

Observations of satellite galaxies in groups at $0 < z < 2.5$

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UCSC Galaxy Workshop

8/12/2013

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Galaxy evolution in groups

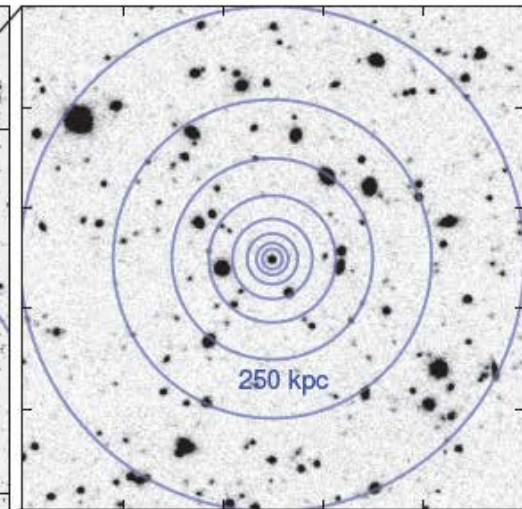
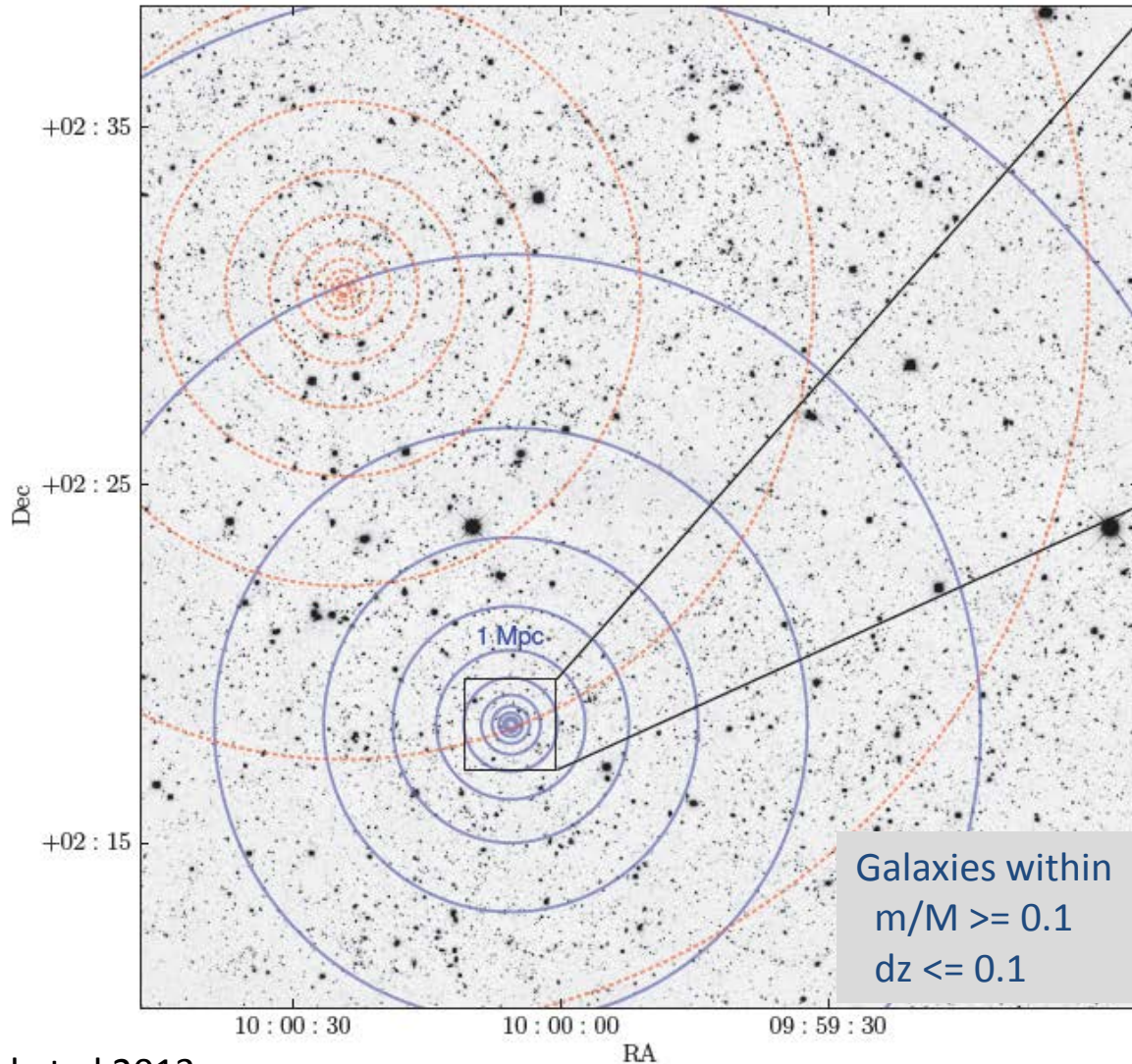
Most galaxies reside and evolve in groups

- At low redshift (redshift surveys):
 - Individual halos
 - Overall environment and halo properties: statistically (e.g., clustering, lensing)

Alternative: statistical background subtraction

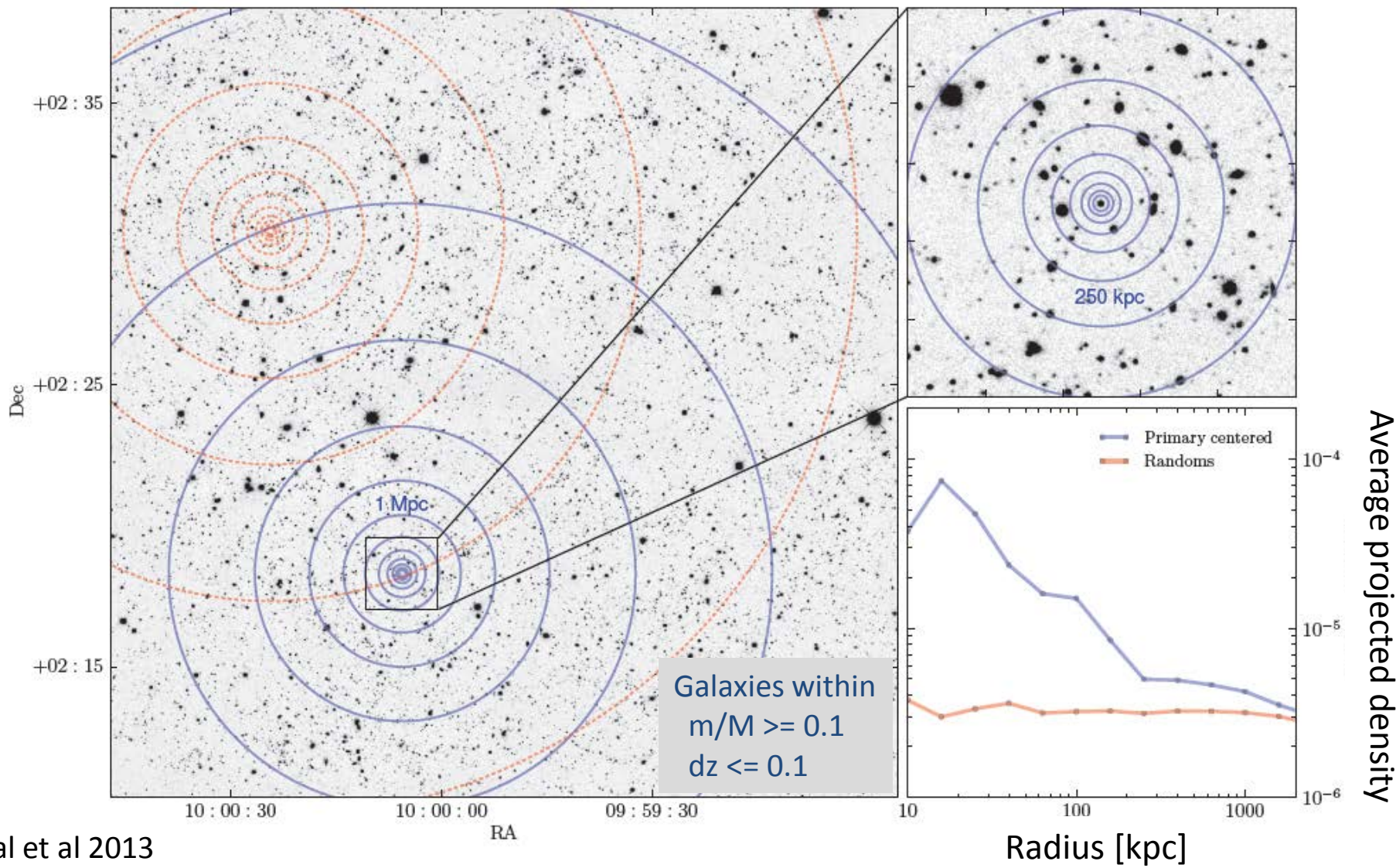
(does not require spec-z so can go to higher redshift)

Statistical background subtraction



- Identify most massive galaxies
- Count neighbors in $\log(r)$ bins
- Repeat in randomly selected positions

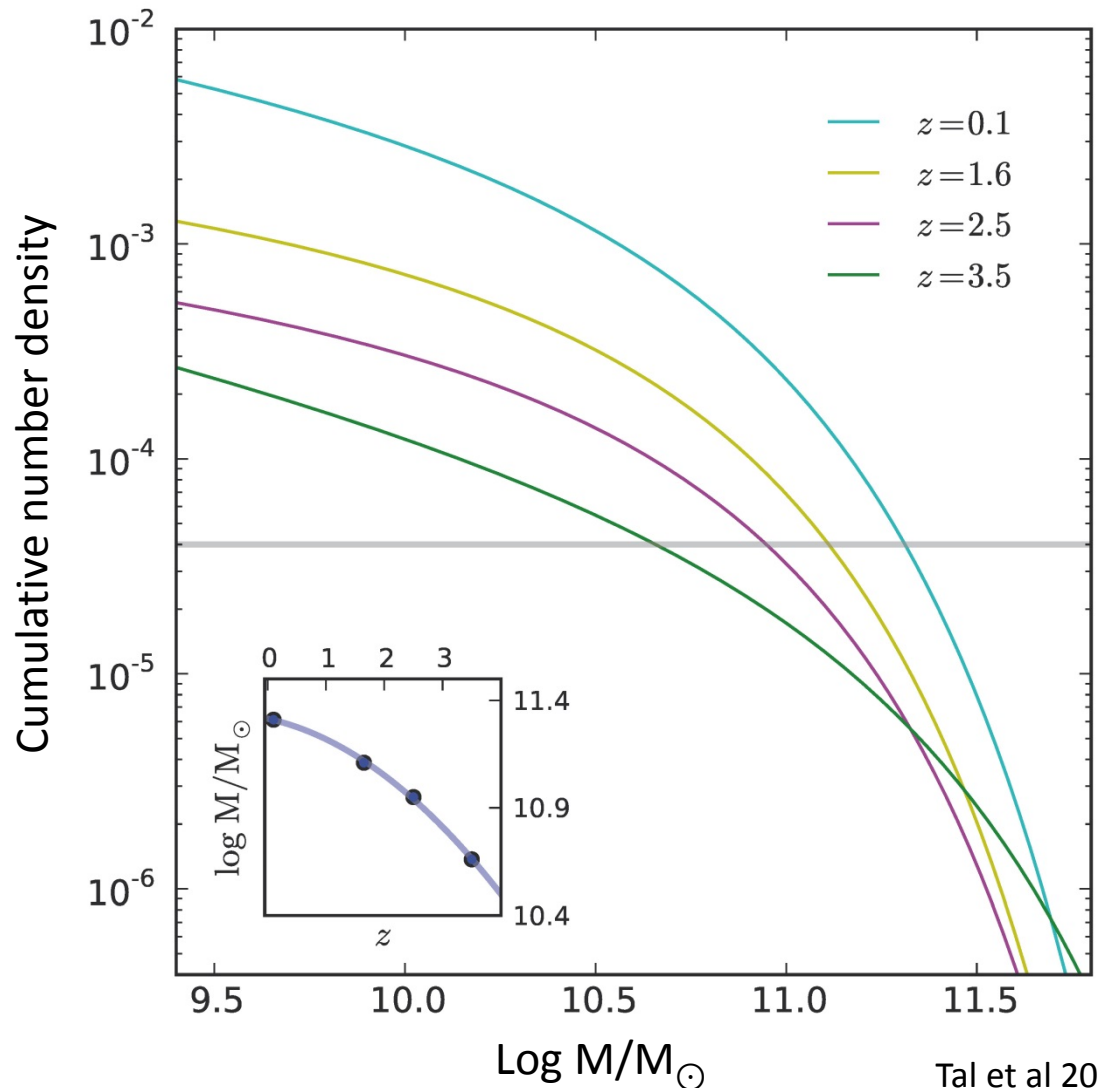
Statistical background subtraction



Cumulative number density

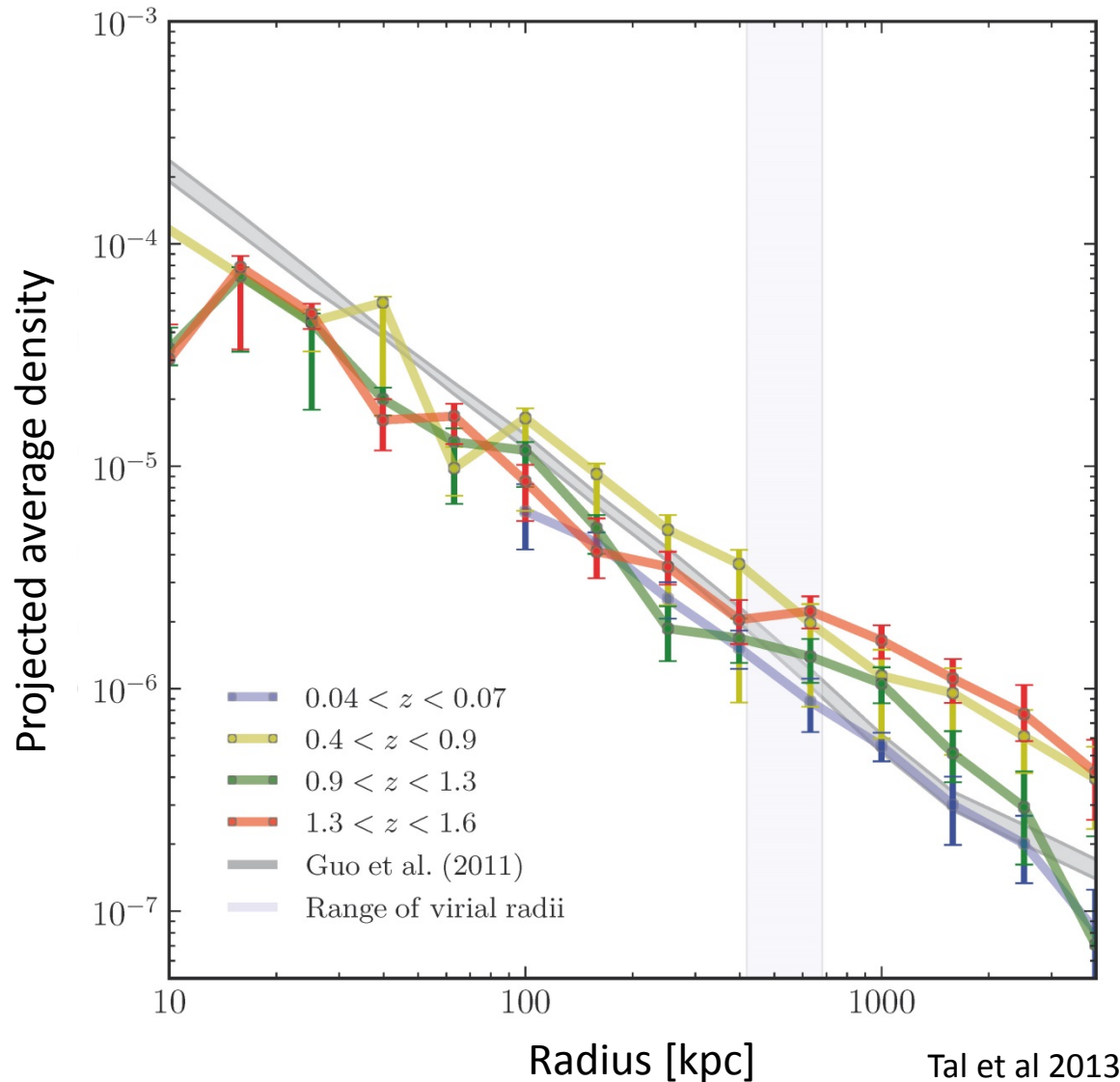
- Rank order does not evolve rapidly even in the presence of mergers
- Follow a galaxy population while **allowing galaxies to evolve in mass**

SDSS + NMBS



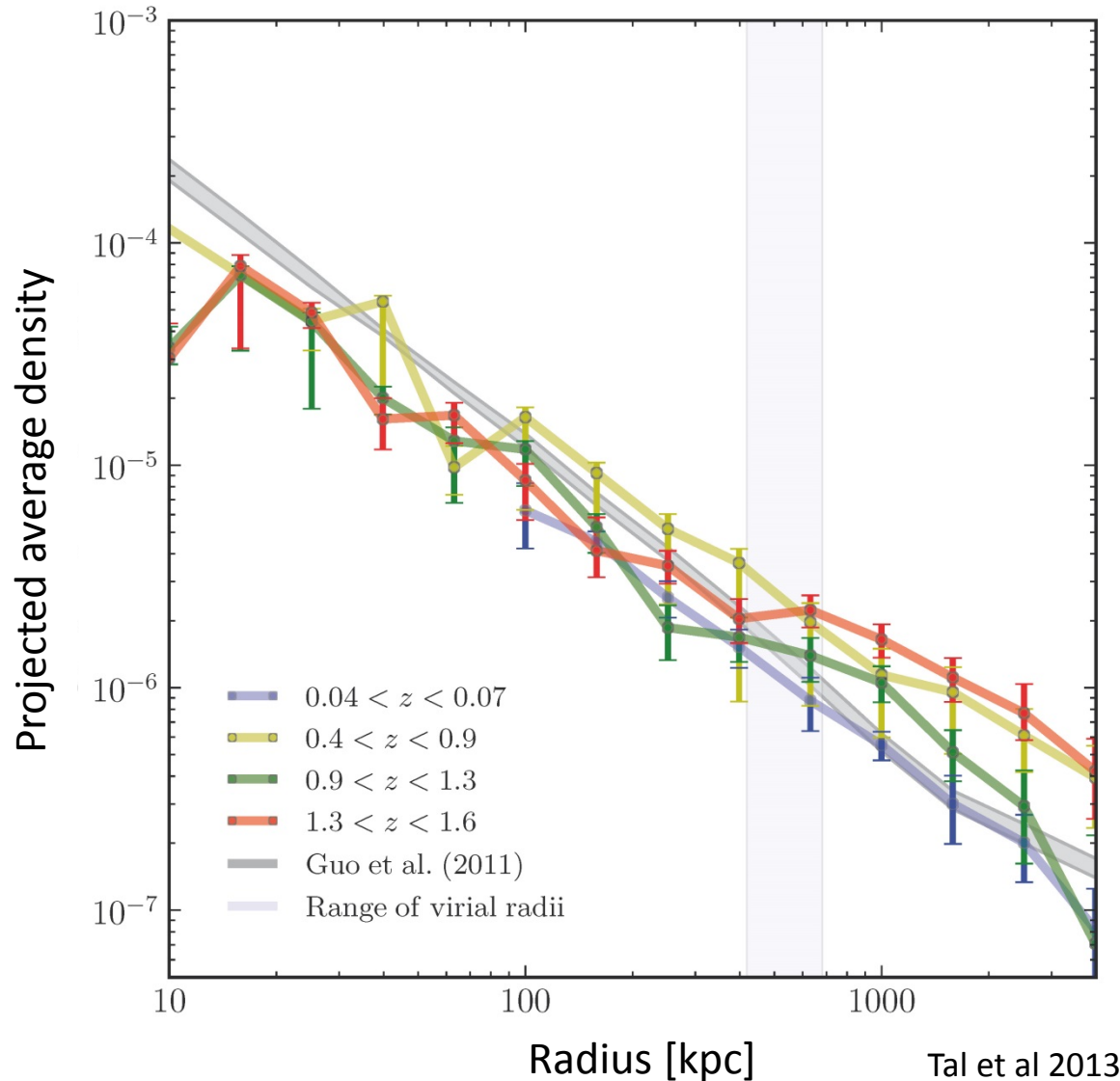
Projected number density functions

- Lack of evolution
- **Remarkable balance between mergers and accretion**



Projected number density functions

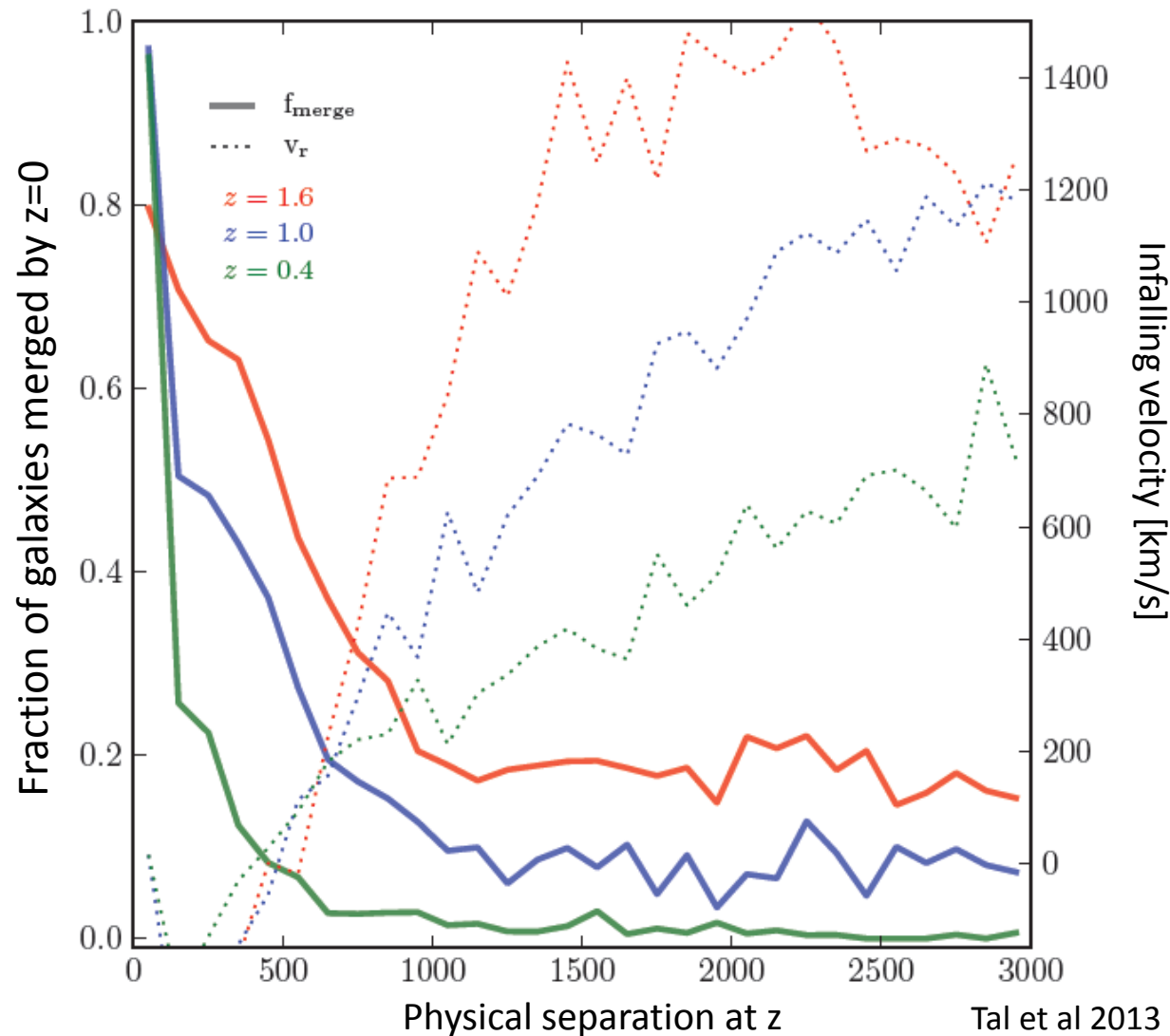
- Lack of evolution
- **Remarkable balance between mergers and accretion**
- Agreement with Guo+11 SAM



Evolution in semi analytic models

Insight from G11:

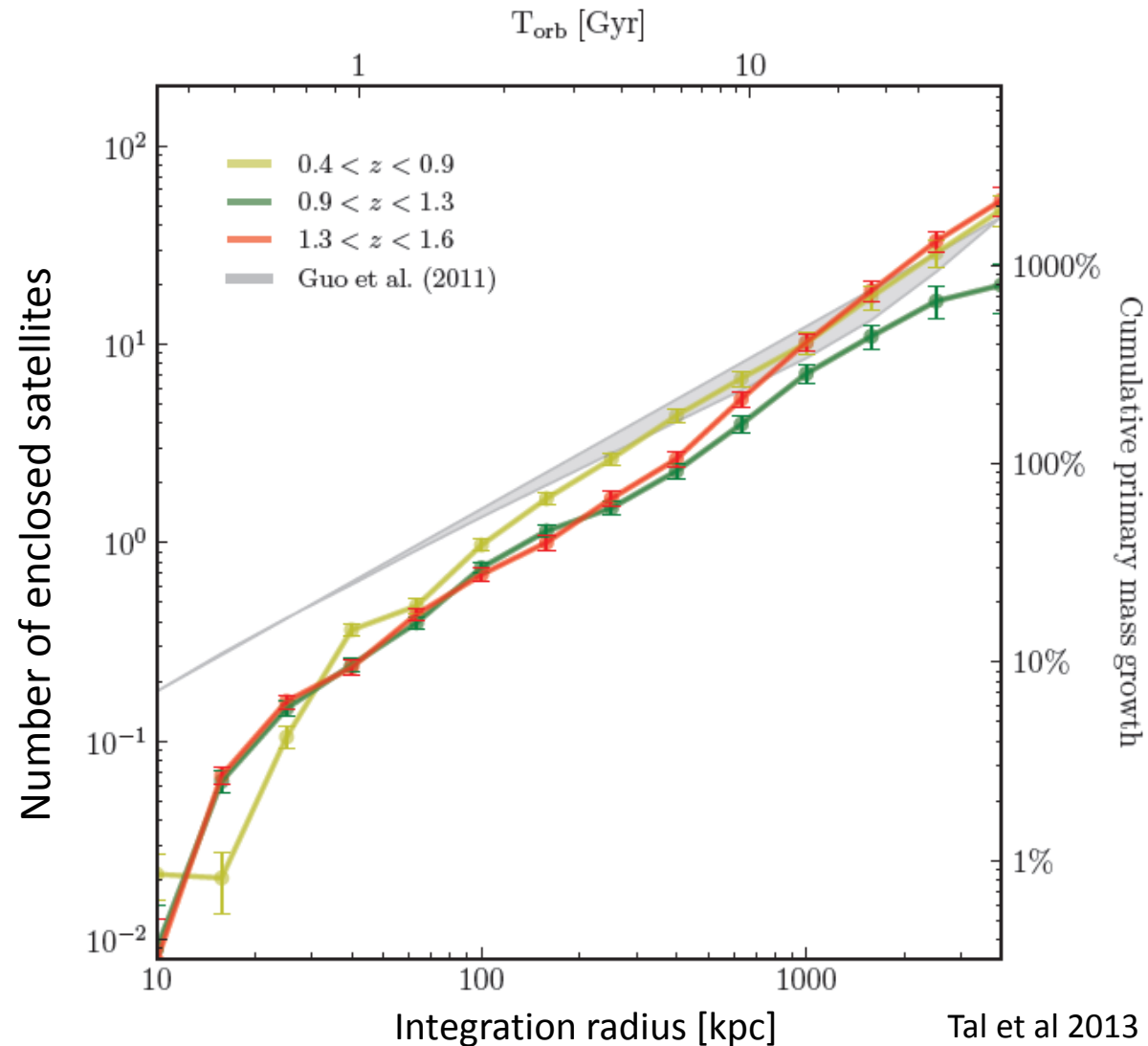
- Most satellites at $1 < r/\text{Mpc} < 3$ are on extreme orbits
- Galaxies inside the virial radius gradually merge with primary



1. What is the potential for growth through mergers (is there enough mass to support observed growth)?
2. Are satellite galaxies even affected by their group environment?

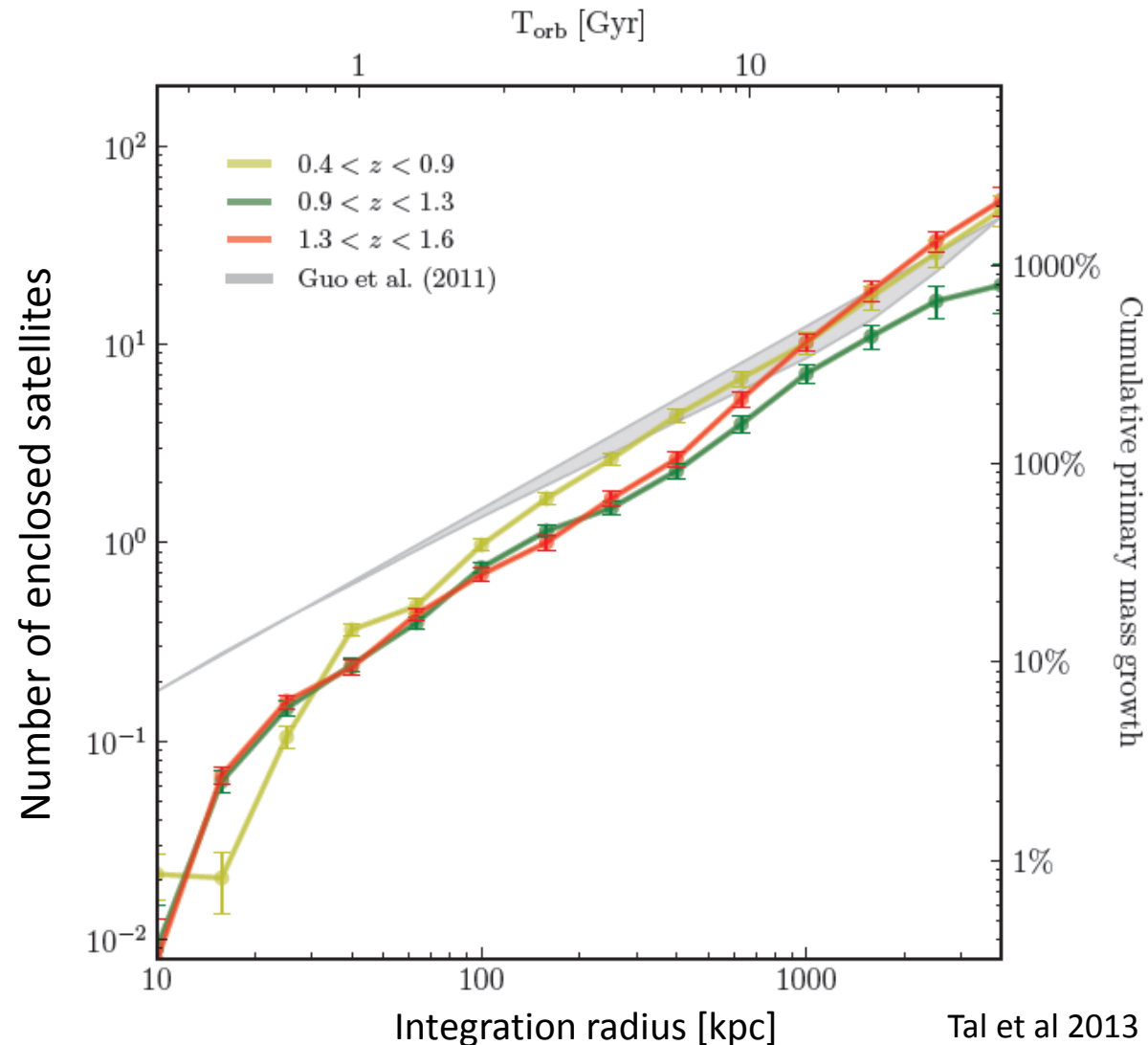
Typical massive galaxy environment

- Integrated number (mass) of satellites
- “Generalized” pair count measurement



Typical massive galaxy environment

- Integrated number (mass) of satellites
- “Generalized” pair count measurement
- Equal total stellar mass in satellites as in primary

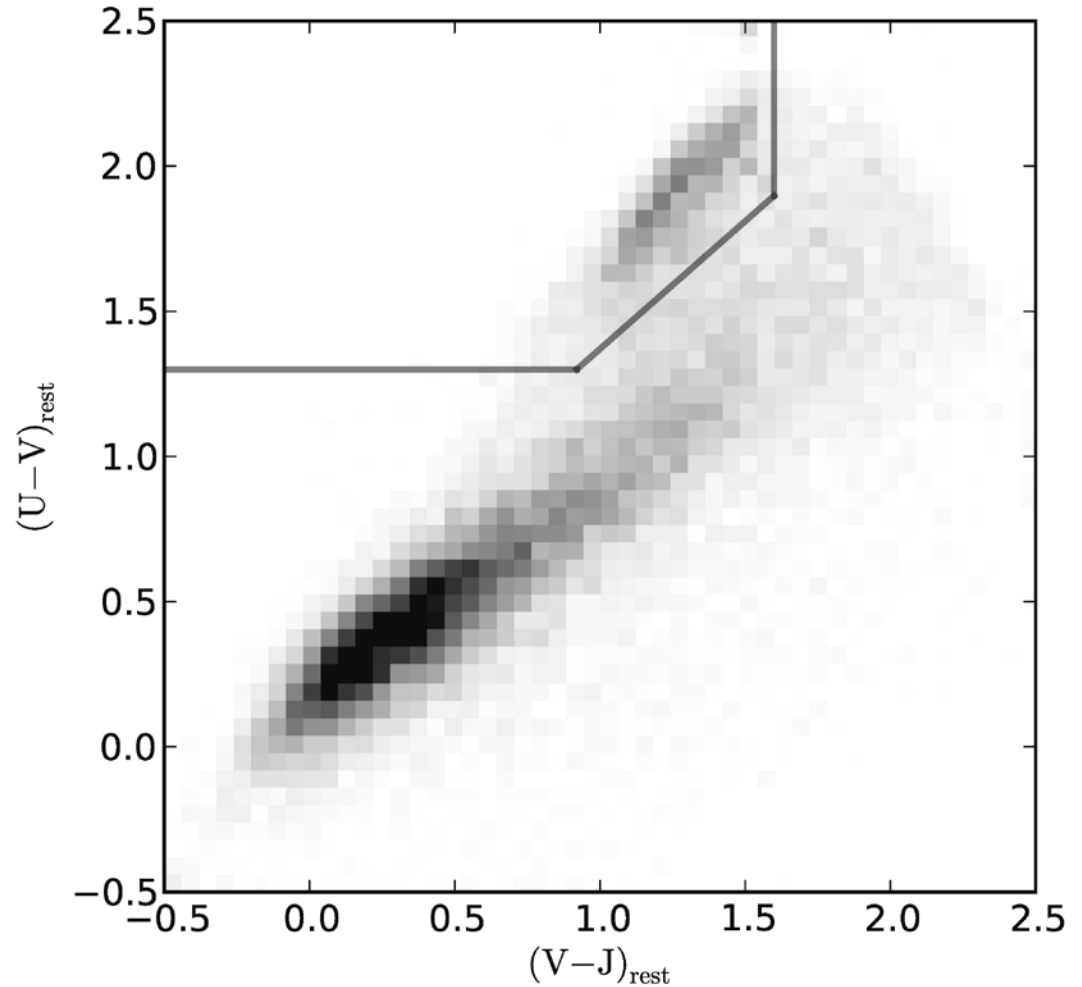


Testing environmental effects

- Groups in a large redshift range from three surveys:
 - $z \sim 0$: SDSS NYU-VAGC (Blanton+ 2005)
 - $z < 1.2$: UltraVISTA (Muzzin+ 2013)
 - $z < 2.5$: 3D-HST+CANDELS (Brammer+ 2012)
- Cumulative number density matching $n=4 \times 10^{-4}$
(corresponds to $M(z=0) \sim 8 \times 10^{10} M_{\odot}$)

Rest frame UVJ

- Location on a UVJ diagram correlates well with star formation activity
- Simple cuts separate quiescent from star forming galaxies



Primary/satellite selection

Selection aperture



Random aperture



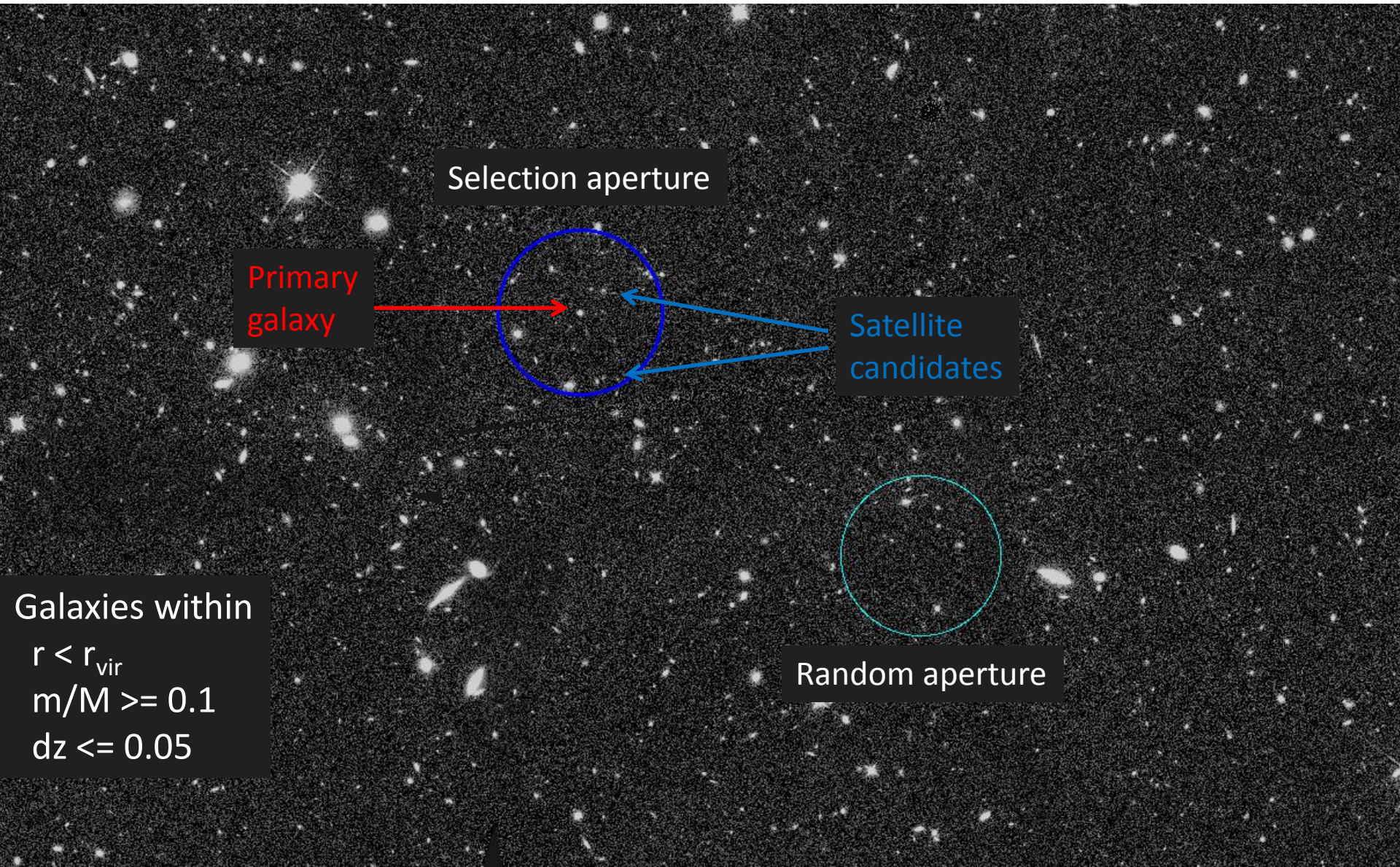
Galaxies within

$$r < r_{\text{vir}}$$

$$m/M \geq 0.1$$

$$dz \leq 0.05$$

Primary/satellite selection



Selection aperture

Primary galaxy

Satellite candidates

Random aperture

Galaxies within

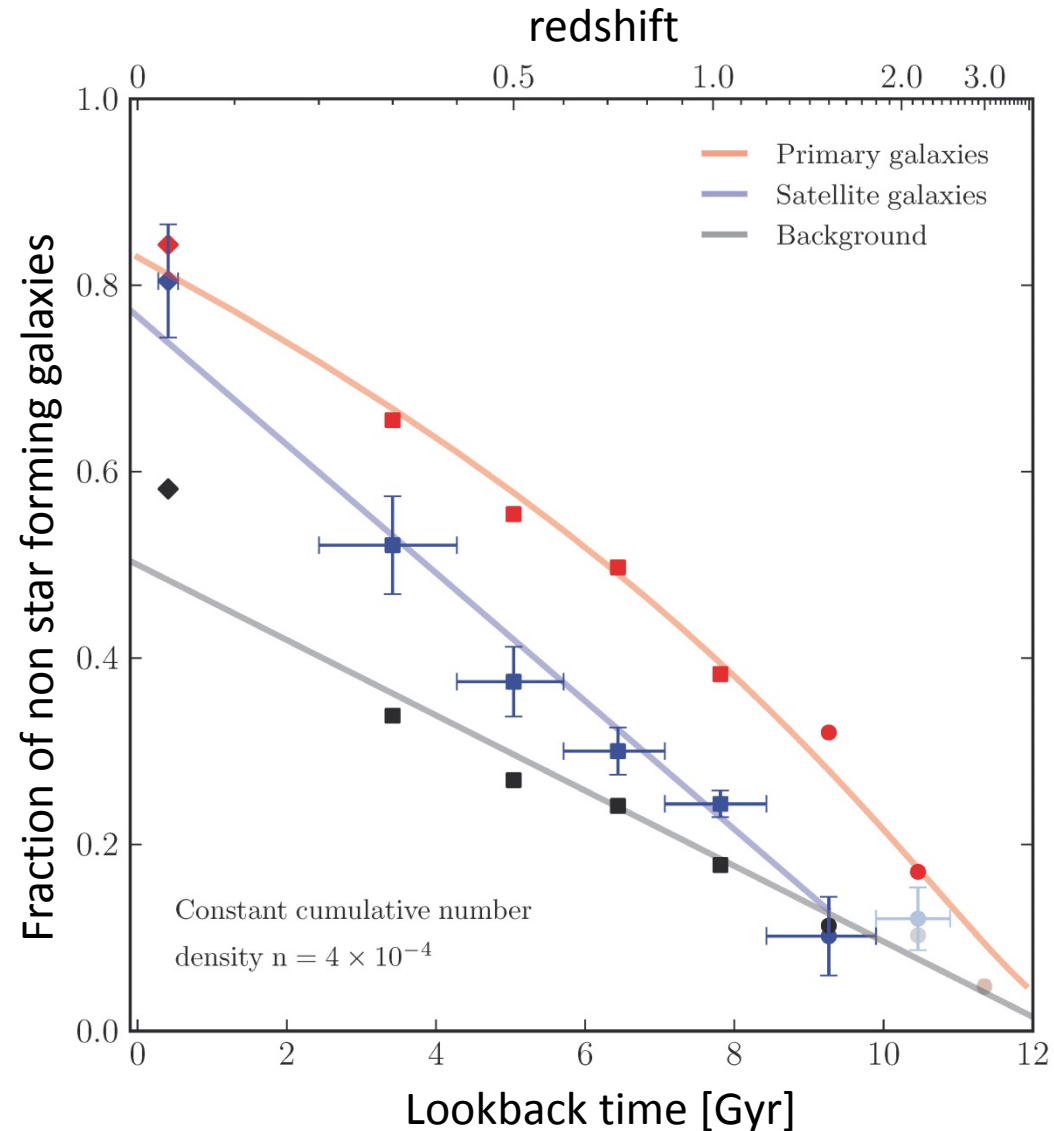
$$r < r_{\text{vir}}$$

$$m/M \geq 0.1$$

$$dz \leq 0.05$$

Evolution of the quiescent fraction

- Constant cumulative number density $n = 4 \times 10^{-4}$
- All galaxy populations get quenched with time



Summary

- Radial distribution of satellite galaxies in massive groups does not seem to evolve
- Remarkable balance between in-halo mergers and accretion of galaxies into the halo
- Star formation in group galaxies is affected by environmental processes