The Search for Assembly Bias: Are Halo and Galaxy Formation Correlated?

Jeremy Tinker

Center for Cosmology and Particle Physics
New York University

Poster 5.45

Andrew Wetzel & Charlie Conroy

a tie? really?

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at fixed mass!

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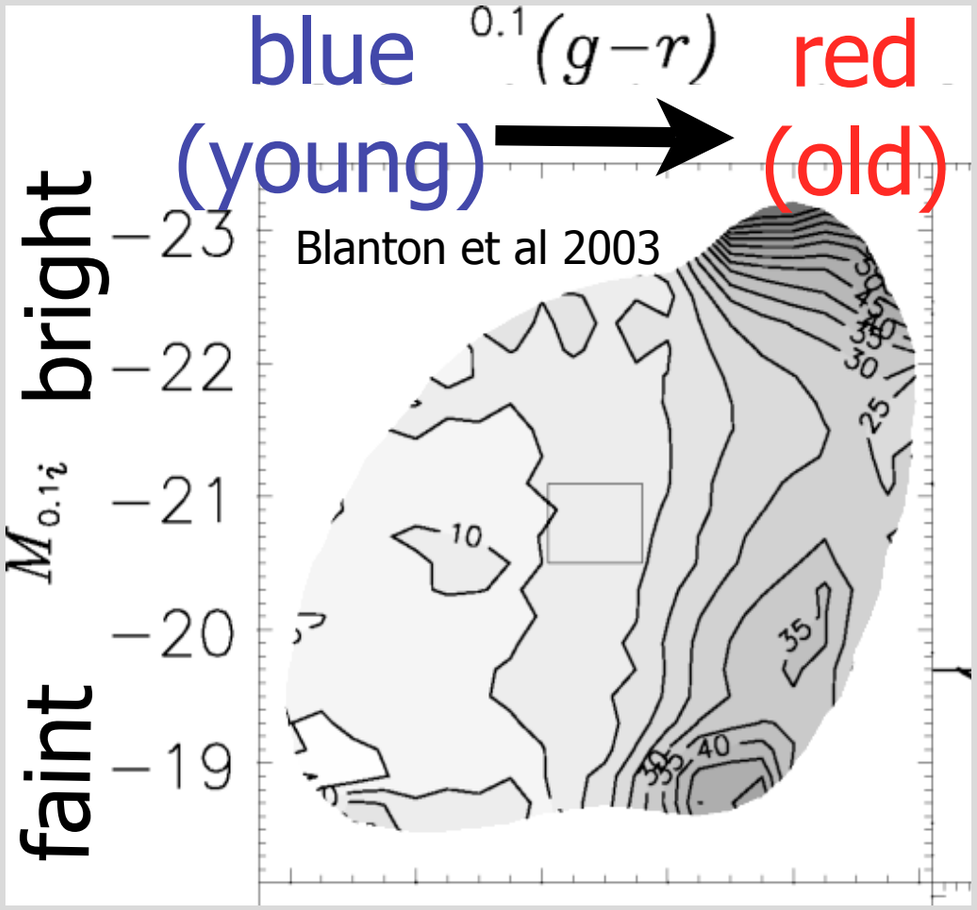
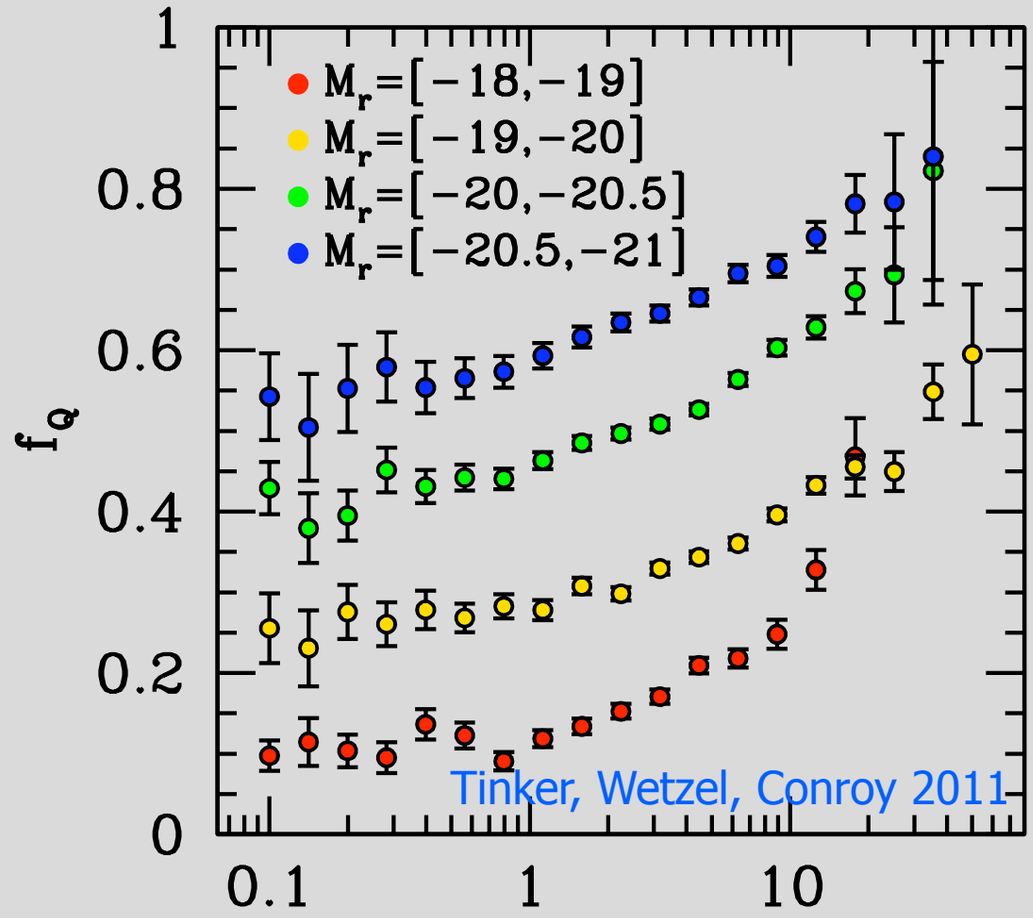
Galaxy Properties and Environment



Contours of constant local density: light->dark

See also: Kauffmann et al 2004, Baldry et al 2006, Park et al 2007, Bamford et al 2009, Wilman et al 2010: Color, morphology, SFR, etc...

Quenched fraction (via D_n4000) vs large-scale density



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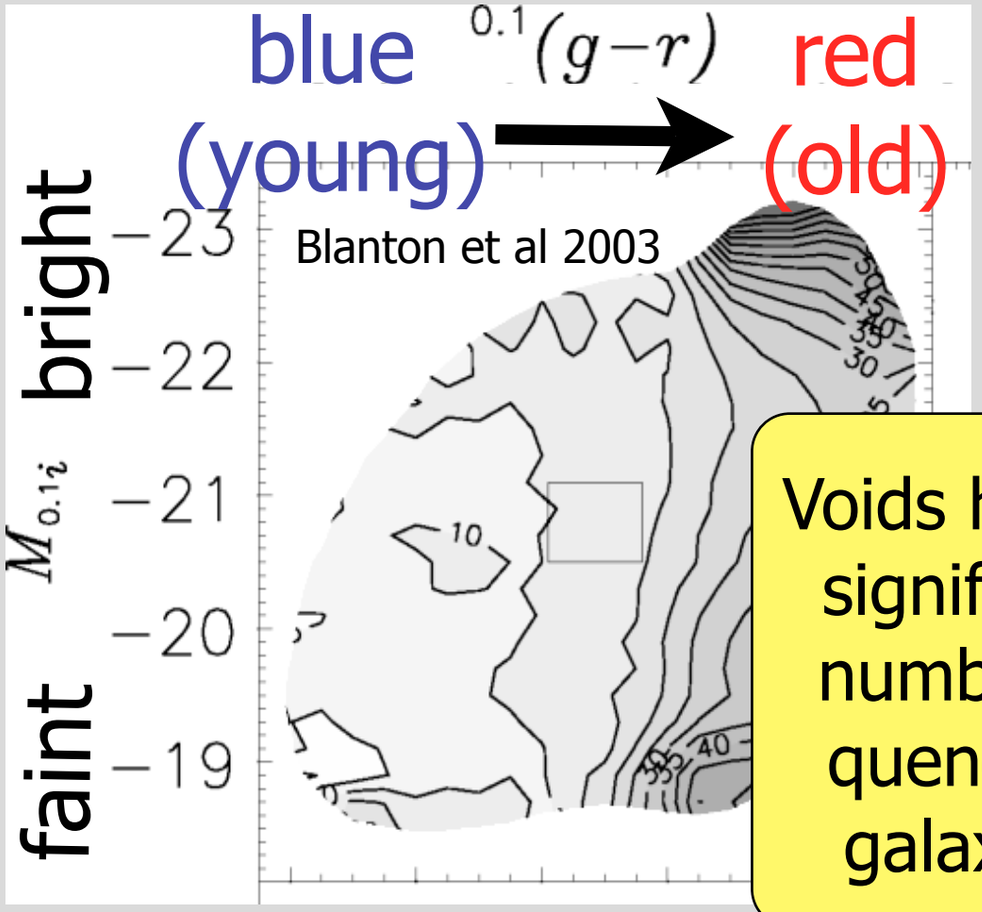
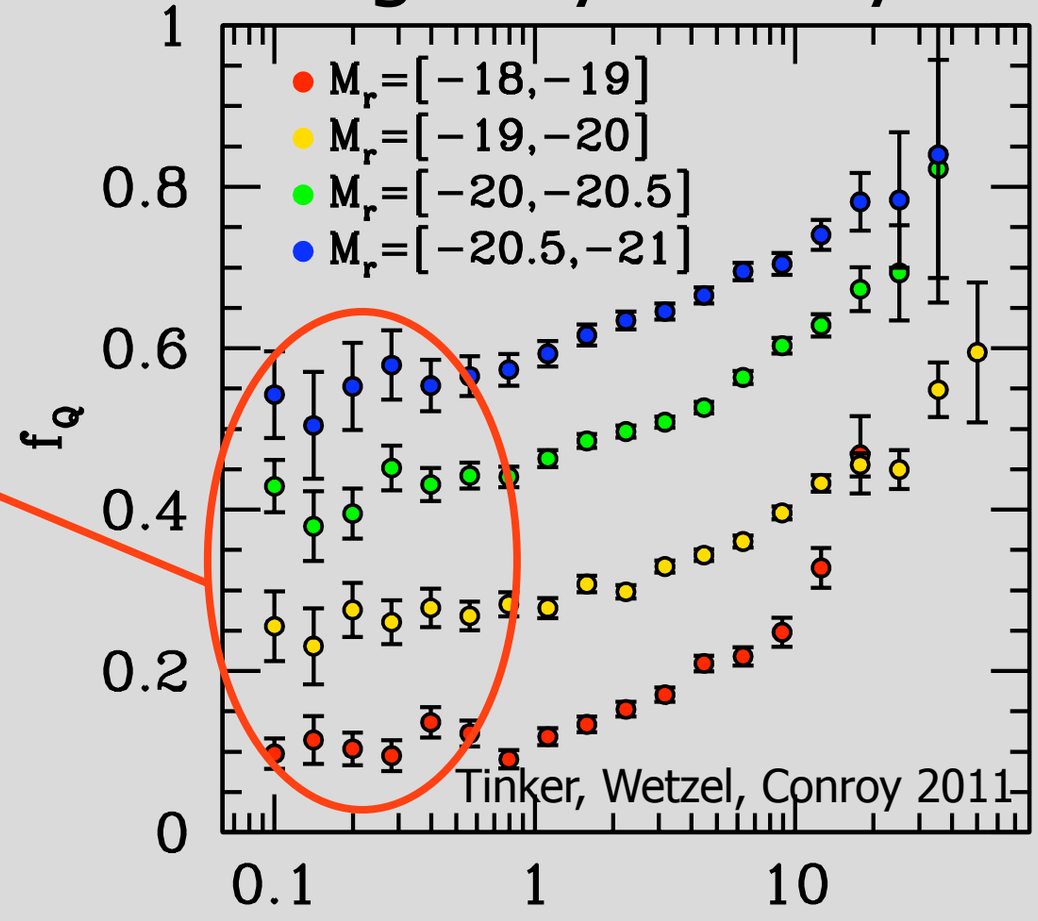


Voids have a significant number of quenched galaxies.

Contours of constant local density: light->dark

See also: Kauffmann et al 2004, Baldry et al 2006, Park et al 2007, Bamford et al 2009, Wilman et al 2010: Color, morphology, SFR, etc...

SDSS DR7: Quenched fraction (via D_n4000) vs large-scale galaxy density



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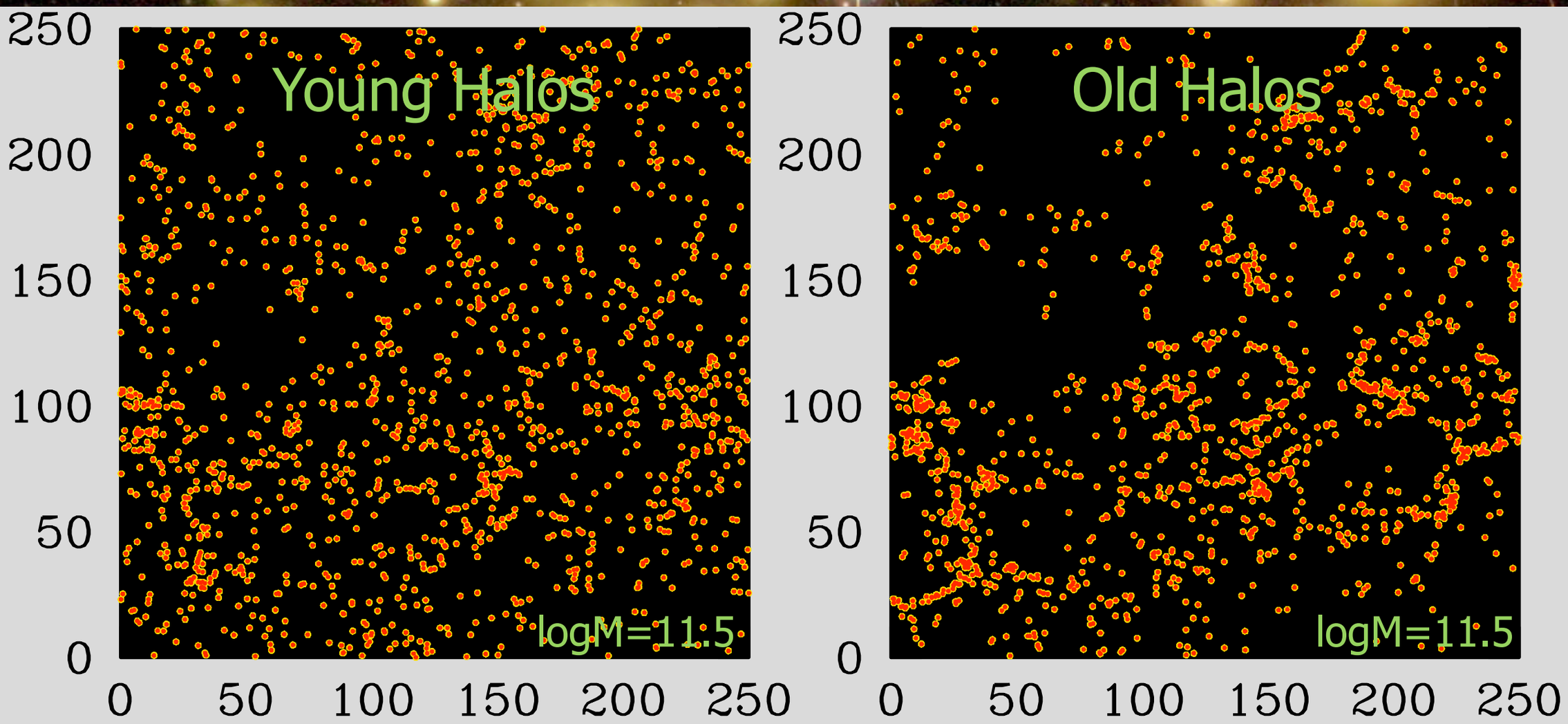
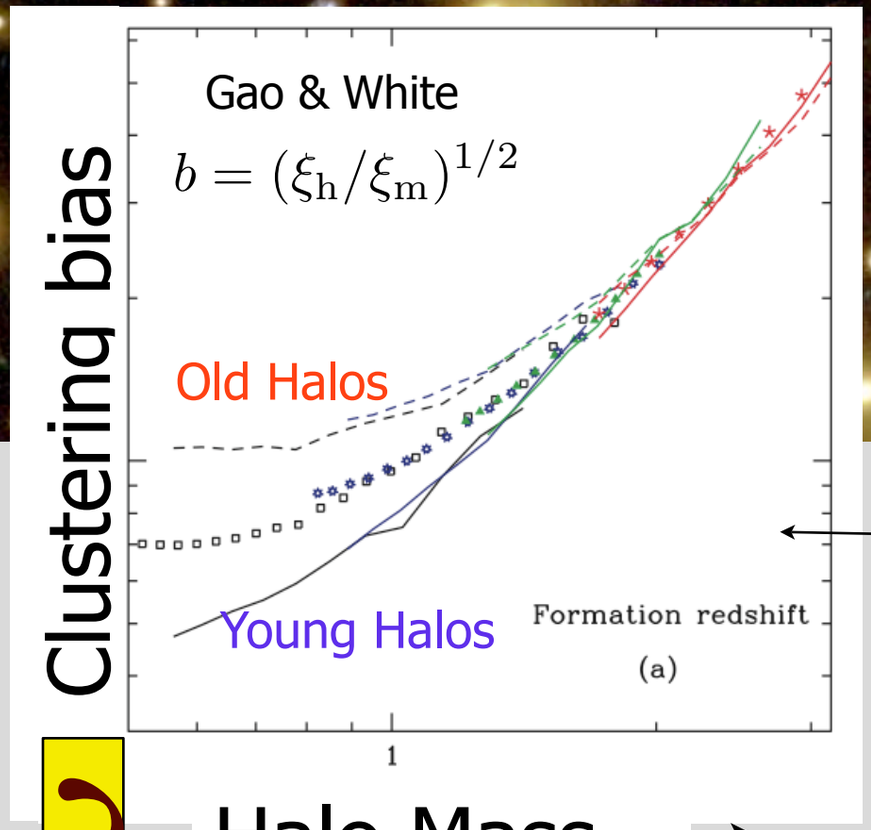


Assembly bias: Properties of halos at fixed mass depend on large-scale dark matter density: formation history, concentration, substructure

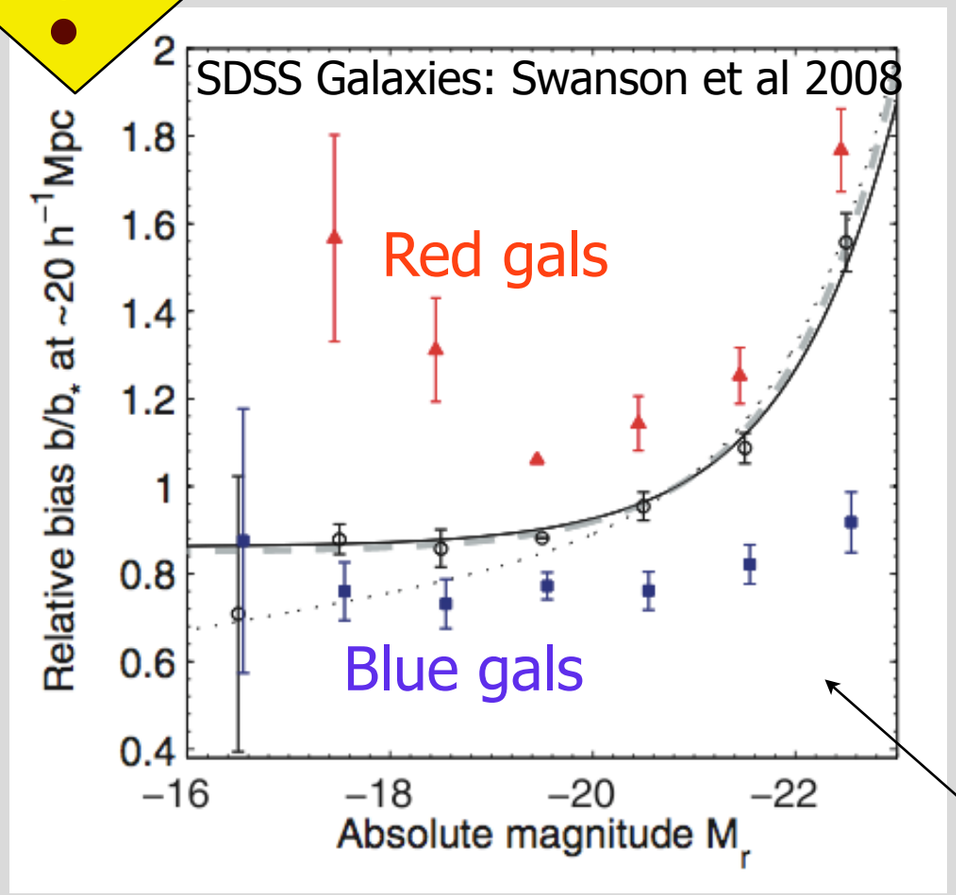
Halo Properties and Environment



See also: Gao et al 2005, Harker et al 2006, Wechsler et al 2006, Croton et al 2007

Open Questions:

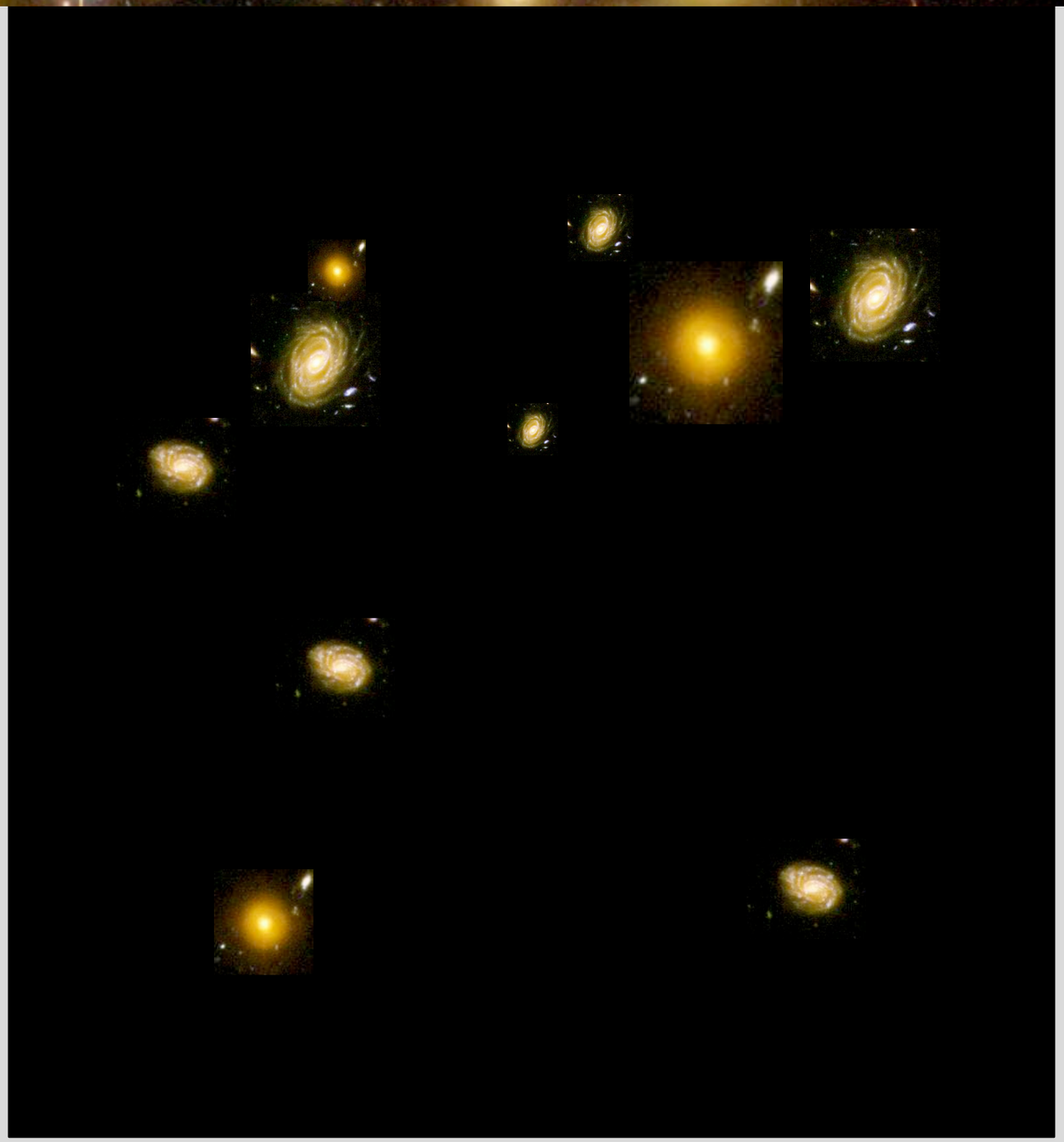
- Satellite galaxies influence bias, but what about central galaxies?
- Does assembly bias in halos propagate into galaxies?
- Does halo formation history effect galaxy formation history?
- What quenches low-mass field galaxies?



See also: Norberg et al 2001, Zehavi et al 2005 & 2010, Li et al 2007

Group Finding in SDSS DR7

- Halo-based group-finding method of Yang, Mo, van den Bosch (2005).
- Affords a central-satellite decomposition of all galaxies in DR7.
- 95% completeness for central galaxies in logM<~12 halos.
- Correct for ‘mislabeling’ of centrals and satellites.



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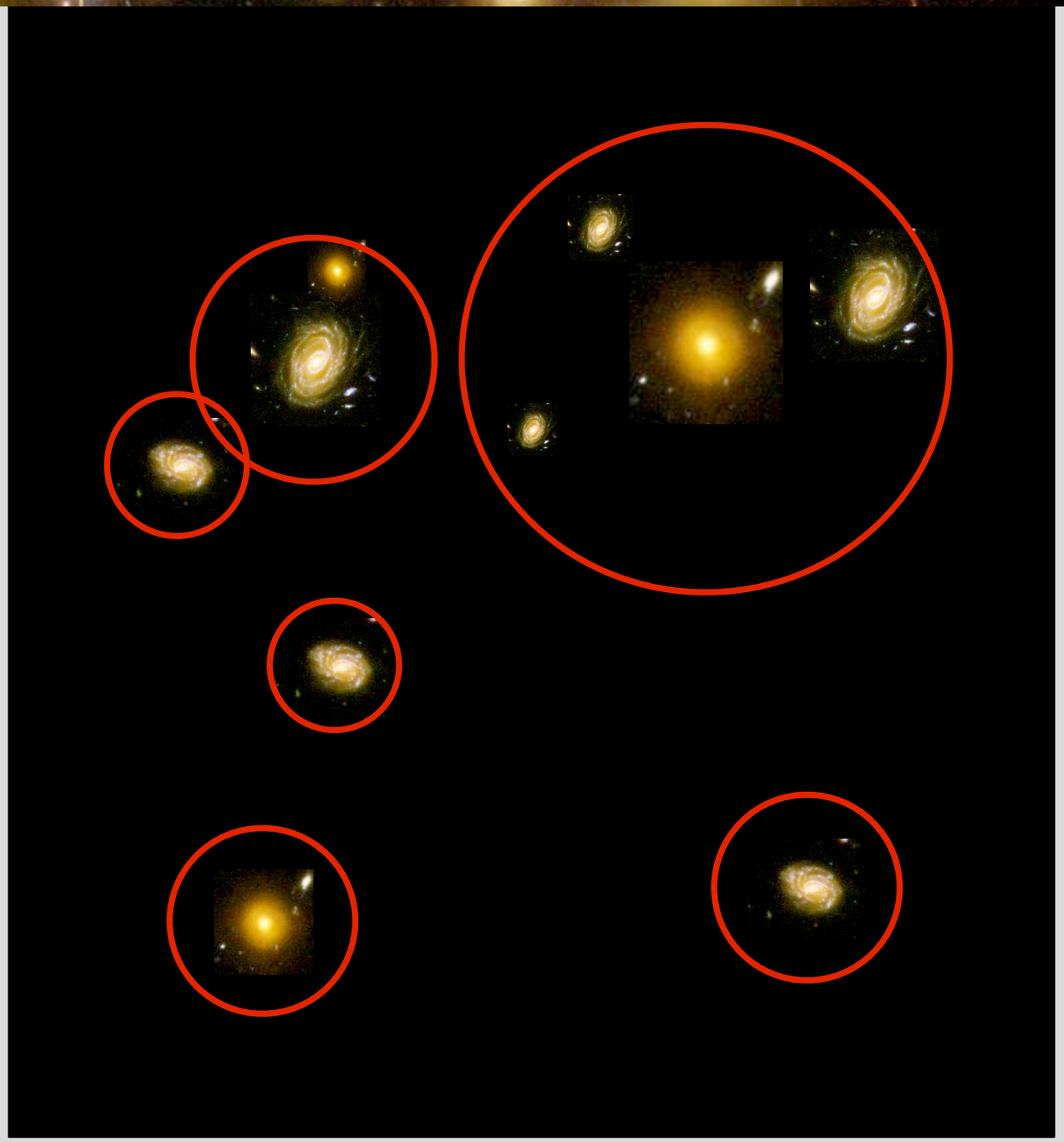

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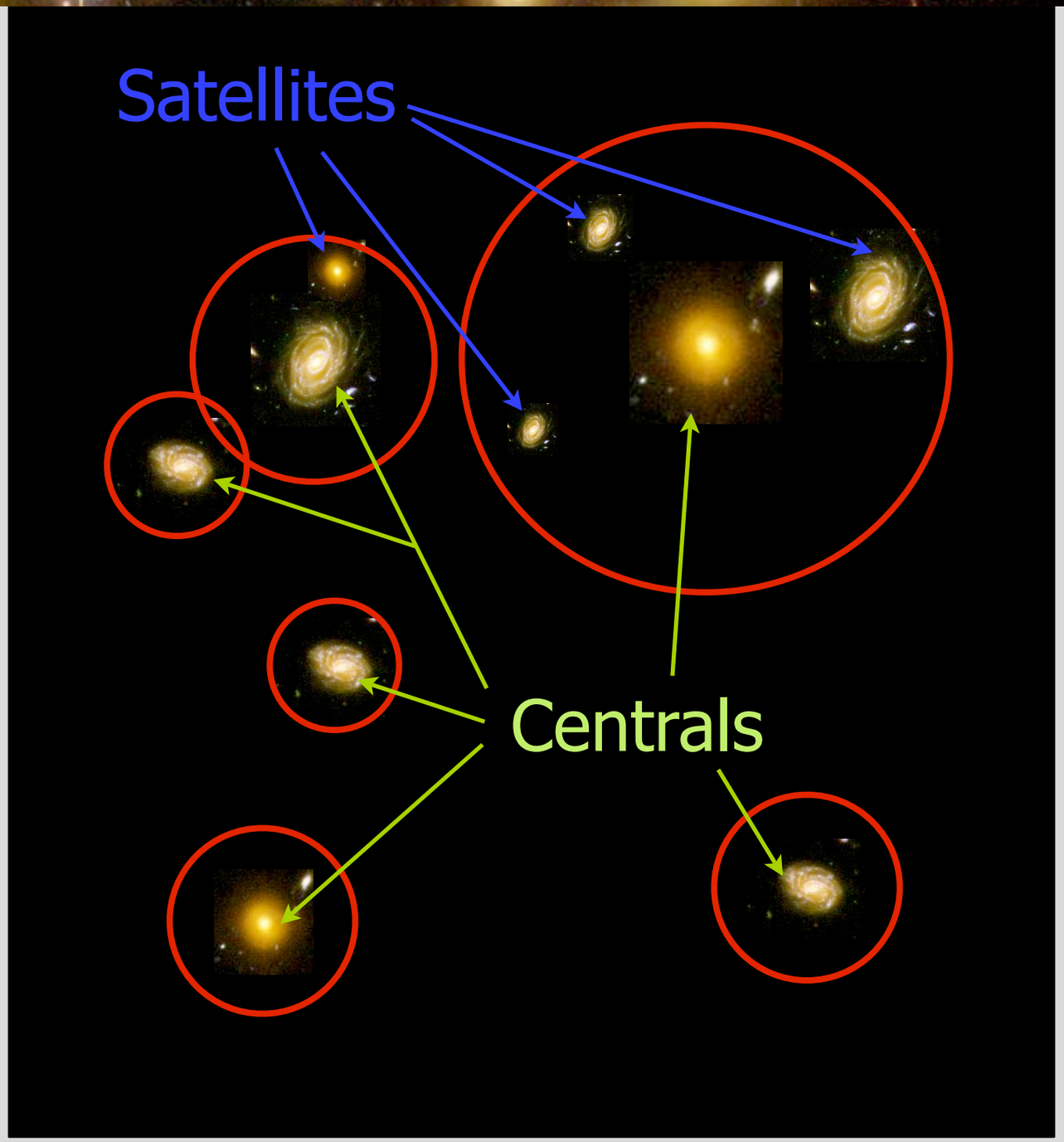
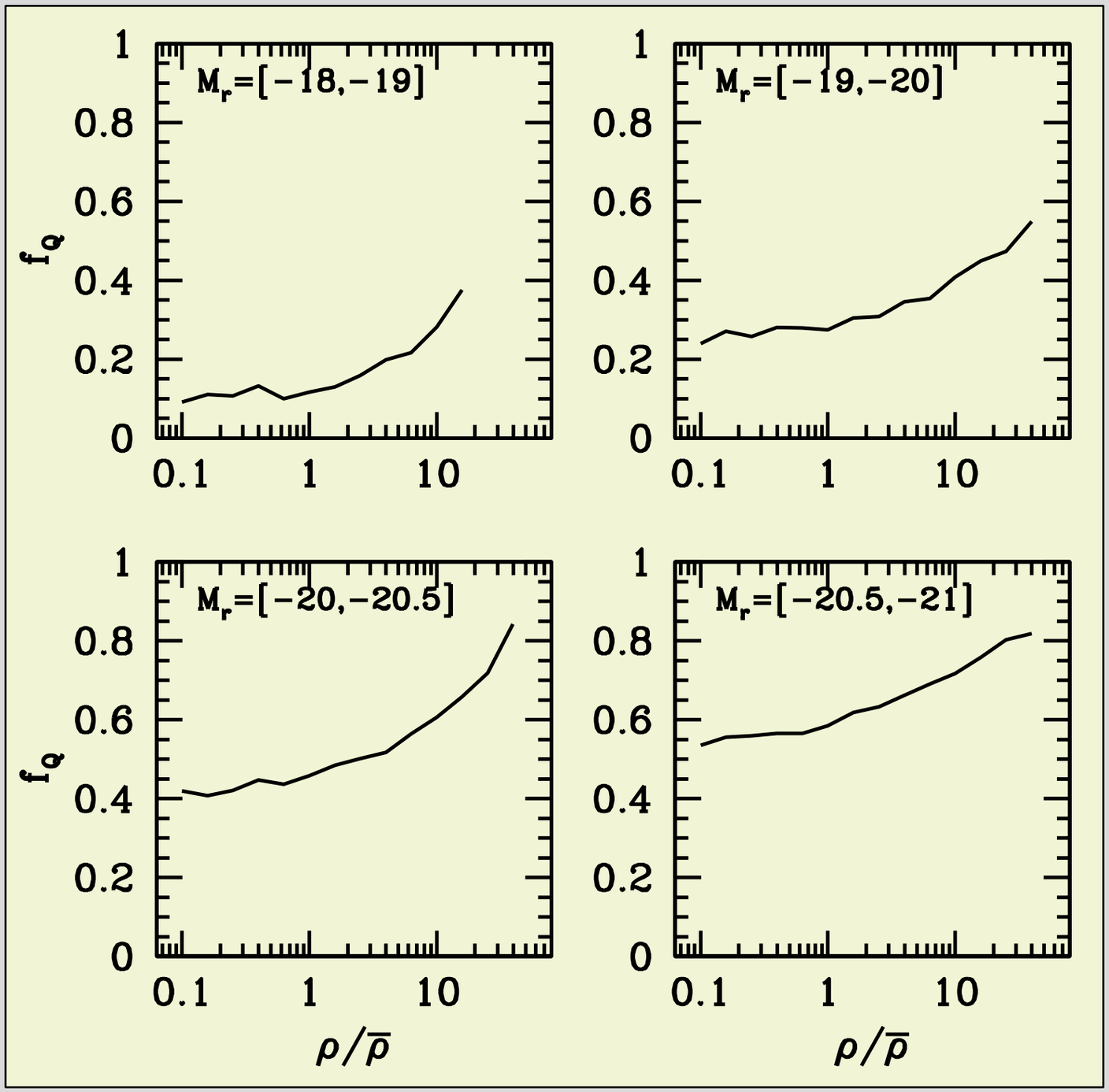
Evolution of satellite galaxies: see Andrew Wetzel’s poster



Breaking down the correlations with density

- Group catalog allows central-satellite decomposition of density correlations.
- Satellites drive the correlation.
- For low-L galaxies, centrals show no δ-dependence.
- For L>L* galaxies, centrals show slight positive correlation.
- Agrees with Wang et al (2008) group clustering, but not what you would expect from assembly bias.



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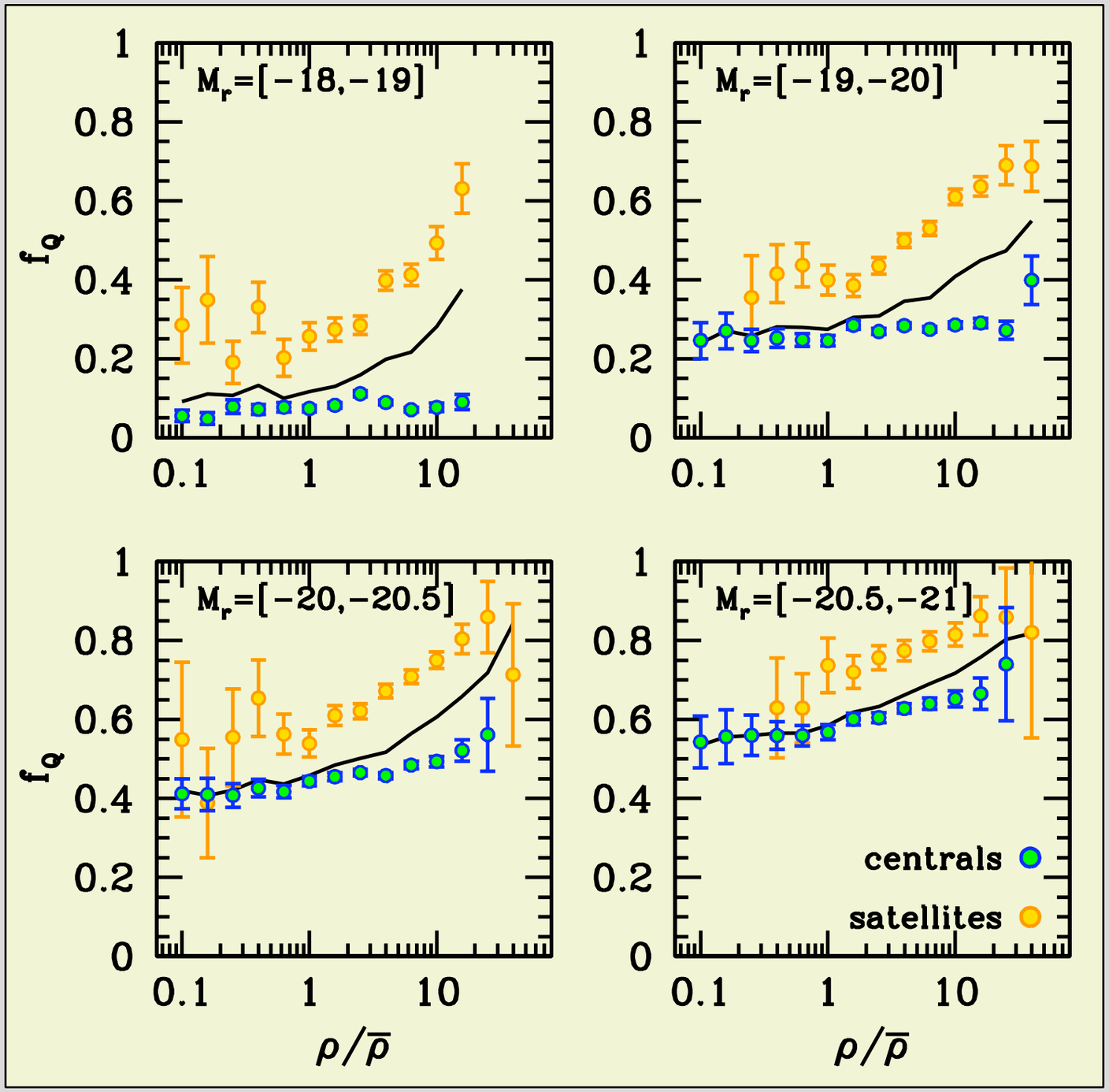
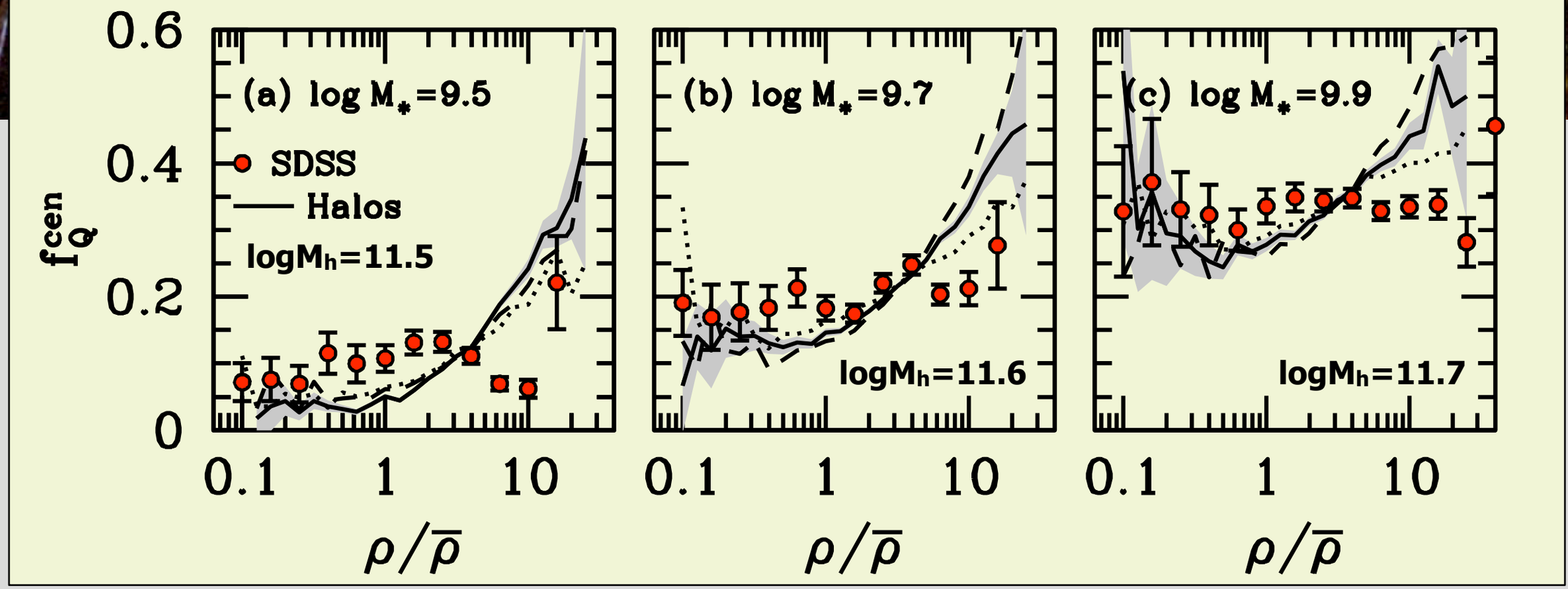


Are Old Galaxies in Old Halos?



Ansatz

Old (quenched) galaxies live in old halos that formed early and grow slowly today. Growth=1-M(z)/M(0), [z=0.3,0.5,1.0]

Test

Rank order halos by growth rate. Define "old" by value that matches observed f_Q^{cen} for that M_{gal}.

Results

The fraction of halos that are "old" varies strongly with ρ (assembly bias). Observations show no trend in central galaxies.

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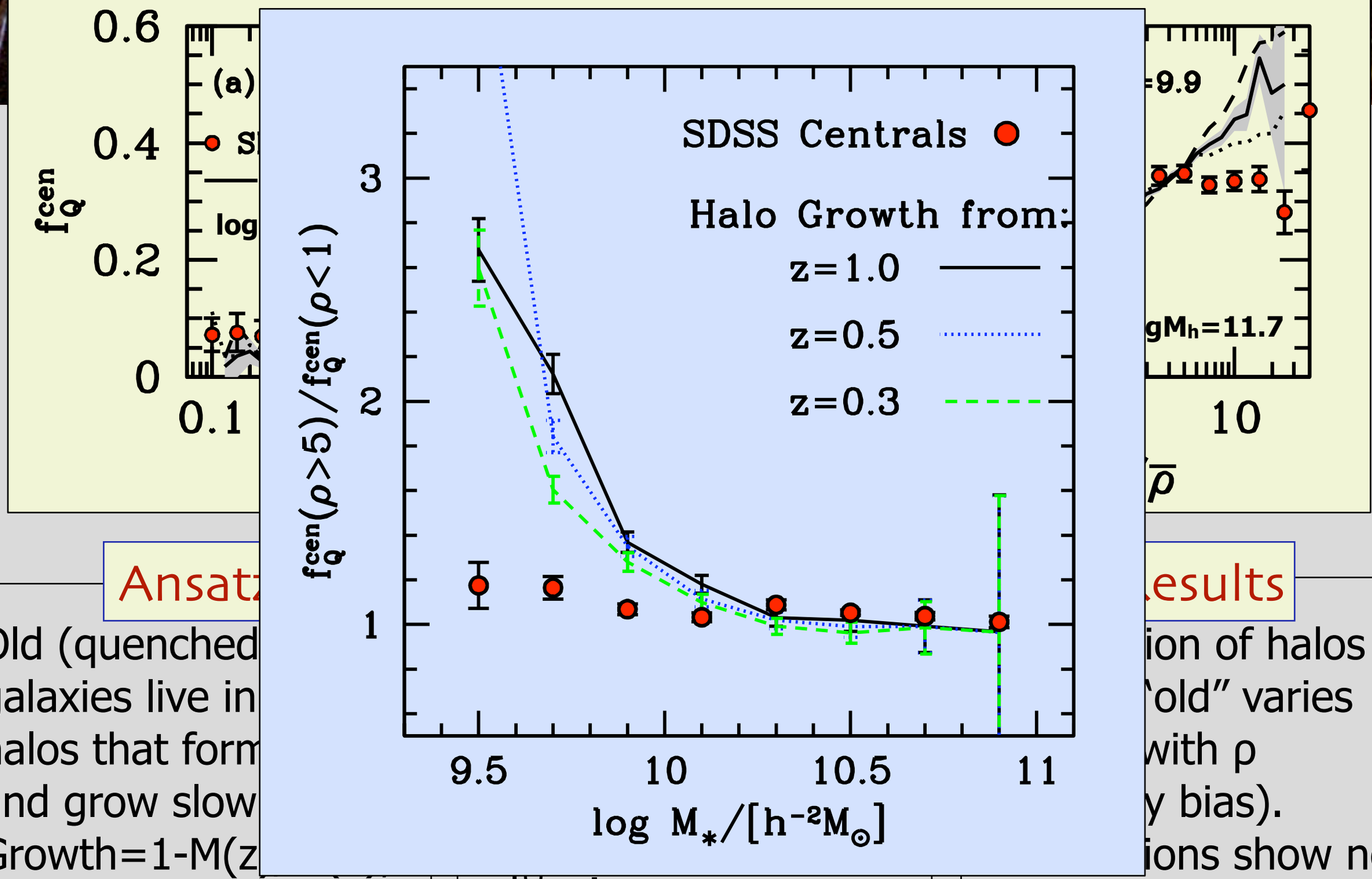

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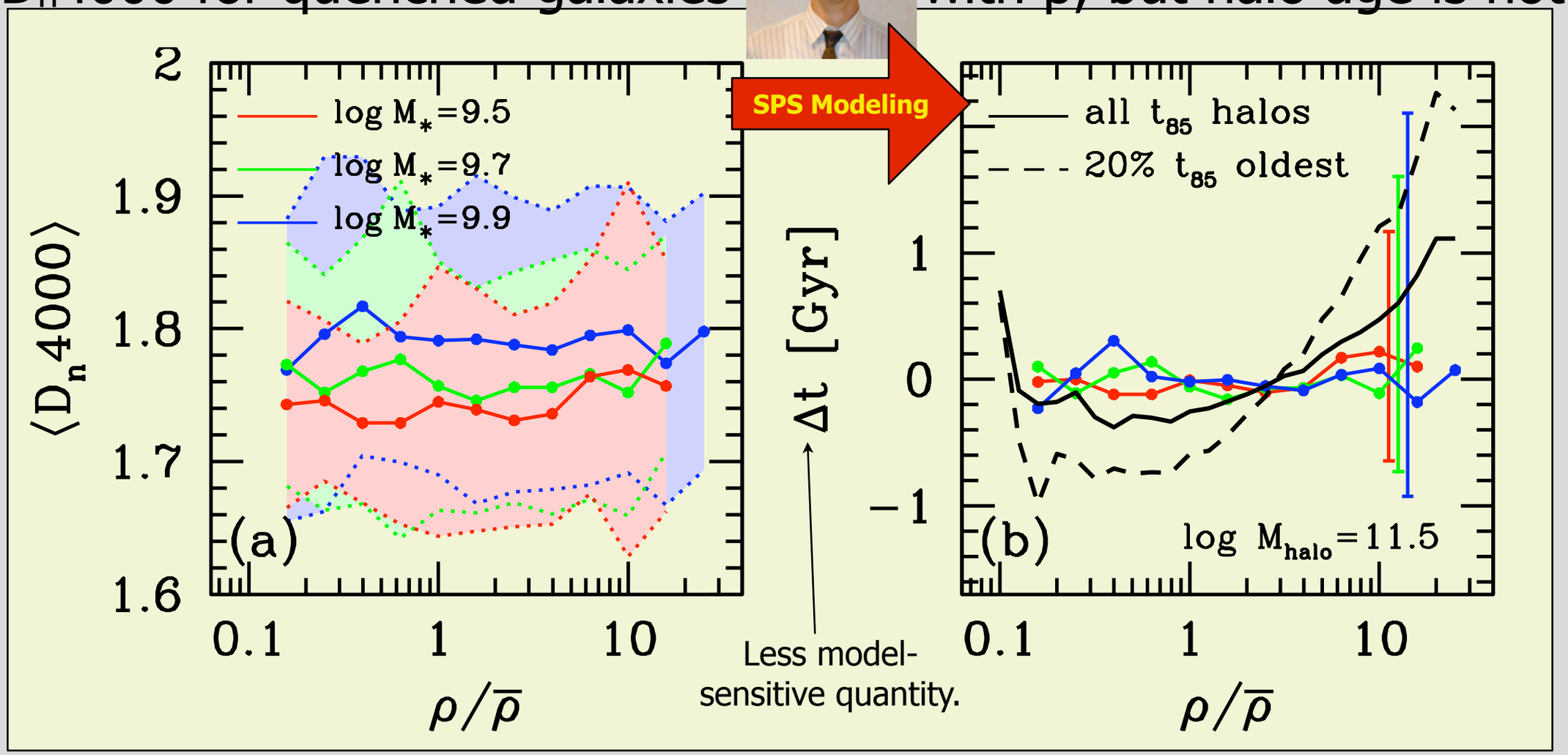
If not "if", what about "when"?

Maybe halo growth doesn't determine whether a galaxy is quenched, but does halo age correlate with mean stellar age?

Mean+dispersion of D_n4000 for quenched galaxies

Stellar age is constant with ρ, but halo age is not

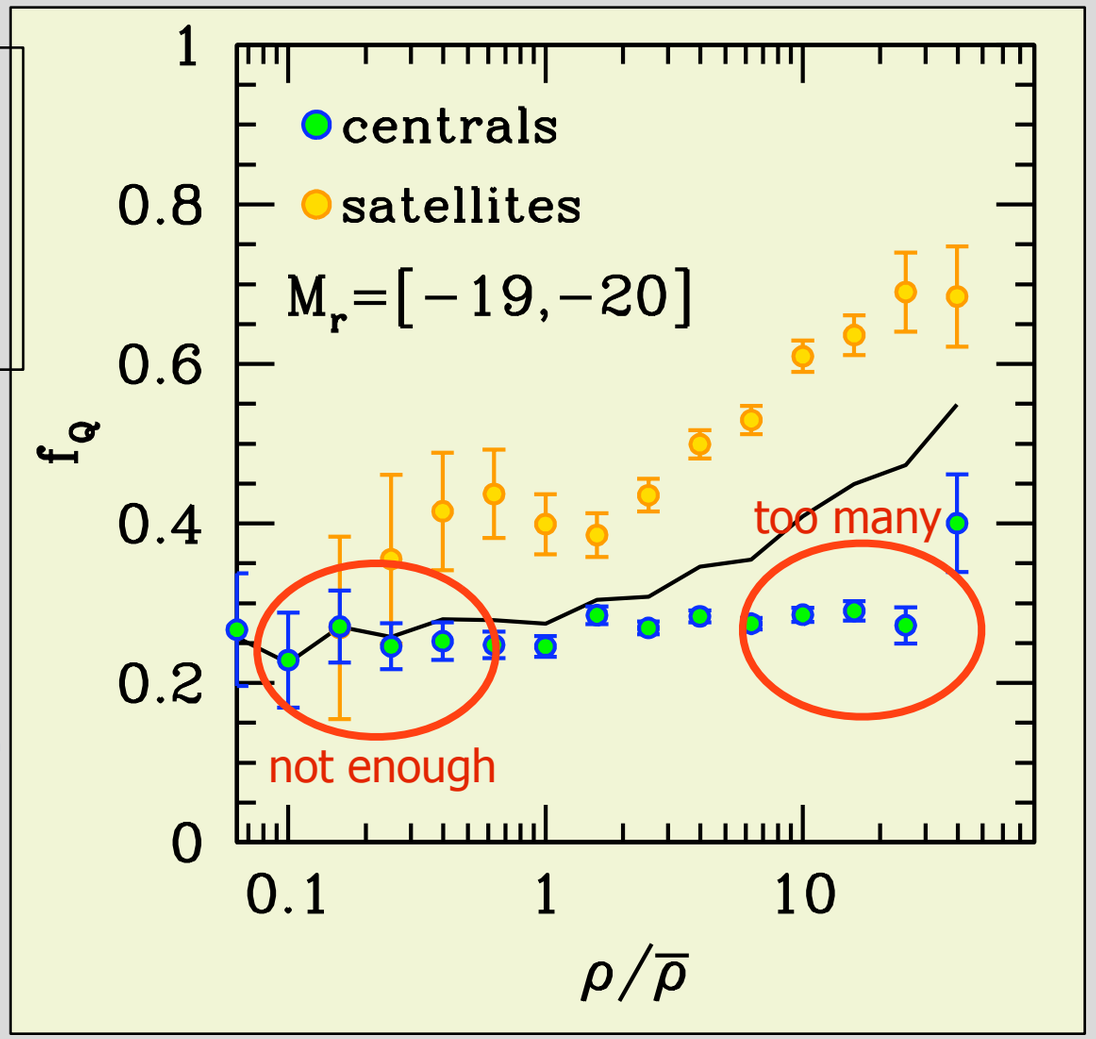


Less model-sensitive quantity.

What quenches low-mass central galaxies?

Process of Elimination

- Not galaxies that have "flown through" groups or clusters.
- Not major galaxy mergers: there simply aren't enough of them.
- Probably not even minor galaxy mergers.



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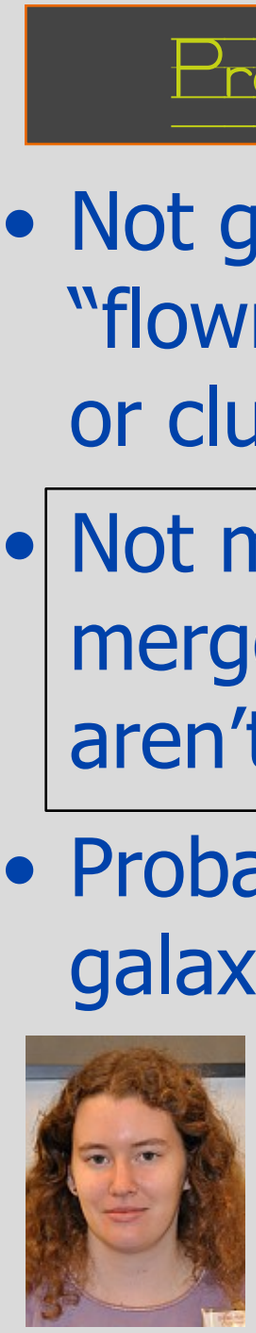
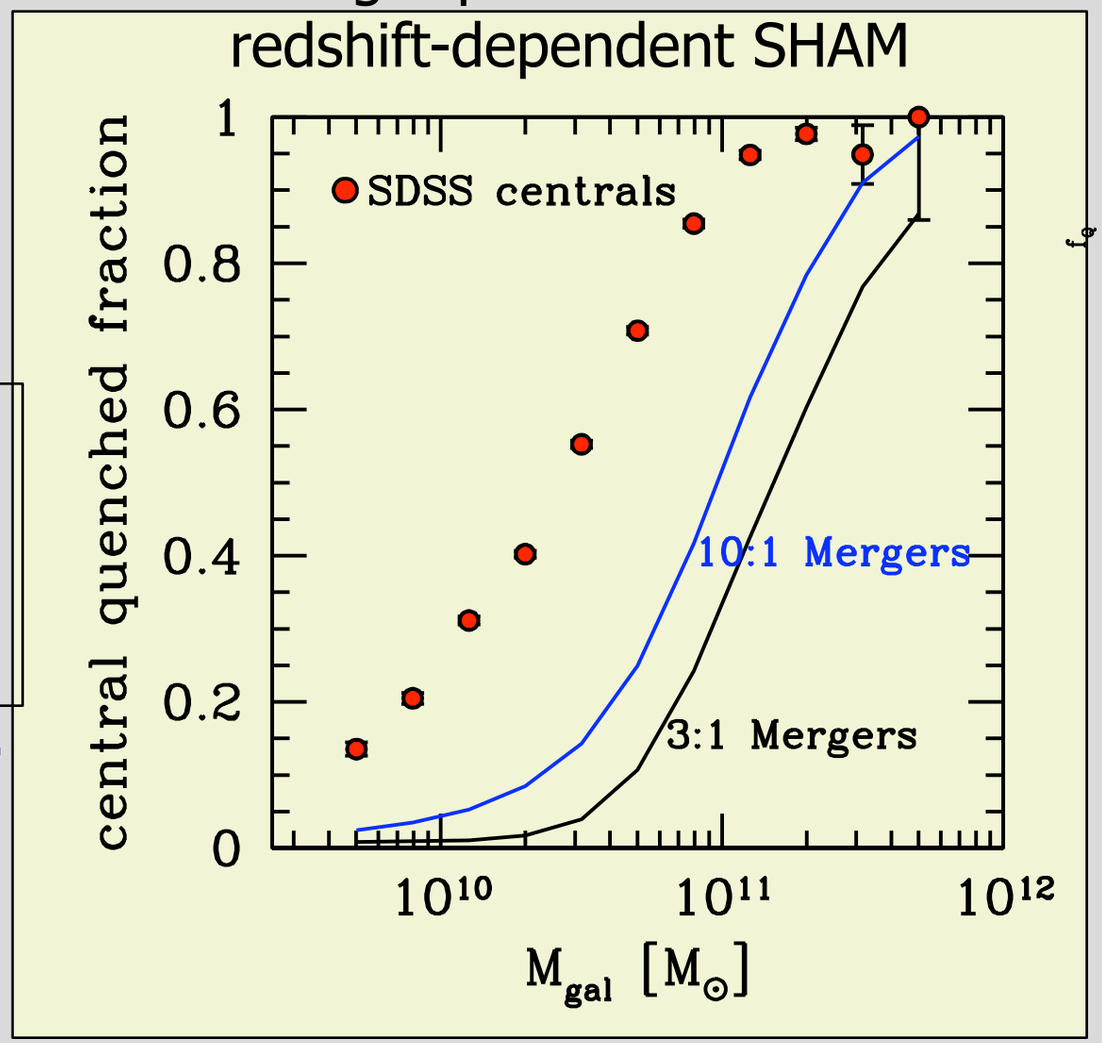
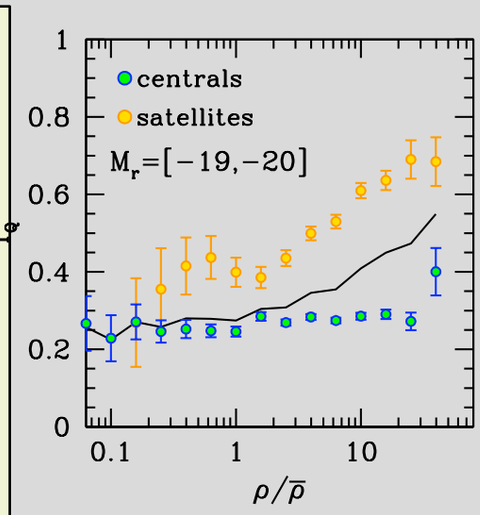


For more information on SHAM: see Rachel Reddick's poster: 7.26

Wetzel et al, in prep:
Merger predictions from
redshift-dependent SHAM





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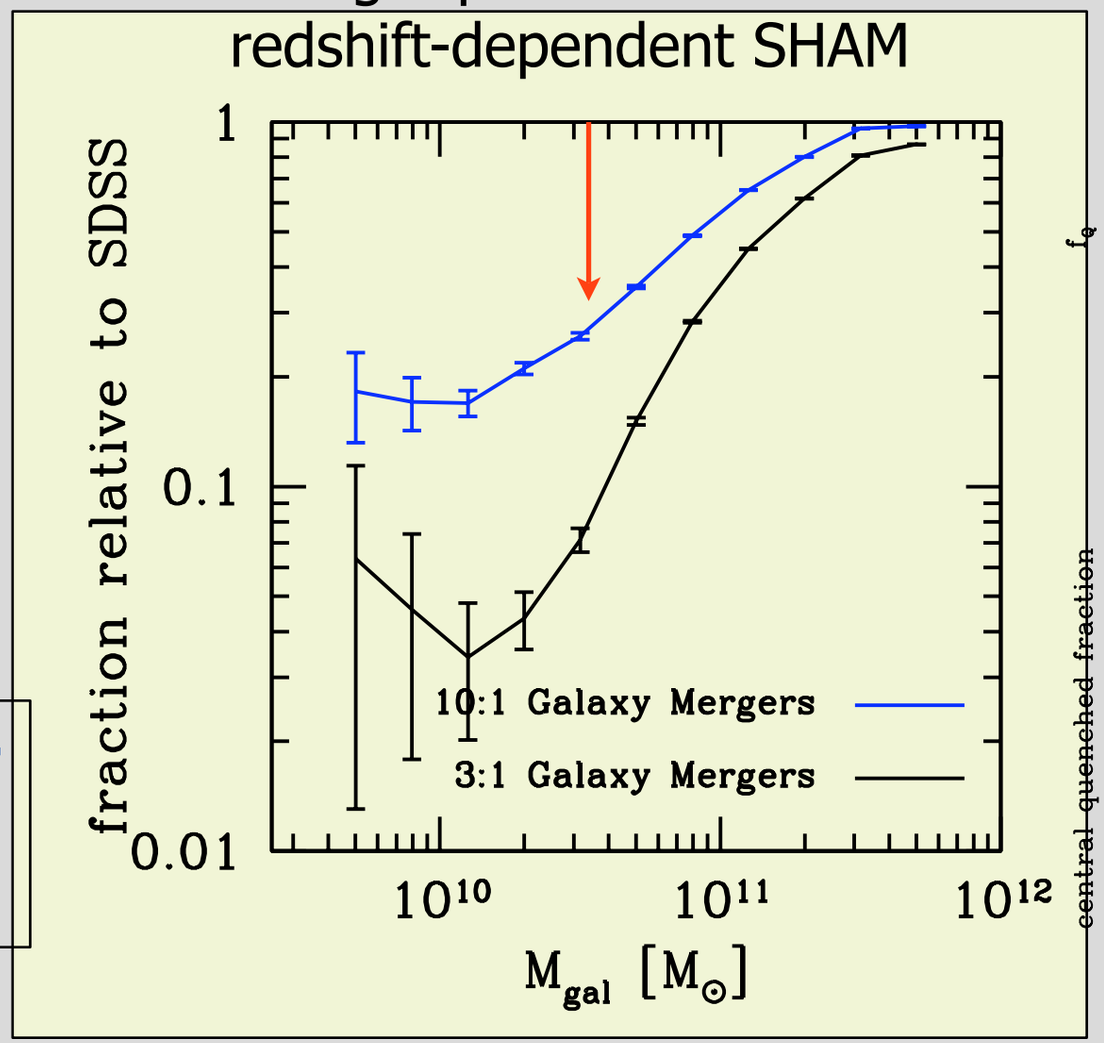

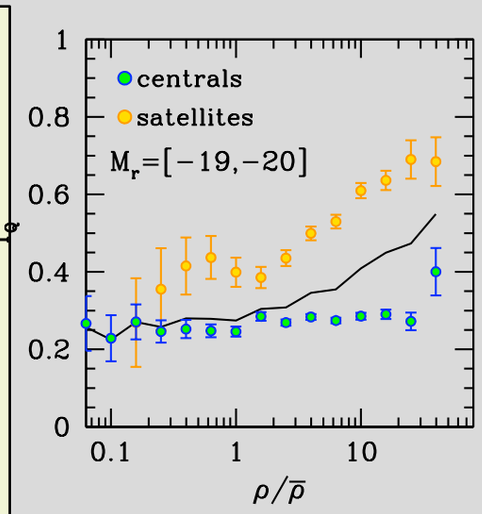

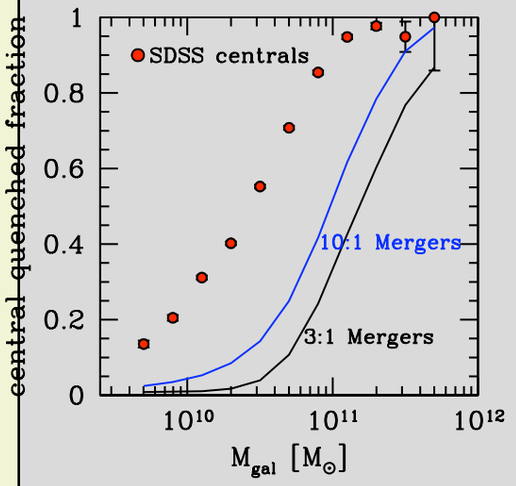

Conclusions

- Environmental correlations are driven by the halo mass function, not by density on scales $>R_{halo}$.
- Halo formation history--at fixed mass--is uncorrelated with galaxy age or the quenching of star formation.
- Further evidence that halo mass is dominant parameter in galaxy formation...
- …but is there any second parameter of importance (for central galaxies)?
- The mystery of quenched low-mass field galaxies continues… AGN? Solution requires both quenching and morphological transformation.