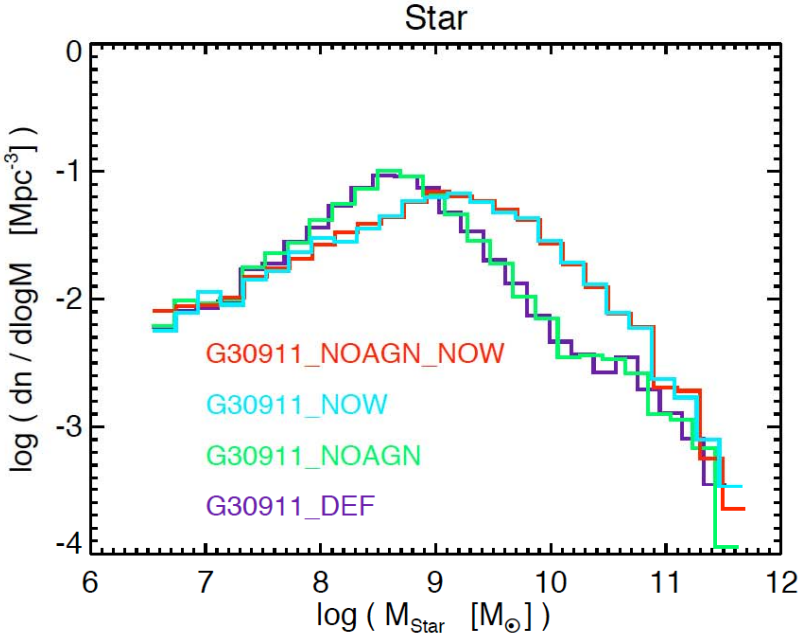


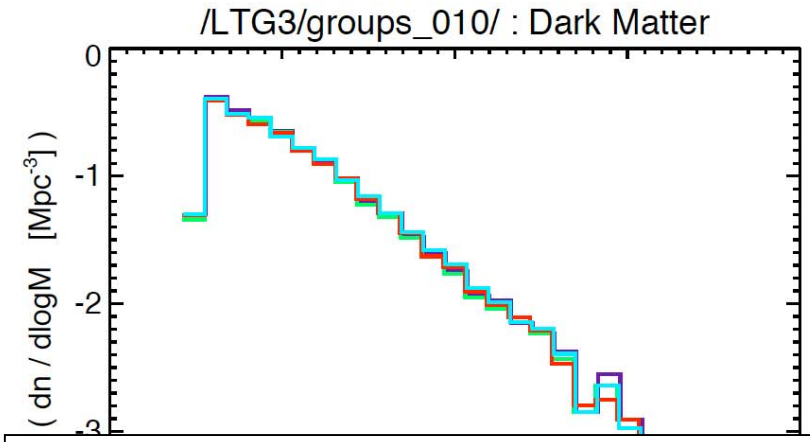
Mass Function

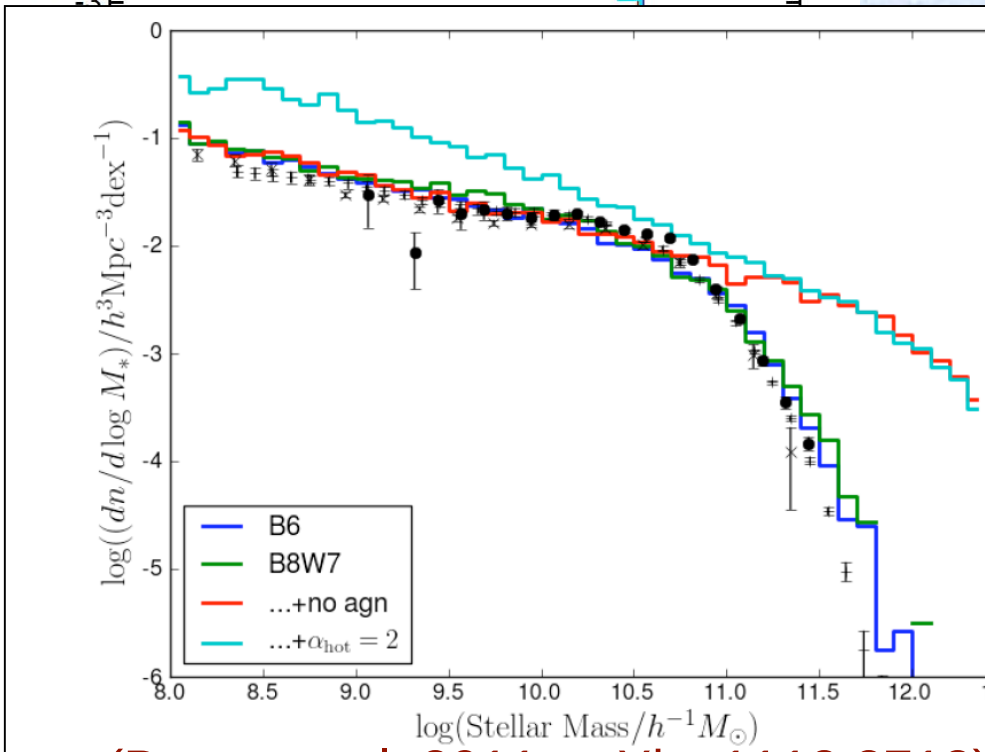


Compare Stellar Mass Fn.





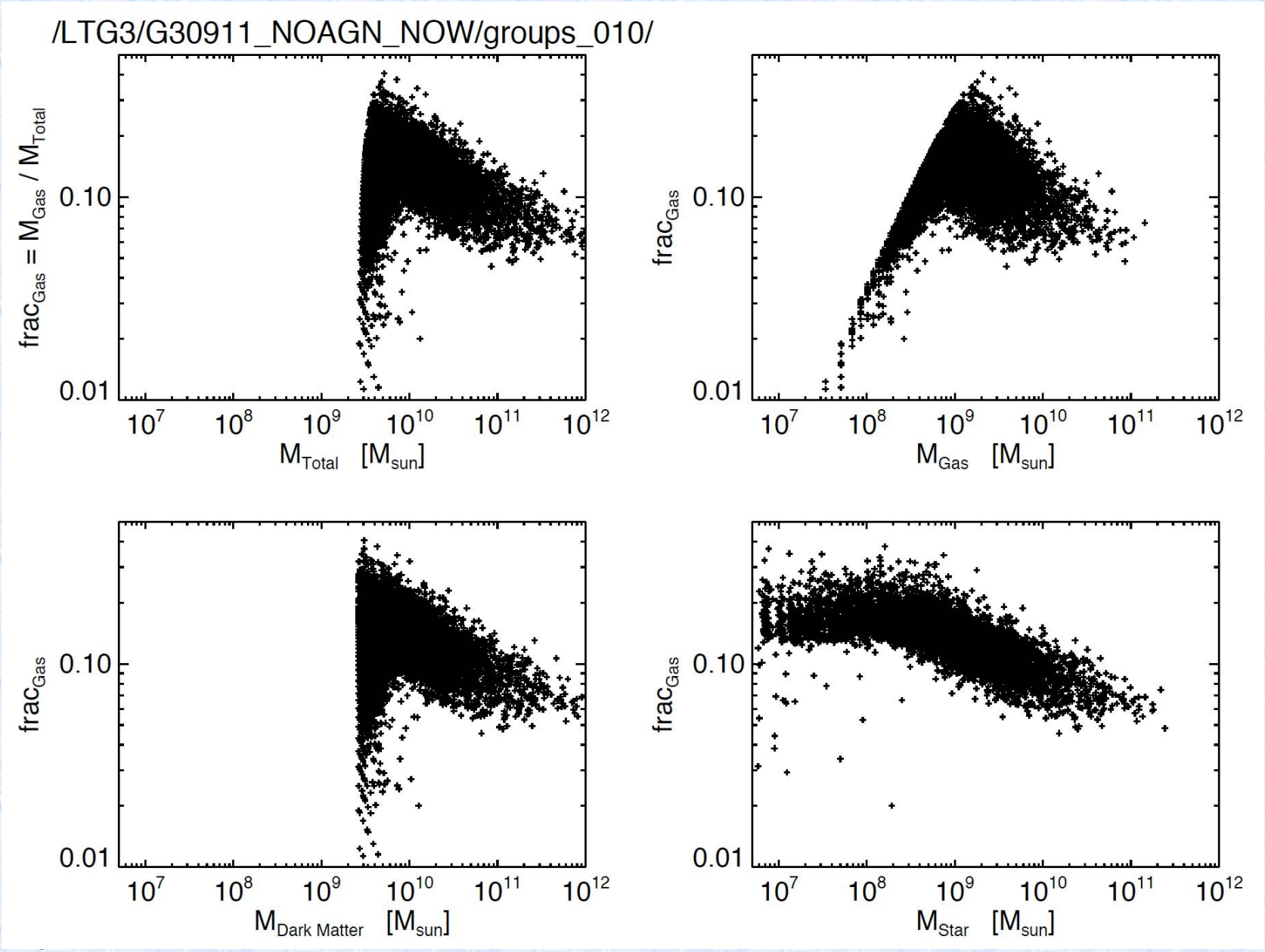


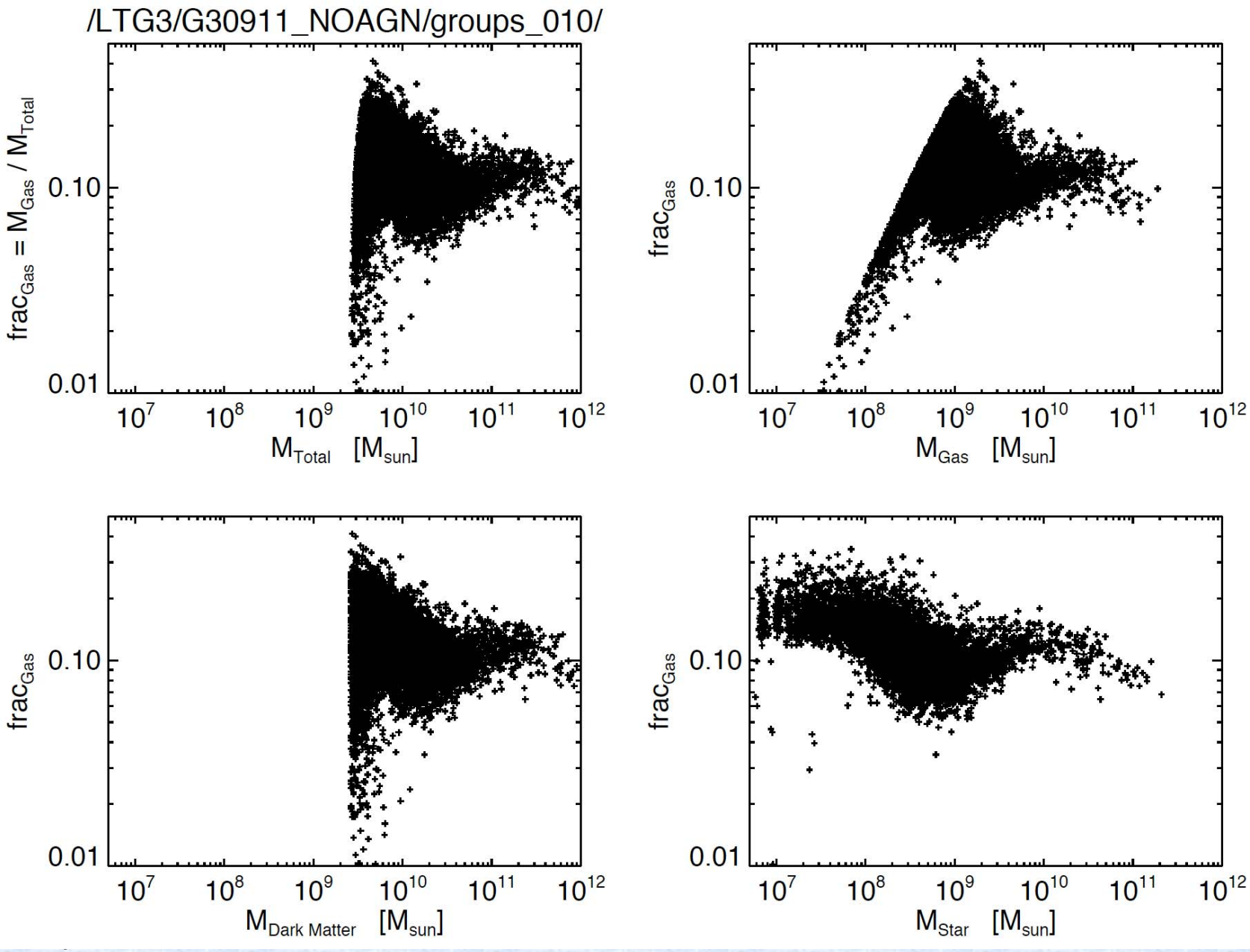


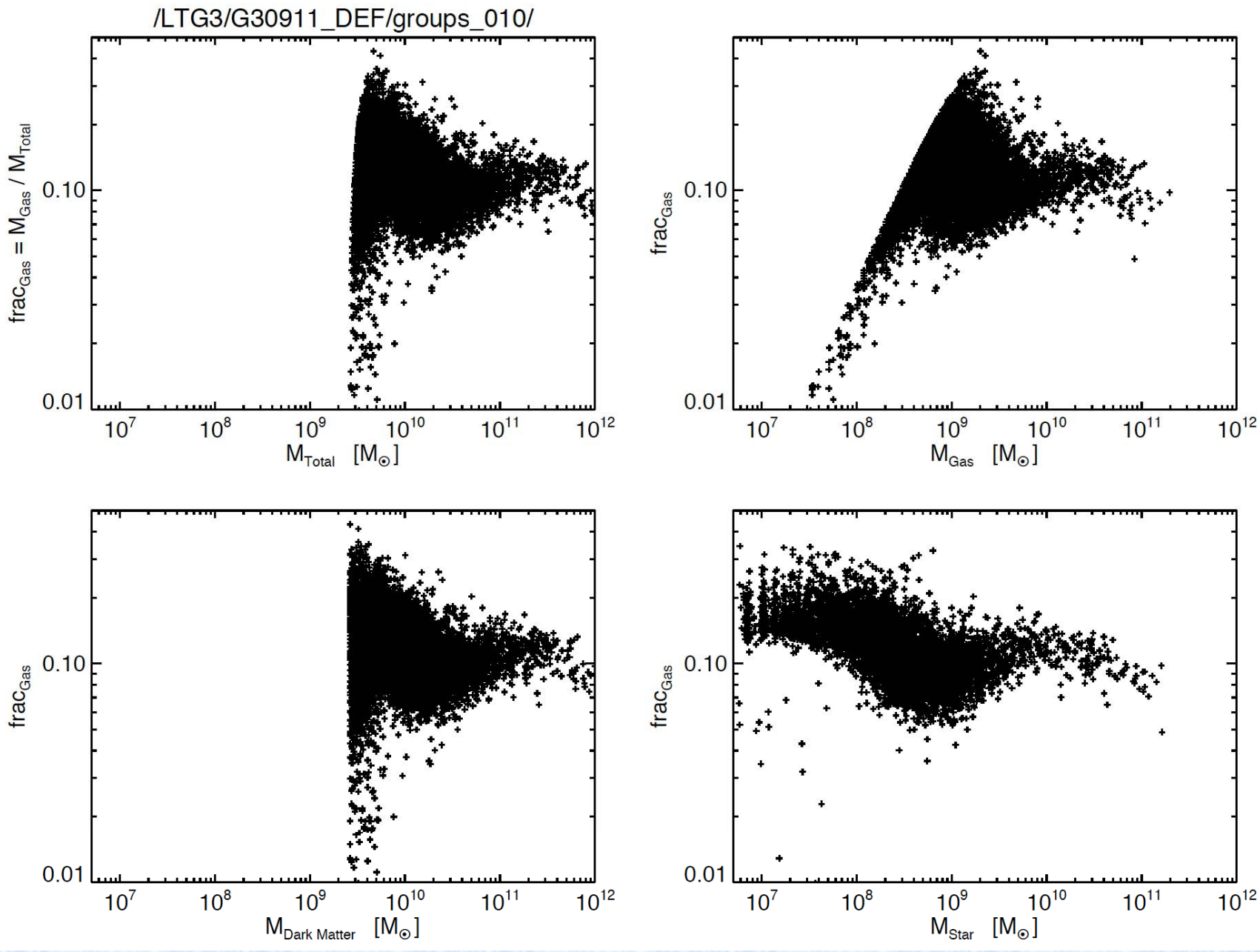
(Bower et al. 2011, arXiv: 1112.2712)

Figure 1. Comparison of the stellar mass function of th
model (blue line) with the base-line B8W7 model usec

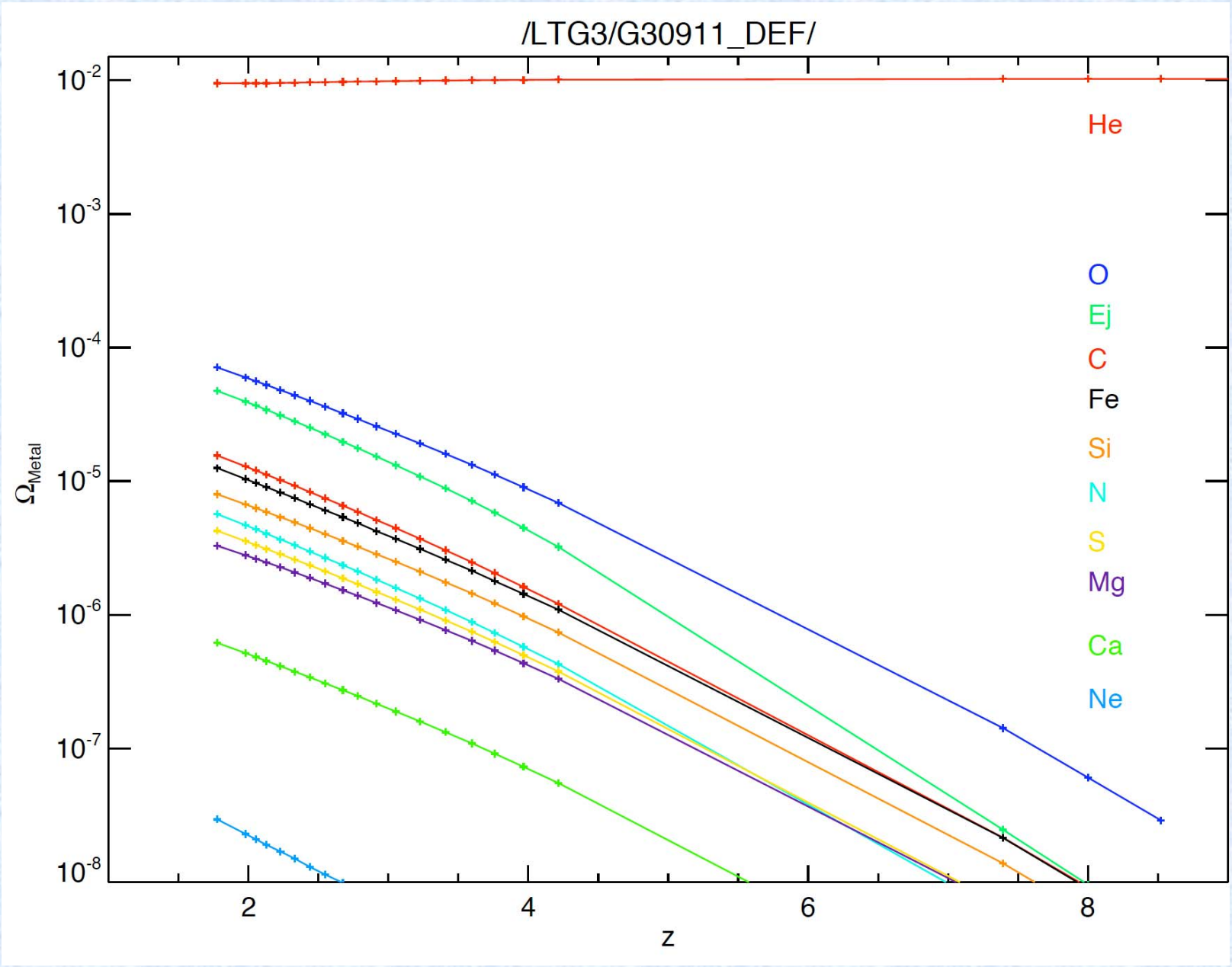
Gas Mass Fraction

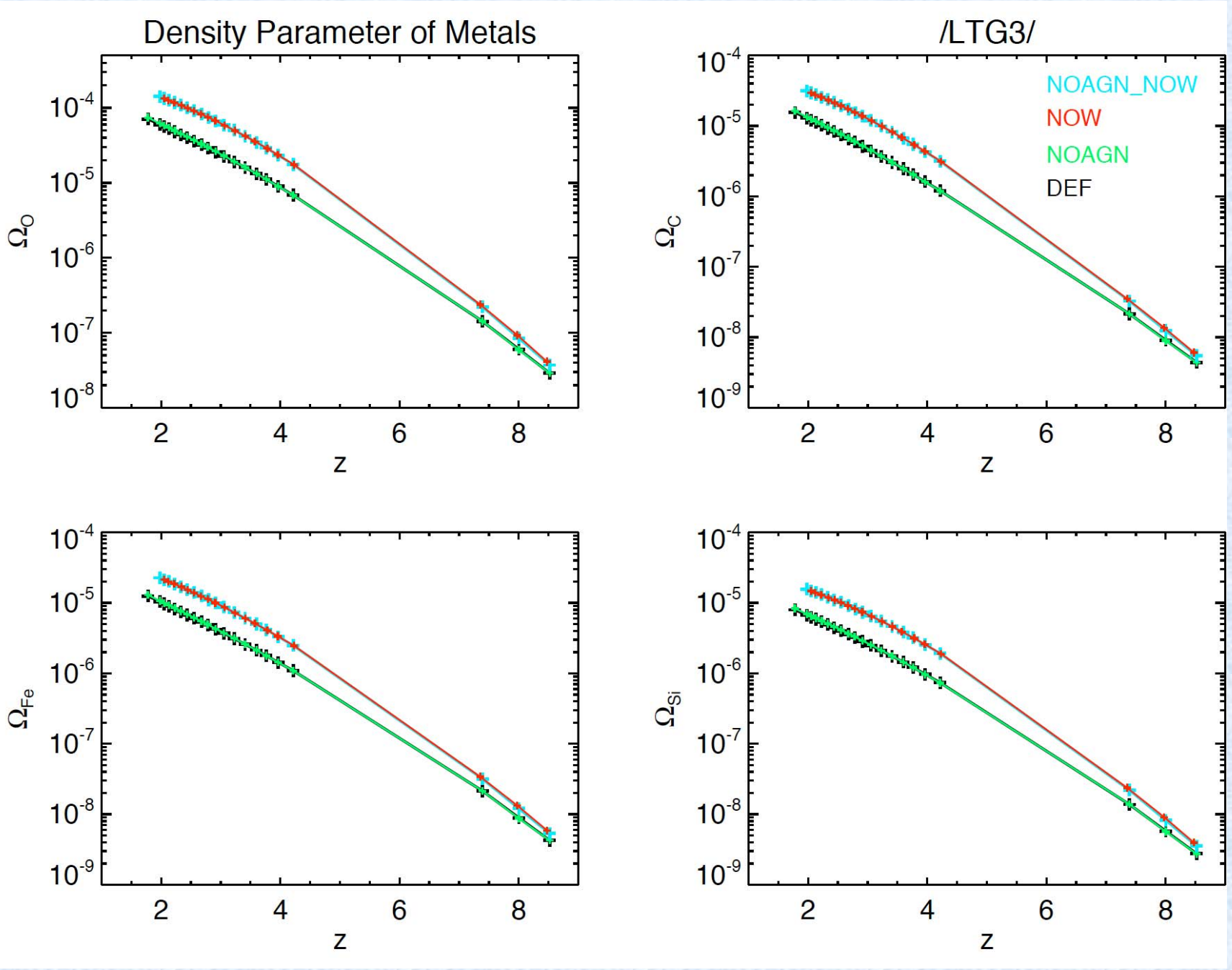


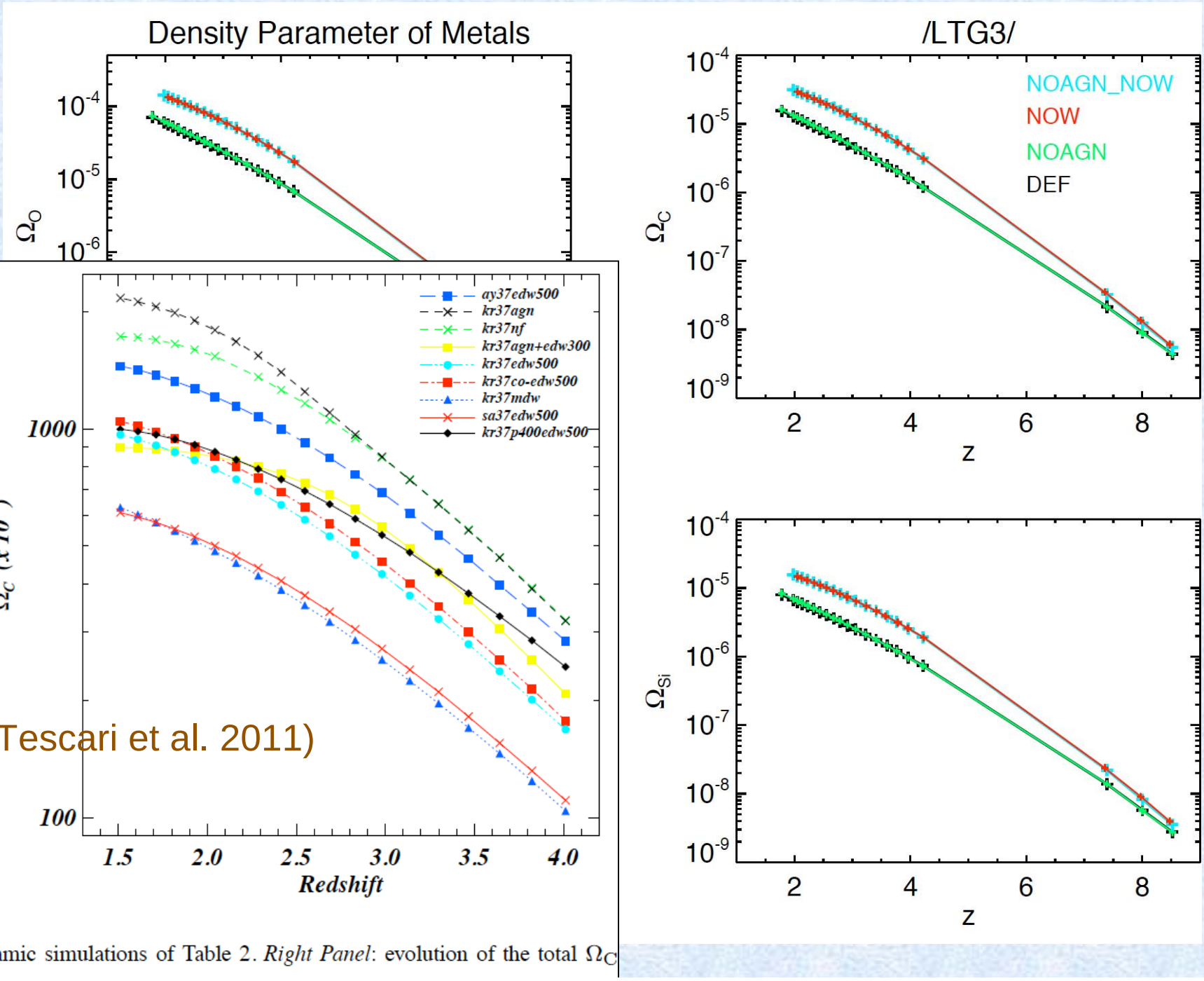

/LTG3/G30911_NOAGN/groups_010/
frac_Gas = M_Gas / M_Total
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Total [M_sun]
frac_Gas
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Gas [M_sun]
frac_Gas
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Dark Matter [M_sun]
frac_Gas
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Star [M_sun]


/LTG3/G30911_DEF/groups_010/
frac_Gas = M_Gas / M_Total
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Total [M⊙]
frac_Gas
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Gas [M⊙]
frac_Gas
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Dark Matter [M⊙]
frac_Gas
0.10
0.01
10^7 10^8 10^9 10^10 10^11 10^12
M_Star [M⊙]

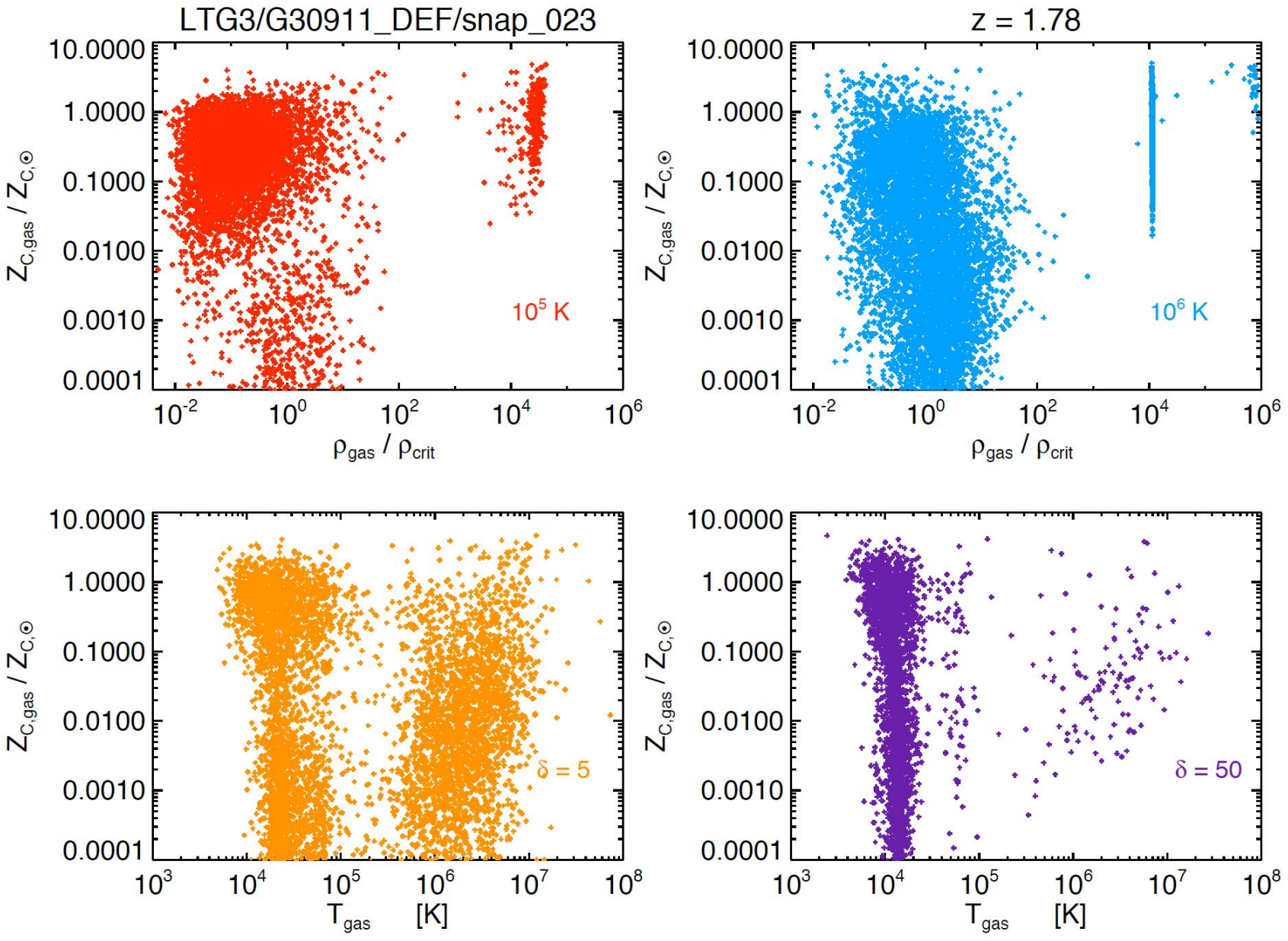
Metal Density

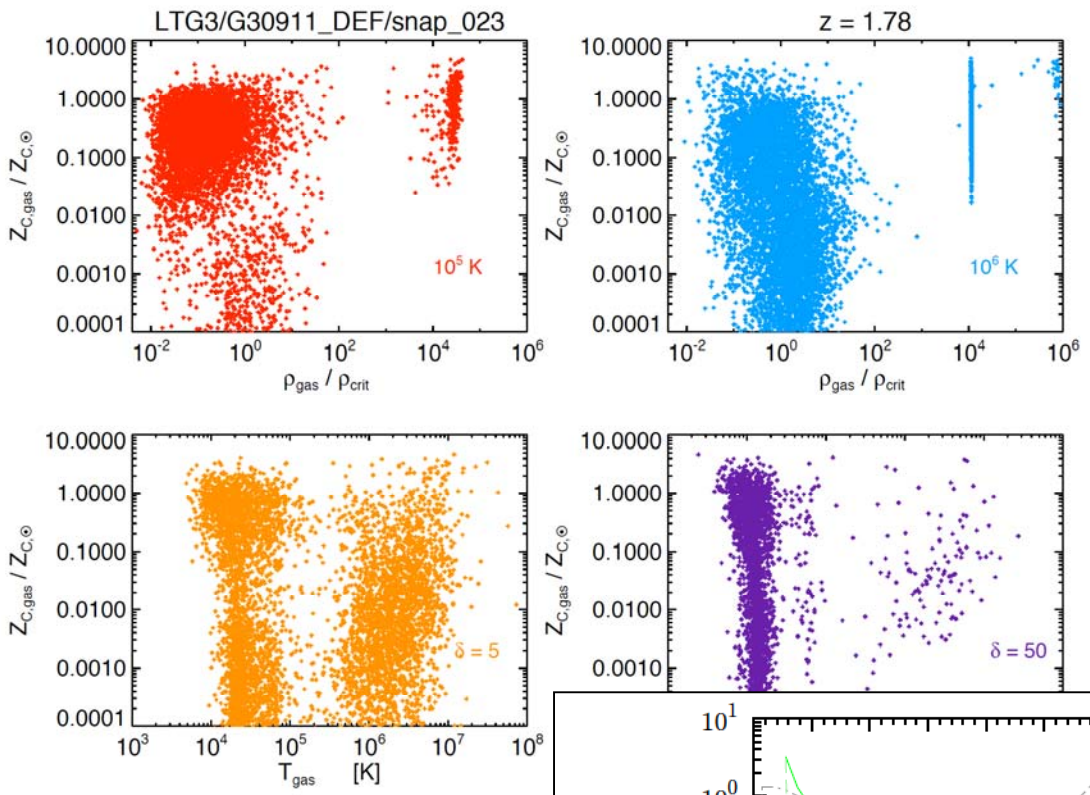



Density Parameter of Metals
/LTG3/
NOAGN_NOW
NOW
NOAGN
DEF
Ω_O
Ω_C
Ω_{Fe}
Ω_{Si}
z
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
2
4
6
8


Density Parameter of Metals
/LTG3/
NOAGN_NOW
NOW
NOAGN
DEF
Ω_O
Ω_C
Ω_{Si}
z
ay37edw500
kr37agn
kr37nf
kr37agn+edw300
kr37edw500
kr37co-edw500
kr37mdw
sa37edw500
kr37p400edw500
Ω_C (x 10^{-8})
Redshift
(Tescari et al. 2011)
namic simulations of Table 2. *Right Panel*: evolution of the total Ω_C

Carbon Abundance





- Range roughly consistent with Tornatore et al. (2010, MNRAS, 402, 1911)

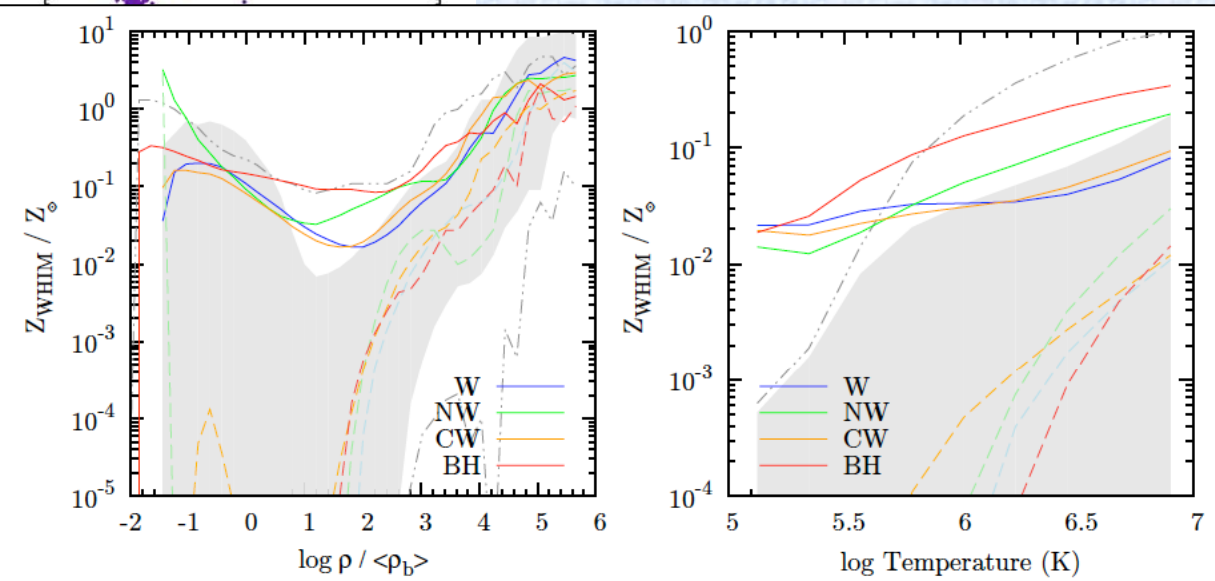


Figure 9. Total metallicity of the WHIM (gas particles at temperatures $10^5 - 10^7$ K) in solar units at $z = 0$, as a function of gas density (in units of the cosmic mean baryon density $\langle \rho_b \rangle$, left panel) and temperature (right panel). In each panel, the grey shaded area encompasses the 10 and 90 percentiles of the W run, while the dot–dot–dashed lines show the same percentiles for BH the run. Thick coloured lines show the average metallicities while thin dashed lines show the median metallicities.

Future Goals

- Add new subgrid physics into Gadget code, perform sims, & study IGM properties

- Wind velocity from observations
  - (Steidel et al. 2010, ApJ, 717, 289)

- Pressure-driven wind model
  - (Sharma & Nath 2011, arXiv: 1112.3447)

- ……..