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

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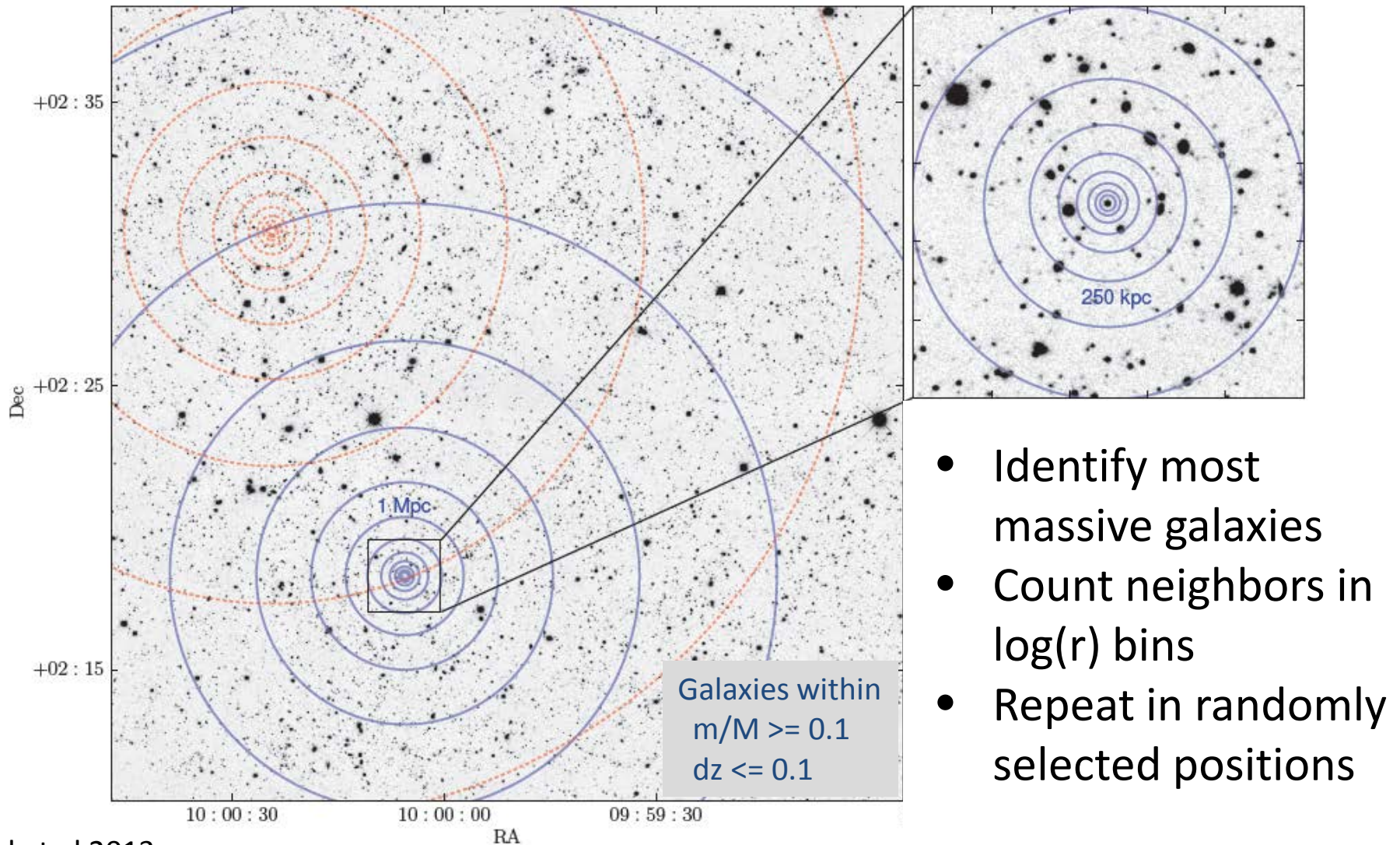
Galaxy evolution in groups

Most galaxies reside and evolve in groups

- At low redshift (redshift surveys):
  - Individual halos
  - Overall environment and halo properties: statistically (e.g., clustering, lensing)
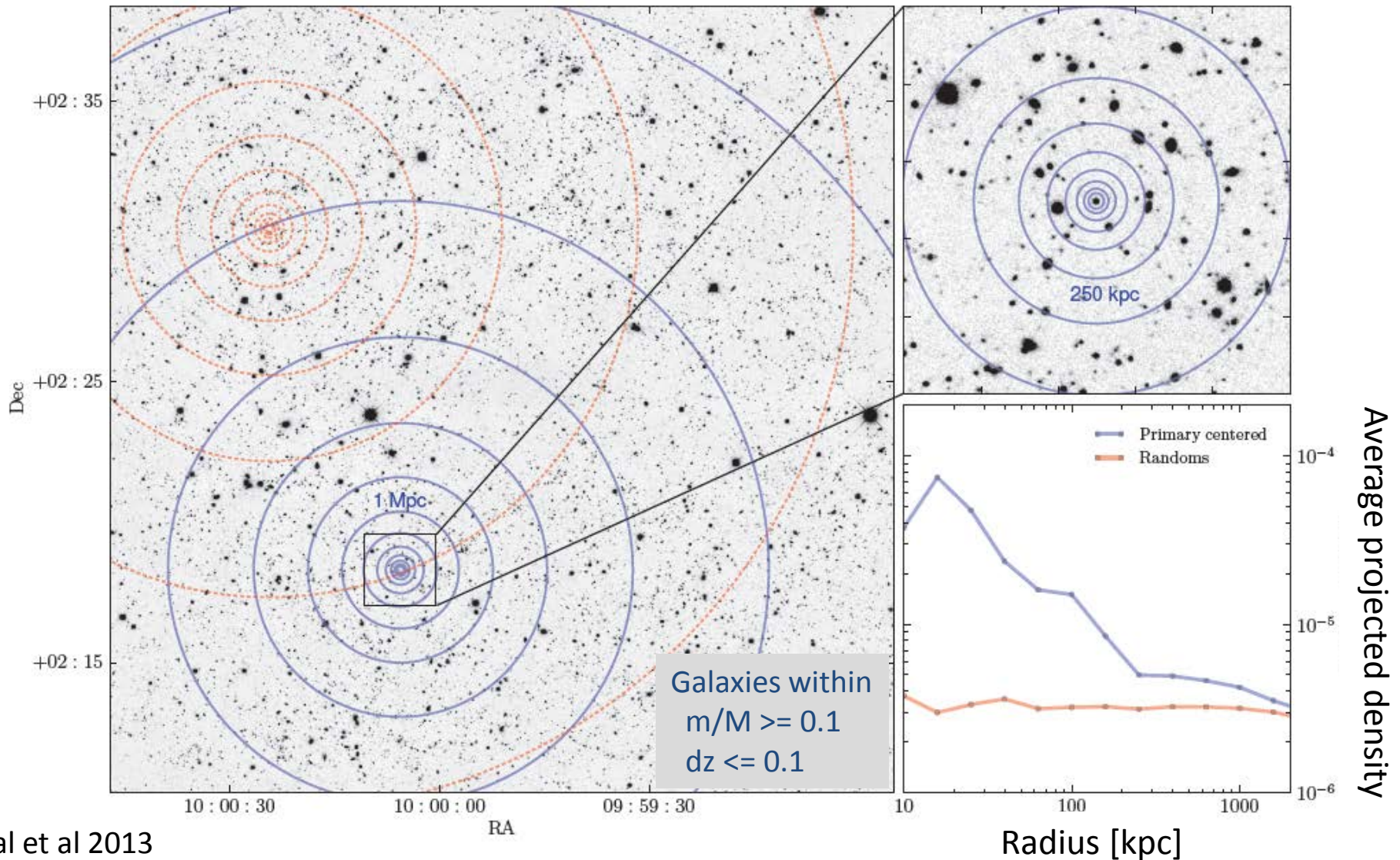
Alternative: statistical background subtraction
(does not require spec-z so can go to higher redshift)

Statistical background subtraction

Galaxies within
m/M >= 0.1
dz <= 0.1

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

Tal et al 2013

Statistical background subtraction

Galaxies within
m/M >= 0.1
dz <= 0.1

250 kpc

1 Mpc

Primary centered
Randoms

Average projected density

Radius [kpc]

Tal et al 2013
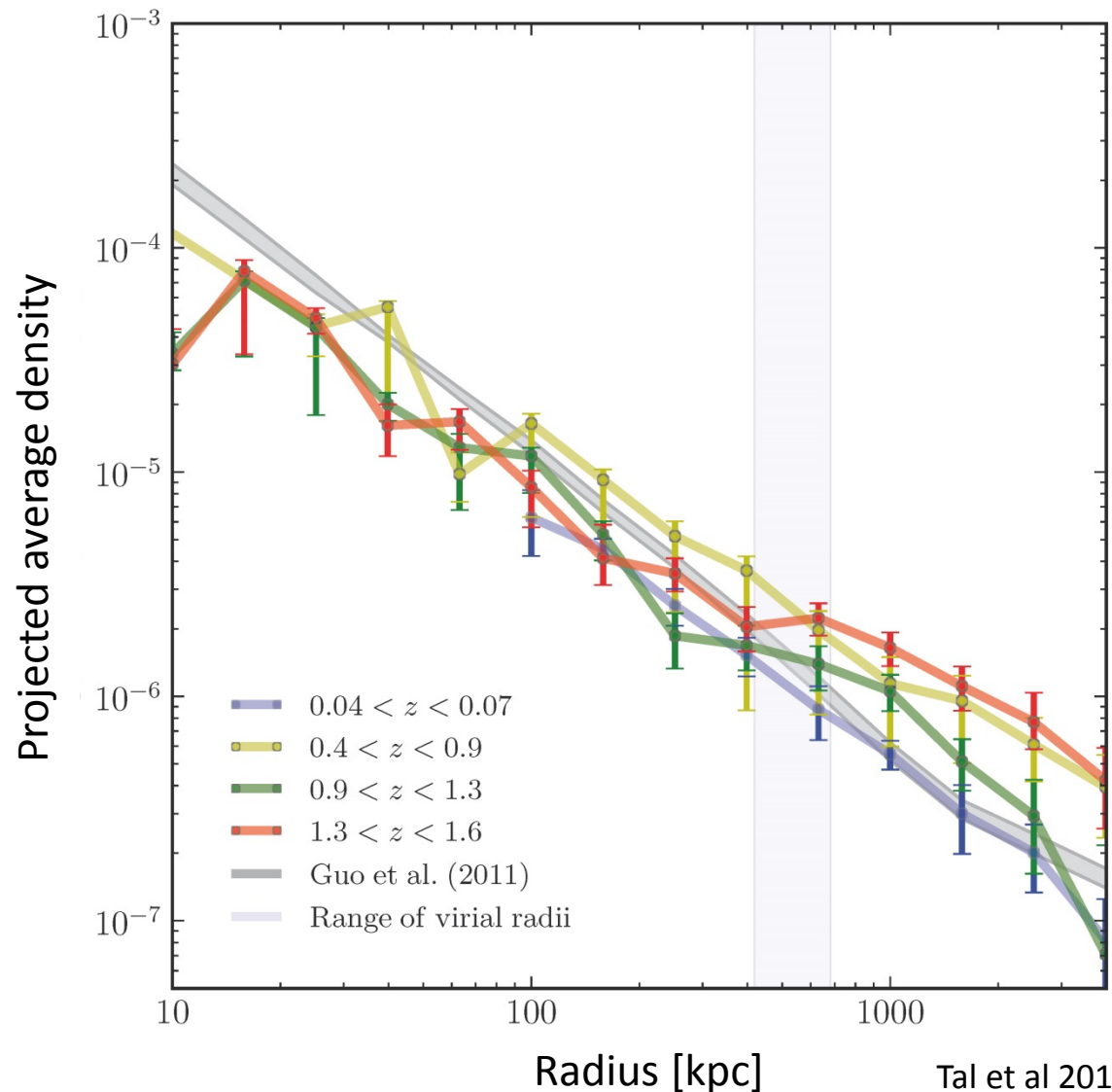
Cumulative number density

- Rank order does not evolve rapidly even in the presence of mergers

- Follow a galaxy population while **allowing galaxies to evolve in mass**
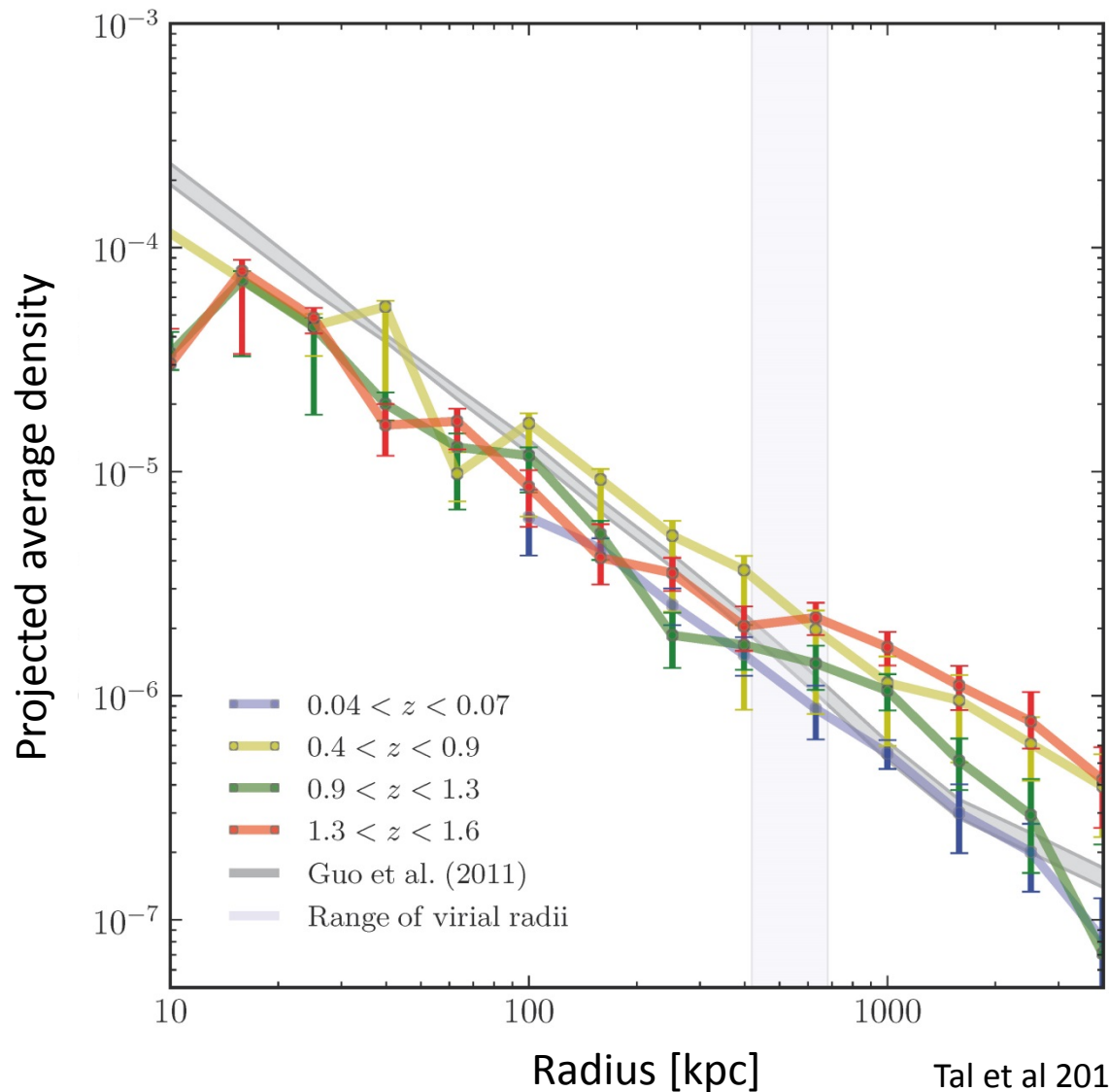
SDSS + NMBS
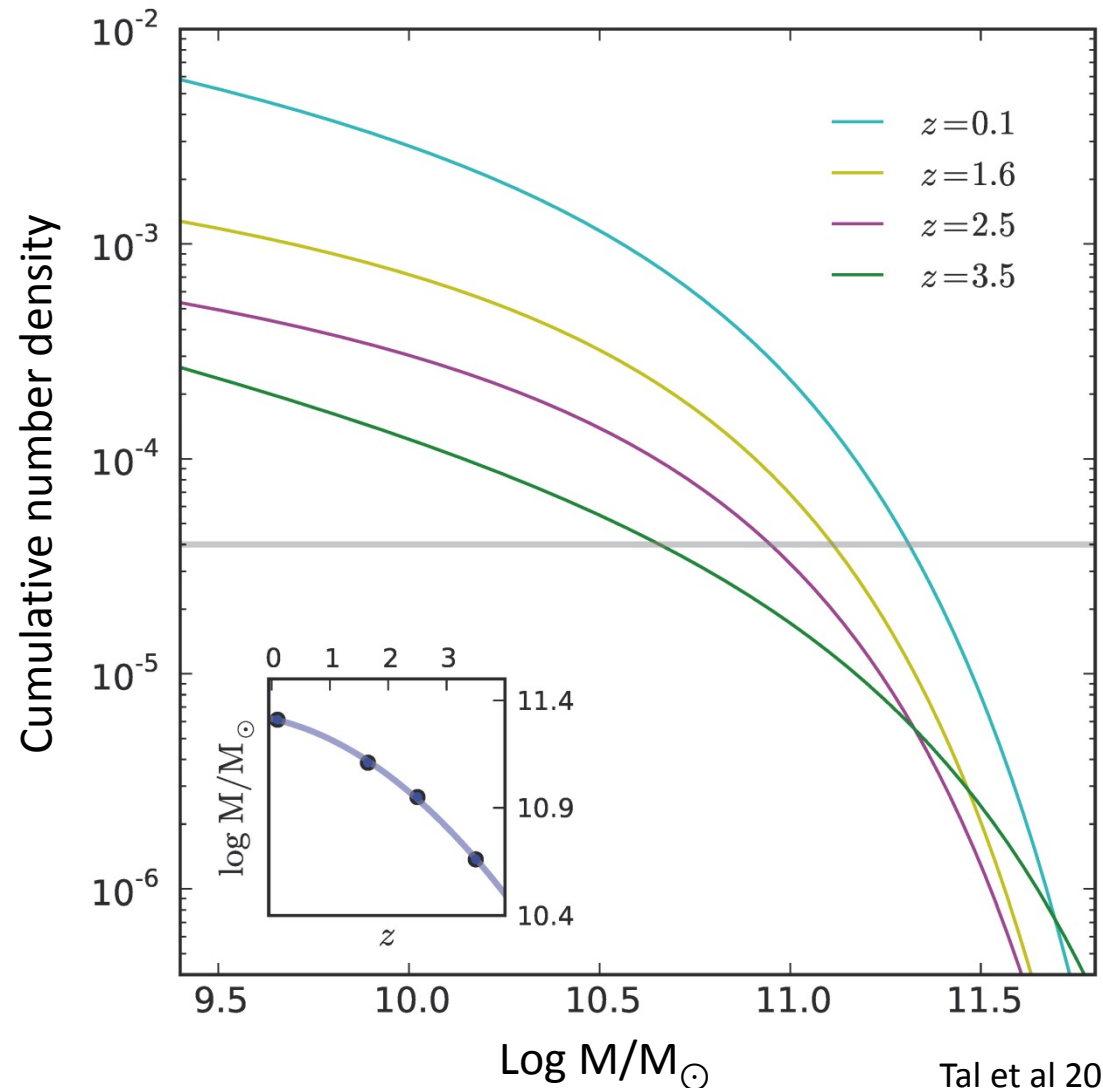
Tal et al 2013

Projected number density functions

- Lack of evolution

- **Remarkable balance between mergers and accretion**

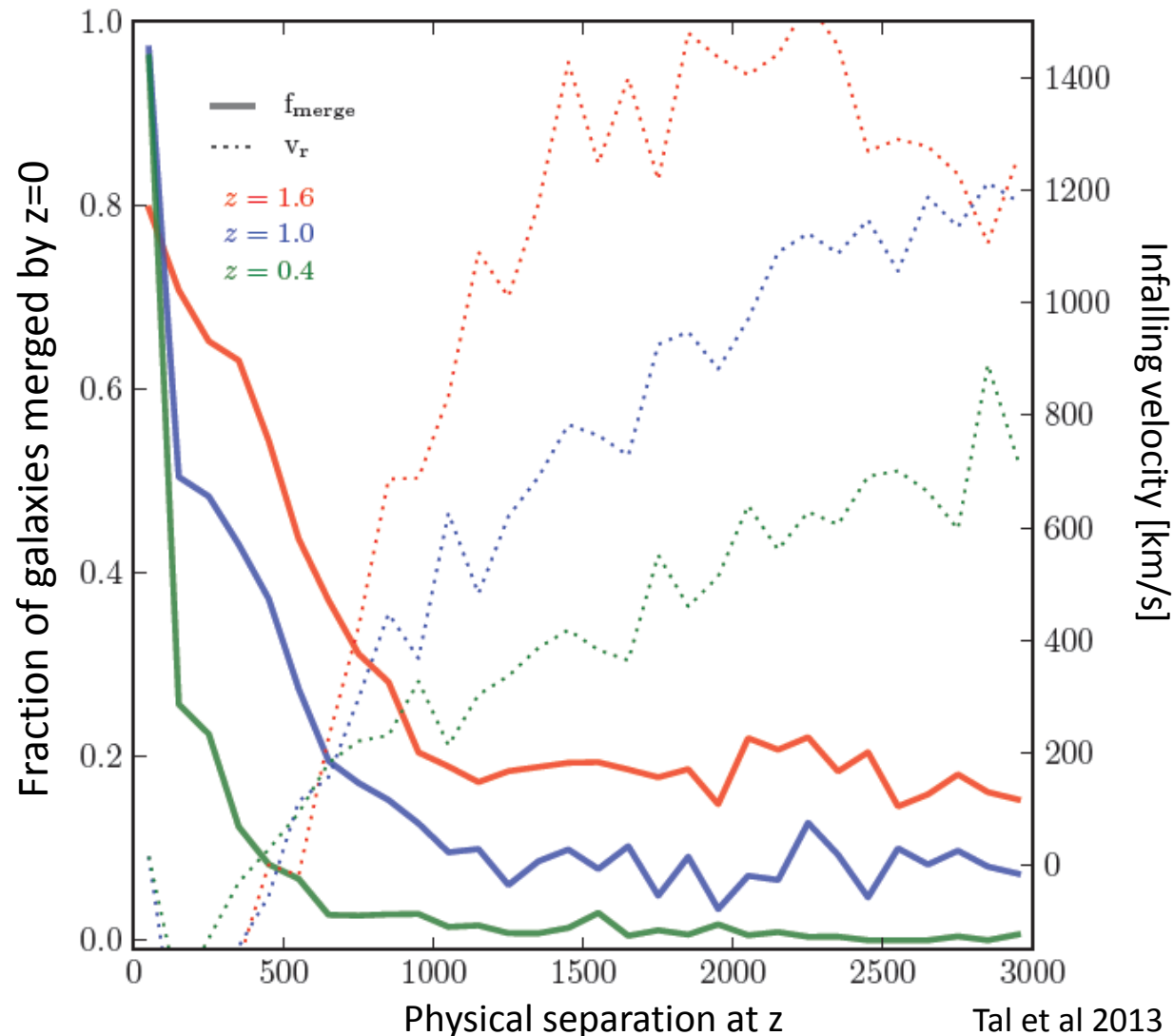Tal et al 2013

Projected number density functions

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

- Agreement with Guo+11 SAM

Tal et al 2013

Evolution in semi analytic models

Insight from G11:

- Most satellites at 1 < r/Mpc < 3 are on extreme orbits

- Galaxies inside the virial radius gradually merge with primary

Tal et al 2013

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

Tal et al 2013
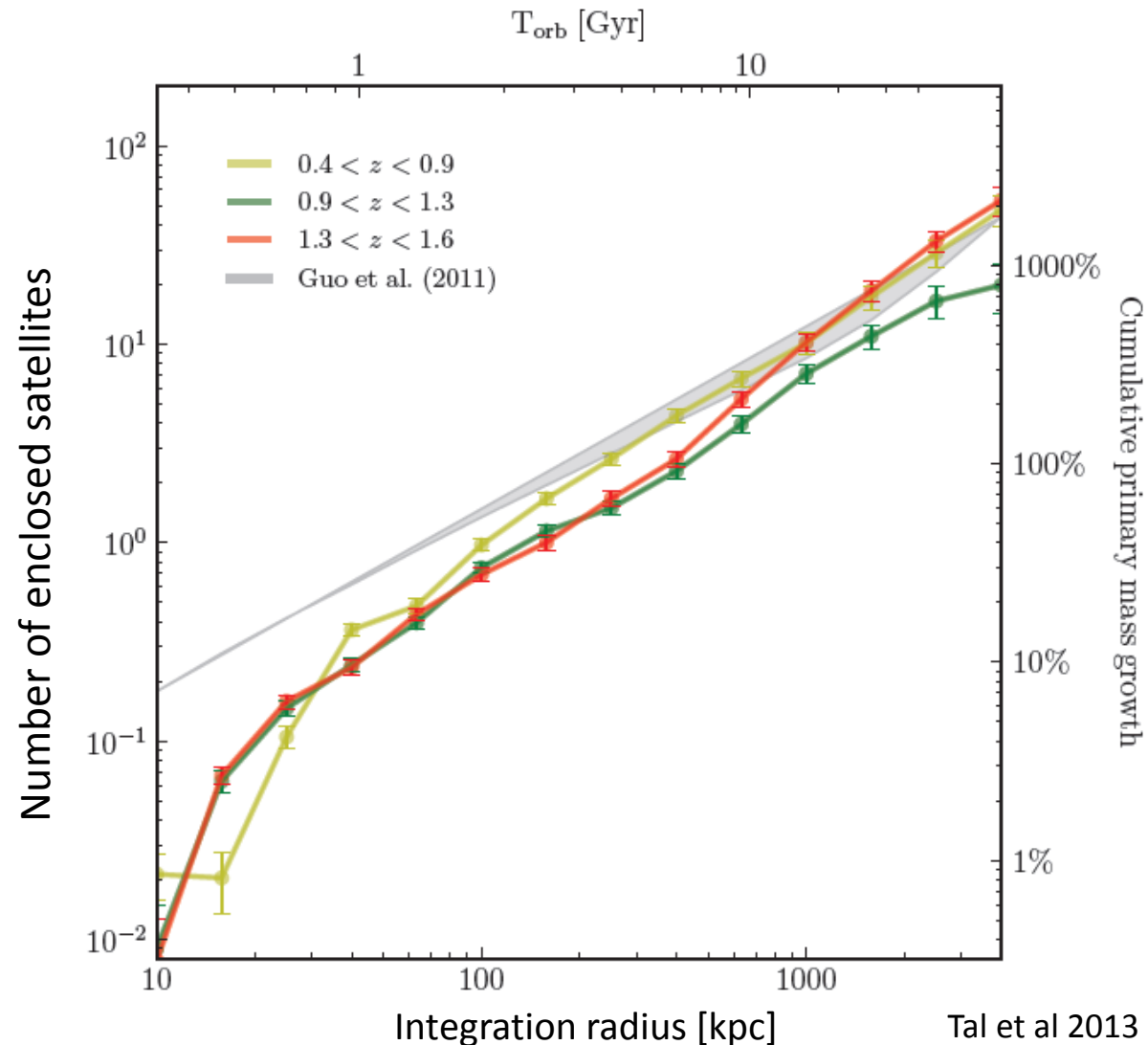
Typical massive galaxy environment

- Integrated number (mass) of satellites

- "Generalized" pair count measurement

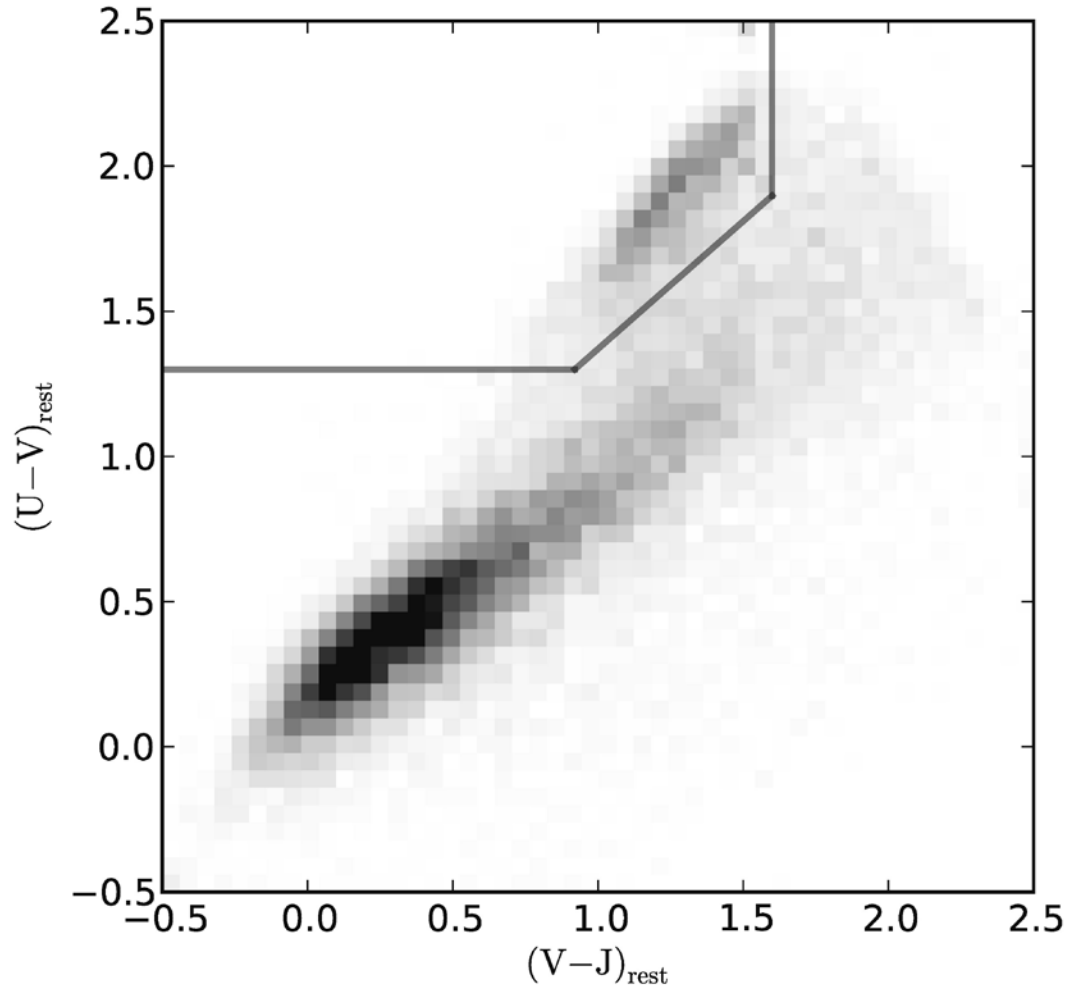- Equal total stellar mass in satellites as in primary

Tal et al 2013
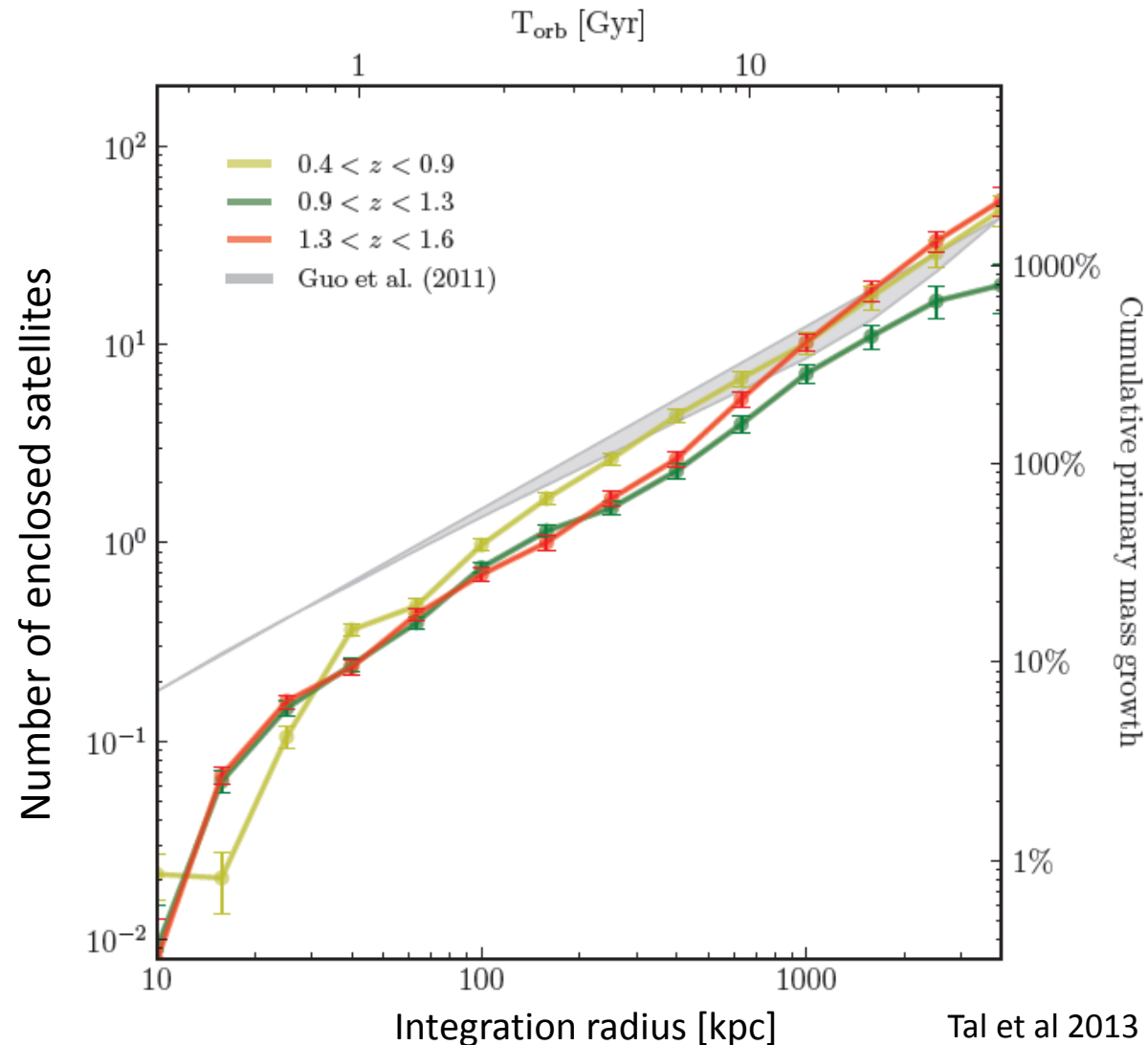
Testing environmental effects

- 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=4x10^{-4} (corresponds to M(z=0) ~ 8x10^{10} M$_{\odot}$)
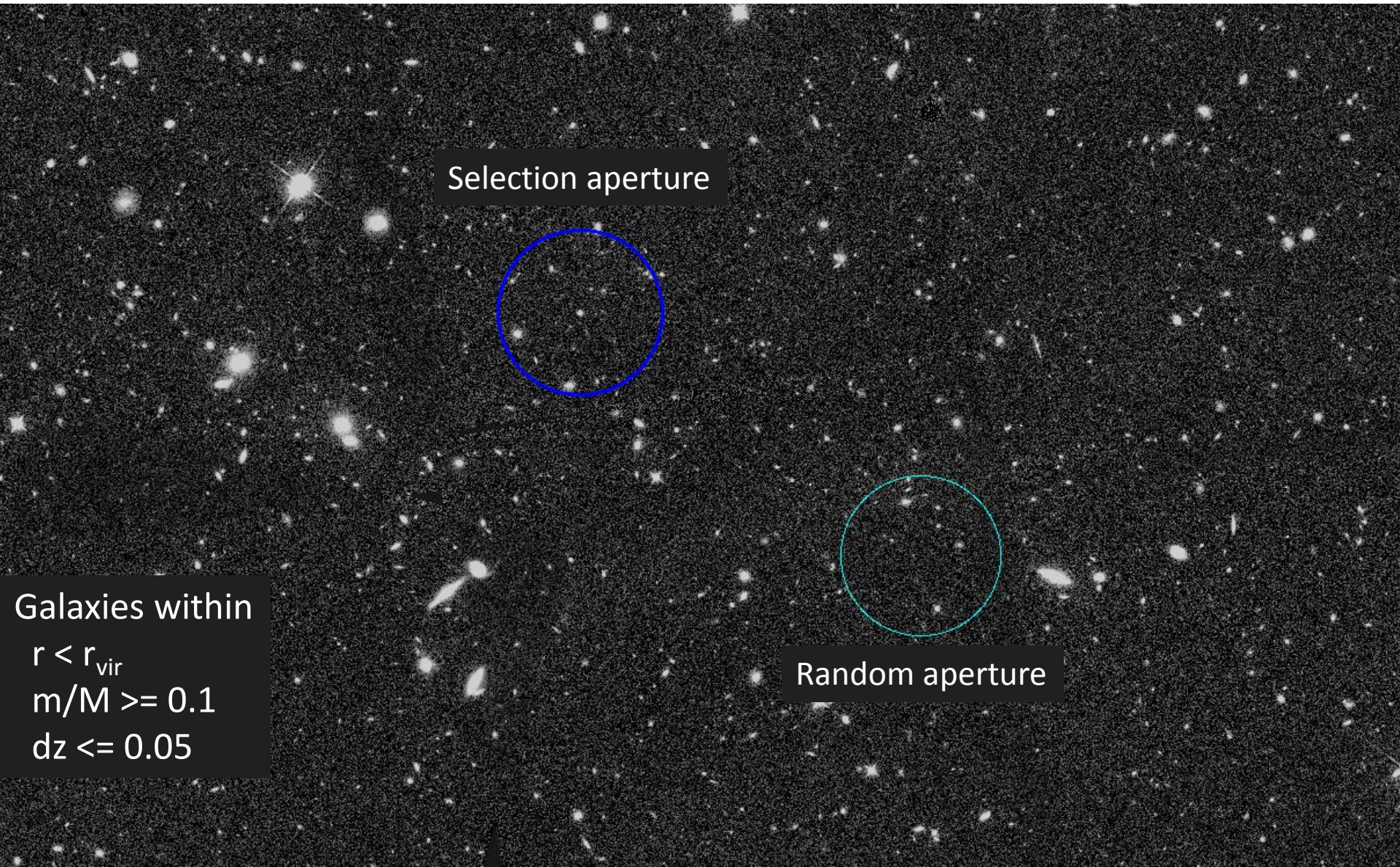
Rest frame UVJ

- Location on a UVJ diagram correlates well with star formation activity

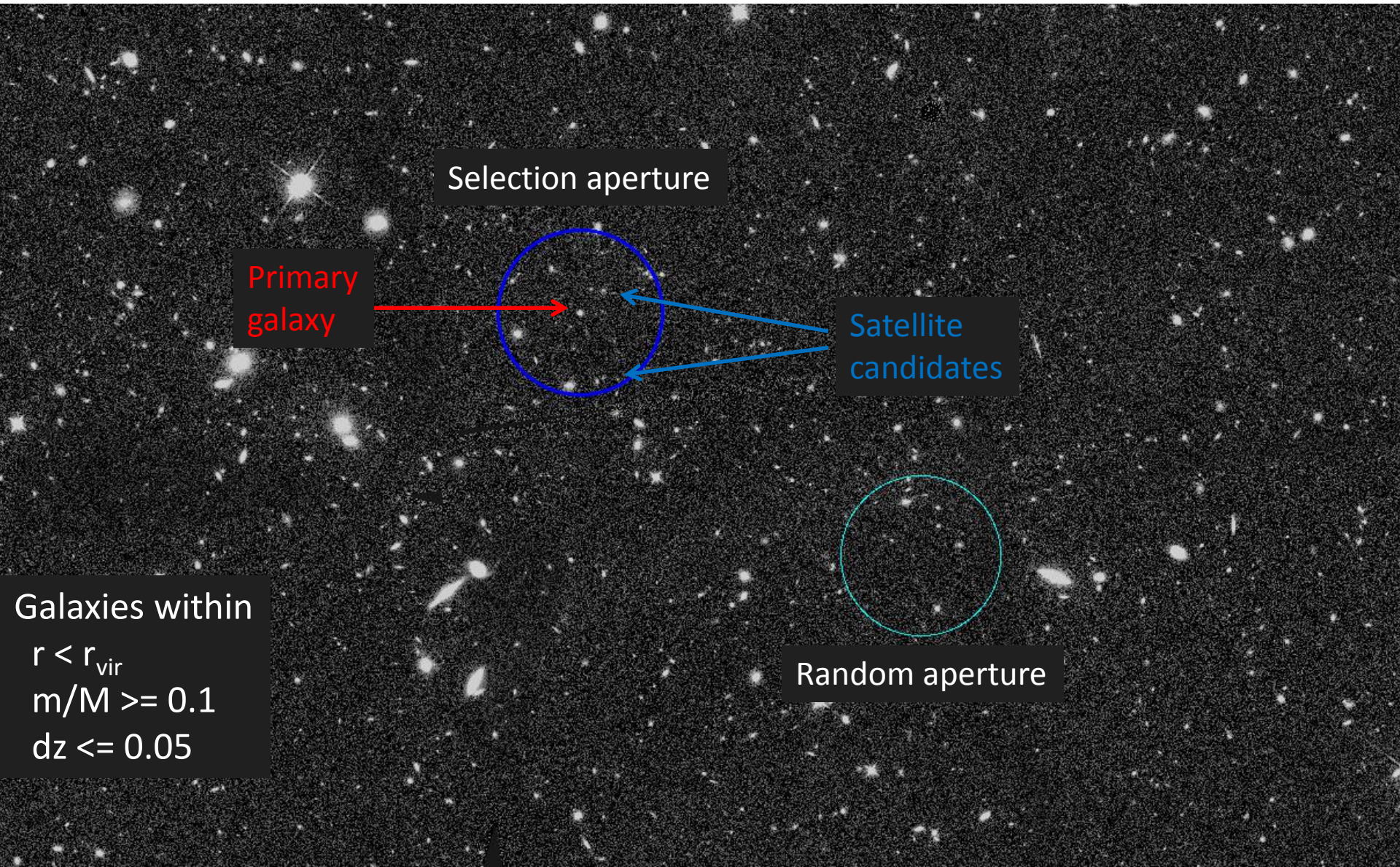- Simple cuts separate quiescent from star forming galaxies

Primary/satellite selection

Selection aperture

Random aperture

Galaxies within
r < r_vir
m/M >= 0.1
dz <= 0.05

Primary/satellite selection

Selection aperture

Primary galaxy

Satellite candidates

Galaxies within
$r < r_{vir}$
$m/M >= 0.1$
$dz <= 0.05$

Random aperture

Evolution of the quiescent fraction

- Constant cumulative number density
  n = 4□10⁻⁴

- All galaxy populations get quenched with time
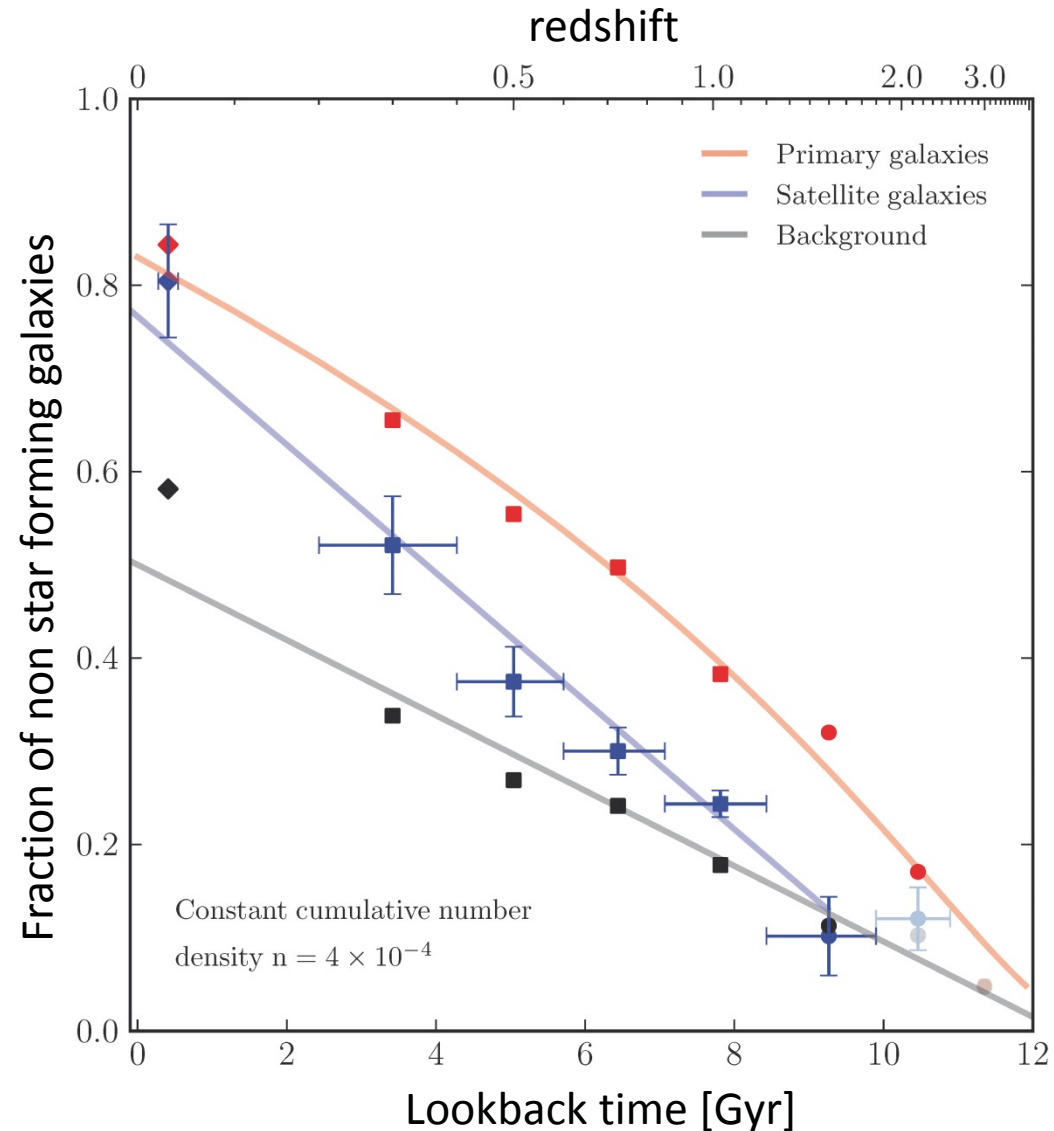
Summary

- 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