The evolution of satellite galaxies in groups at $0<z<1.8$

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Galaxies within the cosmic web

6/18/2013

Galaxy evolution in groups

Most galaxies reside and evolve in groups

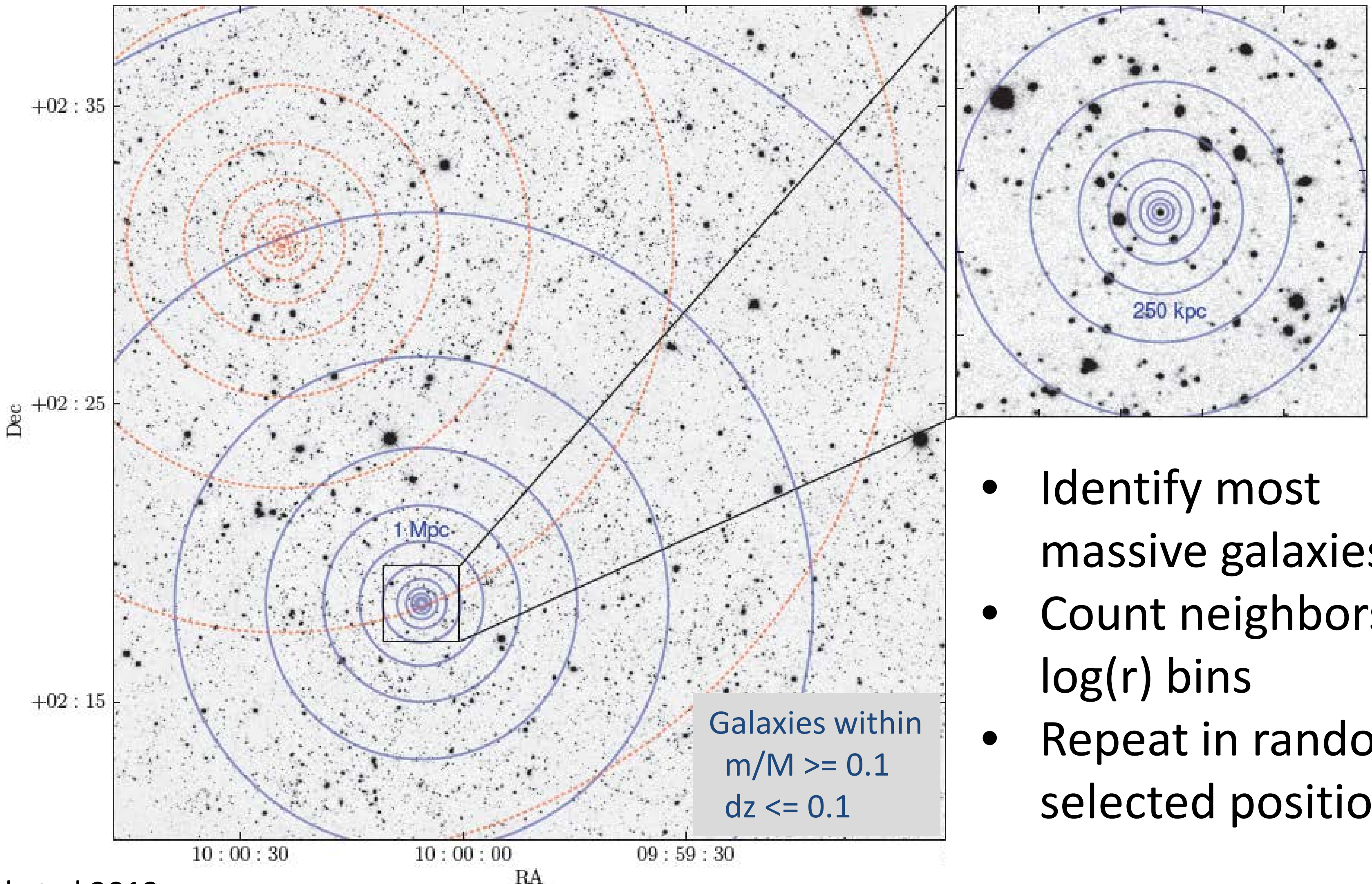
- At low redshift (redshift surveys):
  - Individual halos
  - Overall environment and halo properties: statistically (e.g., clustering, lensing)

Observing satellite galaxies

At high redshift, even accurate (spectroscopic) redshifts may be insufficient

Instead – study satellites with statistical background subtraction (does not require spec-z so can go to higher redshift)

Statistical background subtraction



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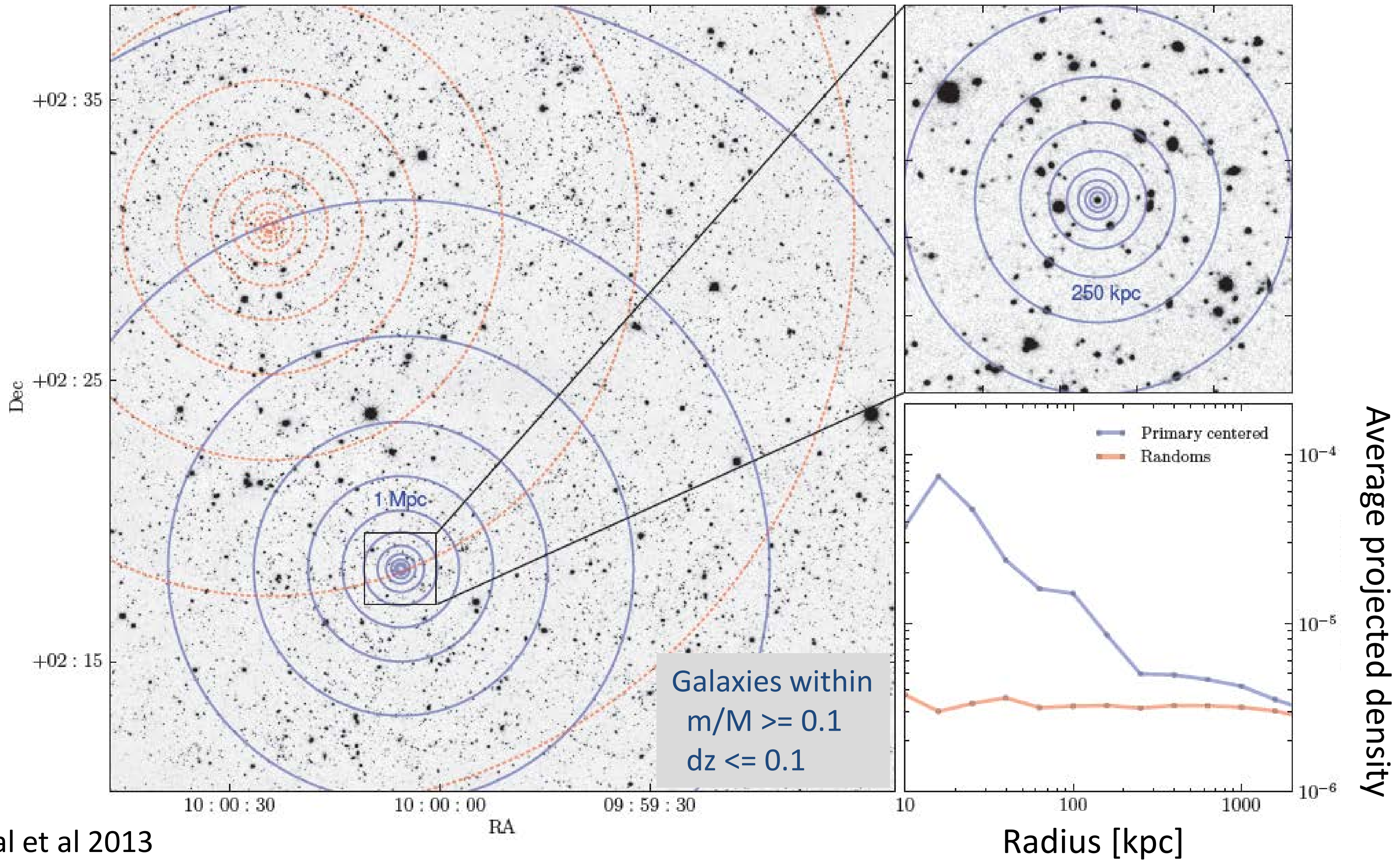
- Identify most massive galaxies
- Count neighbors in log(r) bins
- Repeat in randomly selected positions

Statistical background subtraction



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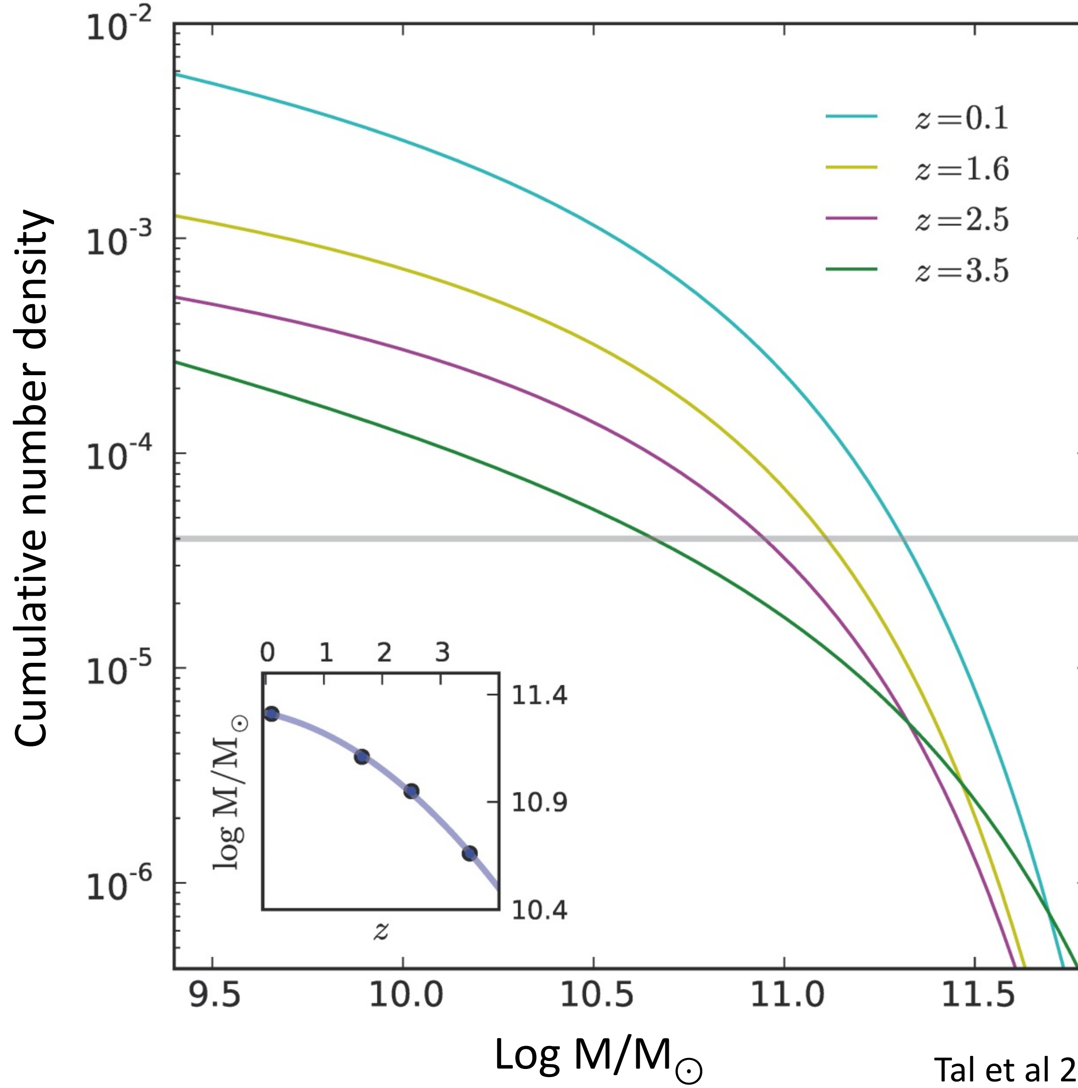
Cumulative number density

- 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



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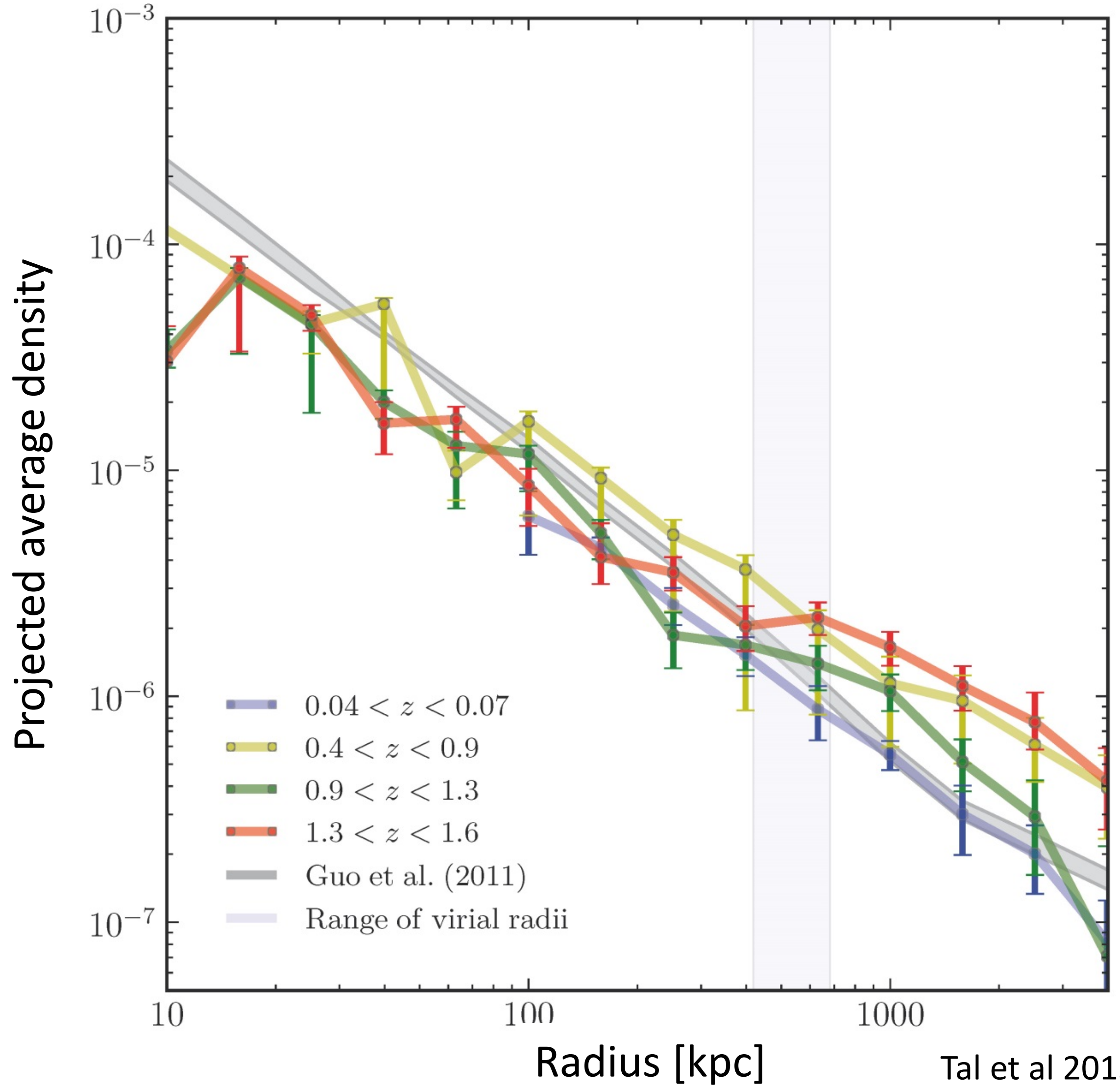
Projected number density functions

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



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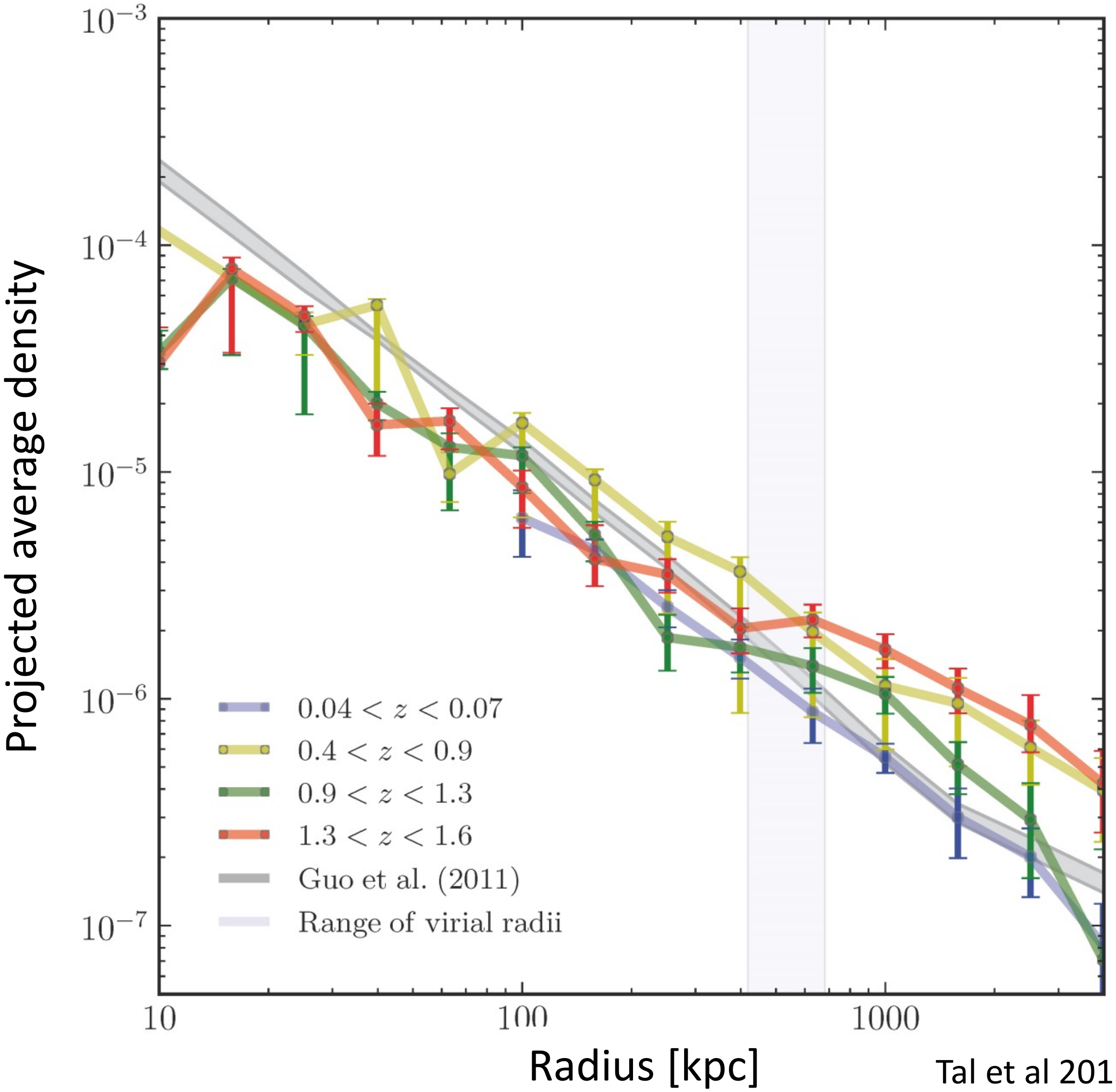
Projected number density functions

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



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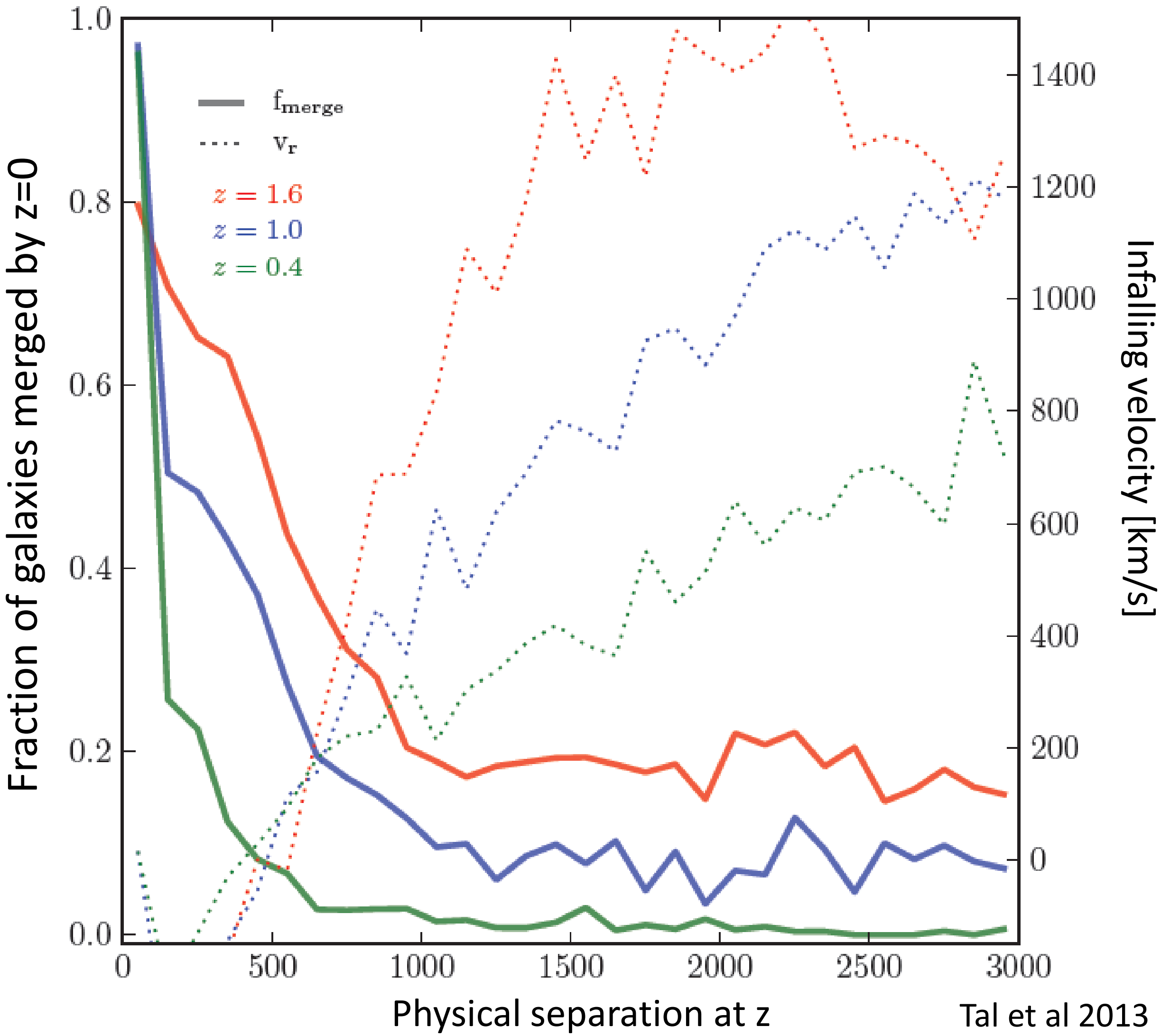
Evolution in semi analytic models

Insight from G11:

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



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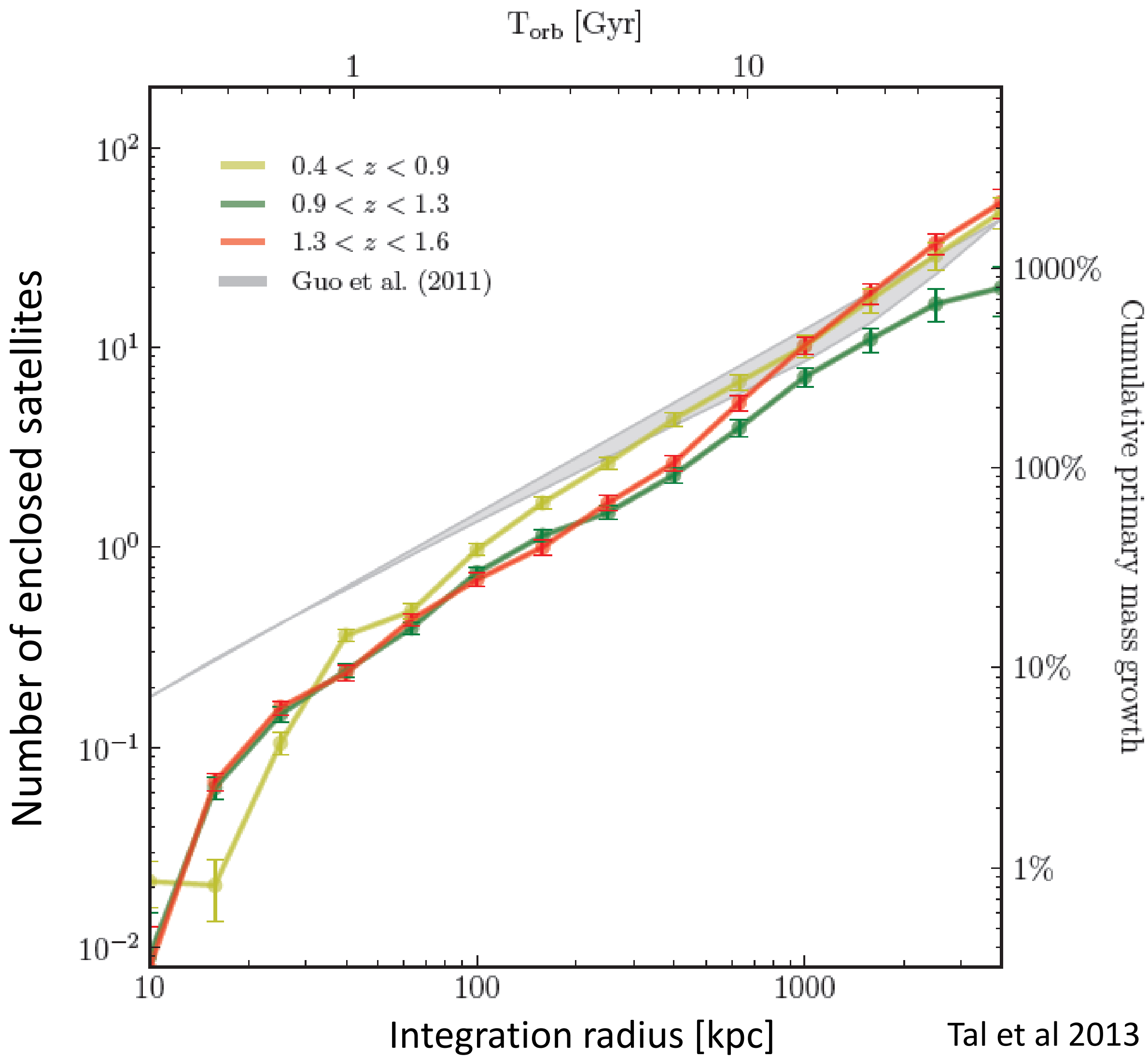
1. What is the potential for growth through mergers (is there enough mass to support observed growth)?

2. Are satellite galaxies even affected by their group environment?

Typical massive galaxy environment

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



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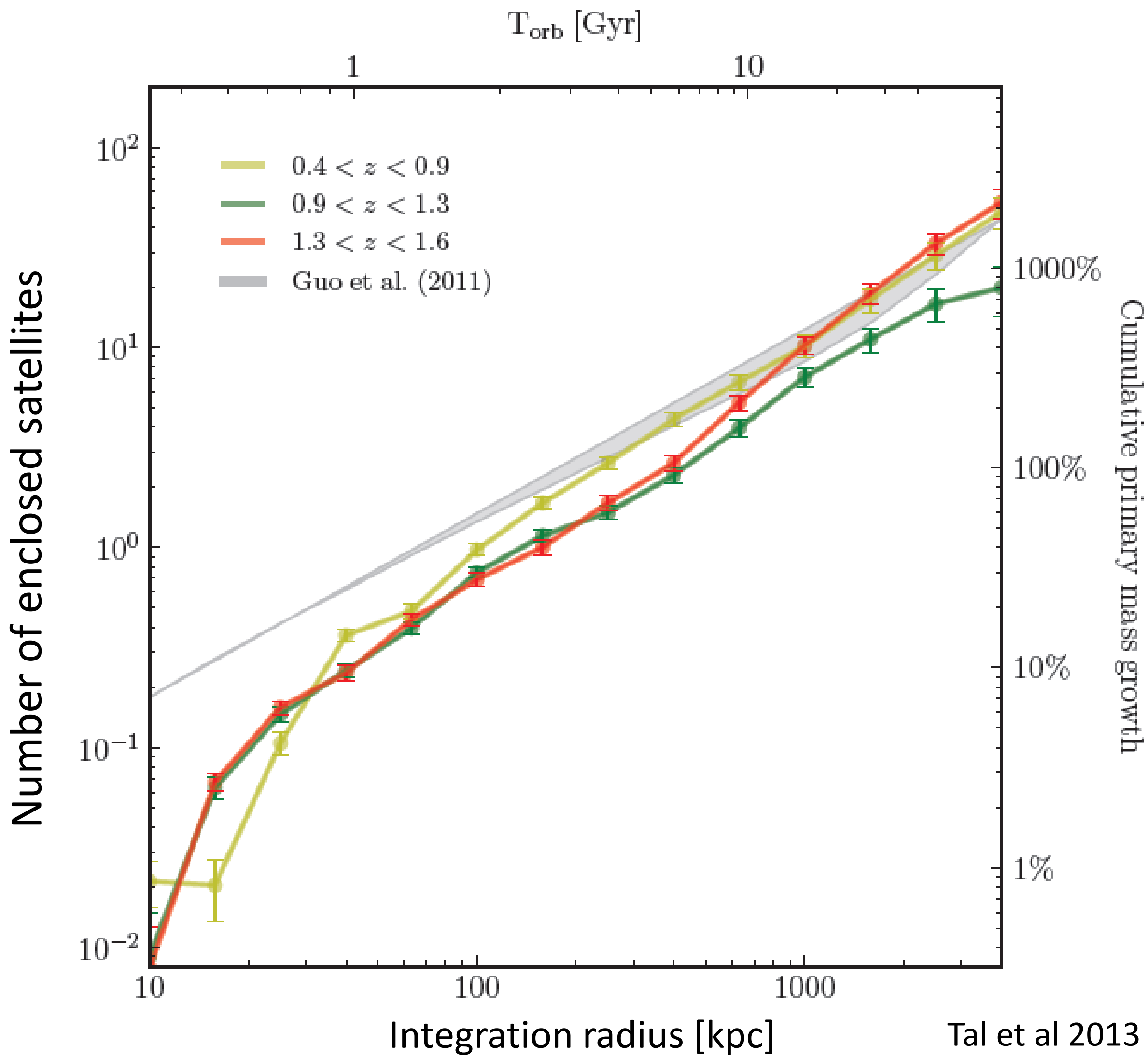
Typical massive galaxy environment

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



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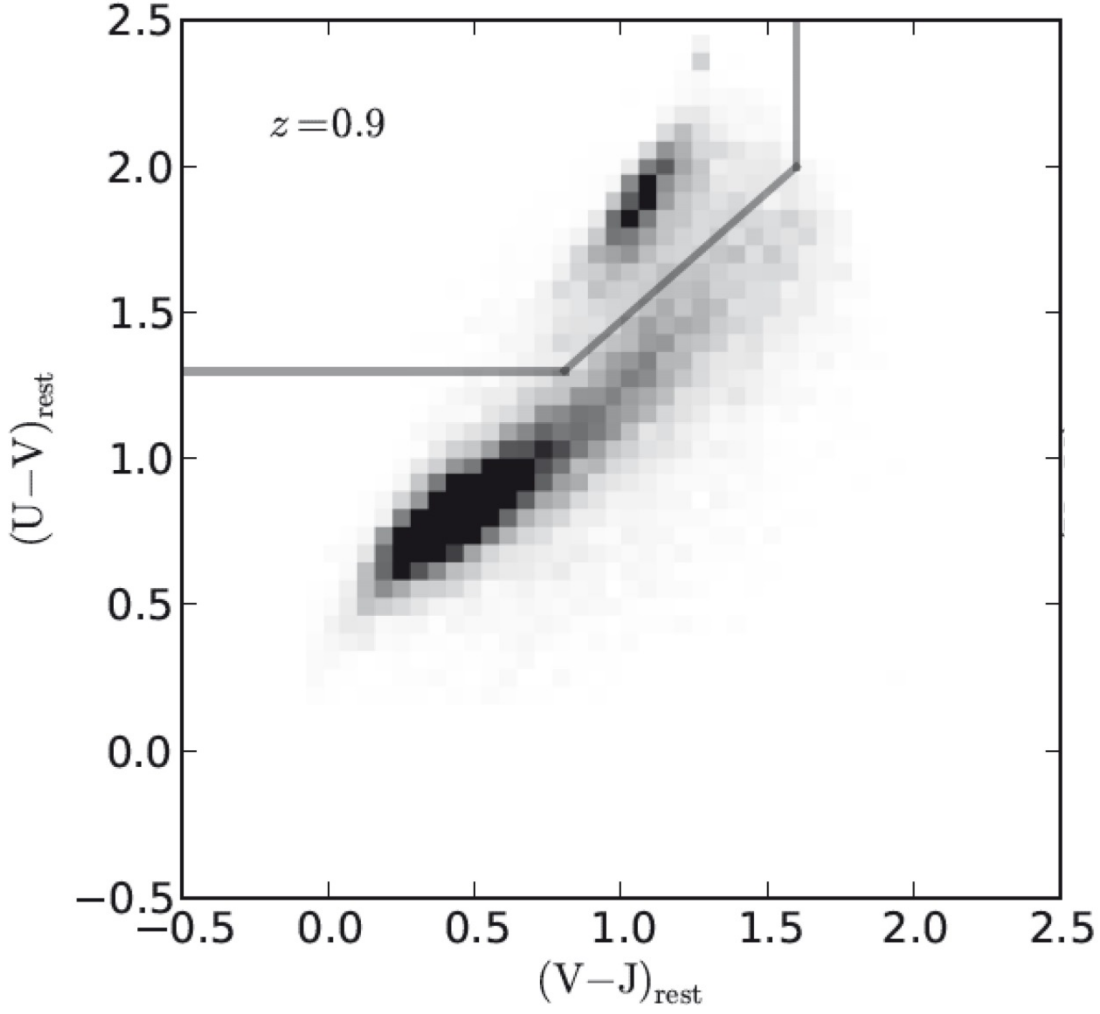
Testing environmental effects

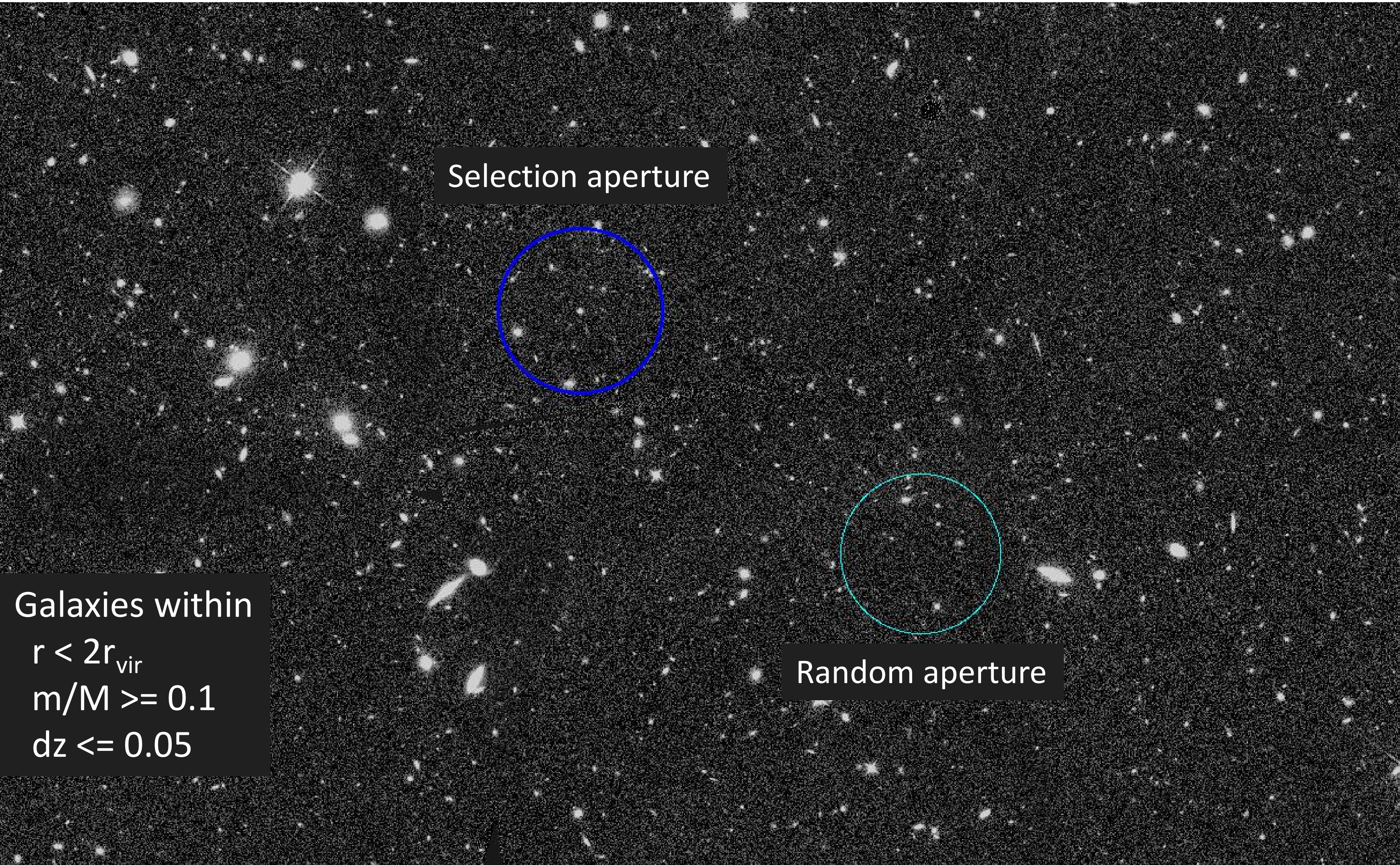
- Groups in a large redshift range from three surveys:
  - $z \sim 0$: SDSS NYU-VAGC (Blanton+ 2005)
  - $z < 1$: UltraVISTA (Muzzin+ 2013)
  - $z < 1.8$: 3D-HST (Brammer+ 2012)
- Cumulative number density matching $n=3.5 \times 10^{-4}$ (corresponds to $M(z=0) \sim 8 \times 10^{10}\ M_{\odot}$)

Rest frame UVJ

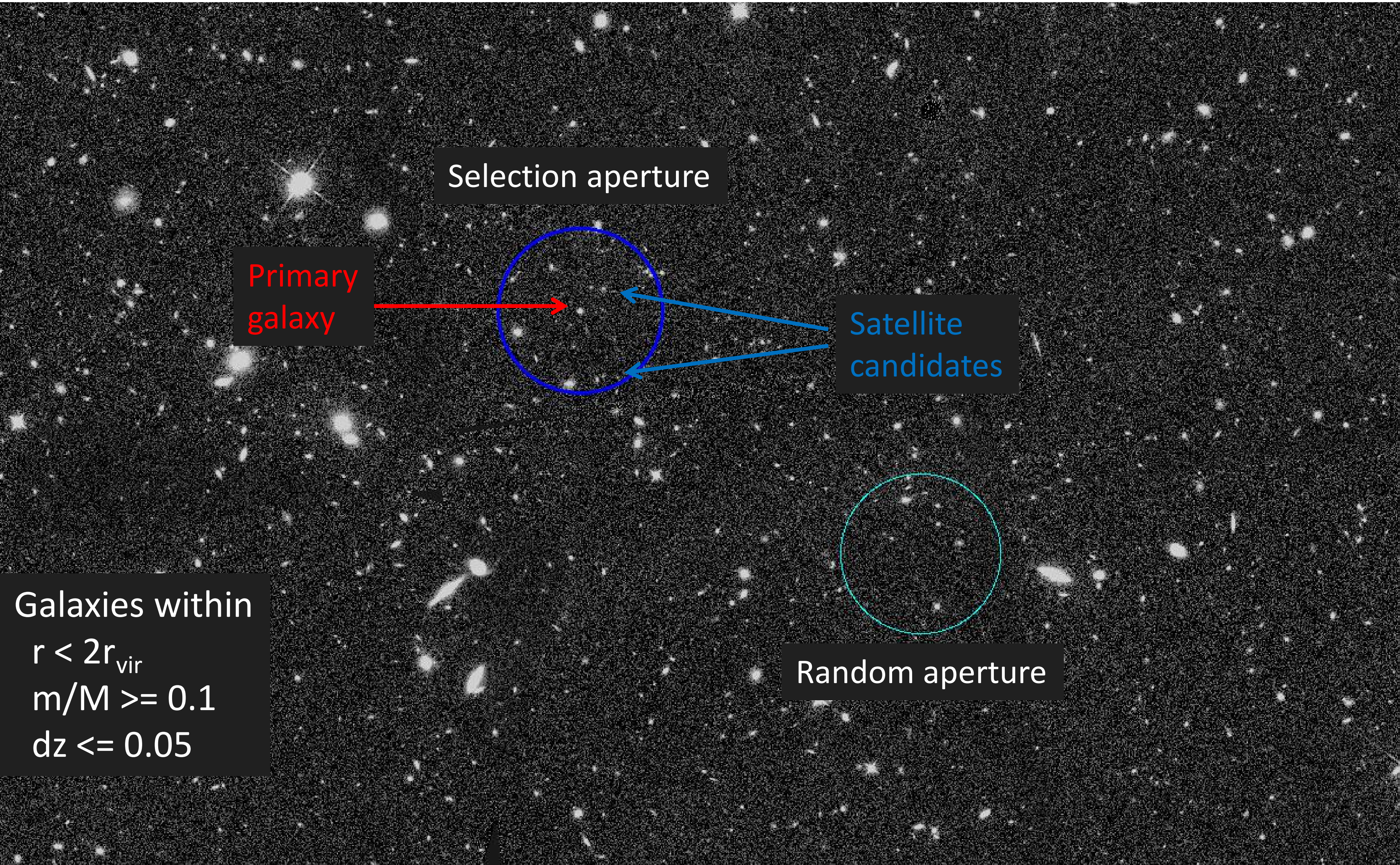
- Location on a UVJ diagram correlates well with star formation activity
- Simple cuts separate quiescent from star forming galaxies



Primary/satellite selection

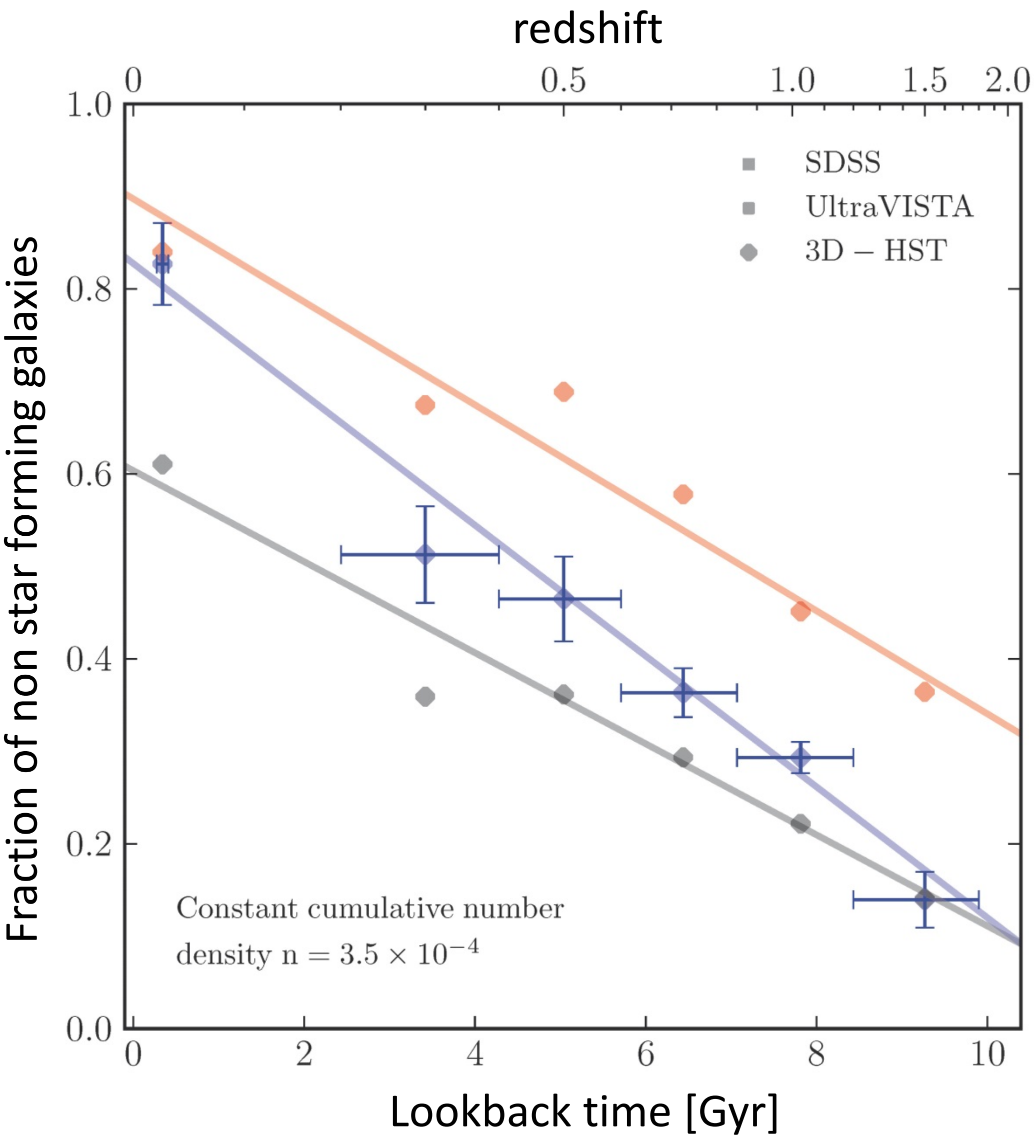


Primary/satellite selection



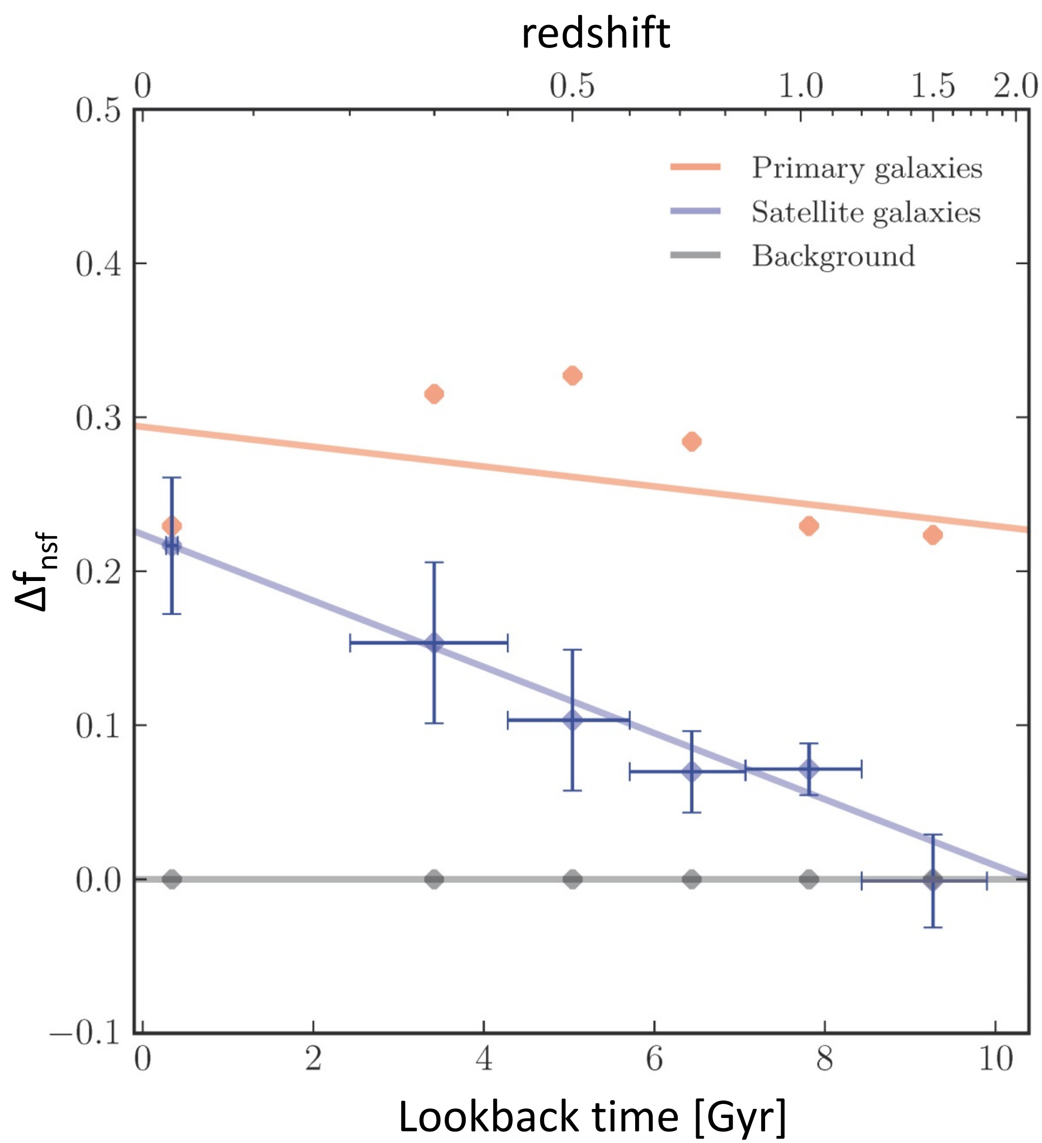
Evolution of the quiescent fraction

- Constant cumulative number density n=3.510^{-4}
- All galaxy populations get quenched with time



Evolution of the quiescent fraction

- The fraction of non star forming satellite galaxies resembles that of "background" galaxies at $z > 1.5$ and that of primary galaxies at $z \sim 0$



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