Comparing L-GALAXIES, GALFORM and EAGLE

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@violegp

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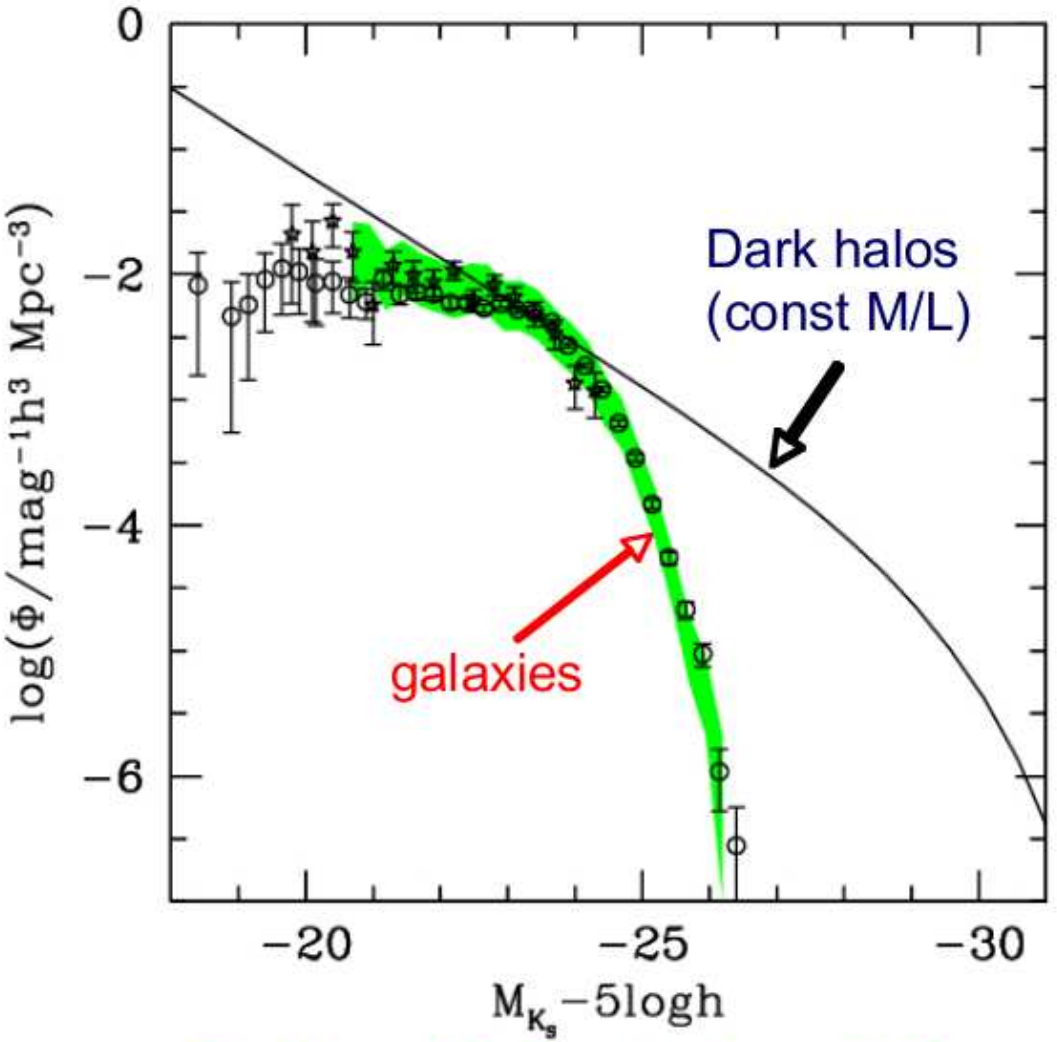
The processes that need modelling: gravity alone is not enough



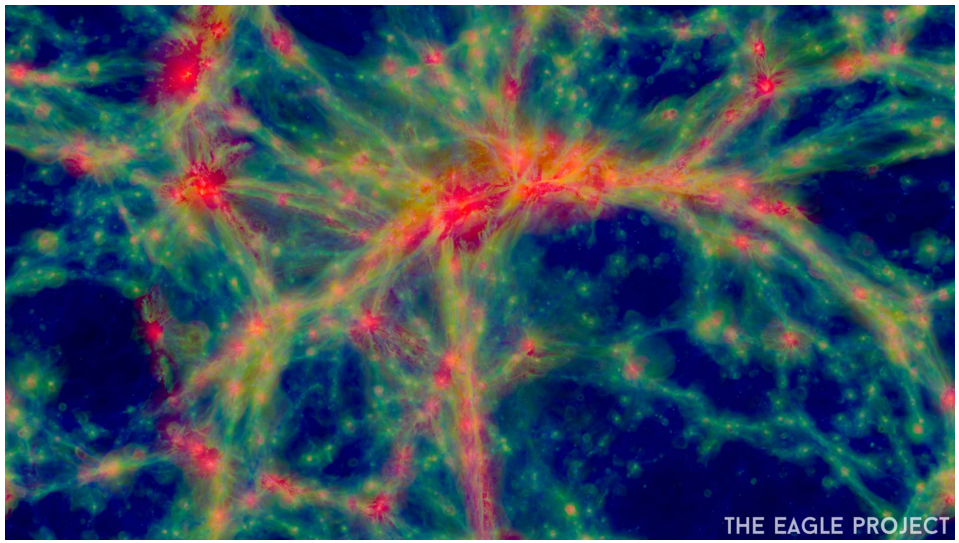
- If we assume a simple approach: There are more DM halos than galaxies at the faint and bright ends.
- Galaxy formation is an inefficient process!

The processes that need modelling: gravity alone is not enough

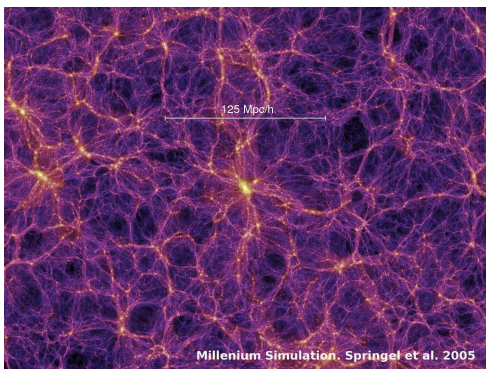
- If we assume a simple approach: There are more DM halos than galaxies at the faint and bright ends.
- Galaxy formation is an inefficient process!
- Galaxies are NOT shaped only by gravity. Gas physics, stellar formation and feedback, mergers, etc., also shape galaxies.

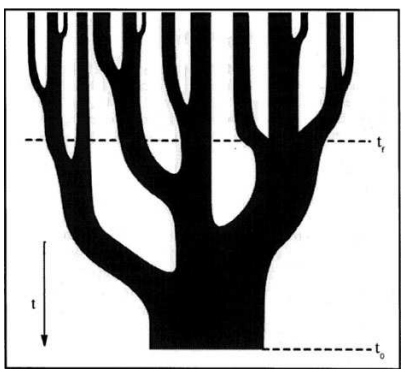
How to proceed?

a) In parallel: hydrodynamical simulations



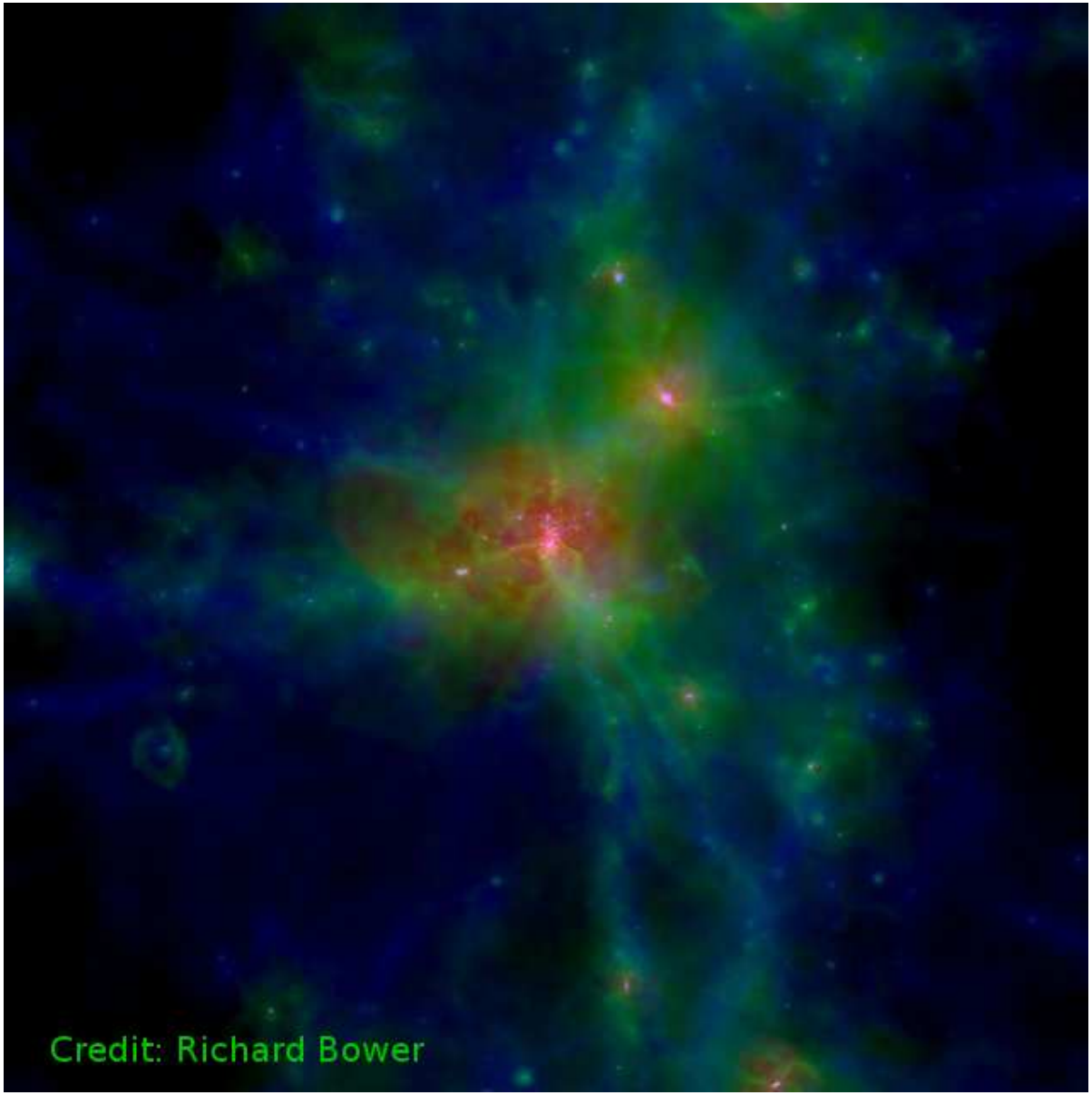
b) In series: SAMs, SHAMs, HOD modelling

1. 

2. 

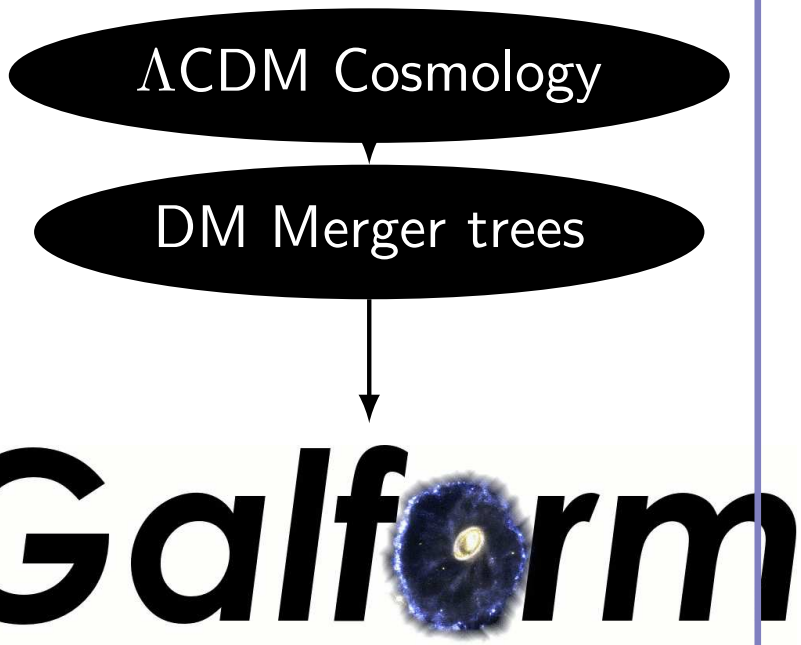
3. 

The EAGLE simulation



- Hydro simulation using GADGET-3 (SPH) + ANARCHY
- 100 Mpc box with a 10^6 $M_\odot$ gas mass resolution
- Planck cosmology

The GALFORM semi-analytical model



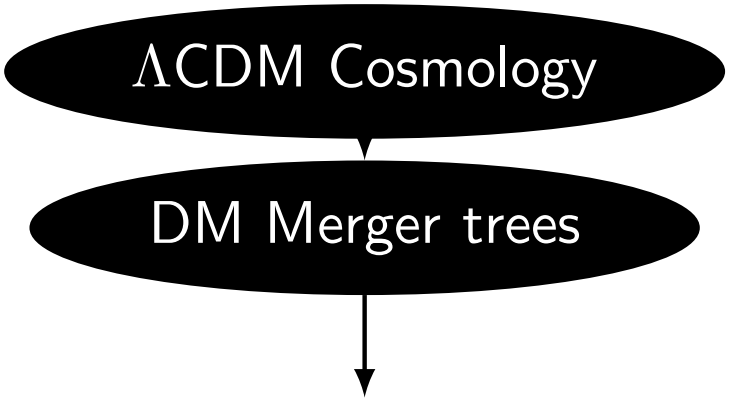
Using analytical equations, containing free parameters, GALFORM calculates the physical processes affecting the evolution of galaxies:

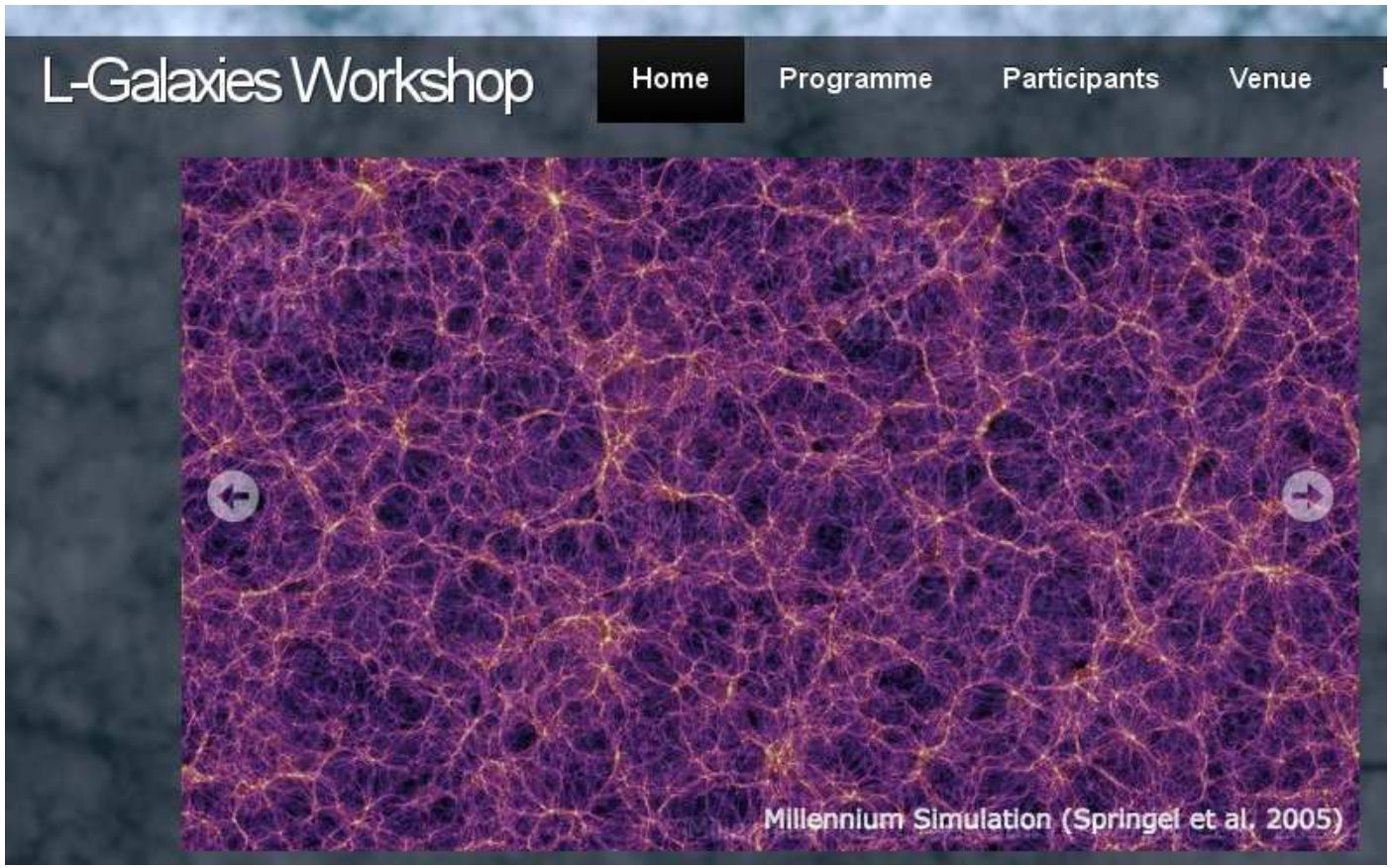
- Gas cooling ⇒ Disk formation
- Galaxy mergers ⇒ Spheroids
- SF* & Feedback
  from both SNe & AGN
- Chemical Evolution
- Stellar population & Extinction

* New improved treatment of SF in disks (Lagos et al. 2011) based on the empirical law from Blitz & Rosolowsky (2006), following explicitly the He, HI & H_2:

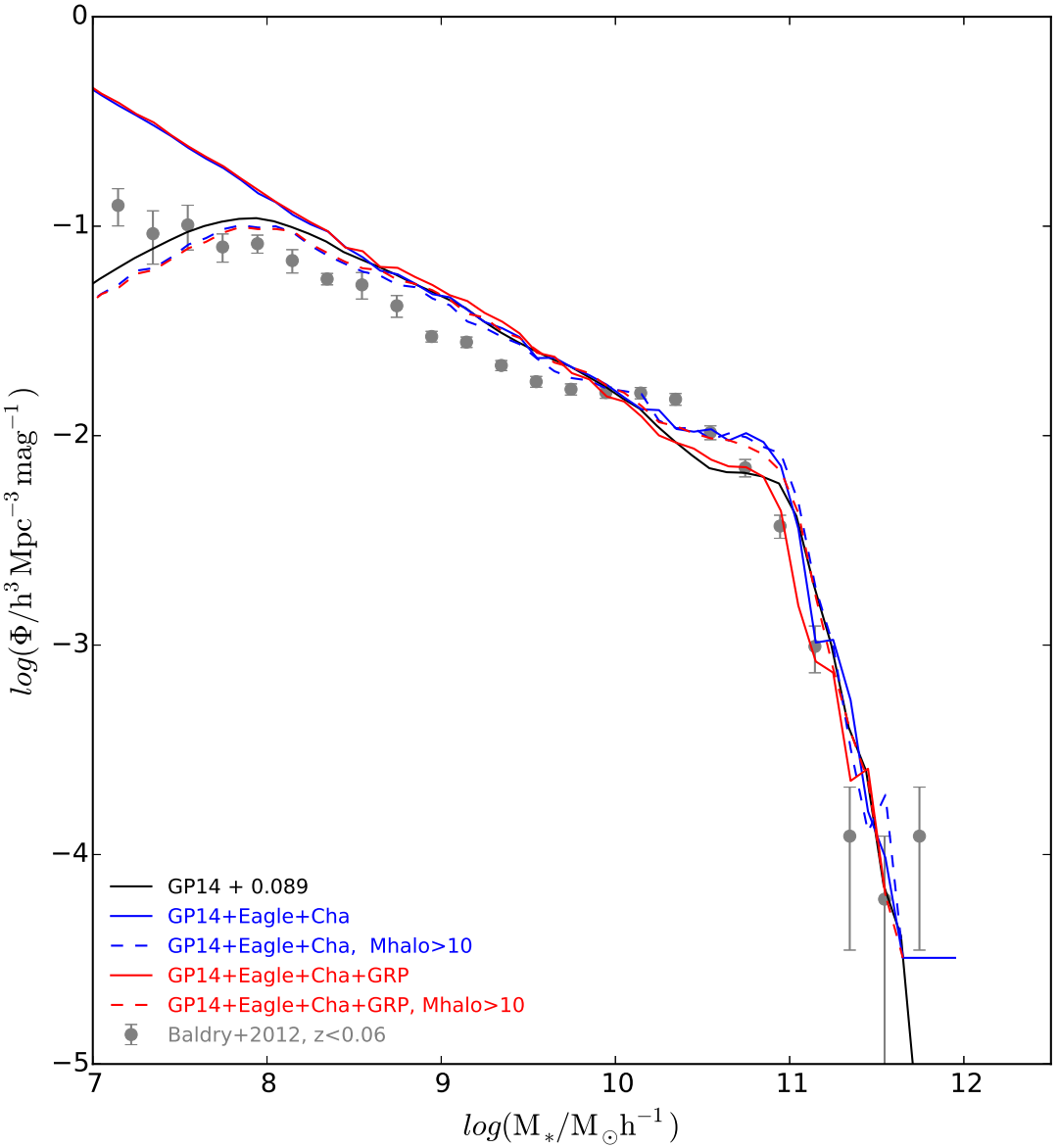
$$\Sigma_{SFR} = \frac{1}{\tau_{mol.\,gas}} \times \frac{\Sigma_{mol.\,gas}}{\Sigma_{total\,gas}} (\mathrm{P}_{\mathrm{hydrostatic\ of\ the\ disk}}) \times \Sigma_{\mathrm{cold\,gas}}$$

The L-GALAXIES semi-analytical model



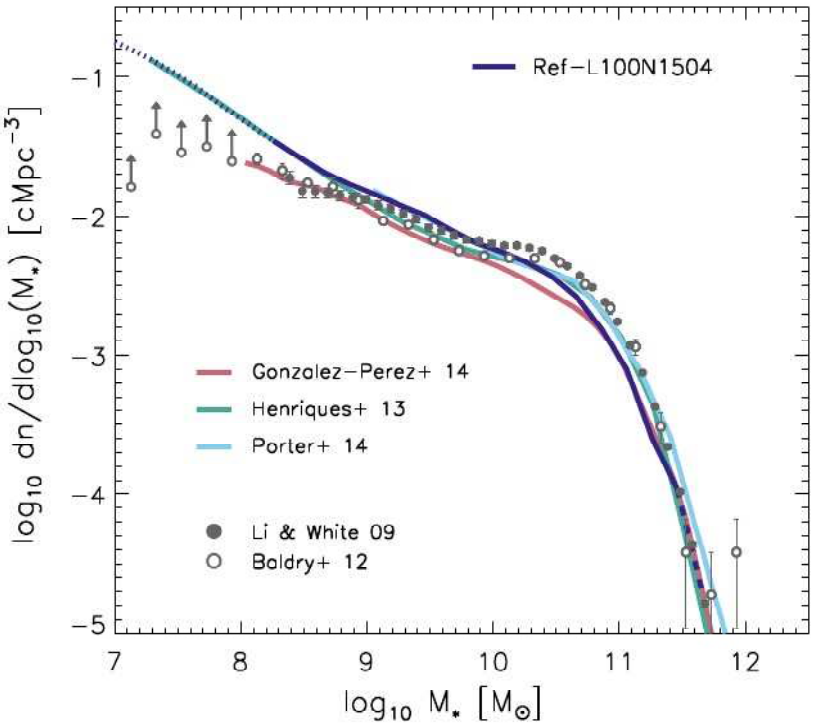


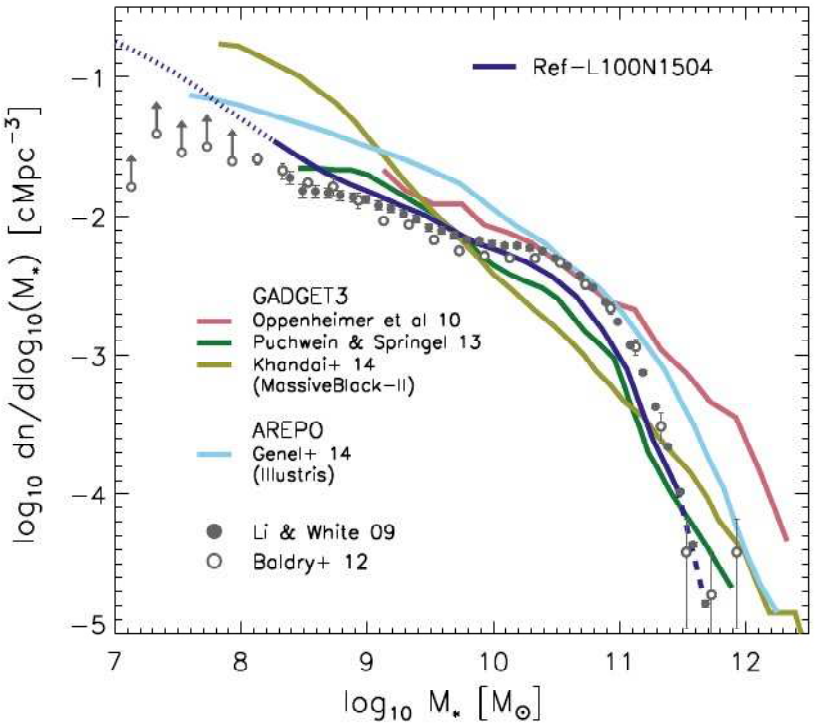
The effect of changing the mass resolution



- MS-W7 haloes $> 10^{10} M_\odot/h$
- EagleDM haloes $> 10^{8} M_\odot/h$

Starting point: the stellar mass function

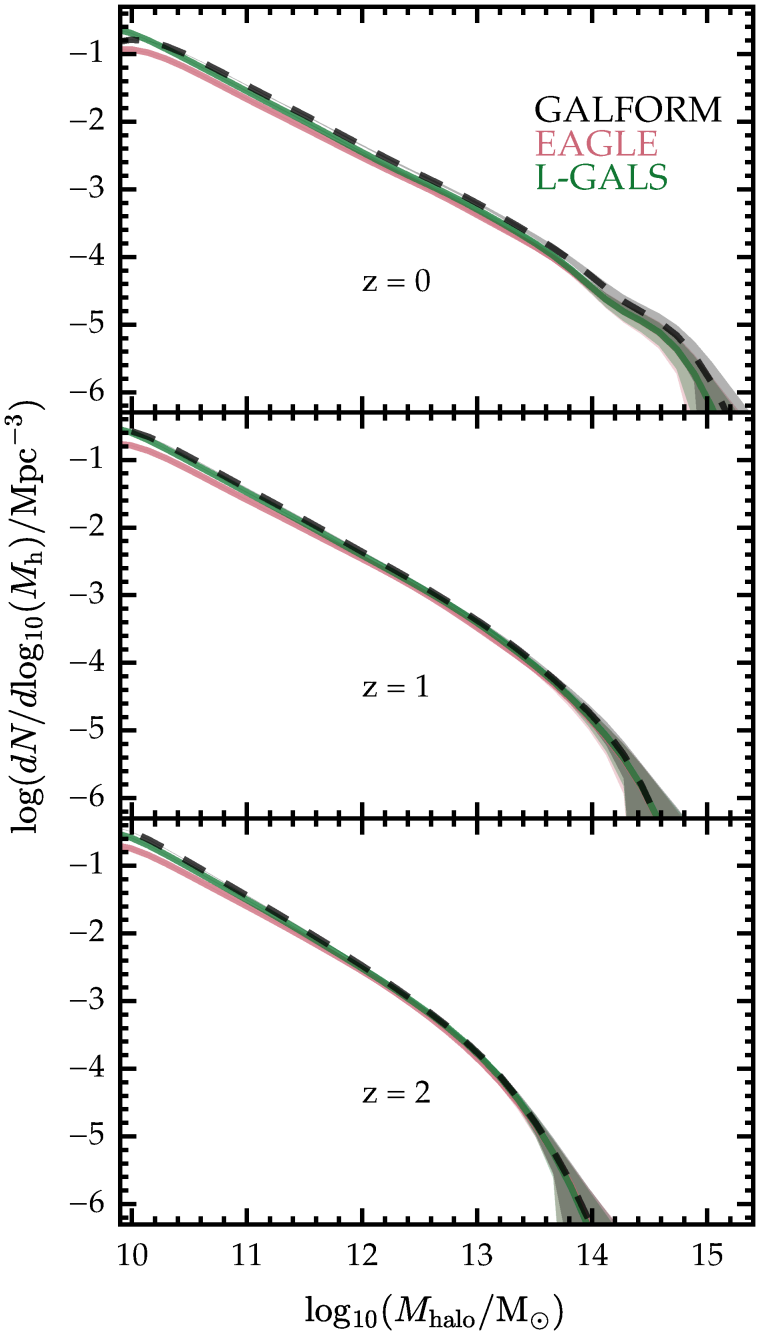


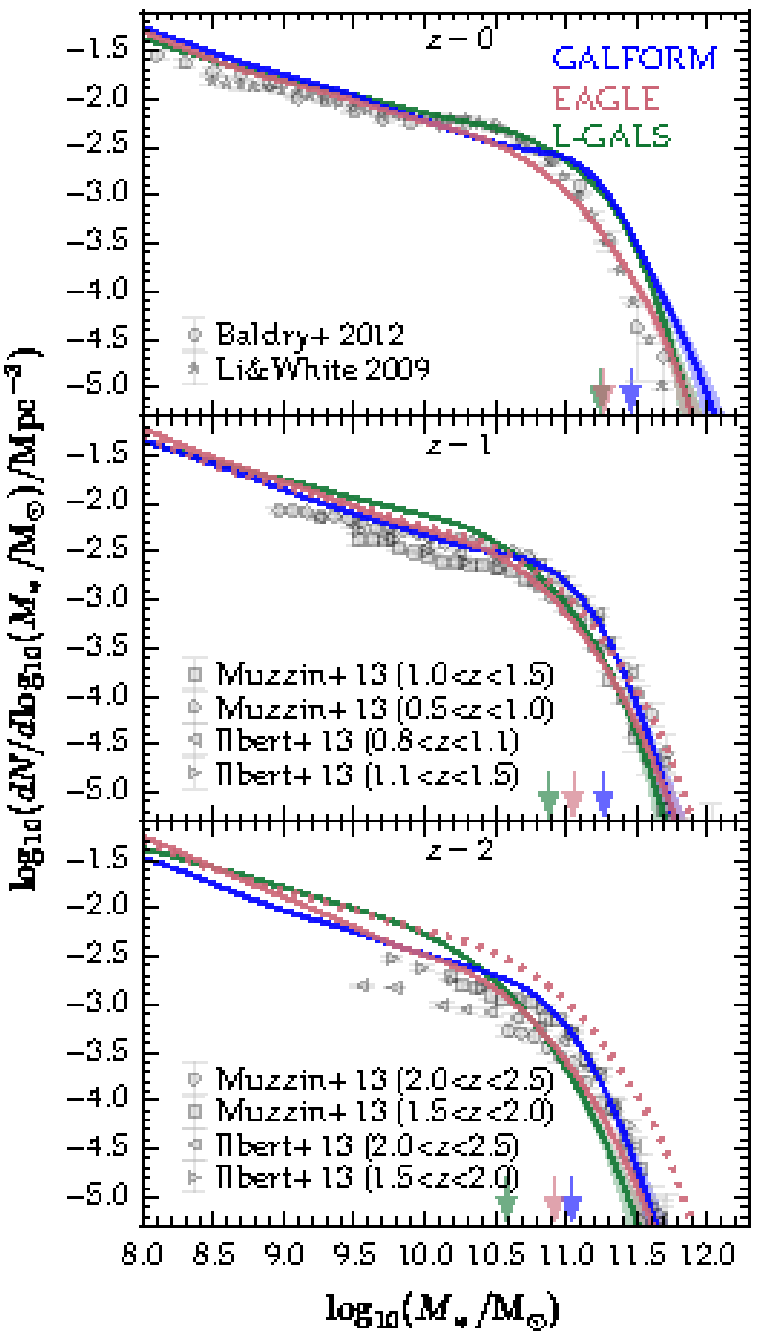


Schaye+15

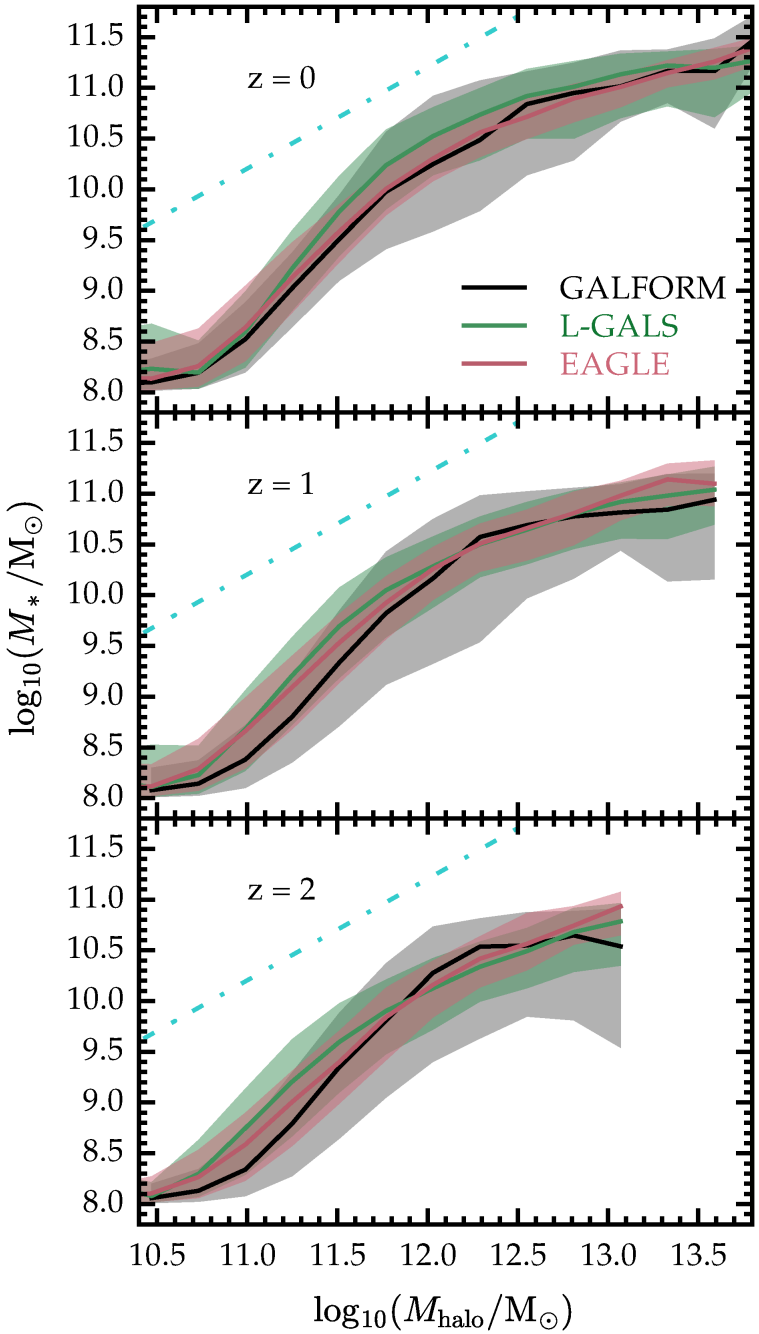
See also Somerville and Dave 2015

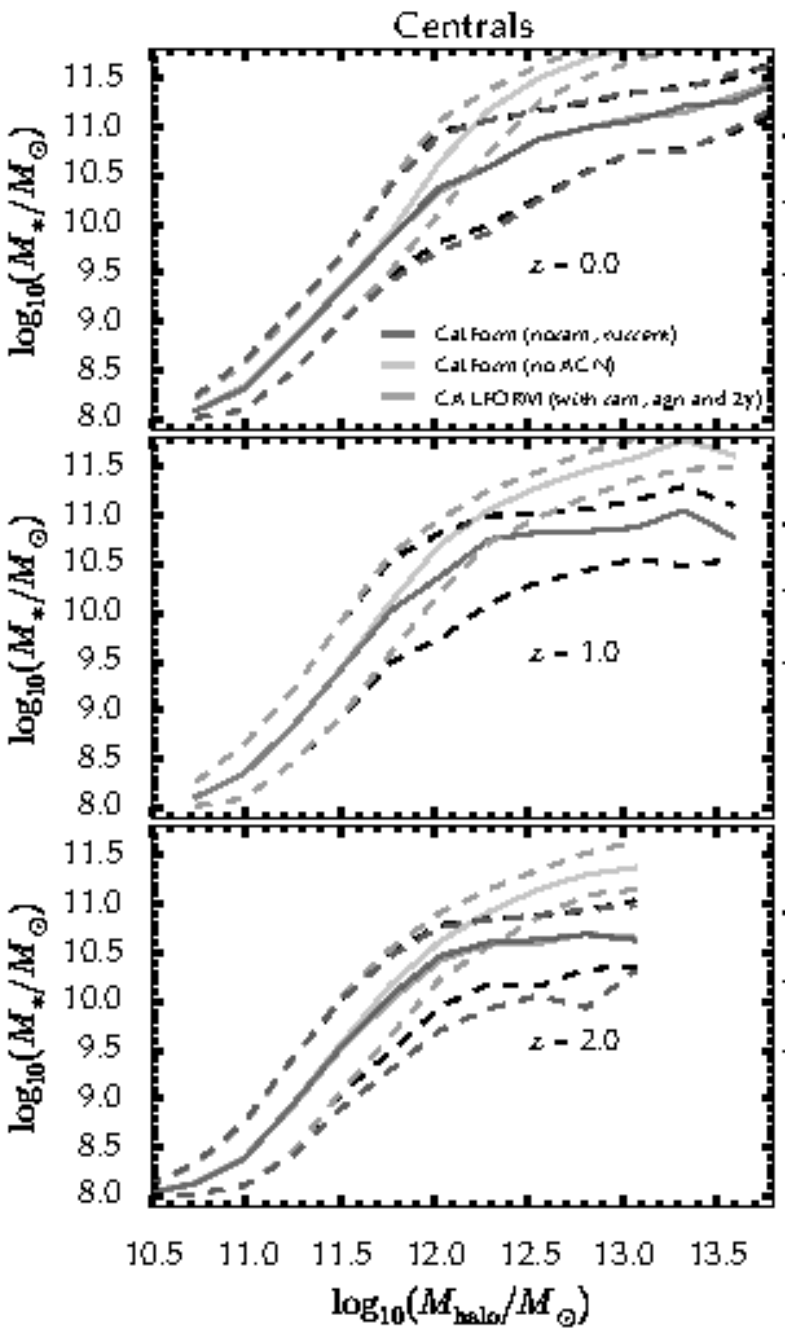
Compared mass functions



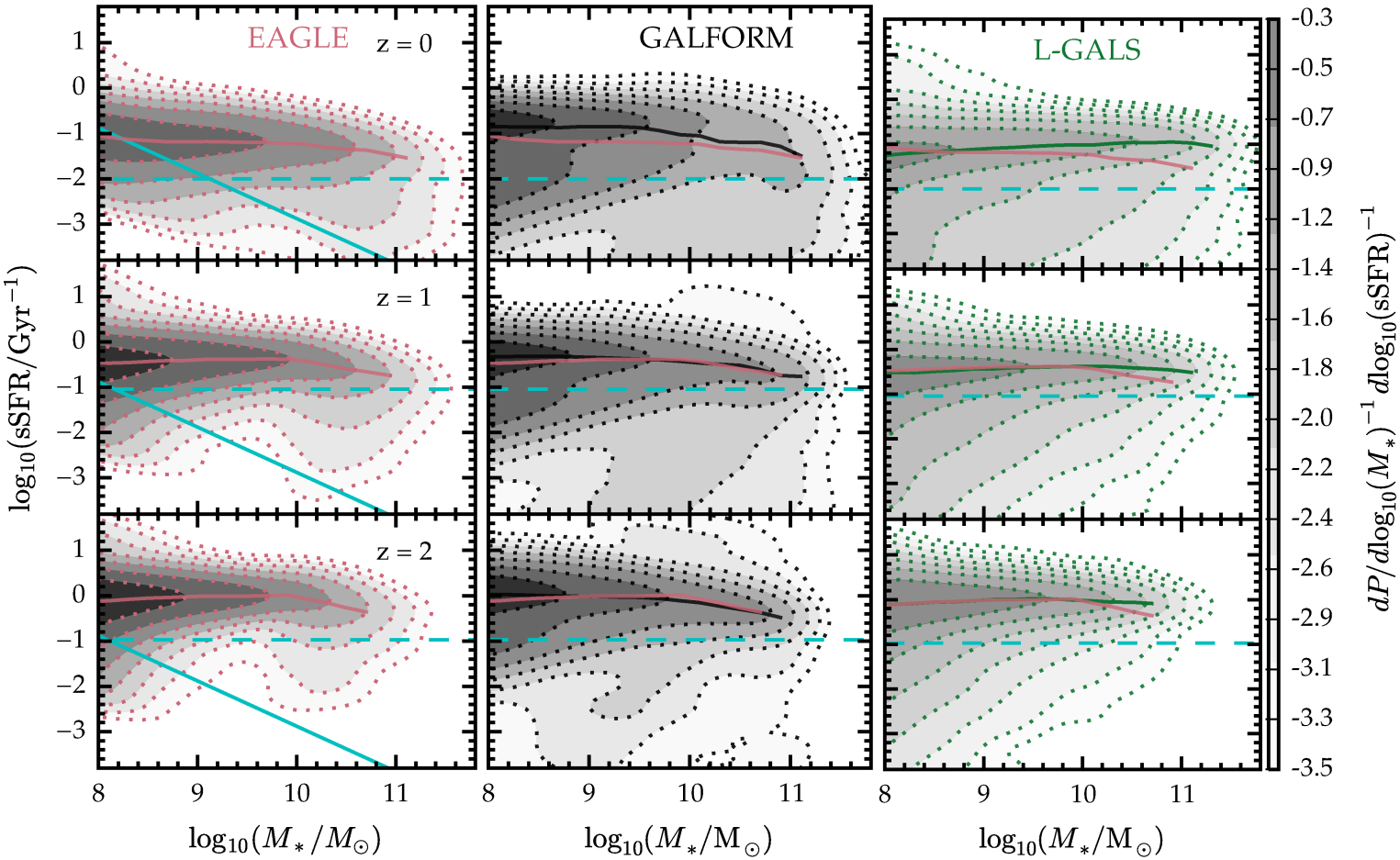


The $M_* - M_{\rm halo}$ relation

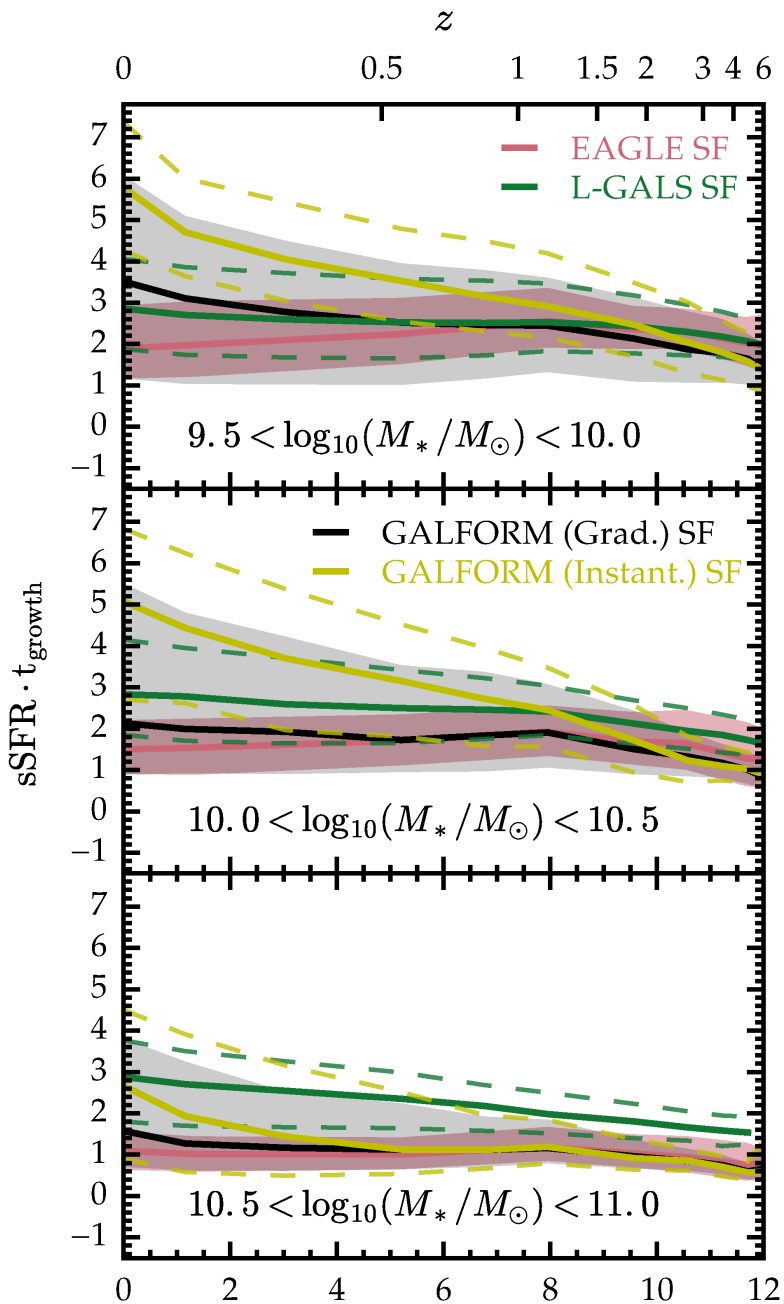




The SF sequence from different models

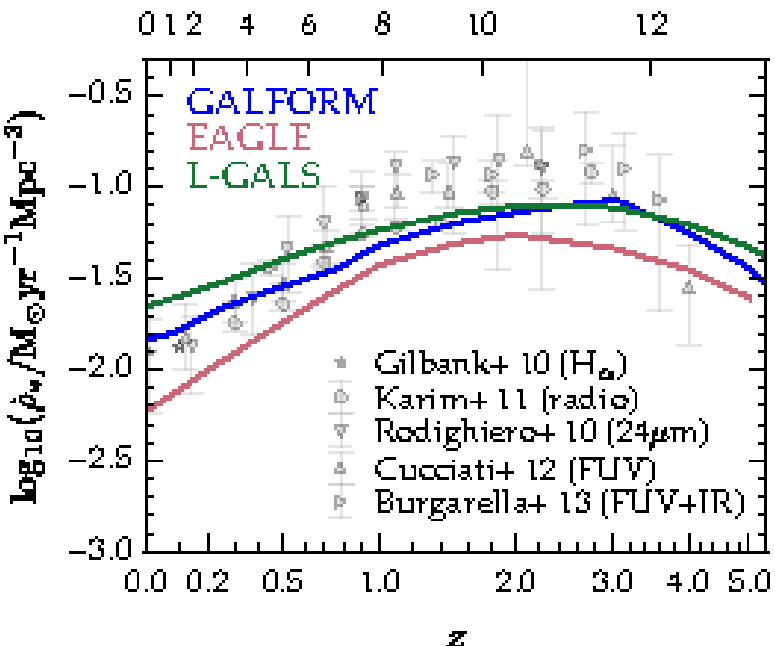


The SFRD and sSFR evolution

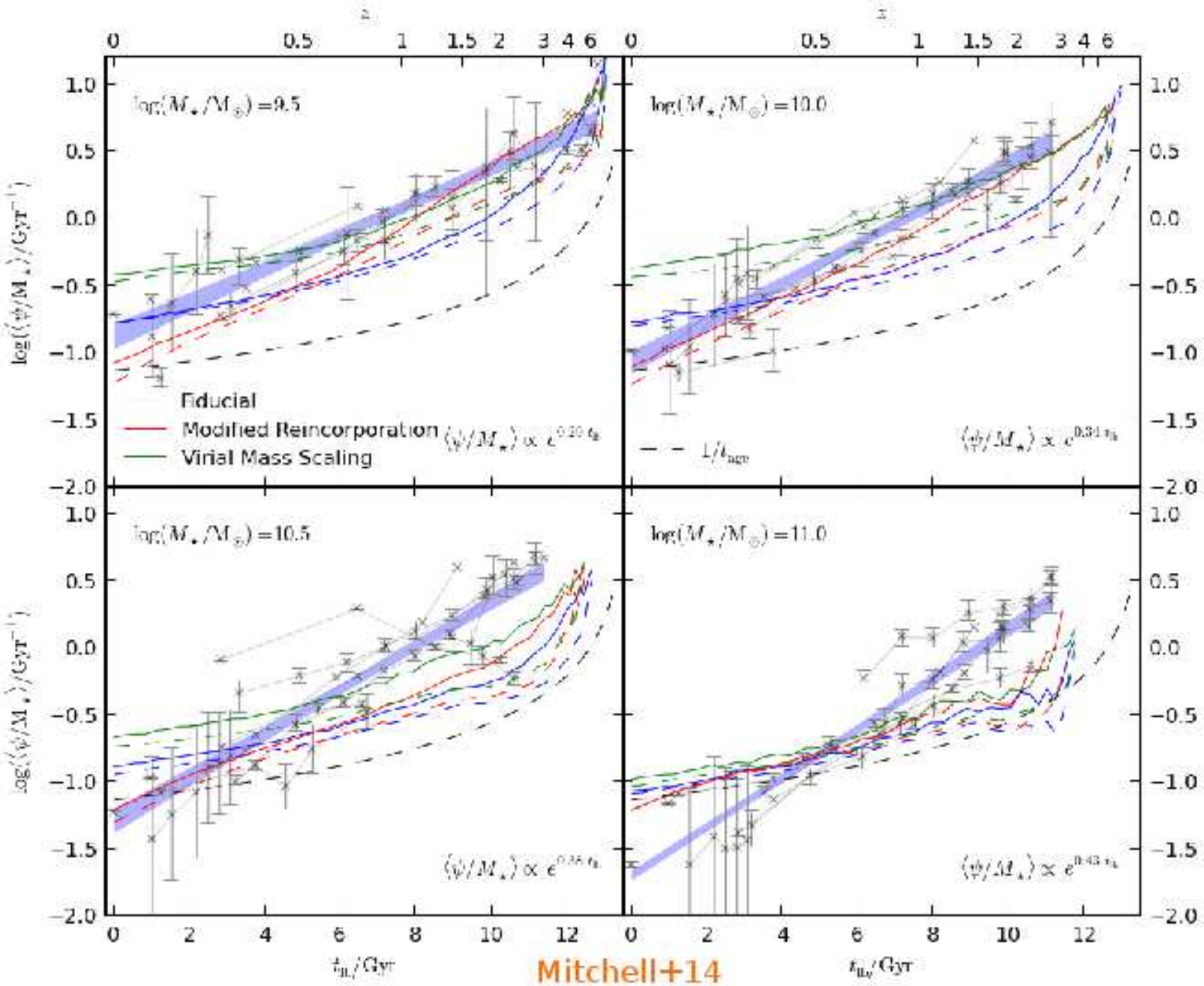


$$t^{-1}_{\mathrm{growth}}(\mathrm{Gyr}^{-1}) = \frac{\mathrm{d}M/\mathrm{d}t}{M(z)}$$

$$M(z) = M_0(1+z)^{\alpha} e^{\beta z}$$

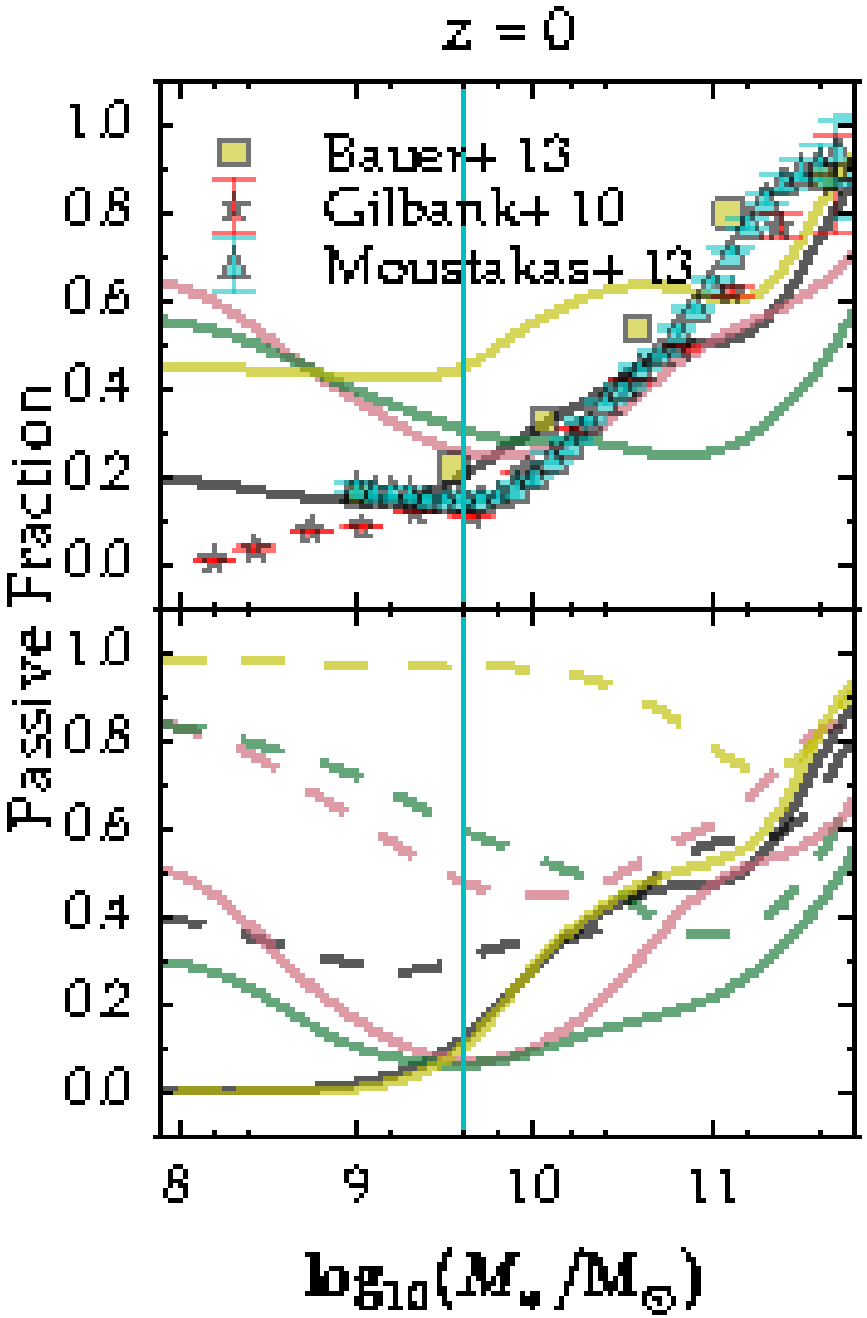


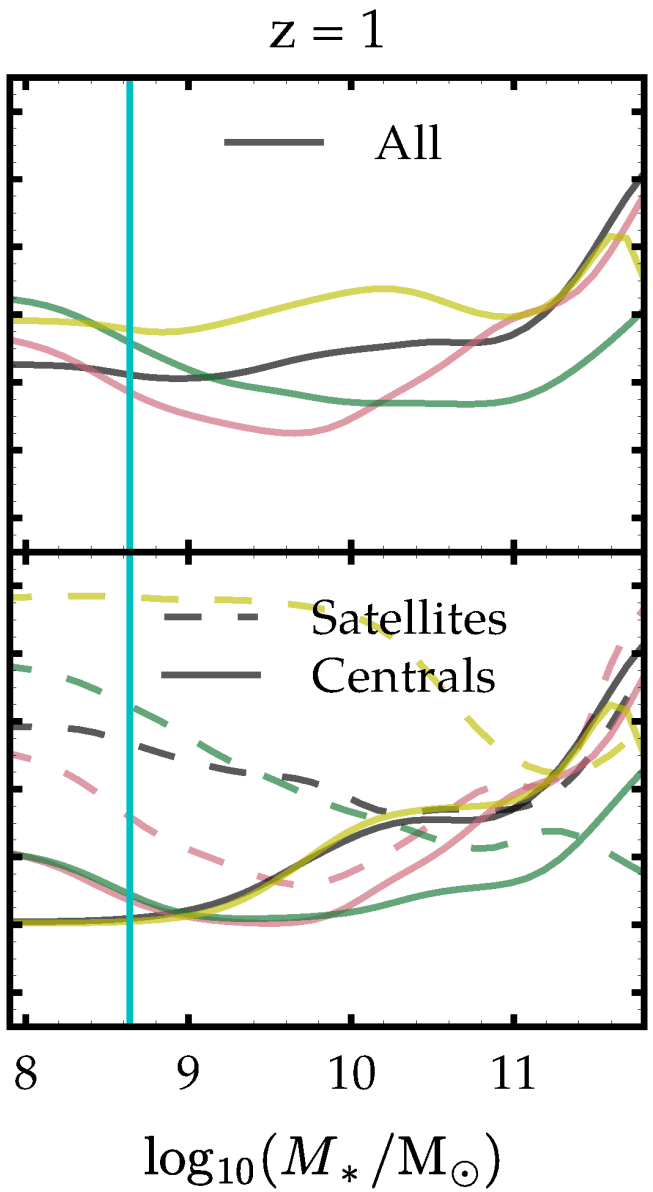
The evolution of the sSFR compared with observations



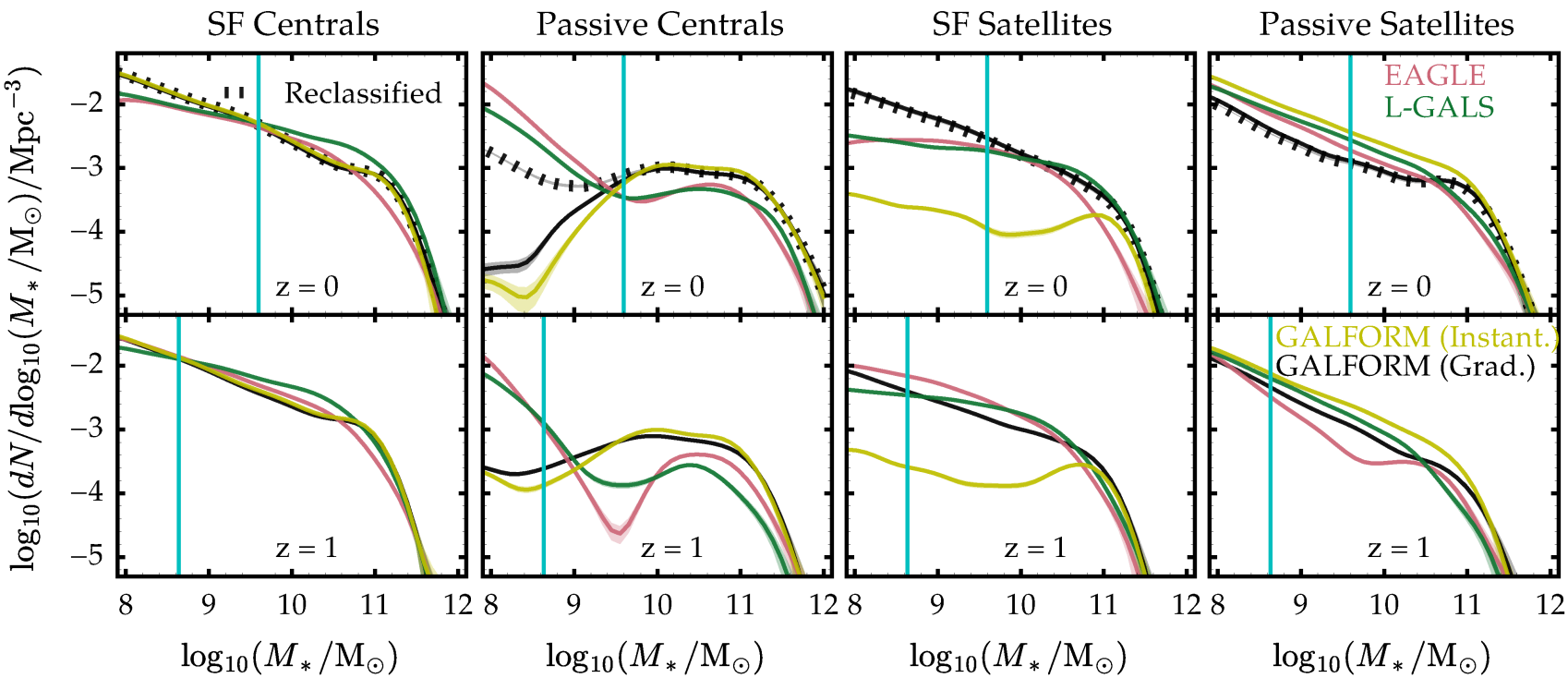
Mitchell+14

The passive fractions

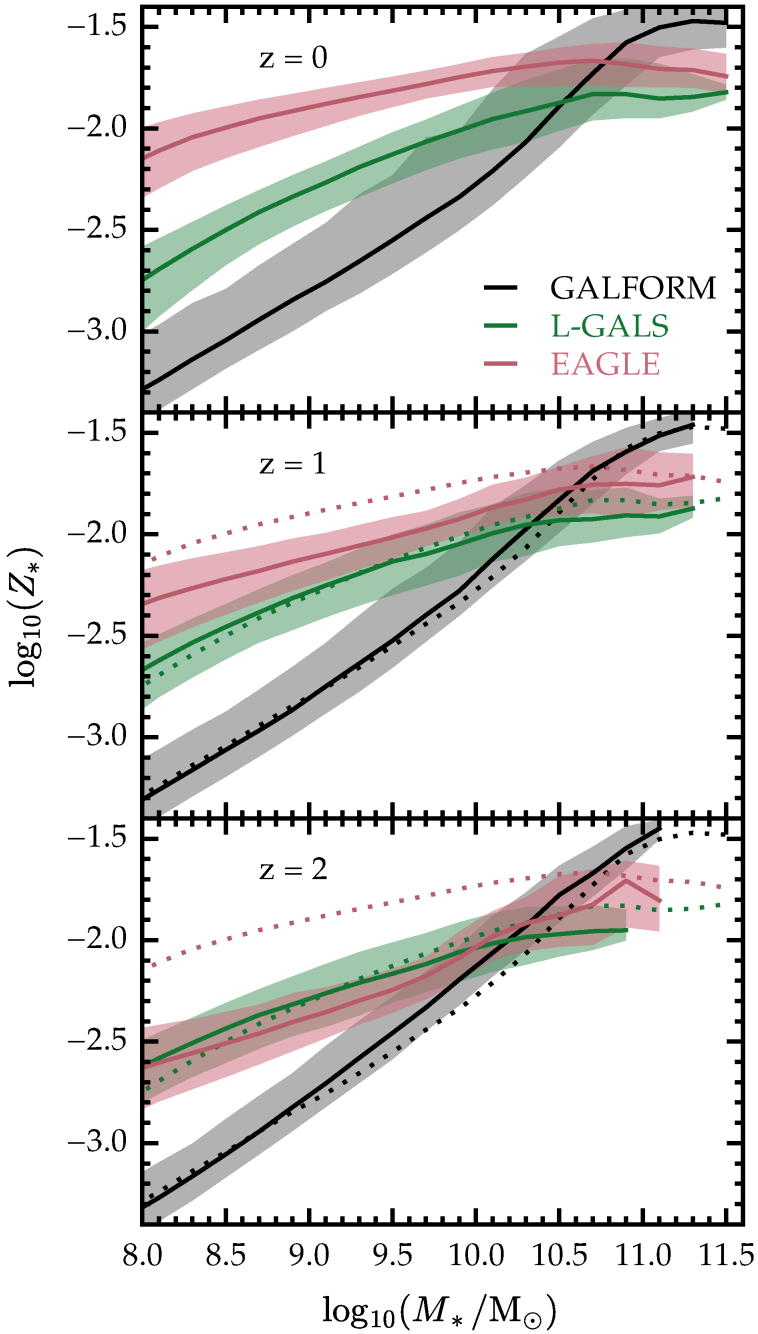


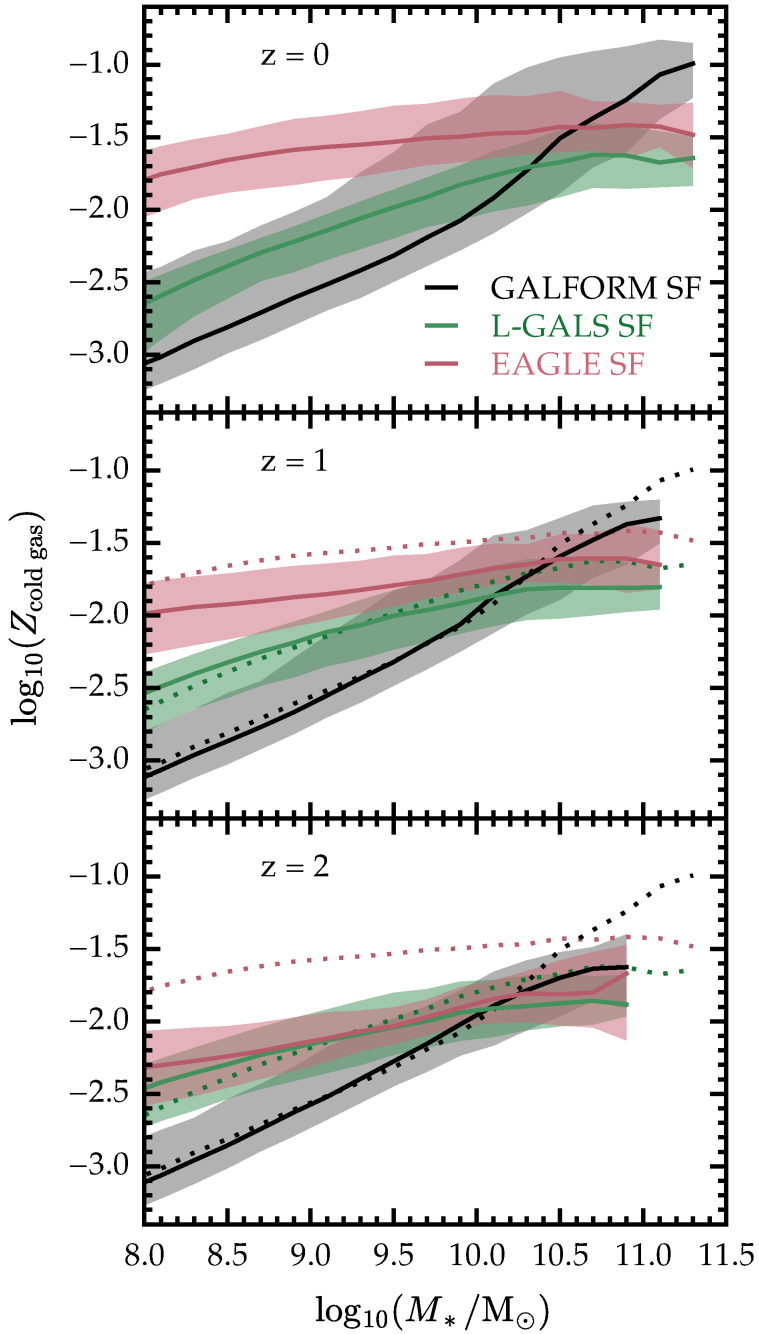


The GSMF split in to passive and star-forming galaxies

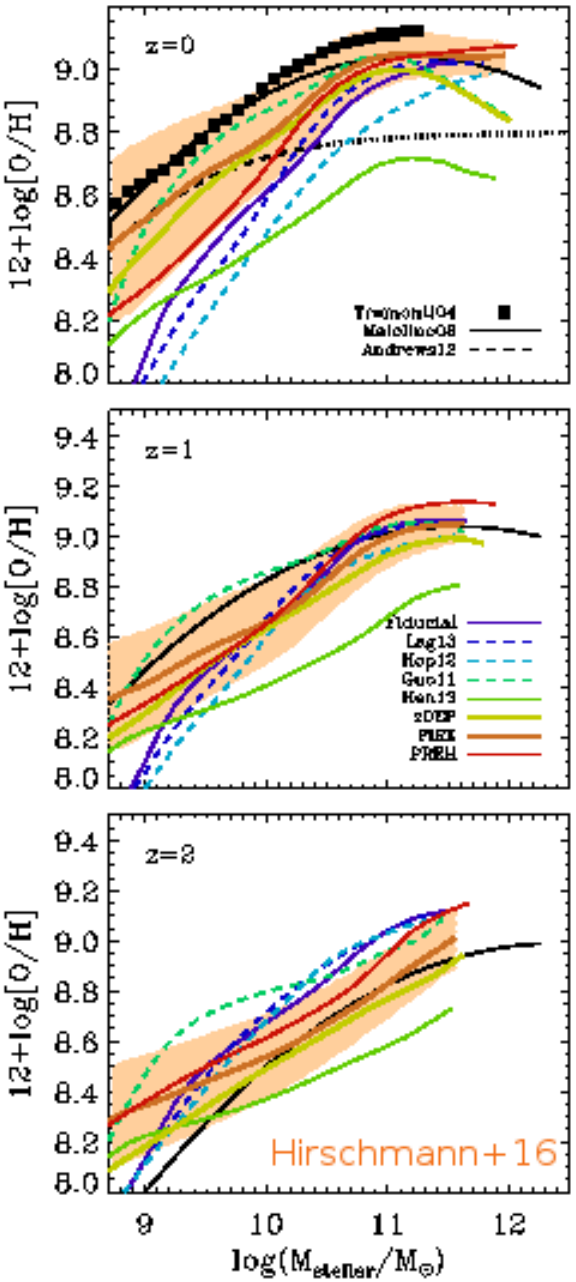


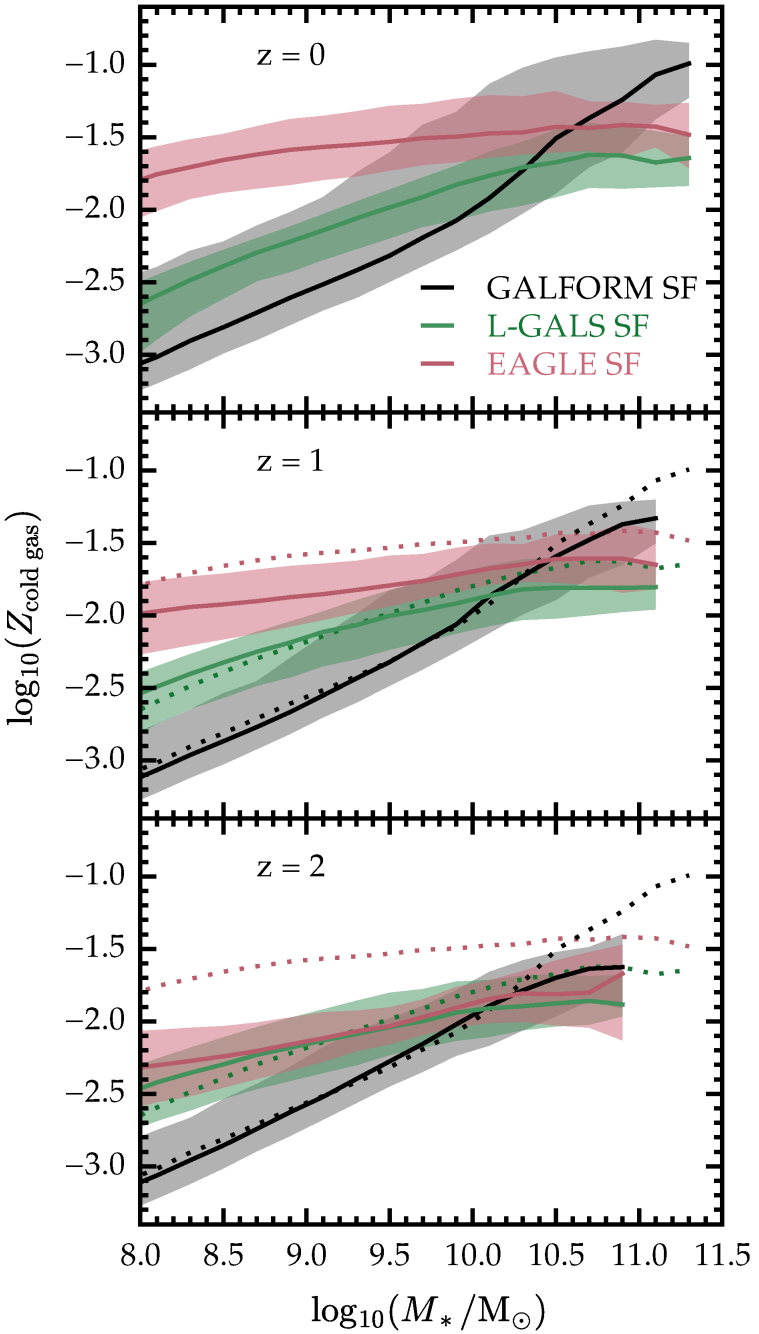
Metallicity



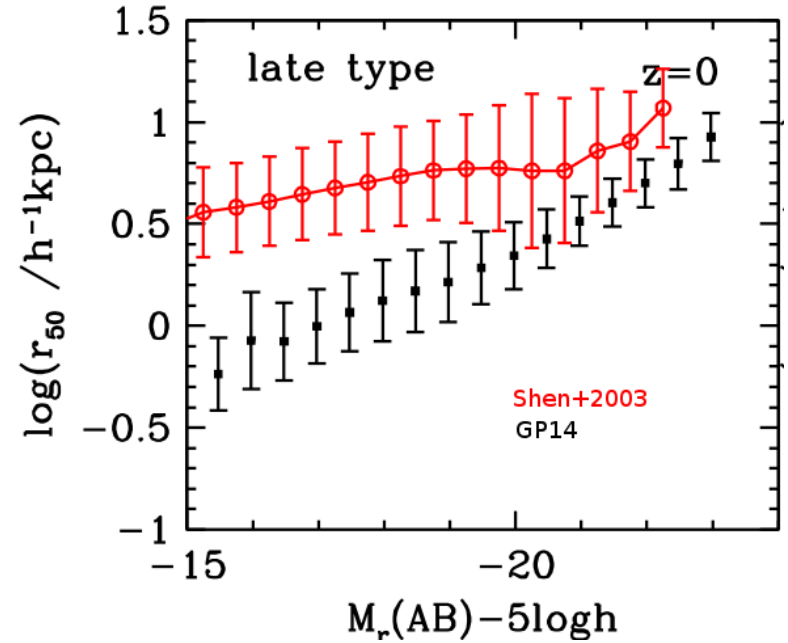


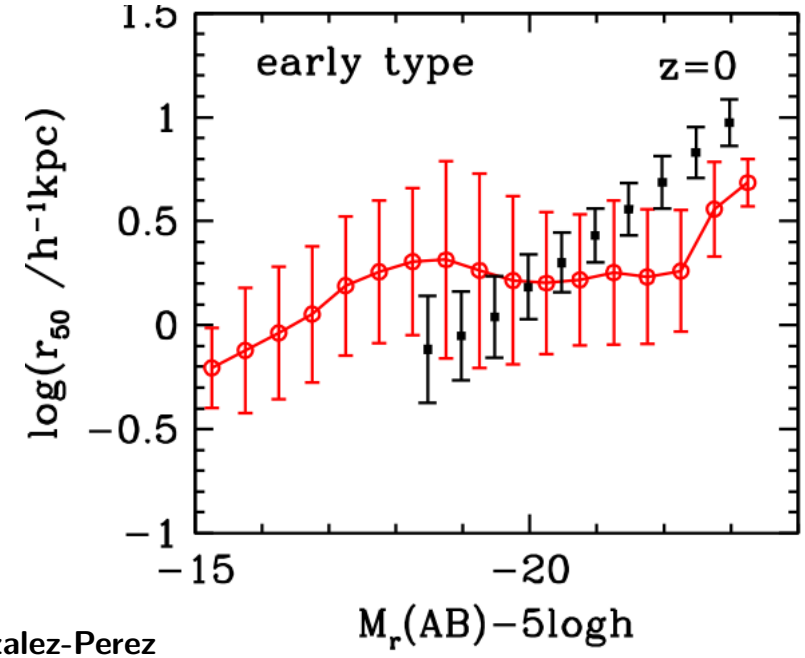
Metallicity

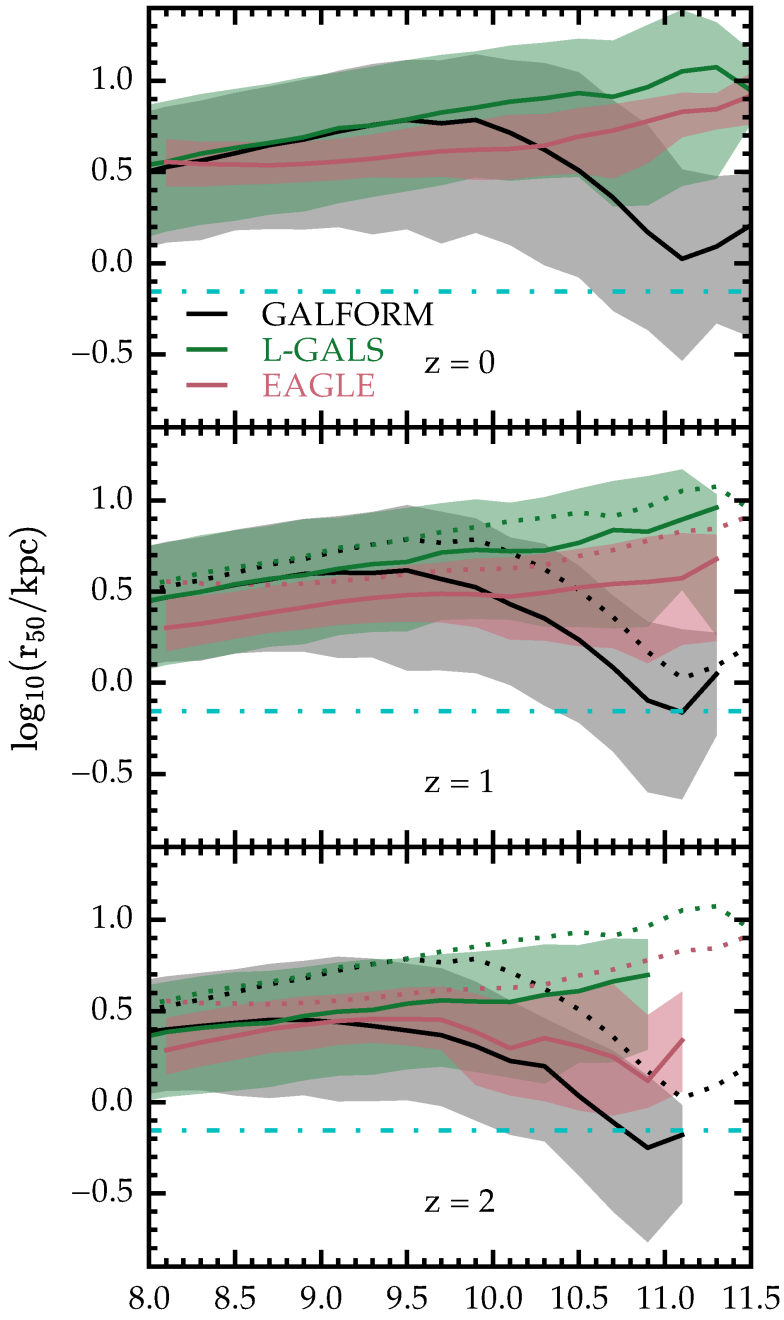




Sizes


late type
z=0
Shen+2003
GP14
log(r50 /h-1kpc)
Mr(AB)−5logh


early type
z=0
log(r50 /h-1kpc)
Mr(AB)−5logh


GALFORM
L-GALS
EAGLE
z = 0
z = 1
z = 2
log10(r50/kpc)

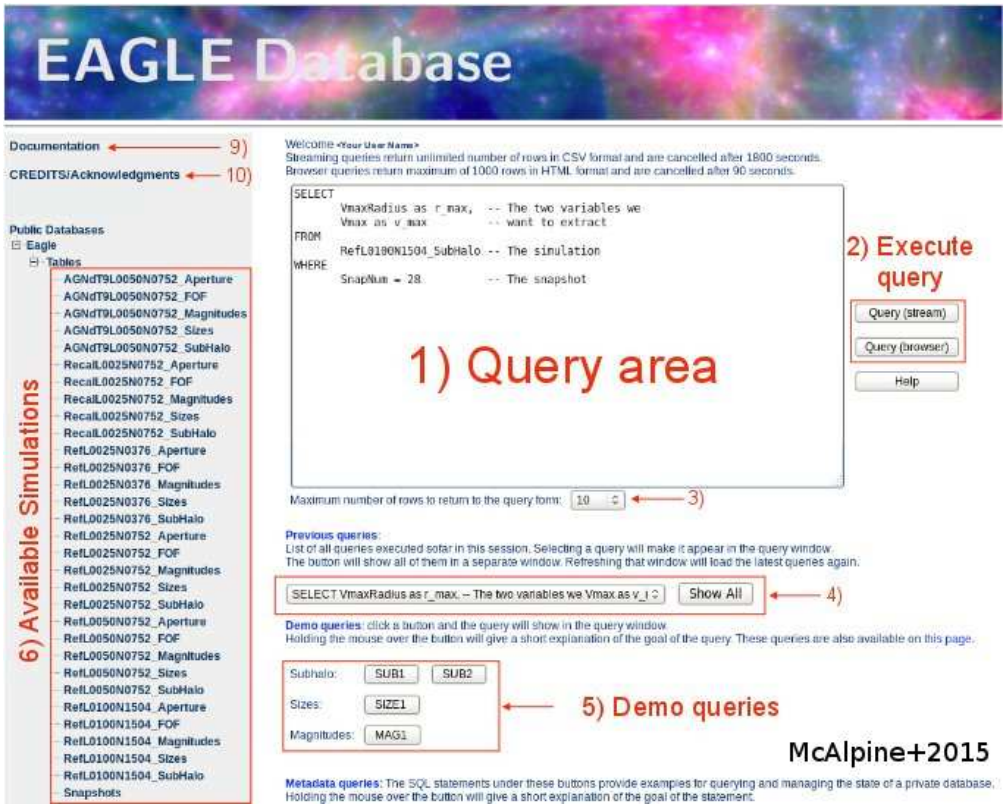
Conclusions

- The stellar mass assembly history closely follows that of the dark matter, which is not the case for observations.
- The GSMF and SF sequence in SAMs have very similar evolution to hydrodynamical simulations.
- The modelling of sizes needs a major improvement. The problem is: sizes affect everything!
- The observed mass-metallicity relation is not reproduced by models which points to a excesively crude modelling of flows.

Guo, Gonzalez-Perez et al., 2016.

Use the Virgo-Millennium and EAGLE Data Bases:

http://virgo.dur.ac.uk



http://www.eaglesim.org/database.html