The spatially-resolved mass assembly of MW-sized galaxies

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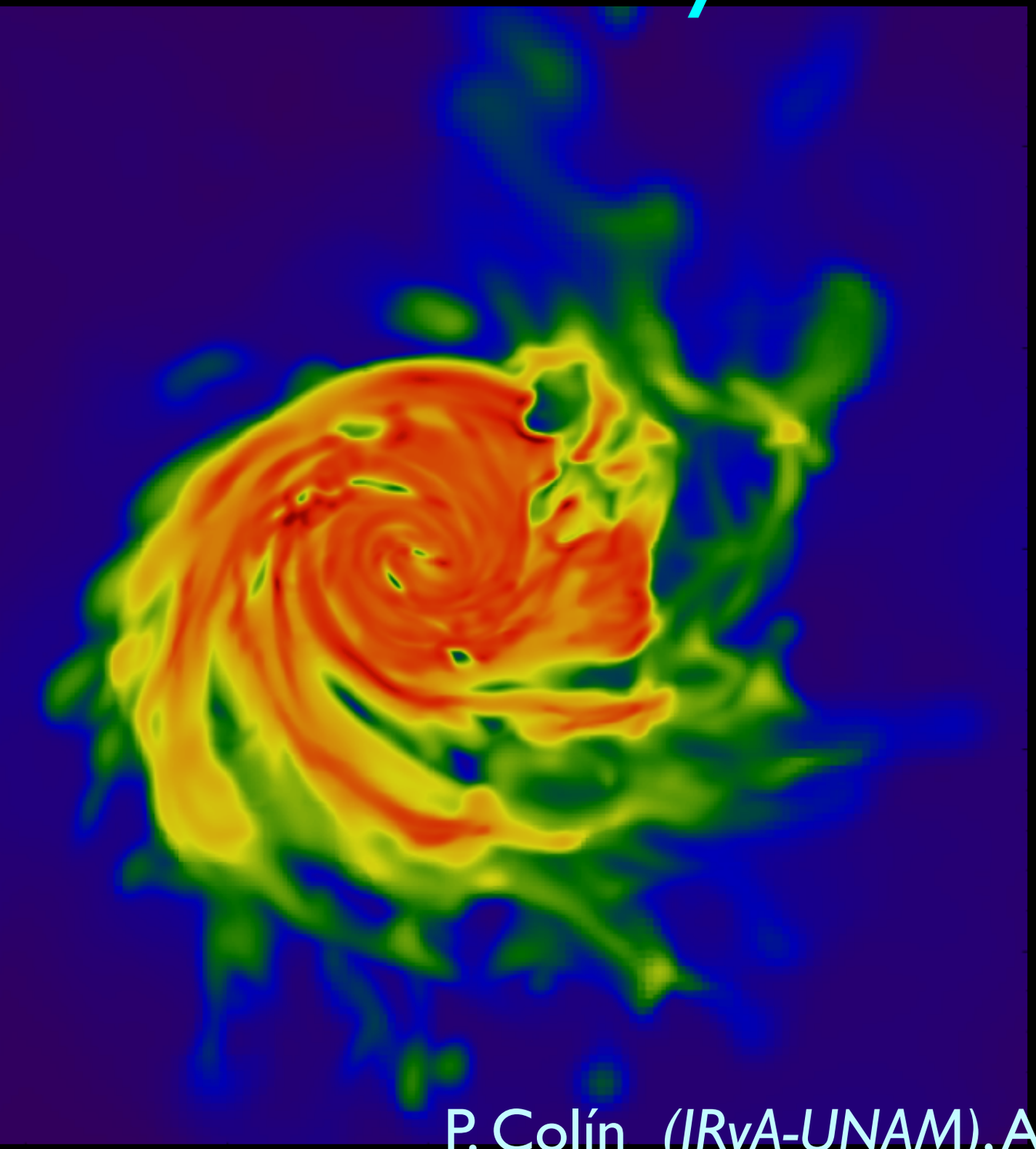
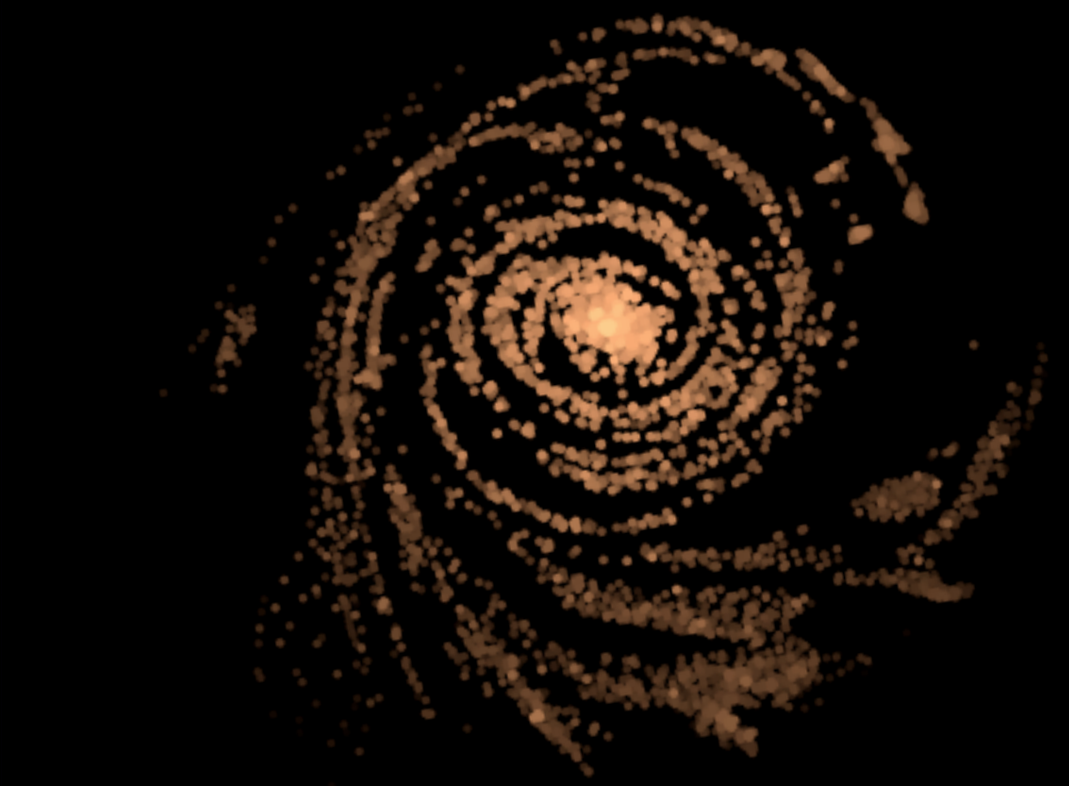




P. Colín *(IRyA-UNAM)*, A. González-Samaniego *(UC-Irvine)*,
H. Ibarra-Medel, S. Sánchez, Octavio Valenzuela *(IA-UNAM)*

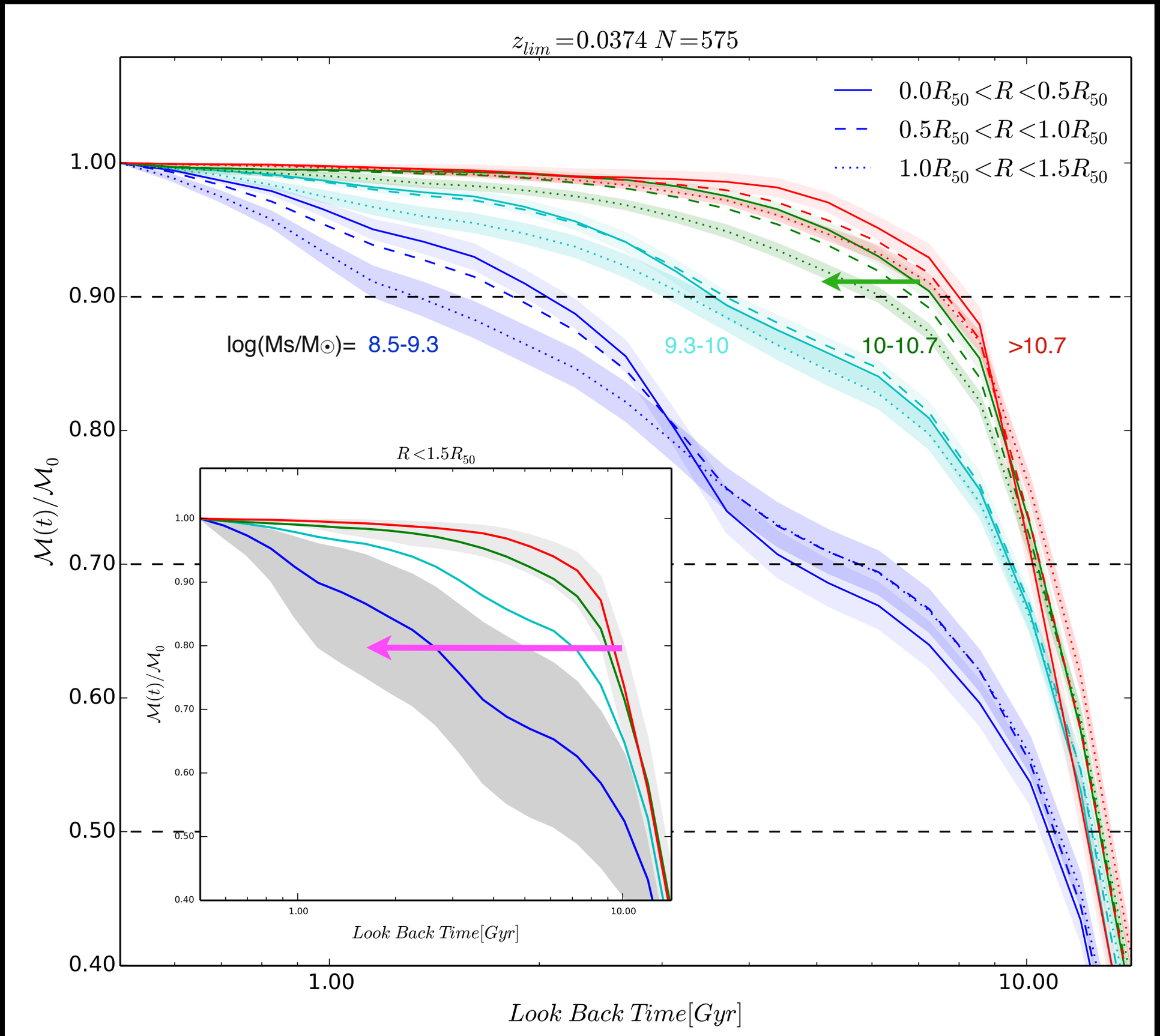
Spatially-resolved archaeological mass growth histories (MGHs)

- MaNGA galaxies *(Bundy+ 2015)* analyzed with the fossil record software Pipe3D *(Sanchez+2016).*

- *Ibarra-Medel+ (see Poster 6)*

- Downsizing

- MW-sized galaxies: clear inside-out mode

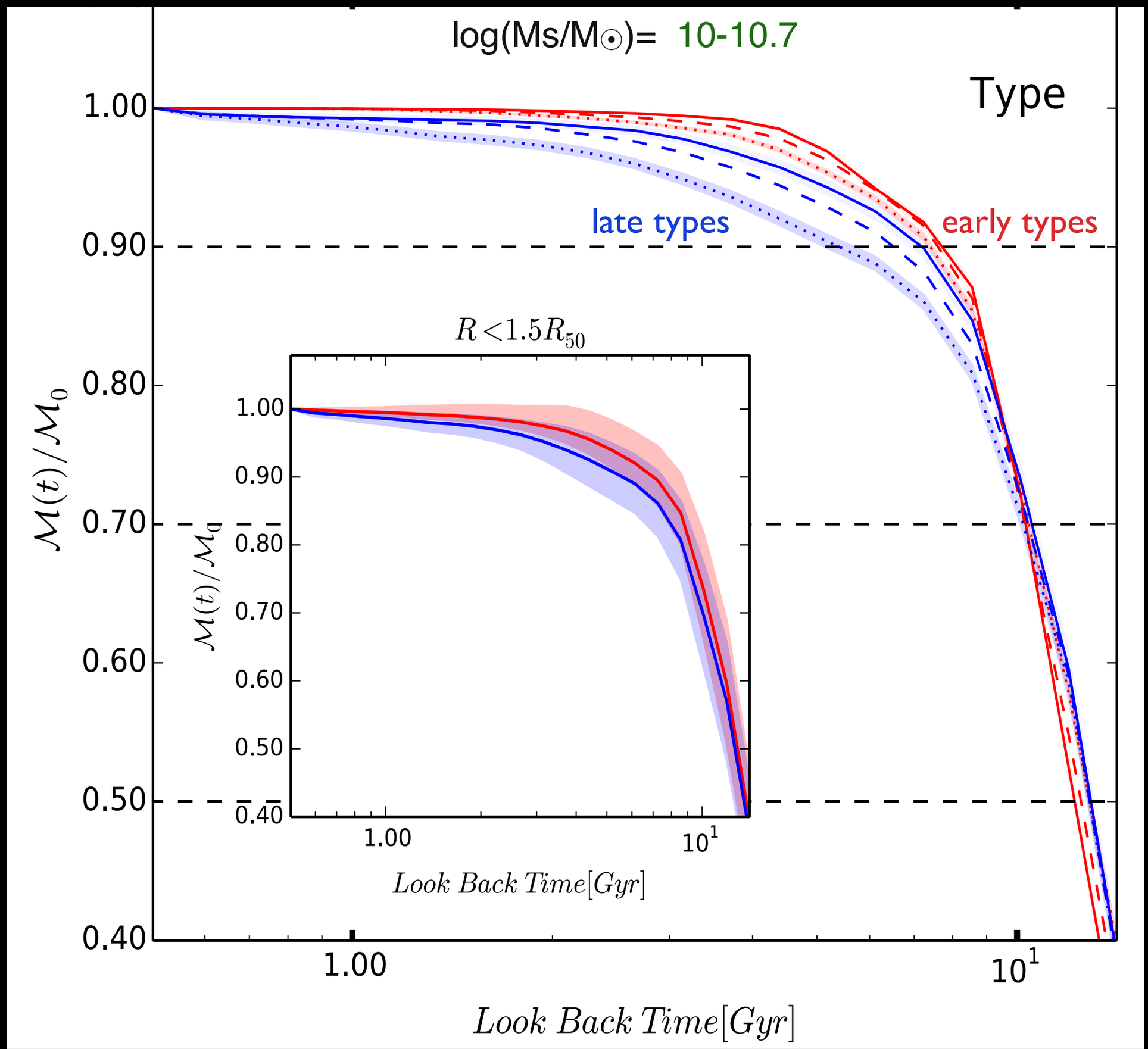


Spatially-resolved archaeological MGHs of MW-sized gals

Late-type gals have a more pronounced inside-out assembly mode than early-type gals.

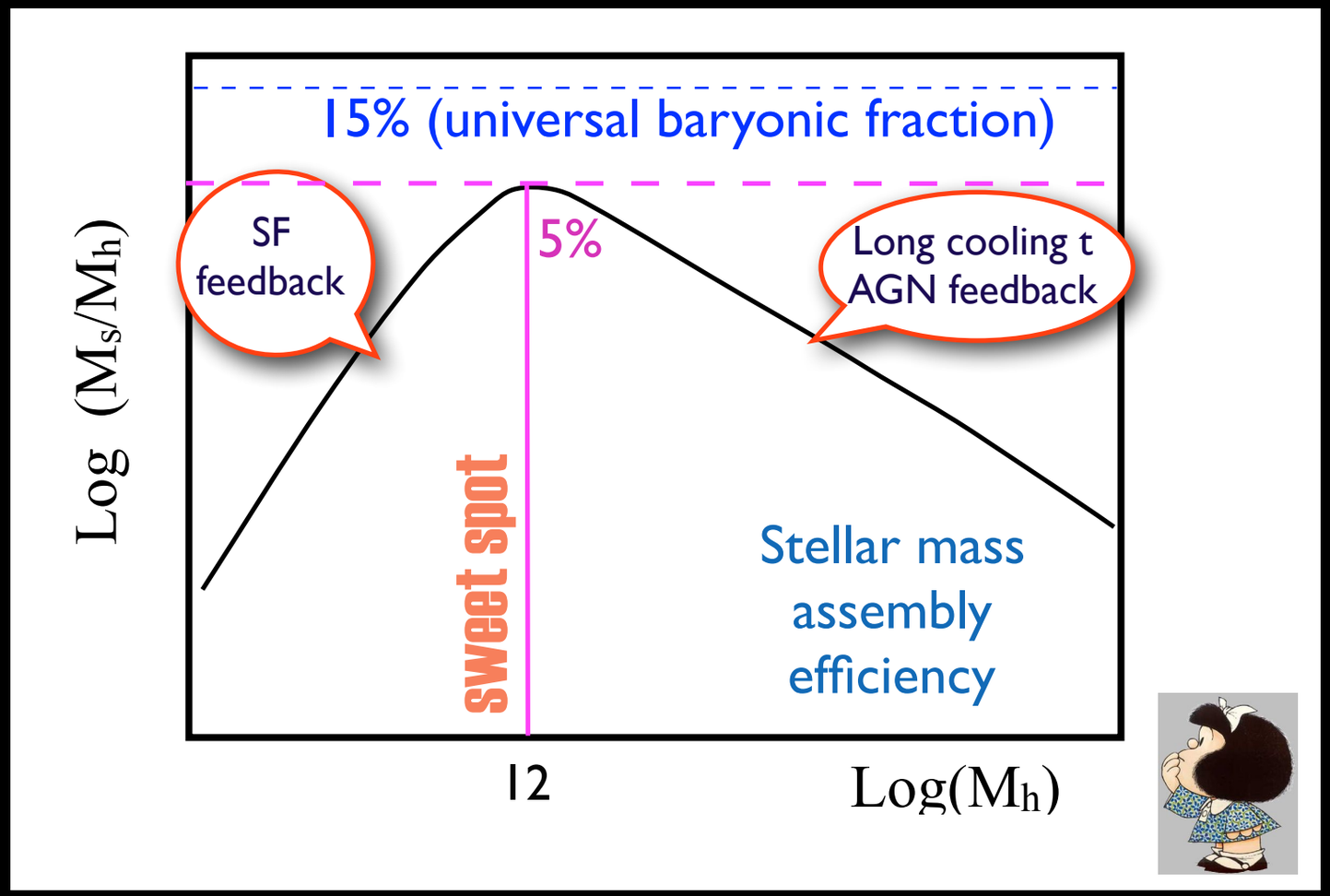
Do the archaeological MGHs trace the intrinsic mass assembly of MW-sized gals?

(migration, mergers)



Why MW-sized gals are particularly interesting?

a) Star formation is most efficient in MW-sized halos



b) As a consequence of a), at MW scales the galaxy MGHs are the lest detached from their halo MGHs ⇒ the MGHs of MW-sized galaxies trace the cosmological dark matter halo MGHs.

Cosmological numerical simulations of MW-sized galaxies

- *N-body+ Hydrodynamics ART*: Adaptive Mesh Refinement code *(Kravtsov+ 1997; 2003)*.

- Atomic, molecular, and metal cooling; Compton cooling/heating; UV heating from a cosmological background.

Subgrid physics:

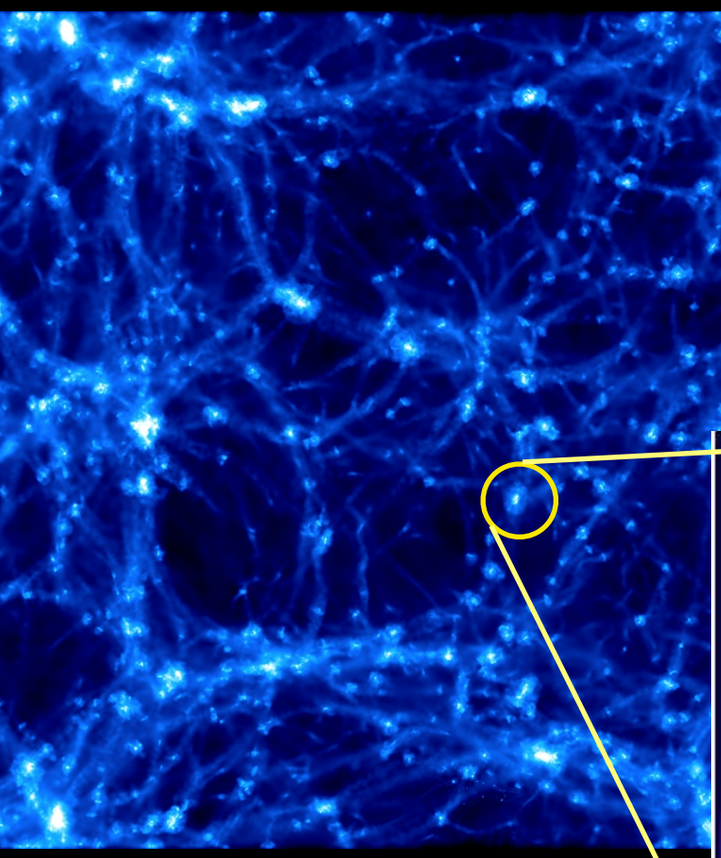
SF: in cold and dense enough gas cells (T_{SF}, n_{SF})

f

Stellar feedback (*SN* + *winds*): instantaneously injected as thermal energy

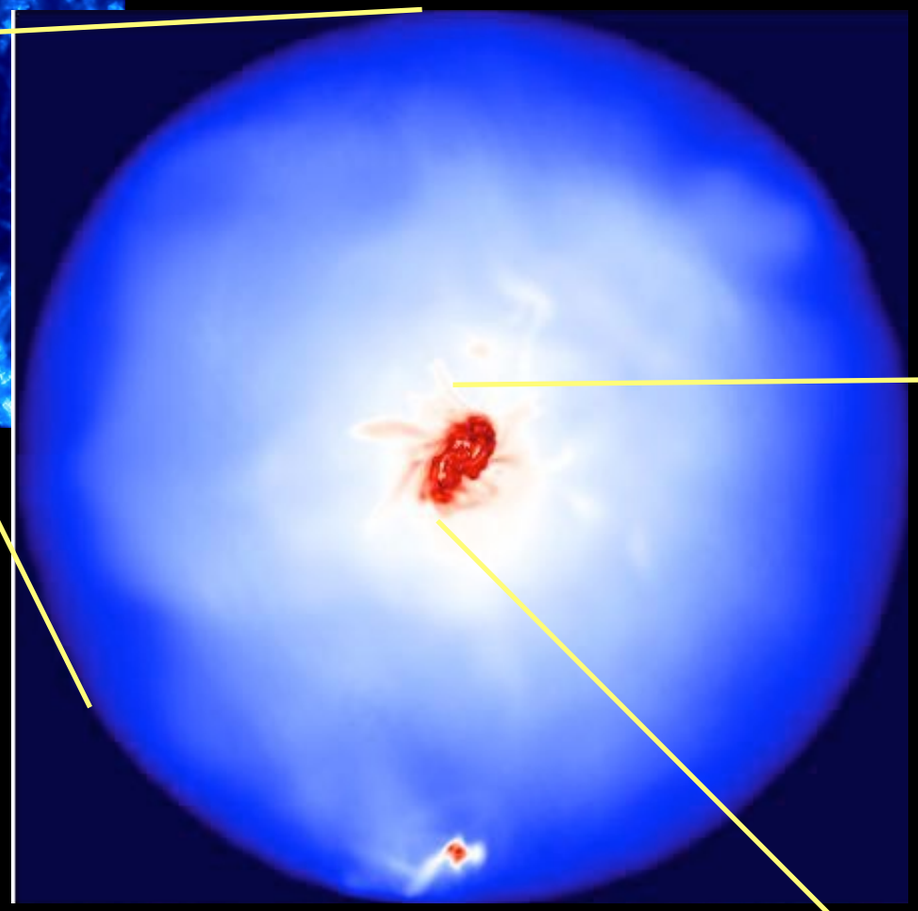
Colin+ 10 (ApJ, 713, 535); Avila-Reese+ 11 (ApJ, 736, 134); González-Samaniego+ 14 (ApJ 785, 58)

Zoom-in simulations of "field" MW-sized halos



Low-resolution N-body simulation of a cosmological box.

Select a particular halo and resimulate with high resolution + baryons (hydrodynamics)



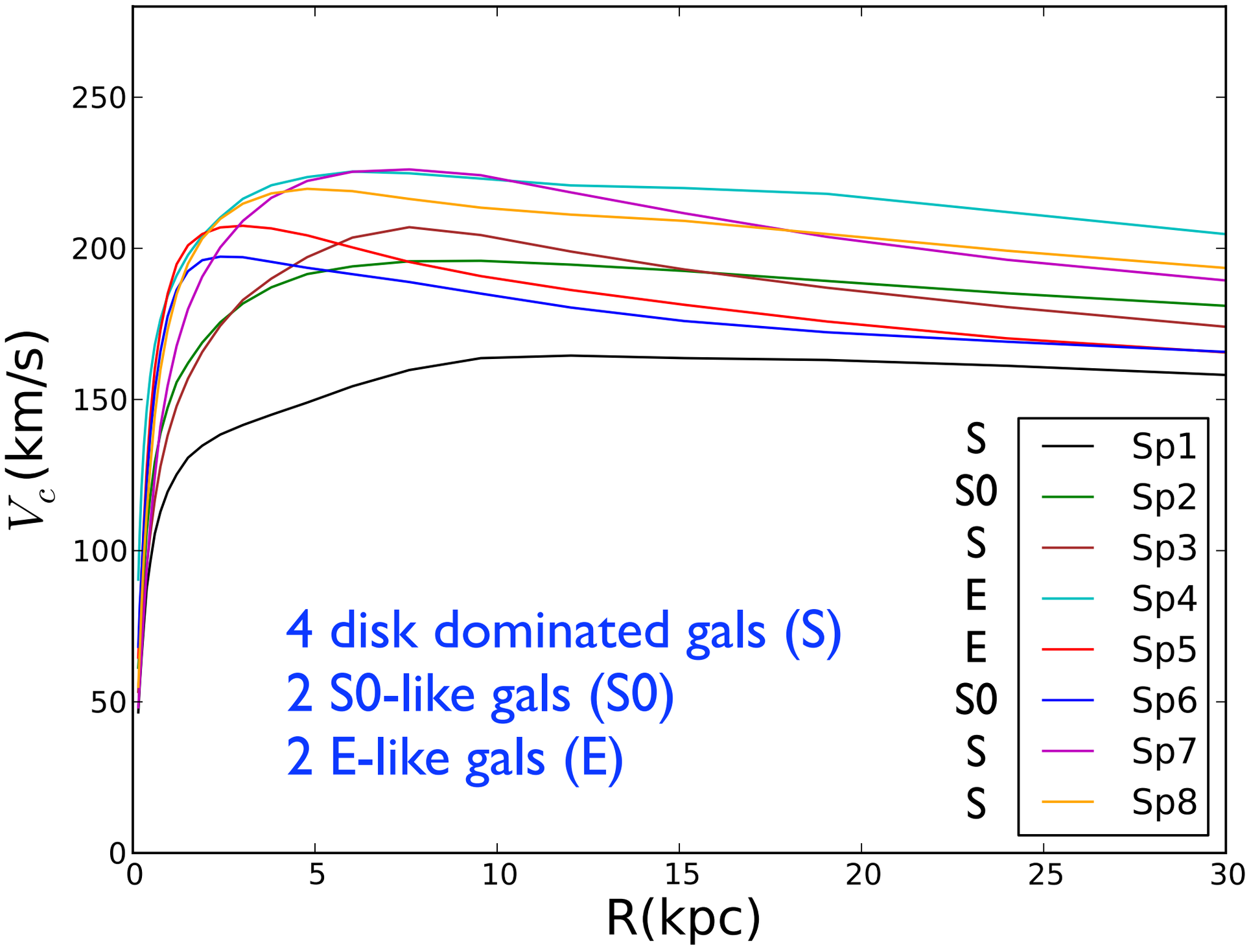
+subgrid physics.
A galaxy with DM, gas, and stars is formed in the cosmological context

- Particle mass: 10^6 $h^{-1}M_\odot$, 1.5-2 M particles. Spatial resolution of ~100 h^{-1}pc (allowed up to 12 refinement levels).

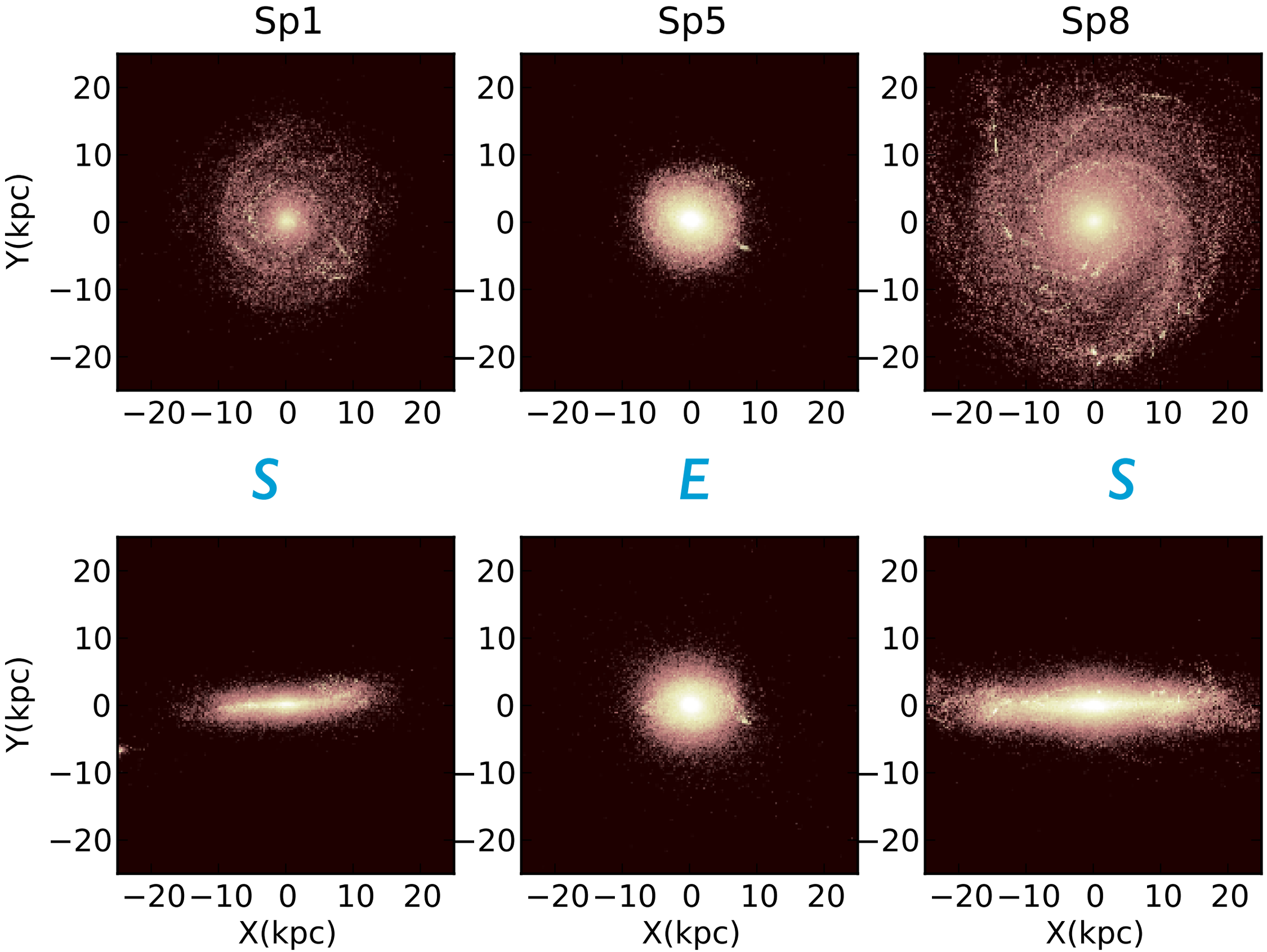
RESULTS: General properties *(Colín, A-R+ submitted)*

Eight "field" galaxies in the *2-8x10*^{10} $M_\odot$ stellar mass range.

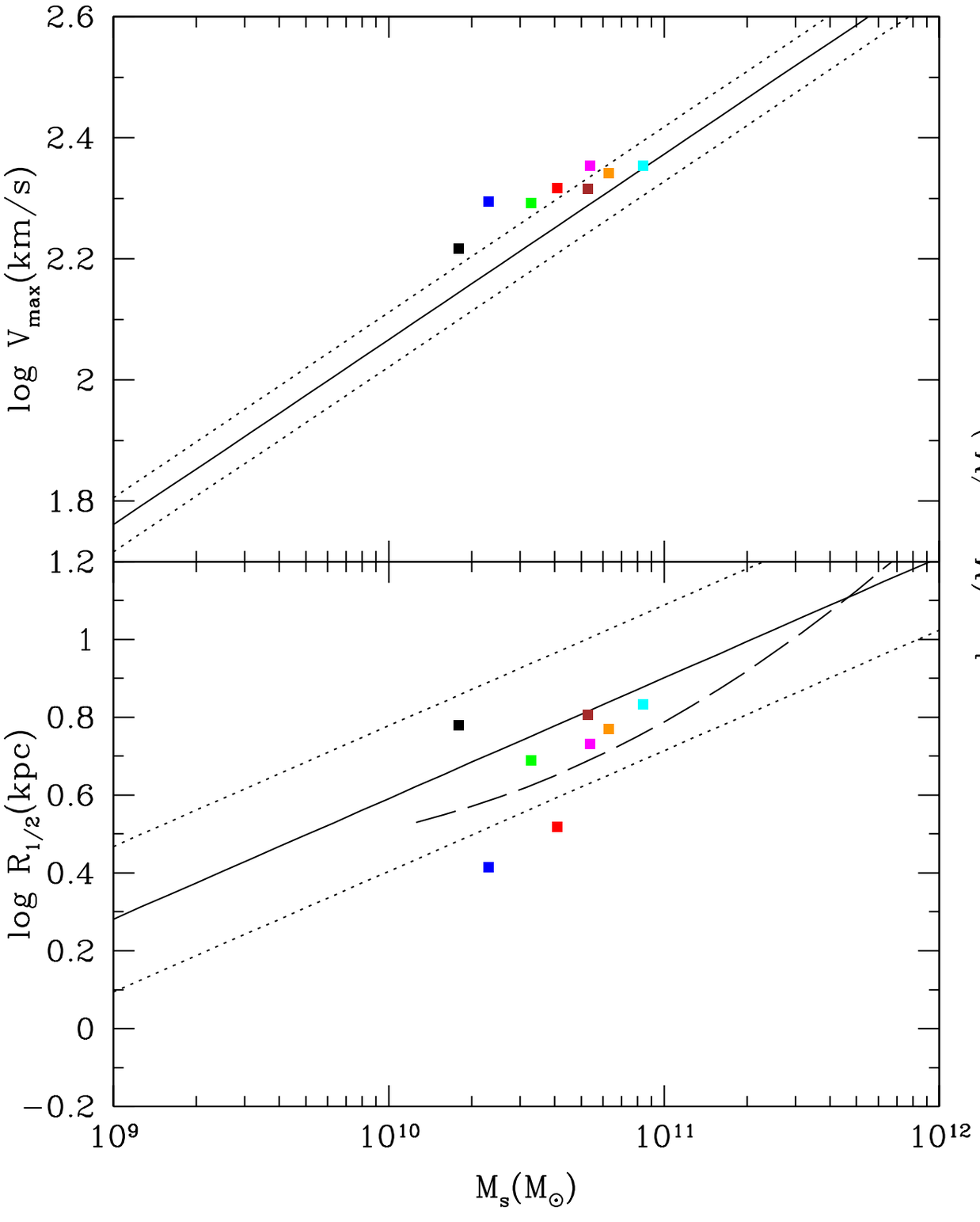
Nearly flat rotation curves.

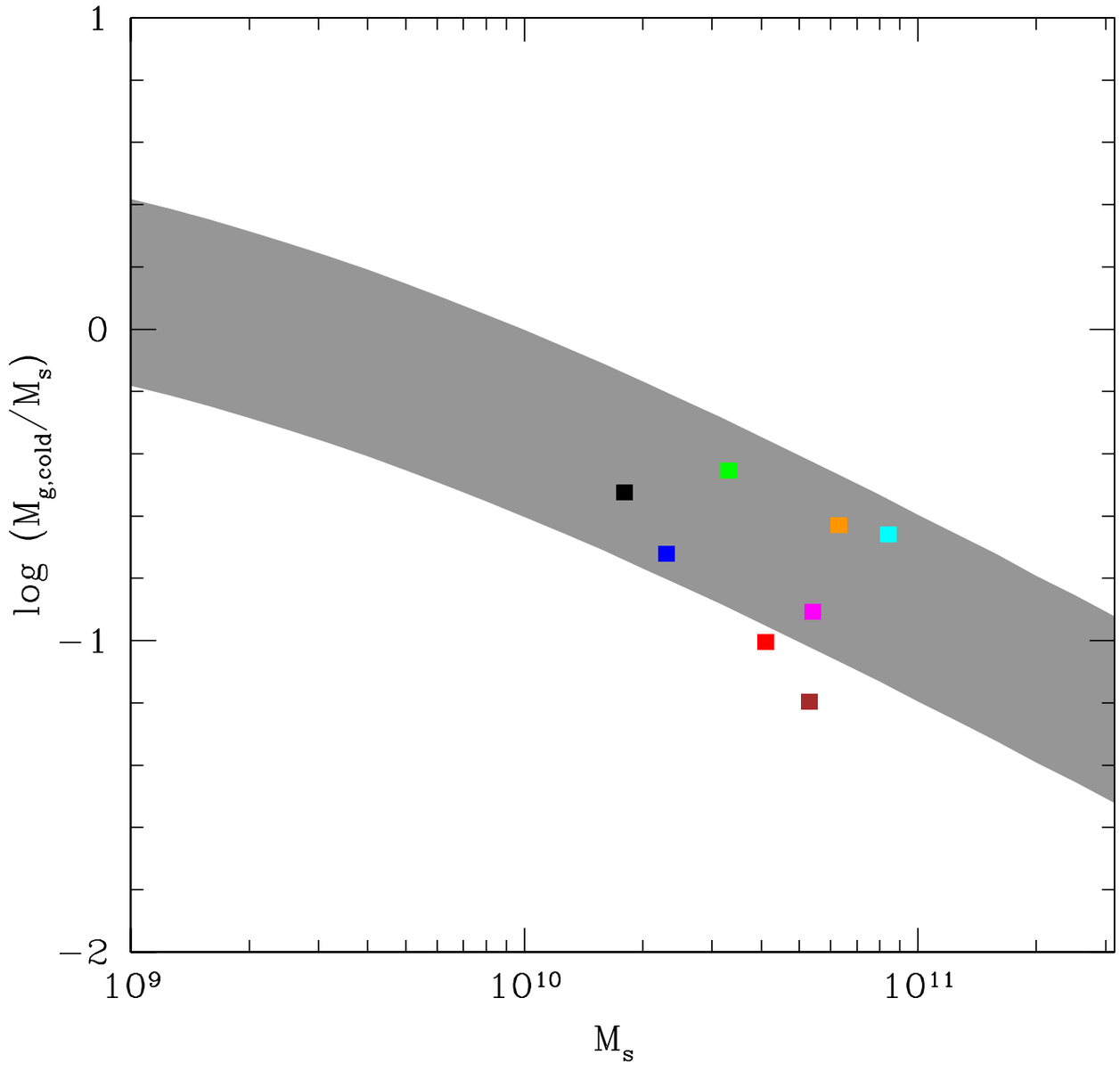


R band face-on and edge-on projections



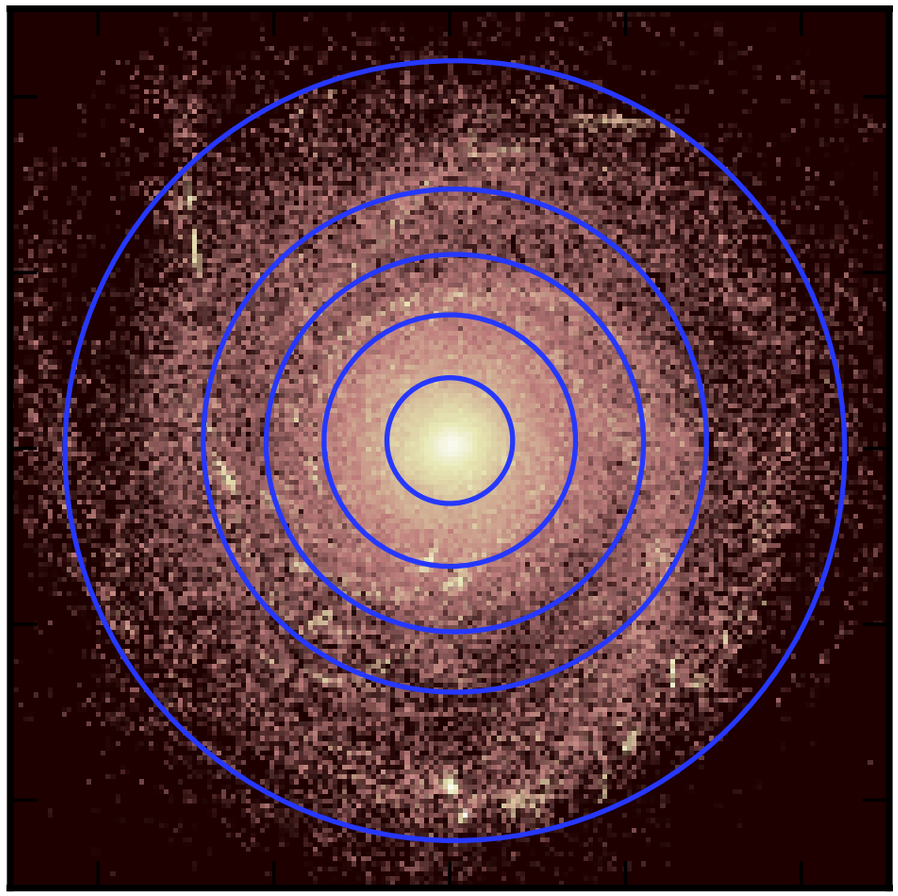
The disk-dominated gals are in agreement with the TF, R_e-M_s, f_{gas}-M_s, j_s-M_s relations of disk gals. All agree with the semi-empirical M_s-M_h relation.





Spatially-resolved MGHs normalized to the *z=0* masses

(Avila-Reese+, in prep.)



At each radial bin we calculate different MGHs:

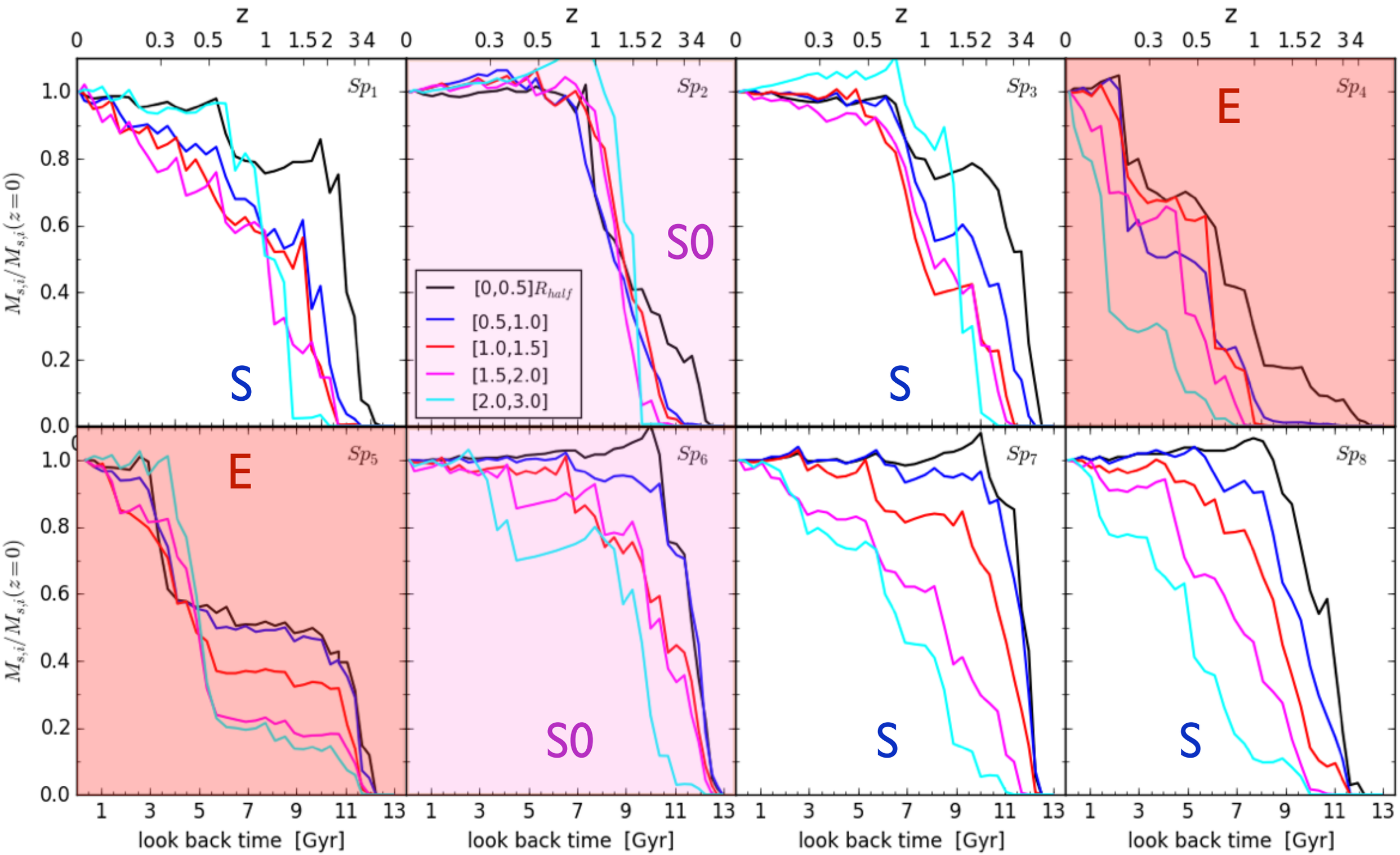
1) In-situ MGH: accumulated mass as a function of time in stars formed in the given radial bin (it takes into account stellar mass losses).

2) Current MGH: accumulated mass as a function of time in stars as measured in a given radial bin (stars formed in situ + stars aggregated from outside - lost stars)

3) Archaeological MGH: cumulative age distribution of stars as measured at z=0 in a given radial bin (they are therein today but could have been formed in other place)

1) In-situ normalized MGHs at different radial bins defined at z=0 (in units of $R_{1/2}$).

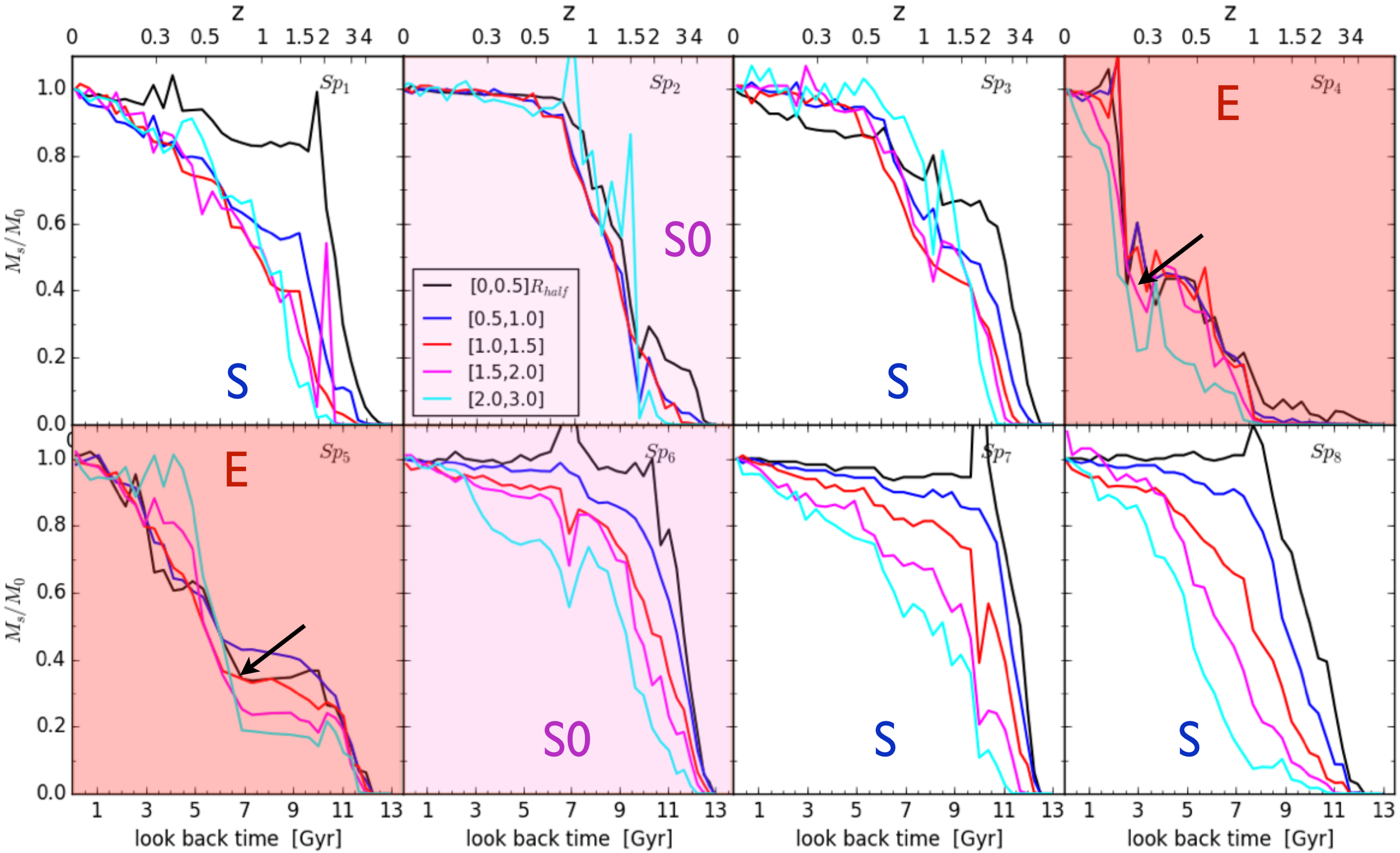
Outside-in formation.



2) Current normalized MGHs at different radial bins defined at z=0 (in units of $R_{1/2}$)

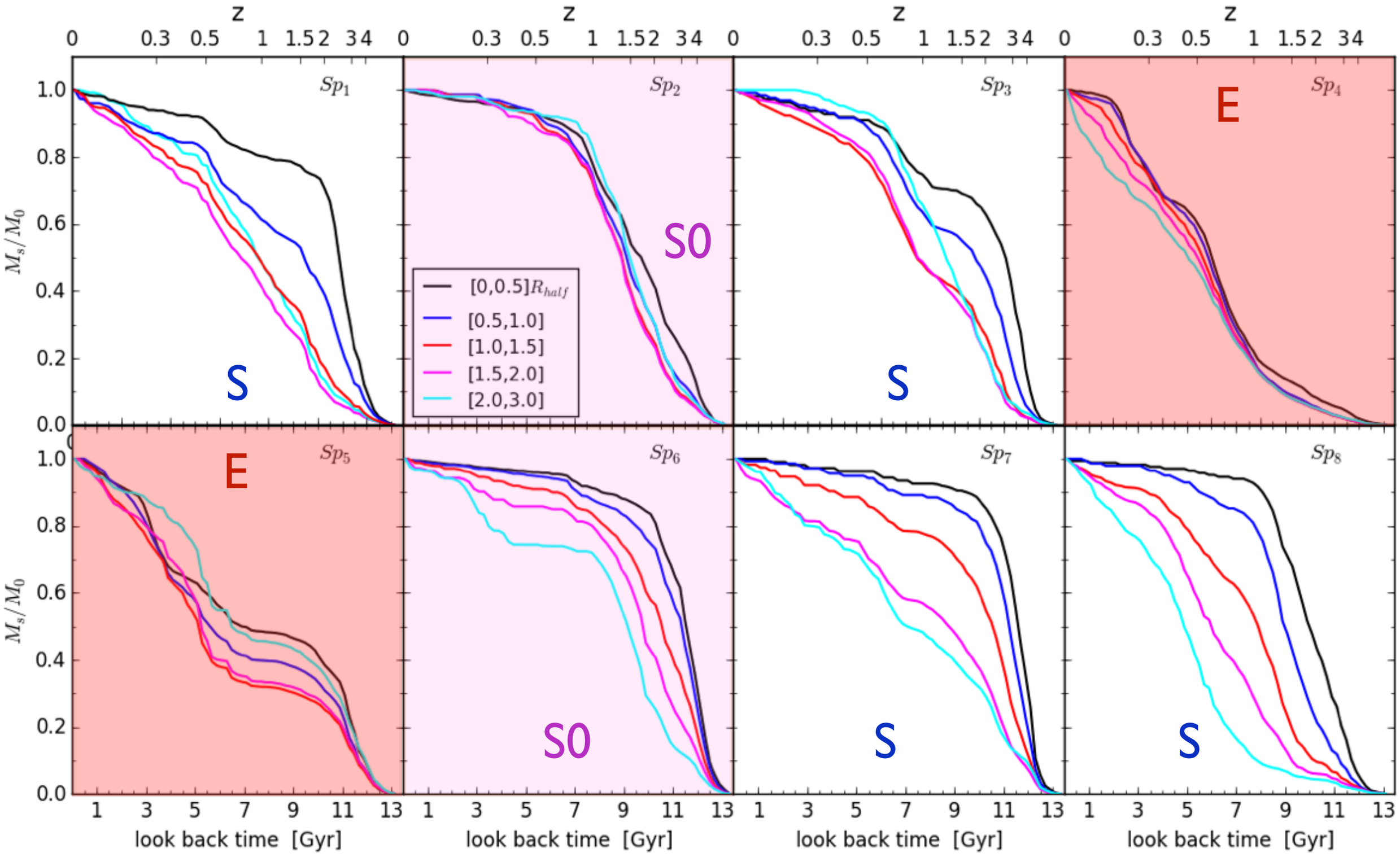
Outside-in formation. In-situ and current MGHs are similar for disk-dominated gals.

For E gals, after the mergers the current MGHs tend to become homogenous.



3) Archaeological normalized MGHs at different radial bins defined at z=0

Outside-in formation (less for E/S0 galaxies)



Current normalized MGHs at different radial bins defined at z=0 (in units of $R_{1/2}$)

Outside-in formation. Archaeological and current MGHs are similar for disk-dominated gals.
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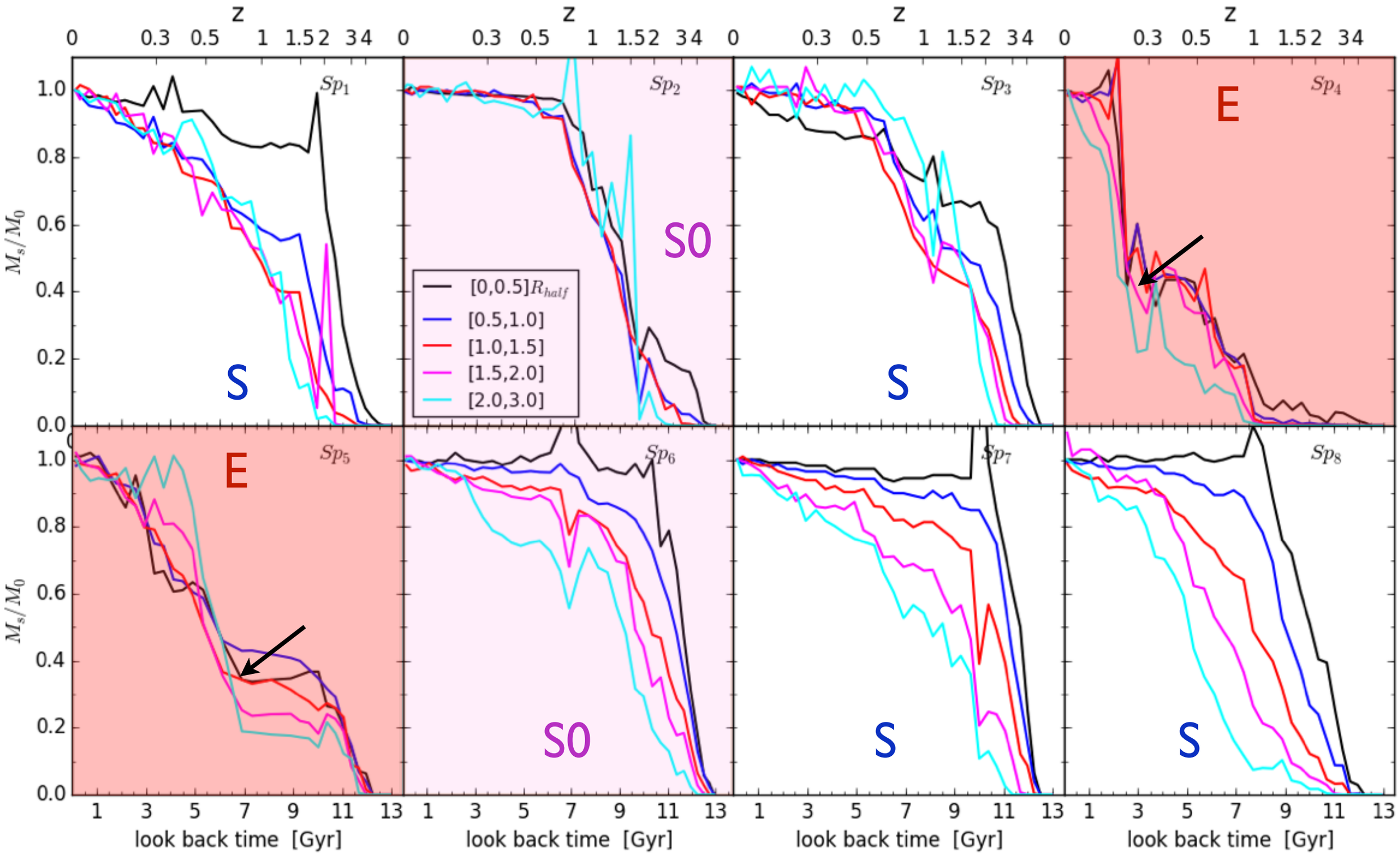
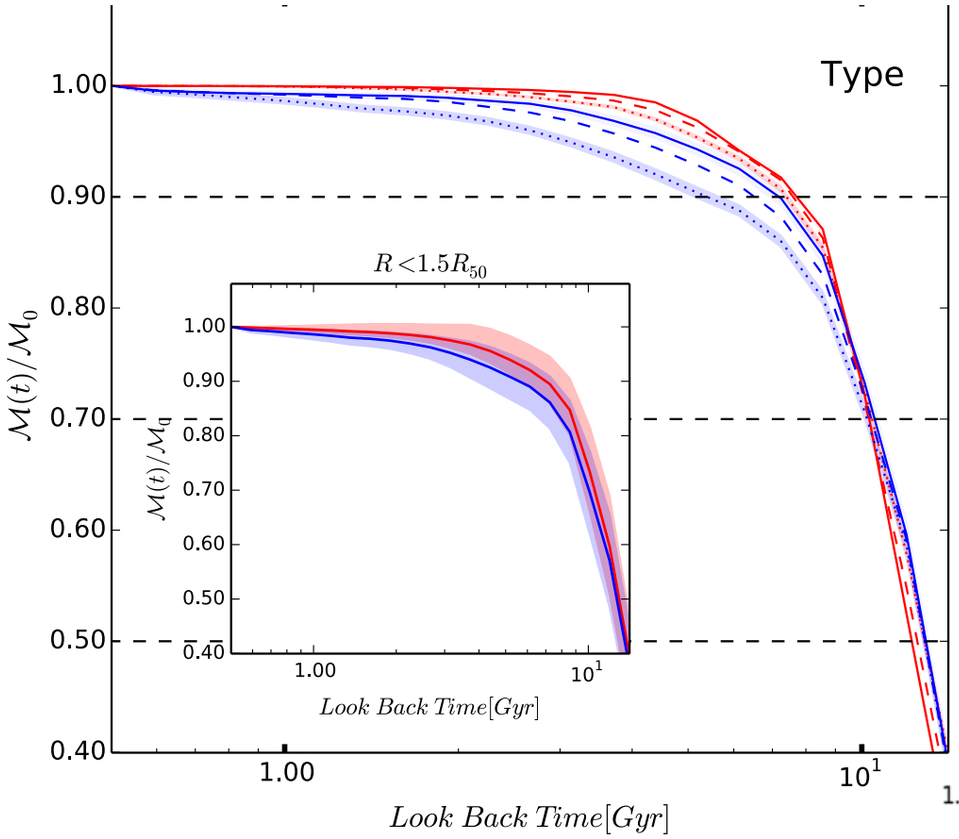
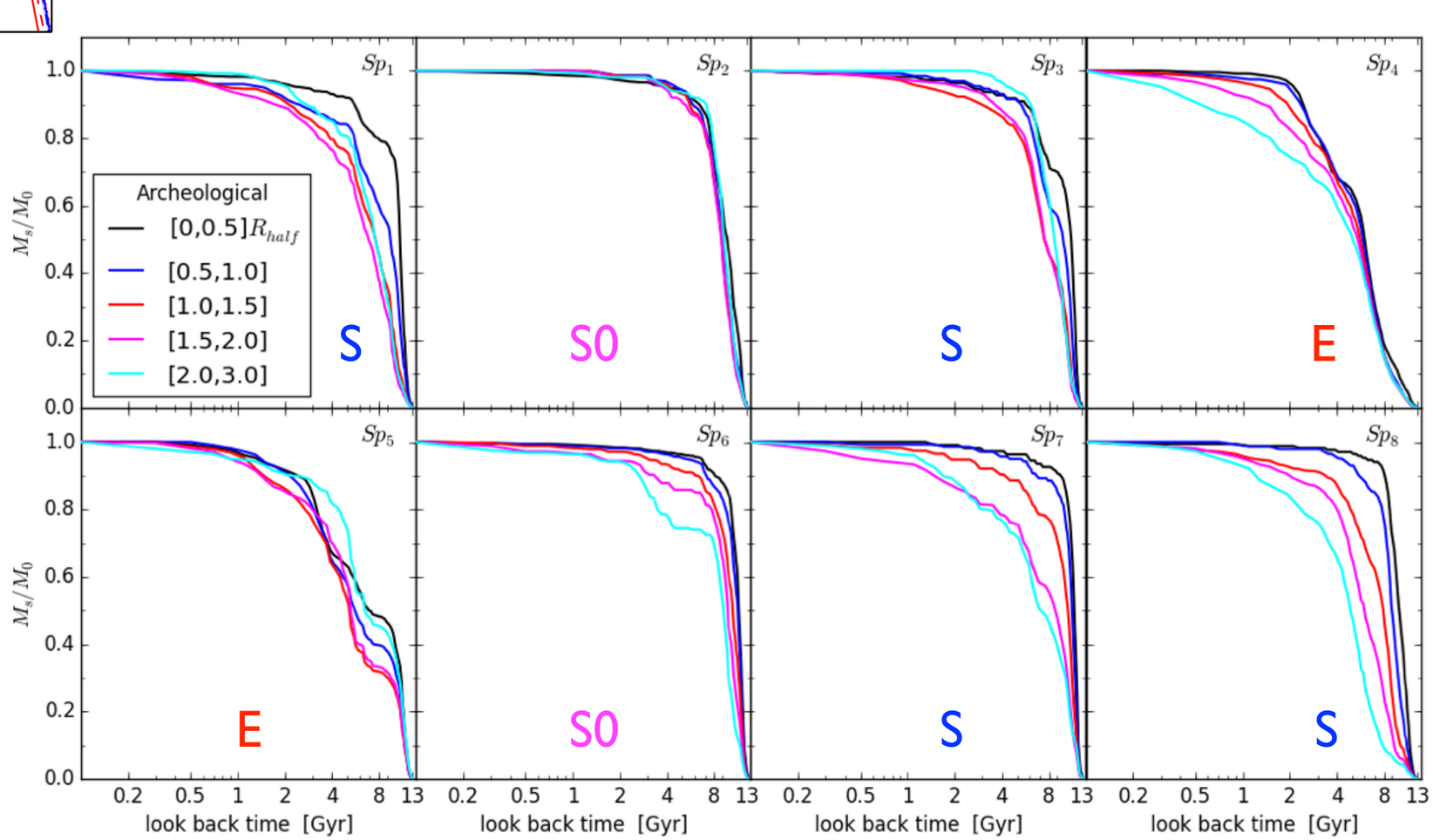


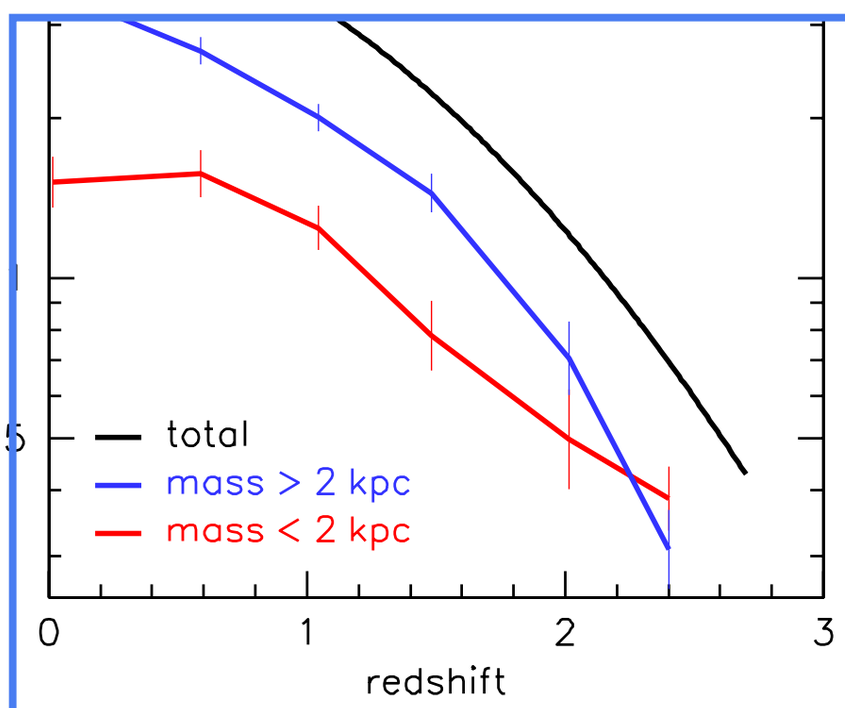
Archaeological normalized MGHs: sims vs obs



The inferences from MaNGA (Ibarra-Medel+ 2016, poster 6)

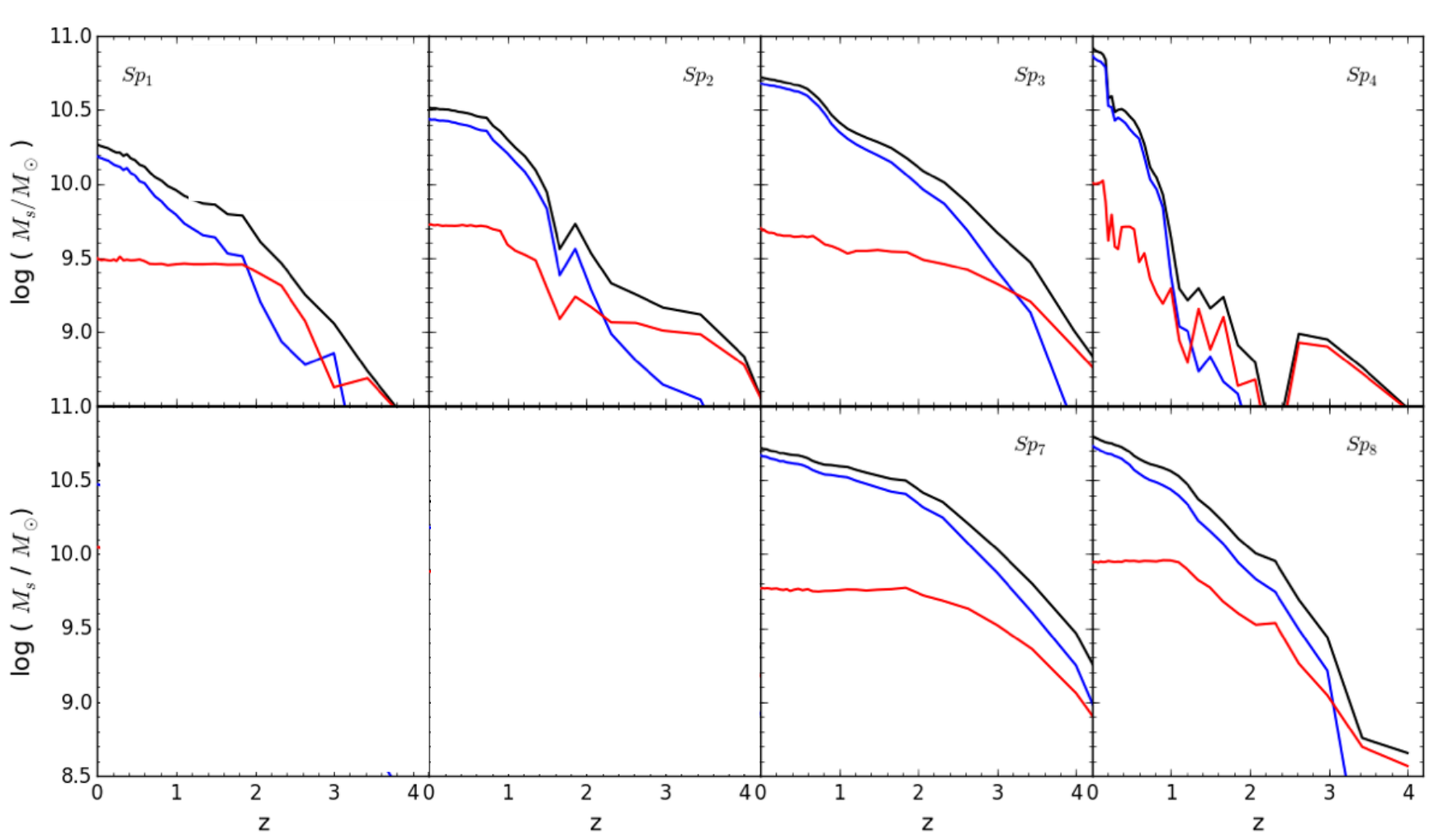
The LCDM-based simulations





MGHs from CANDELS observations of disk MW-sized galaxies at different z's *(van Dokkum + 2013)*

The LCDM-based simulations



Conclusions

- Simulated disk-dominated MW-sized galaxies assemble their stellar mass ***from inside to out.***
- The spatially-resolved MGHs measured for stars formed in-situ, for all stars, and those inferred archaeologically (as from observations) are similar. Therefore, *the effects of migration and ex situ star formation in the simulations are small.*
- Spheroid-dominated MW-sized galaxies assemble from inside to out but after the merger(s) the radial MGHs tend to become more homogenous.
- The spatially-resolved MGHs of MW-sized disk galaxies inferred *1) by means of the fossil record method from MaNGA, and 2) by observations at different z's* are in agreement with the simulations.

For S gals, M_s and M_{bar} follow M_{vir} since the last 7-10 Gyr