Results using a halo-based group finder in the SDSS and 2dFGRS

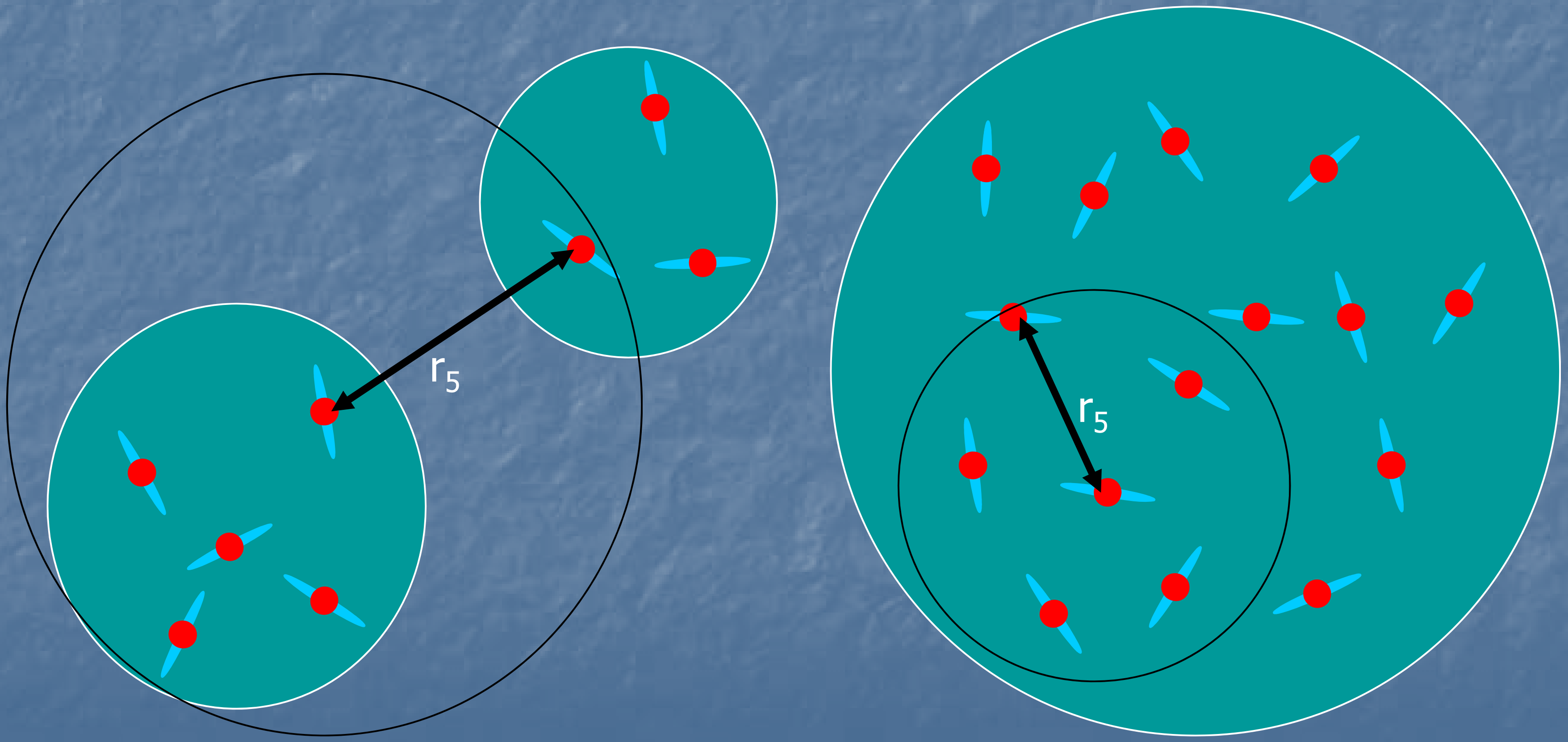
Weinmann et al., astro-ph/0509147

Yang, Mo and van den Bosch, astro-ph/0509626

Why a halo-based group finder?

- Attempts to identify galaxies residing in the same dark matter halo.
- More direct comparisons with models via halo model or halo occupation distribution formalism.
- Overcomes problems with definitions of environment incorporating a fixed spatial or density scale.
- Gives three separate measures of environment: halo mass; halo-centric radius; and large-scale environment.

Problems measuring environment on a fixed scale.

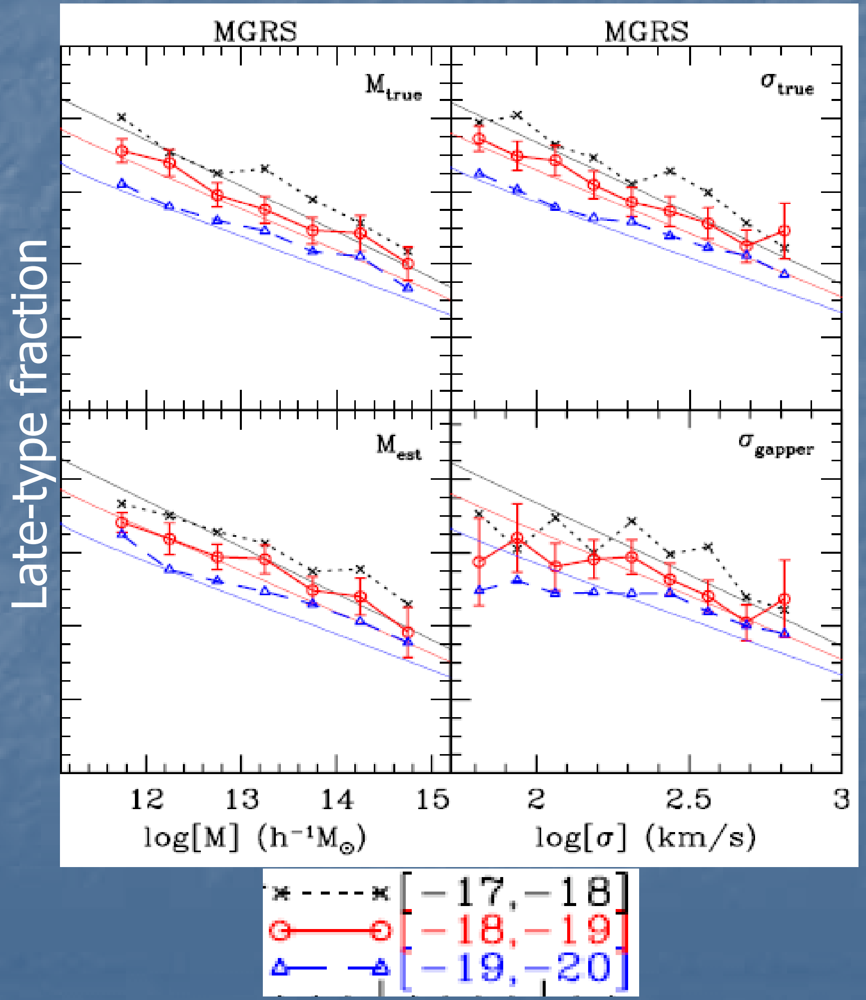


Group finding algorithm

1. Use FOF algorithm with small linking length to identify potential group centres.
2. Estimate the total group luminosity.
3. Estimate group mass (using assumed M/L), and thence radius and velocity dispersion.
4. Reassign group memberships to all galaxies using three-dimensional density contrast in redshift space.
5. Recompute a luminosity-weighted group centre and iterate steps 2-5 until convergence.

Tests of group finding algorithm

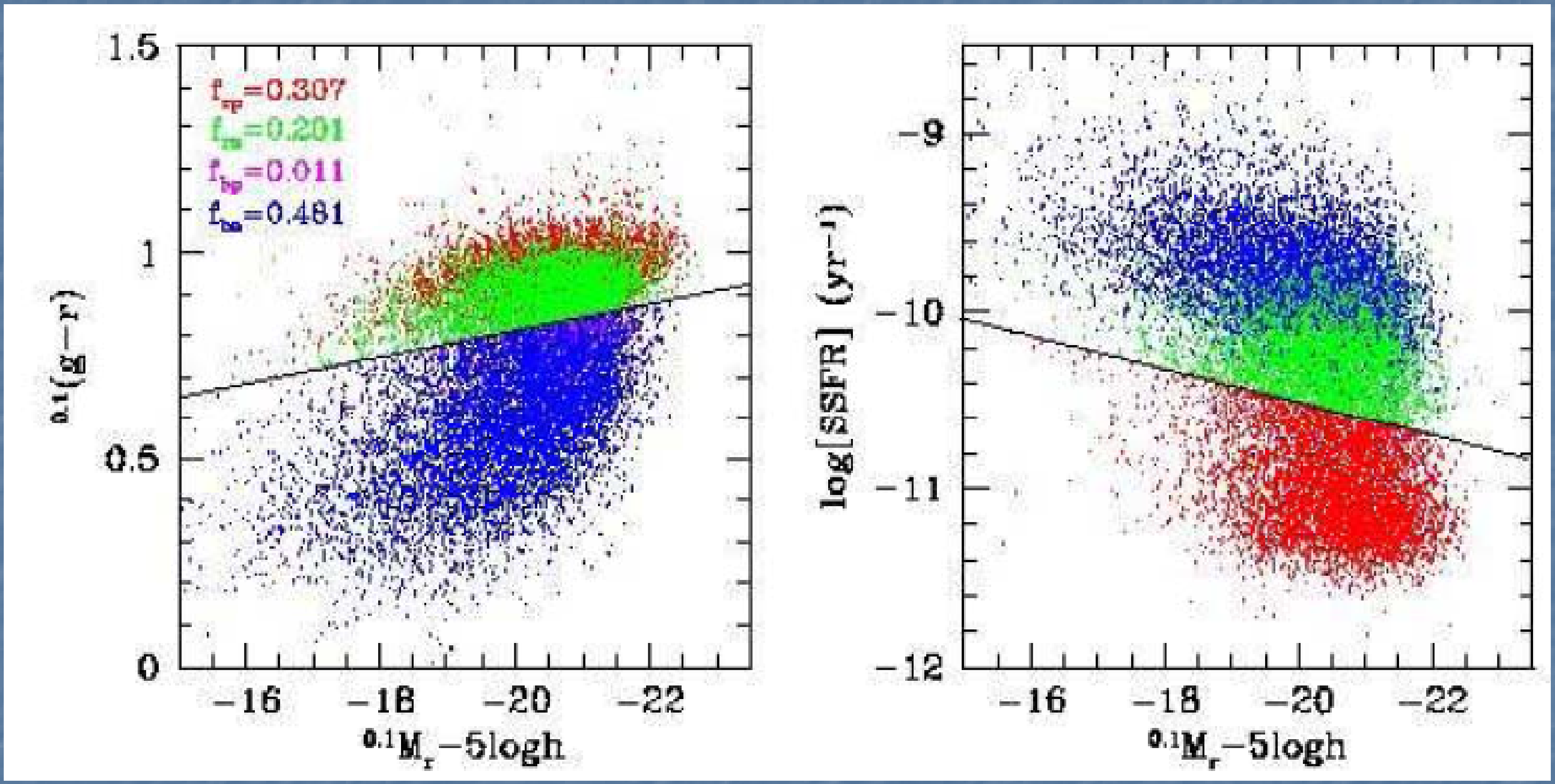
- Tested using 2dFGRS mock catalogues.
- ~90% completeness.
- ~20% interloper fraction.
- Better group mass estimates by using estimated L_{group} than by using velocity dispersion.
- Estimate L_{group} at higher redshift from low-redshift calibration, not using the global luminosity function.



SDSS sample

- New York University Value Added Galaxy Catalogue, based on SDSS DR2.
- 'Main' galaxy sample:
  - $r<18$
  - $0.01 \leq z \leq 0.2$
  - Redshift completeness >0.7
- Stellar masses obtained from 4000Å break and $H\delta_A$ as described by Kauffmann et al. (2003).
- SFR from emission lines as in Brinchmann et al. (2004); divide by stellar mass to obtain specific SFR.
- 179197 galaxies.

SDSS sample

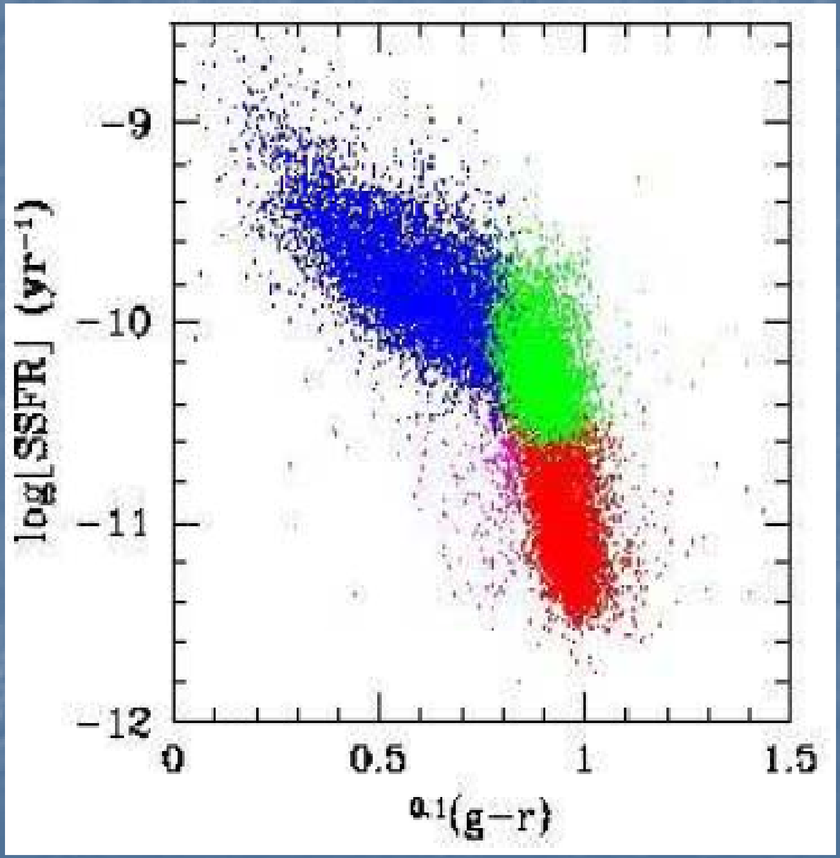


'Late type' 'Intermediate' 'Early type'

SDSS sample

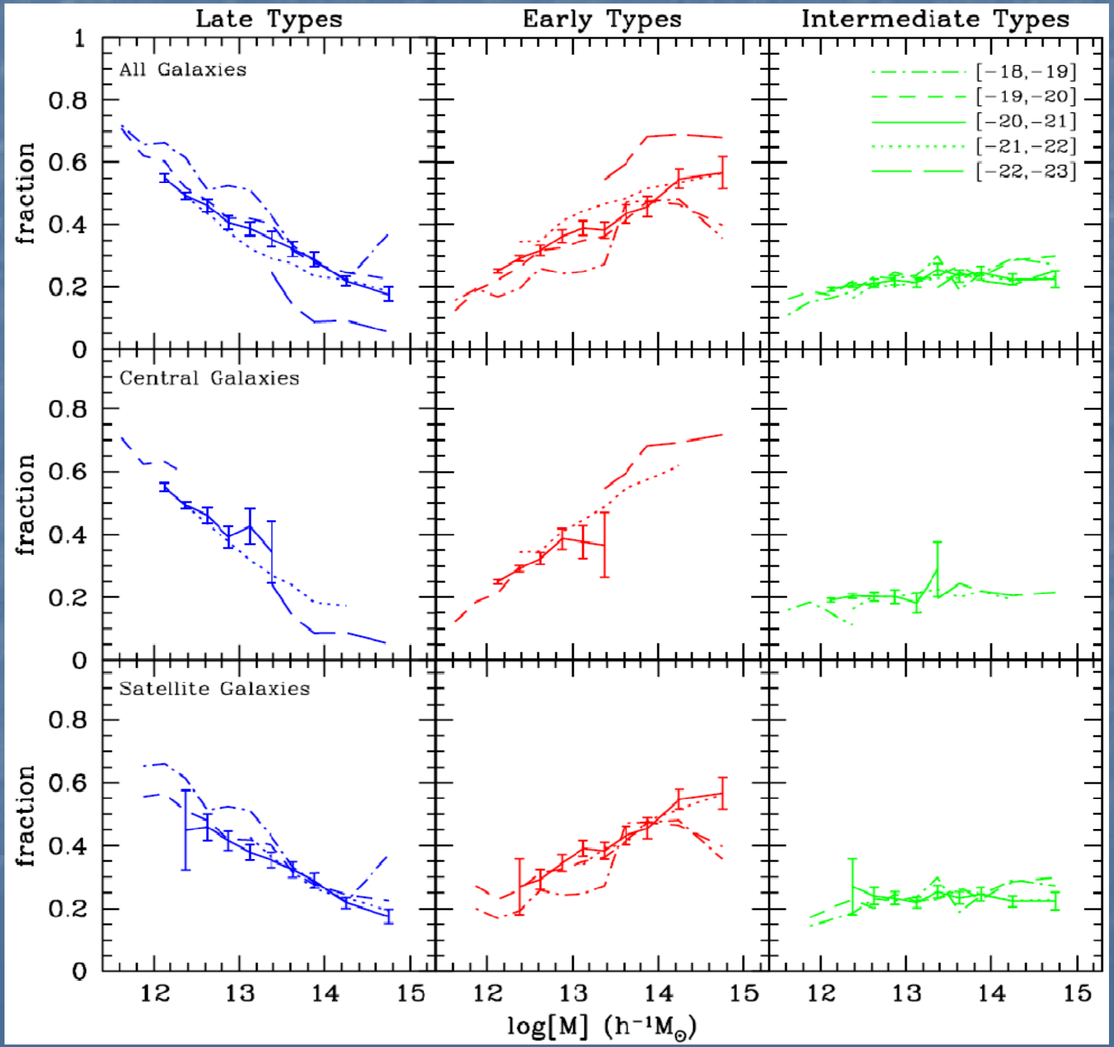
- Almost a one-parameter family of galaxies.
- 48.1% blue & active ('late').
- 30.7% red & passive ('early')
- 20.1% red & active ('intermediate)
- 1.1% blue & passive – unclassified.

More active →



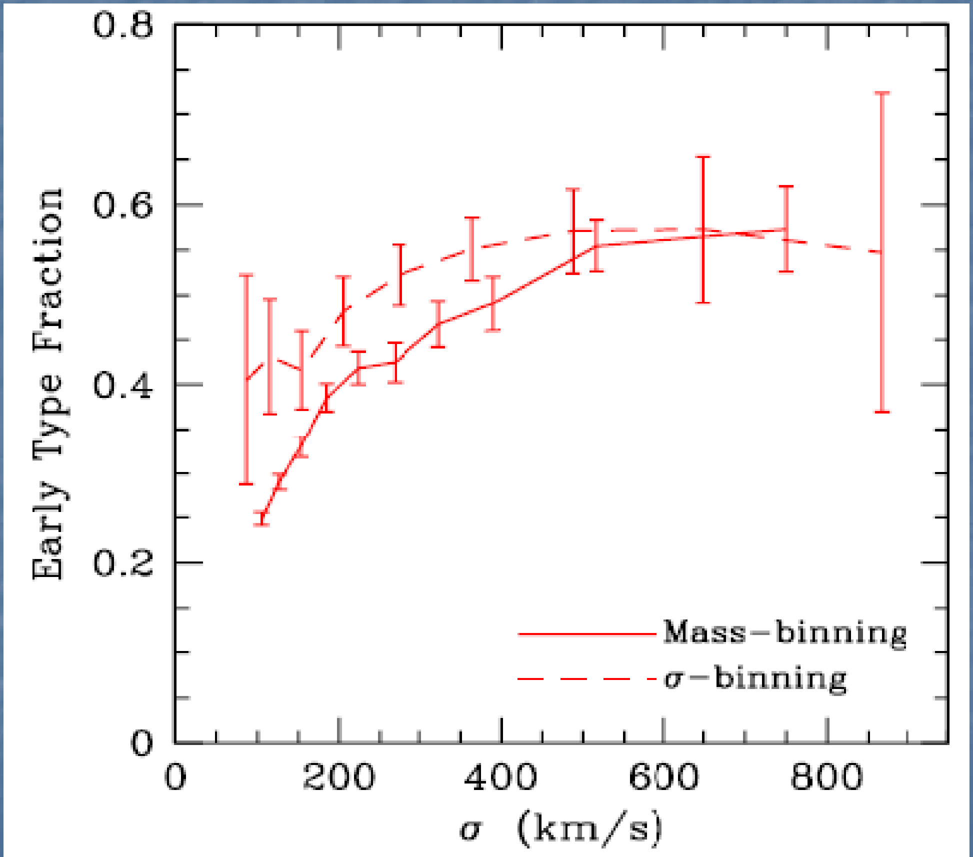
Redder →

Type fraction by halo mass

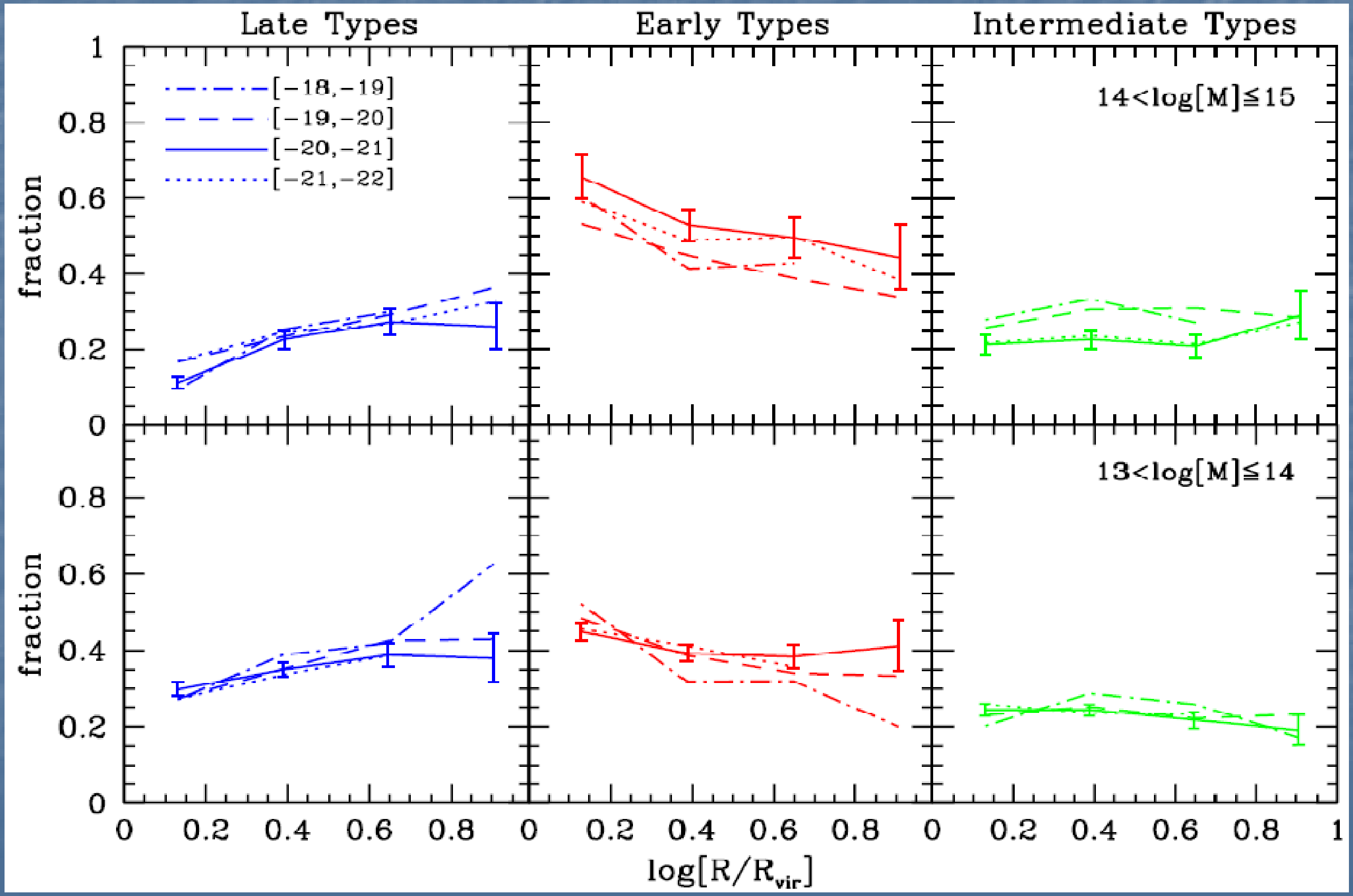


Use L_{group}, not σ !

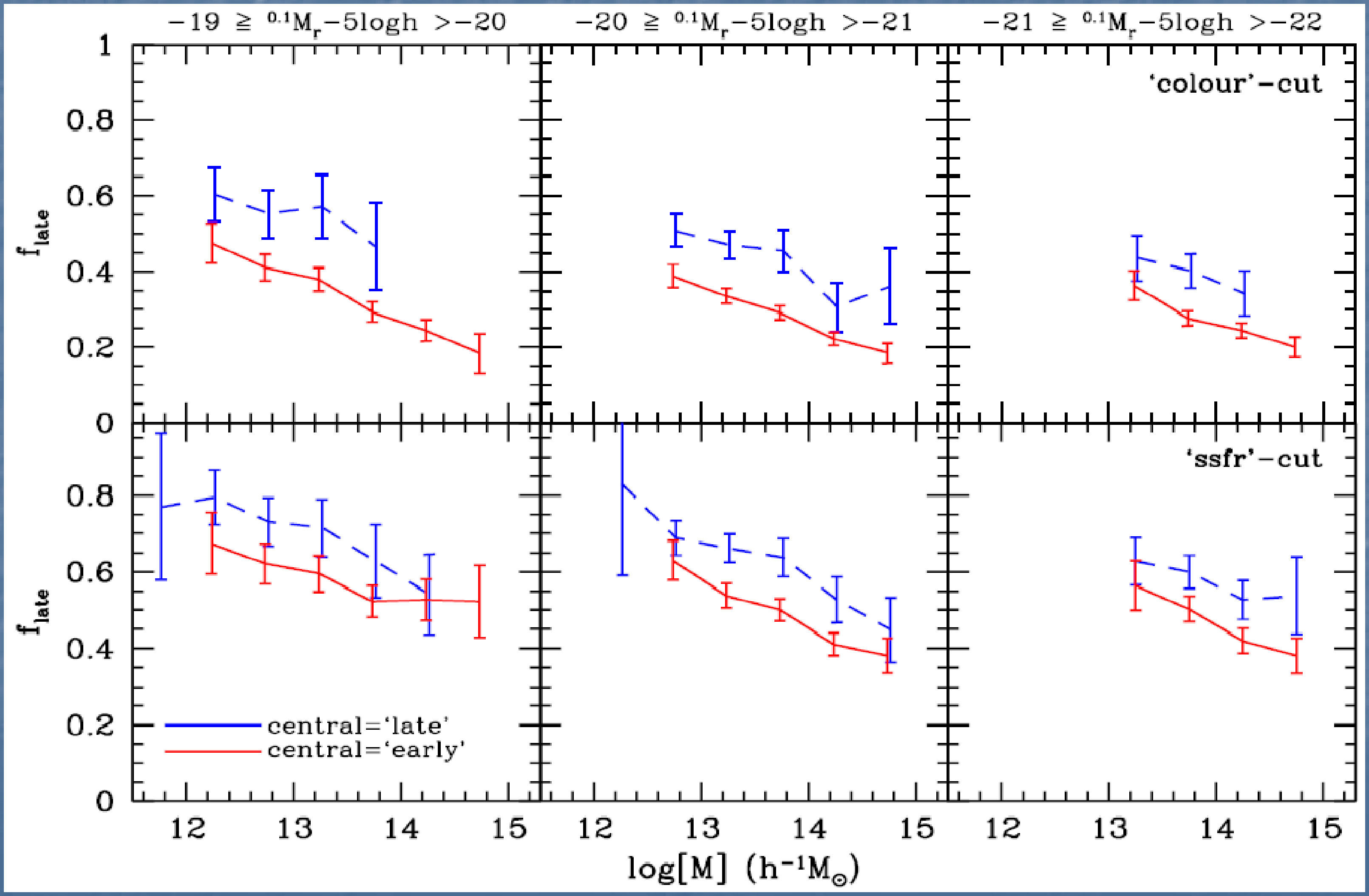
- $-20 \geq {}^{0.1}M_r - 5\log h \geq -22$
- Using velocity dispersion as a mass estimator washes out mass dependence of type fraction.



Type fraction of satellite galaxies by halo-centric radius



Galactic conformity

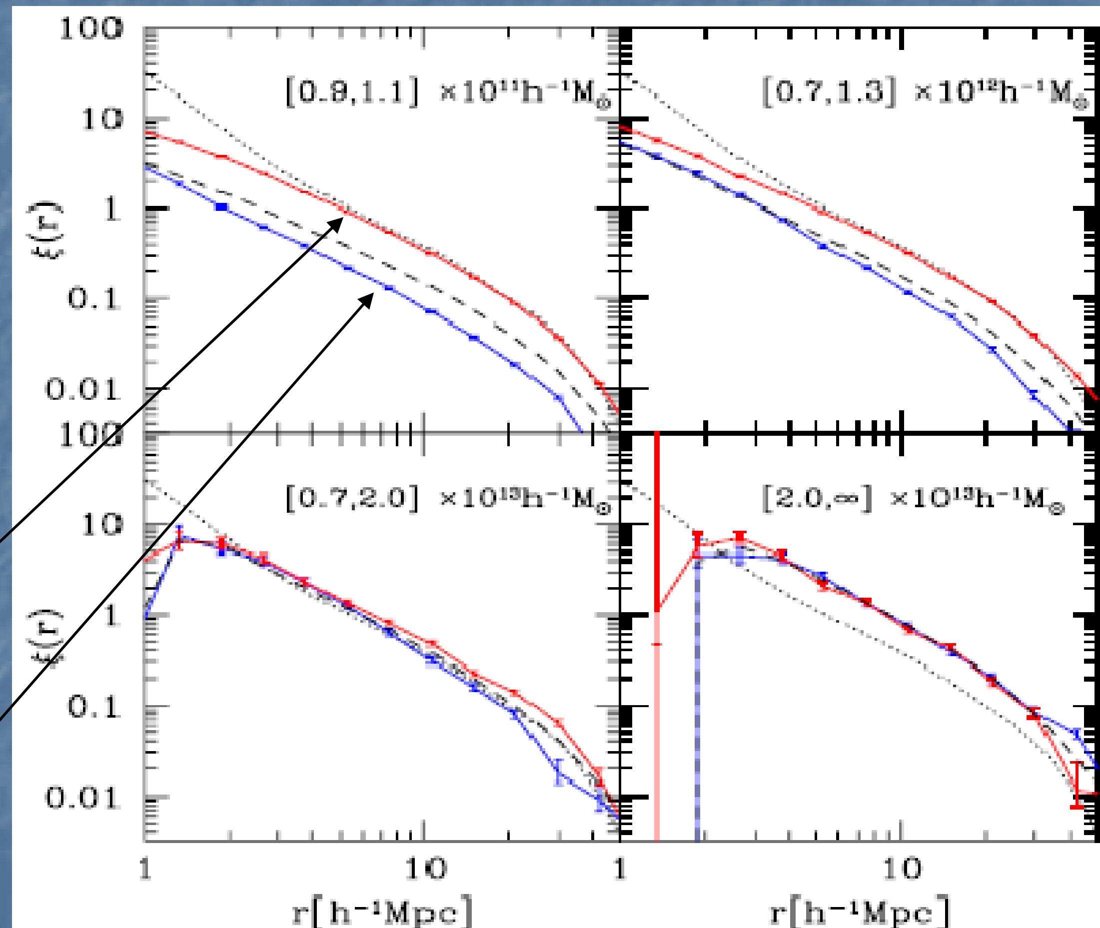


Summary of SDSS results.

- Late type fraction decreases smoothly with halo mass, and decreases (weakly) with luminosity at fixed halo mass.
- Late type fraction increases with increasing halo-centric radius.
- ~20% intermediate type galaxies at every halo mass, luminosity and halo-centric radius.
- Satellite galaxies seem to know about the properties of the halo central galaxy, even for haloes of a given mass.
- Median galaxy properties depend only weakly on halo mass.

A theoretical interlude

'The Gao Effect': for haloes of a given mass (below about $10^{13}h^{-1}M_{sun}$), those with more recent formation times are less clustered.



Oldest 20%

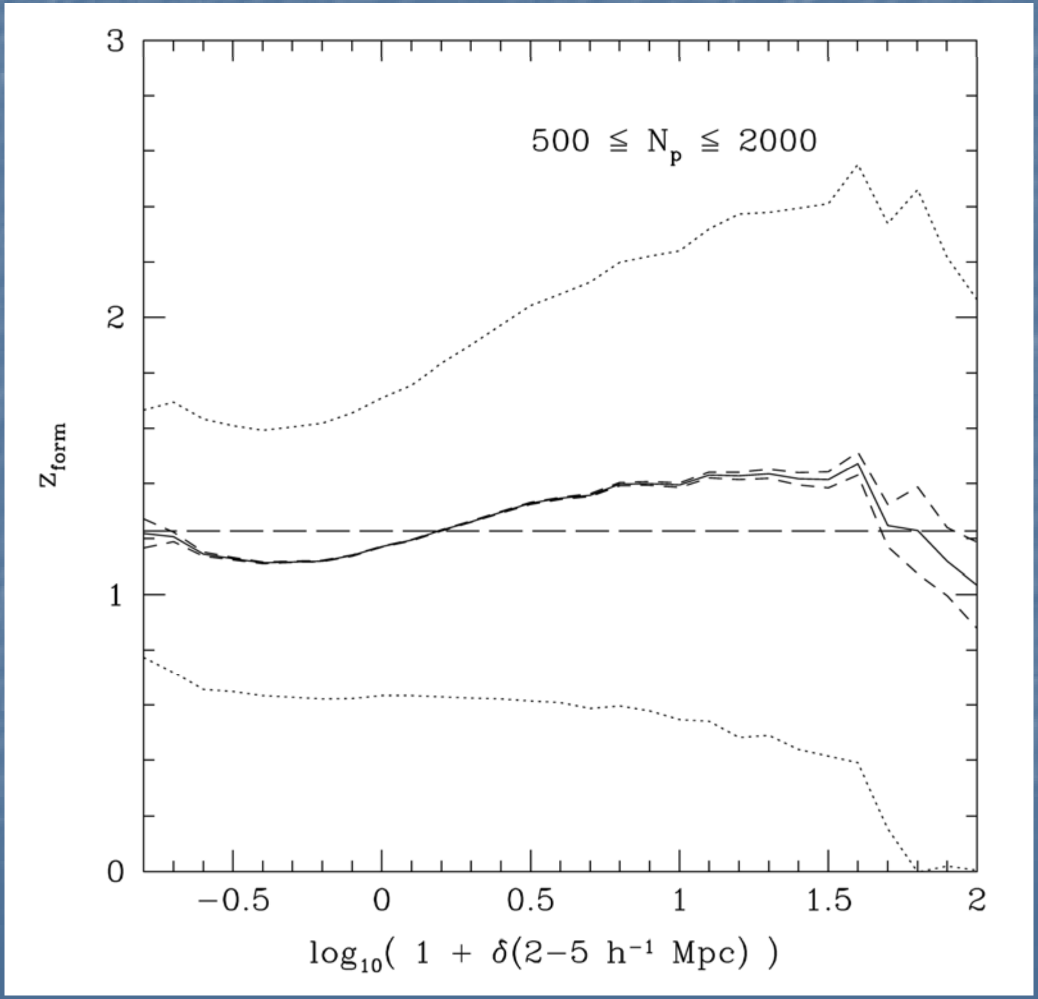
Youngest 20%

Gao, Springel & White (2005)

Or in other words…

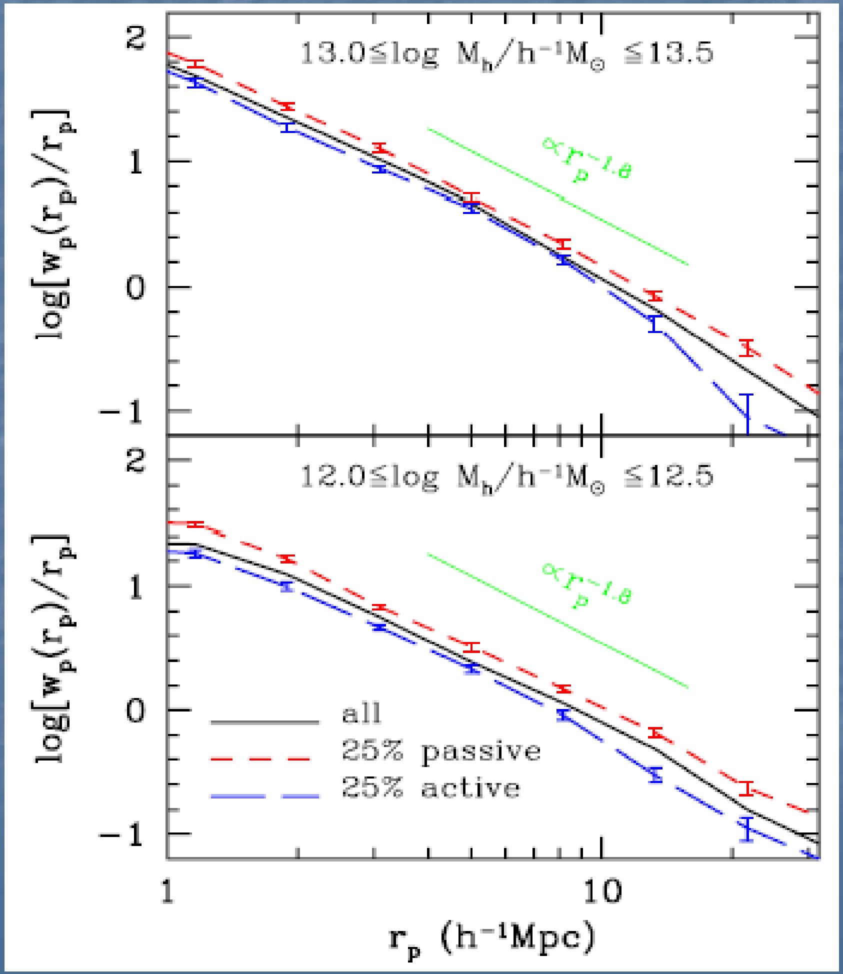
Haloes of a given mass in denser regions form earlier, on average.

Wide dispersion in formation times at a given mass and overdensity.

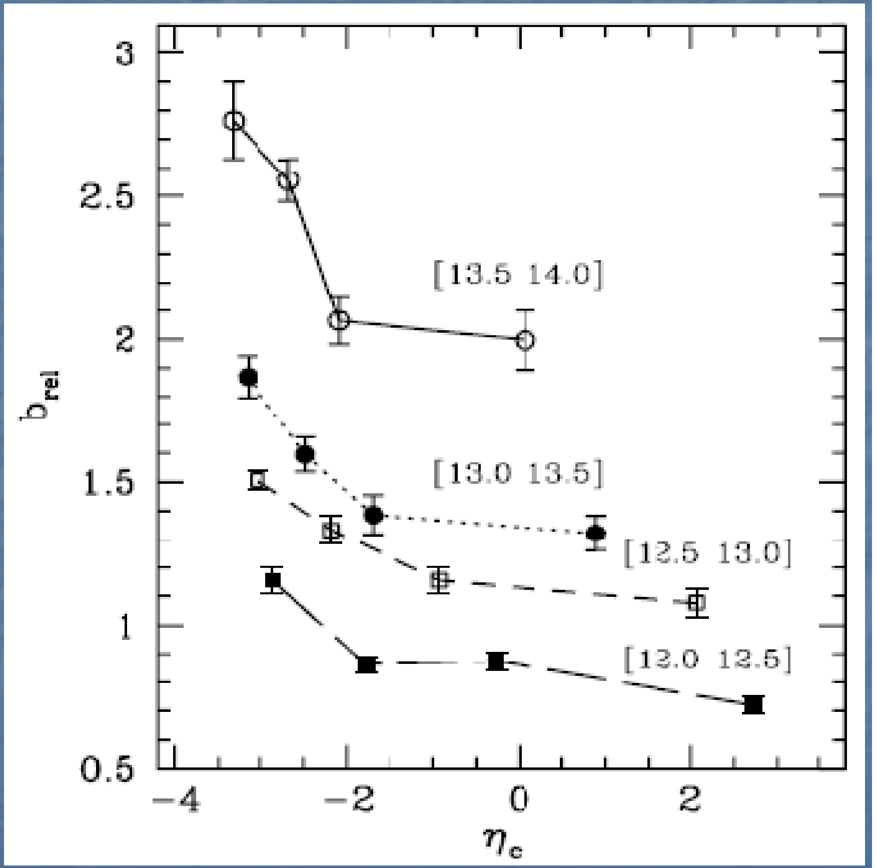


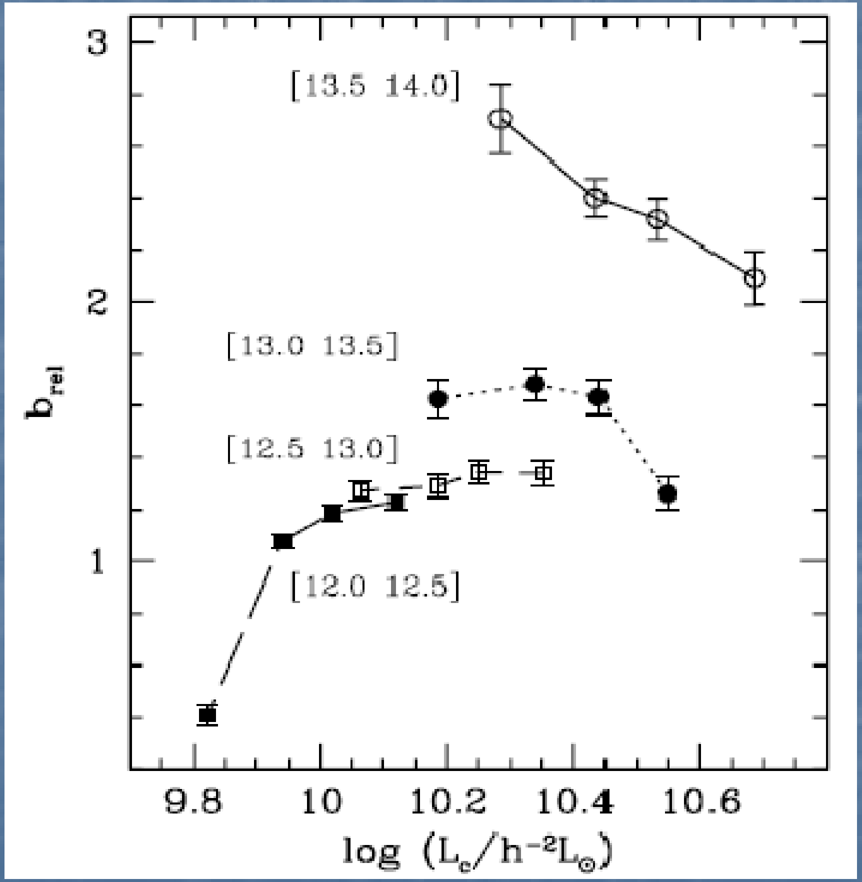
Looking for the Gao Effect in the 2dFGRS

- Given the halo-based groups (constructed as for the SDSS), calculate the galaxy-group cross-correlation function.
- Use η parameter for central galaxies to distinguish between early types and late types.
- Works for halo masses $>10^{13}h^{-1}M_{sun}$.



Relative bias of halo central galaxies

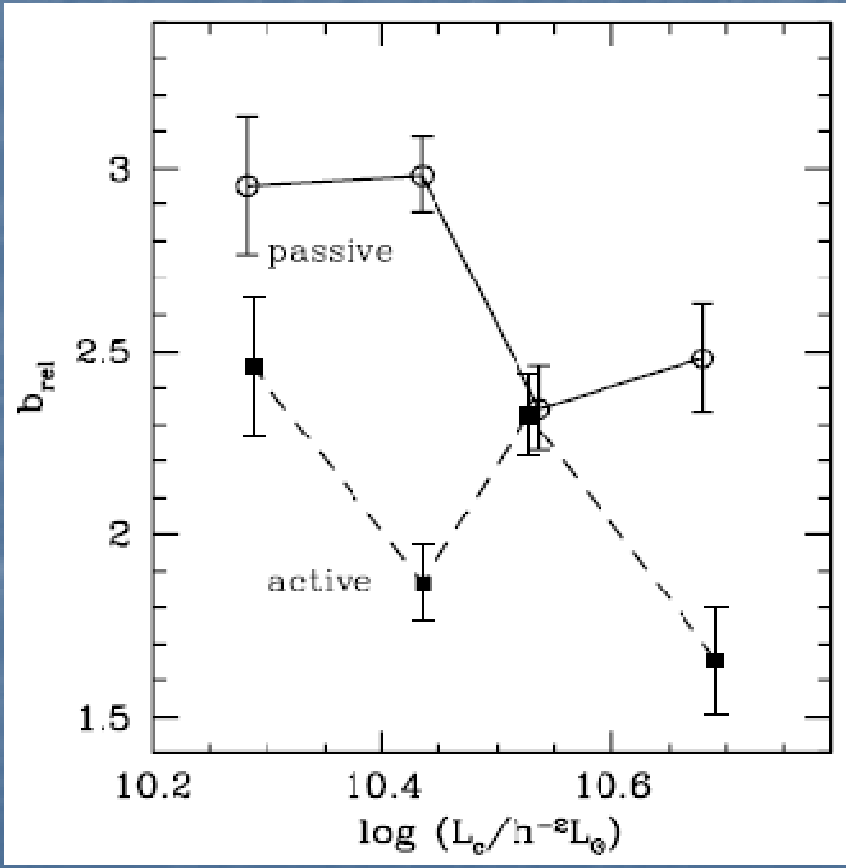




More active →

Relative bias split by η_c

- Haloes with a more passive central galaxy have a higher relative bias.
- Massive groups with passive but relatively faint central galaxies have the highest bias.



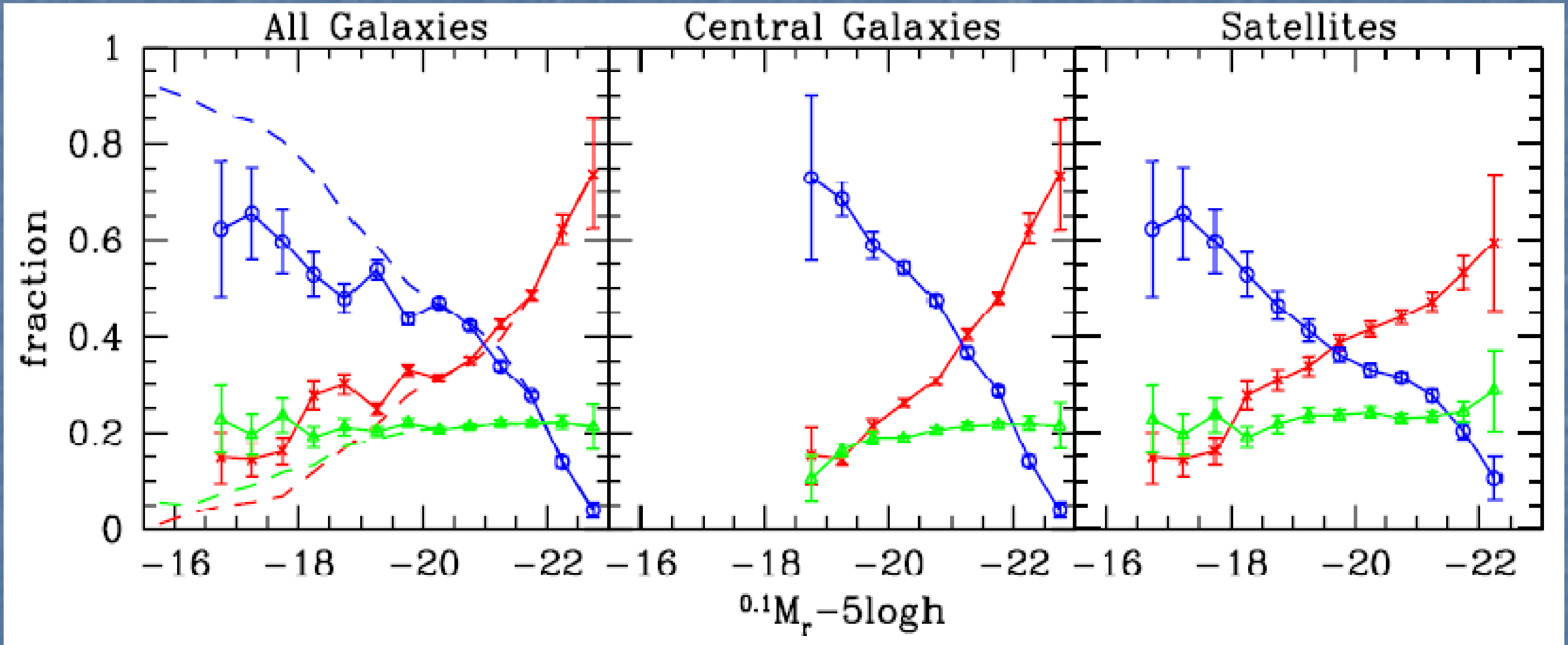
Consequences for galaxy formation models

- Ram pressure stripping?
  - Scales inversely with mass, which seems to give wrong dependence on luminosity.
  - Hard to explain same radial dependence in haloes of all mass.
- Strangulation?
  - Can it explain enhancement of spheroidals? Seems OK for S0s…
- Harassment?
  - More trouble with luminosity dependence (LSBs more vulnerable).
- Merger history?
  - Drives differences between haloes, but via other processes; large-scale bias must come from this to some extent.

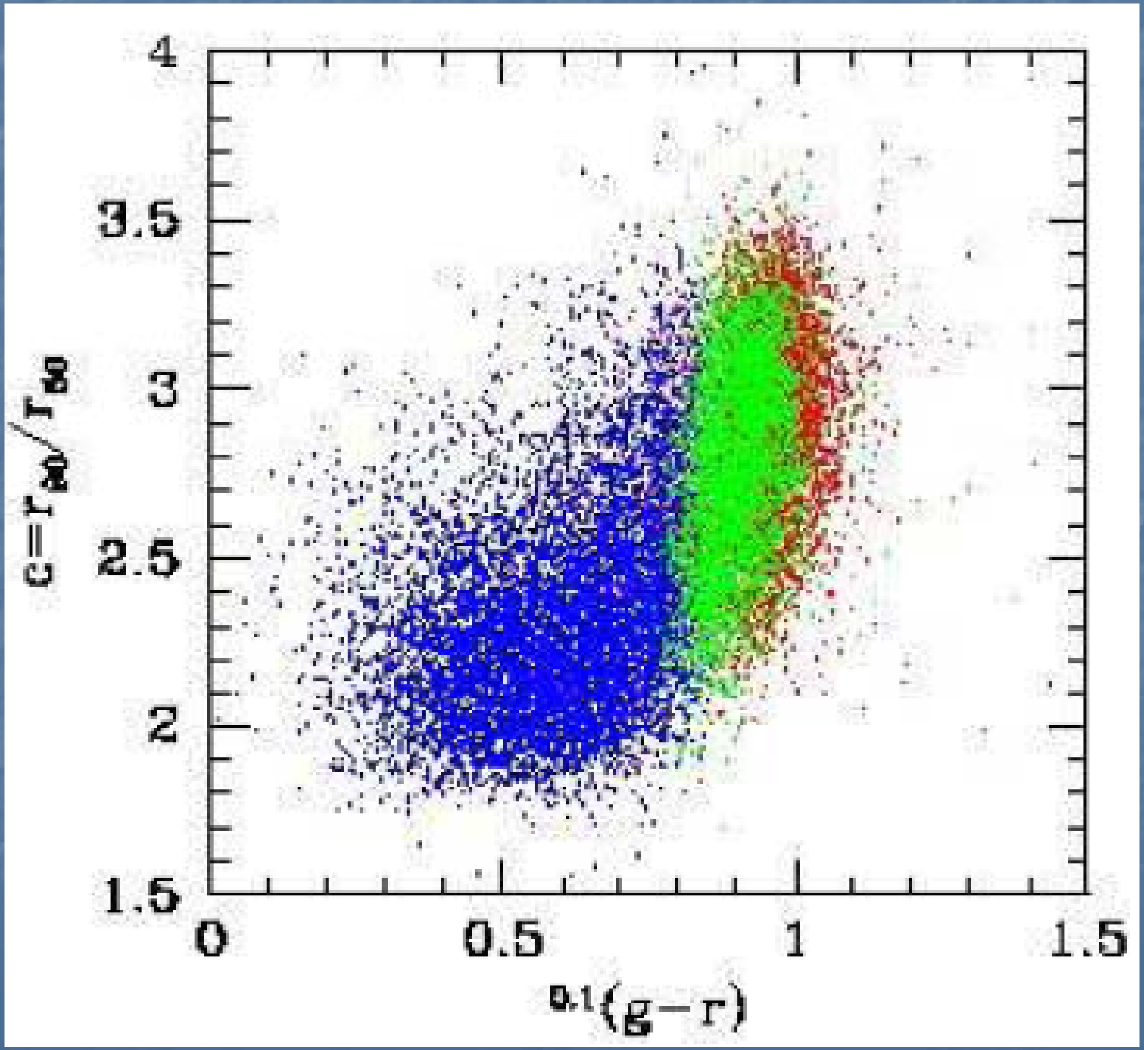
Conclusions: Gao Effect + galactic conformity

- Clustering of central halo galaxy at given halo mass depends on galaxy properties.
- Properties of satellite galaxies correlate with properties of central galaxies at given halo mass.
- This implies a bias dependence on the entire galaxy population of a group.
- Older, more clustered halo had galaxies fall in earlier and become late types by some process.
- If AGN feedback is active in the central galaxy, it's had more time to act if the halo is older (hence consistent with explanations for the bright end of the galaxy luminosity function).
- L_c dependence of group clustering strength is harder to explain.

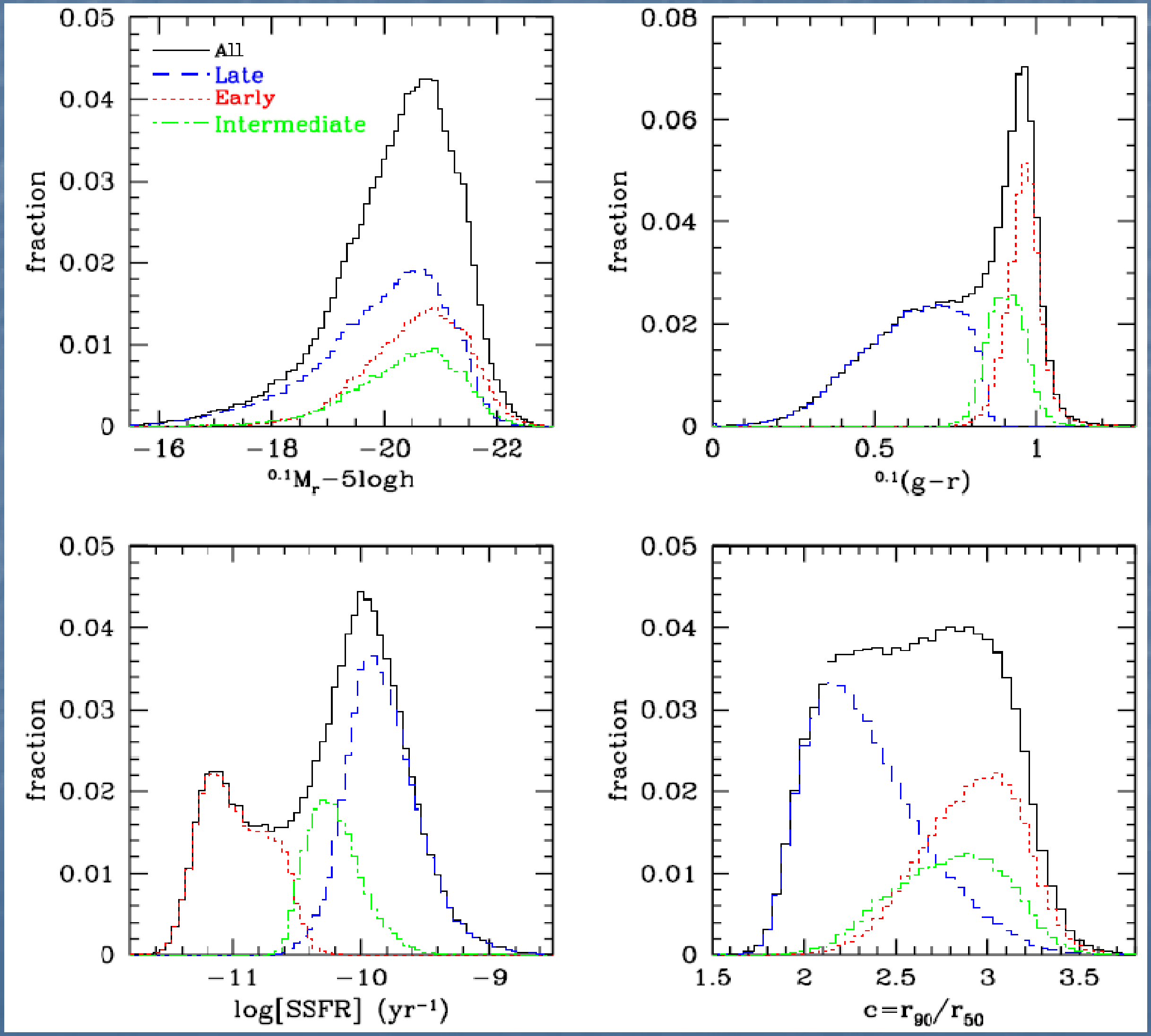
Overall type fraction as a function of magnitude



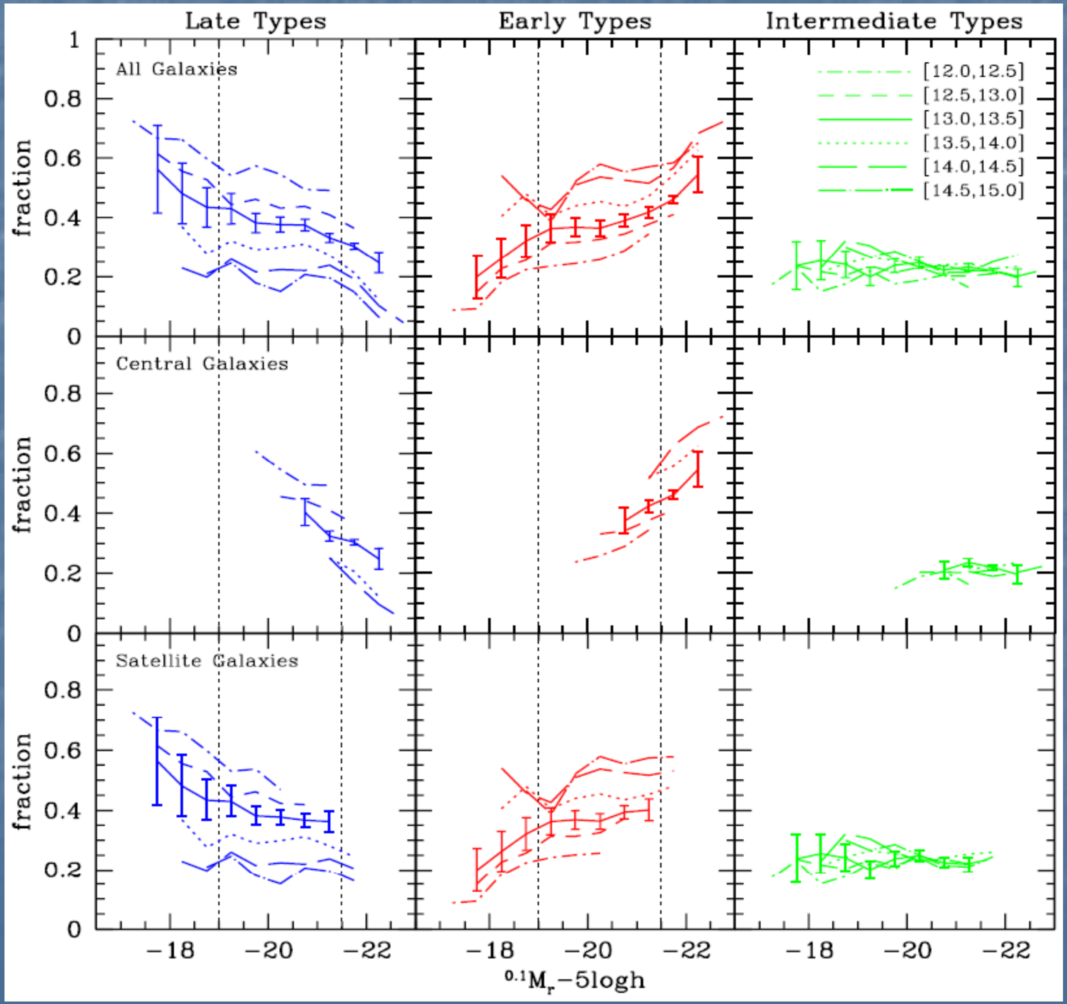
Colour vs. concentration



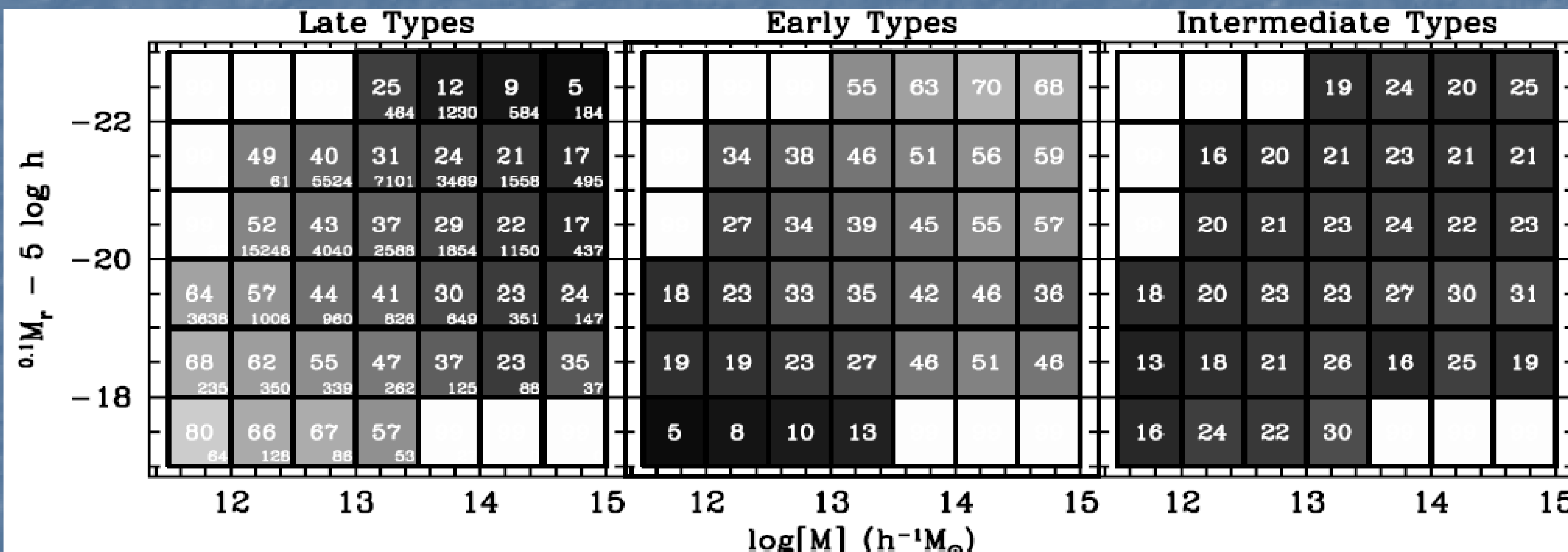
Bimodality of galaxy properties



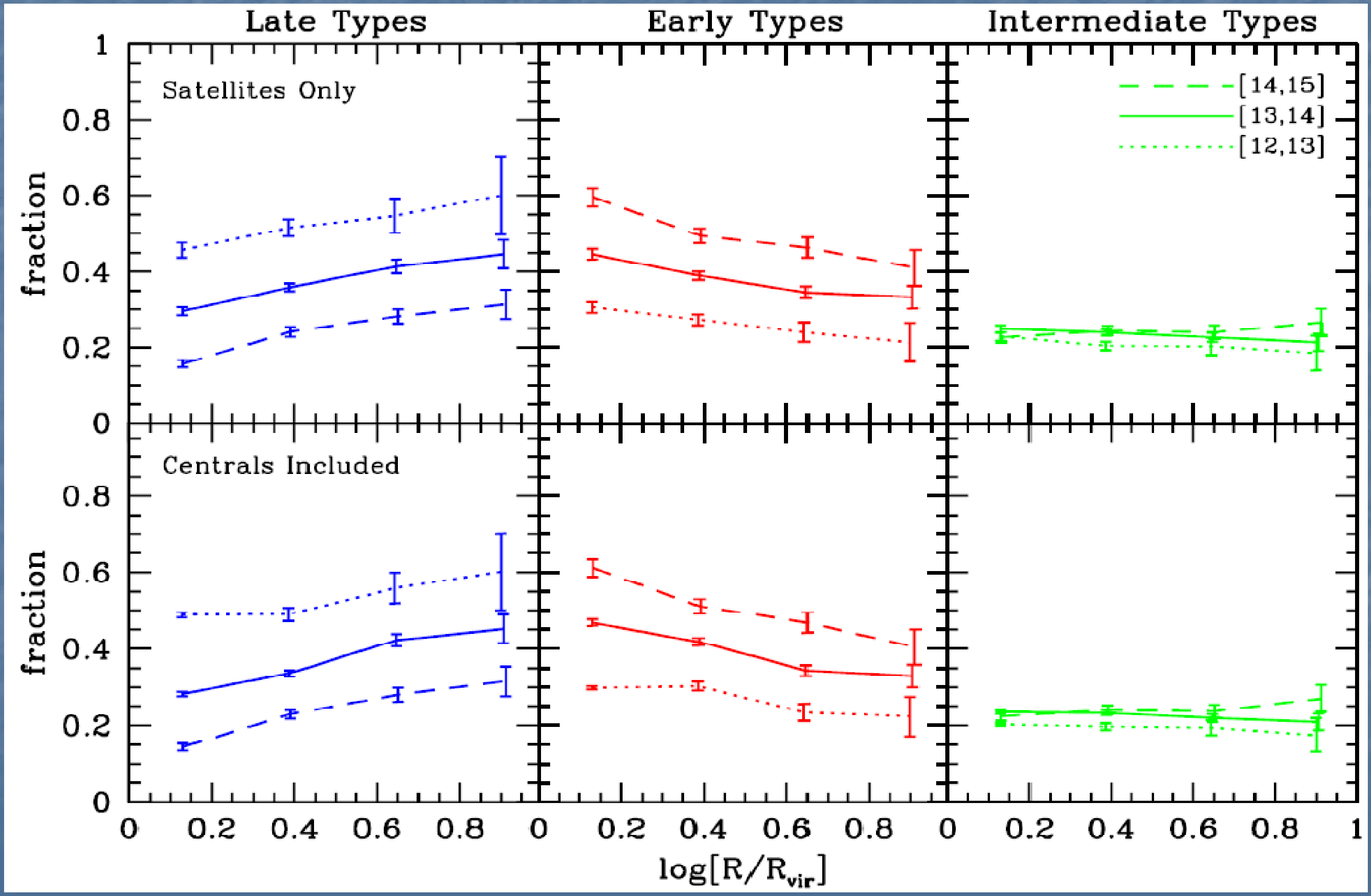
Type fraction by magnitude



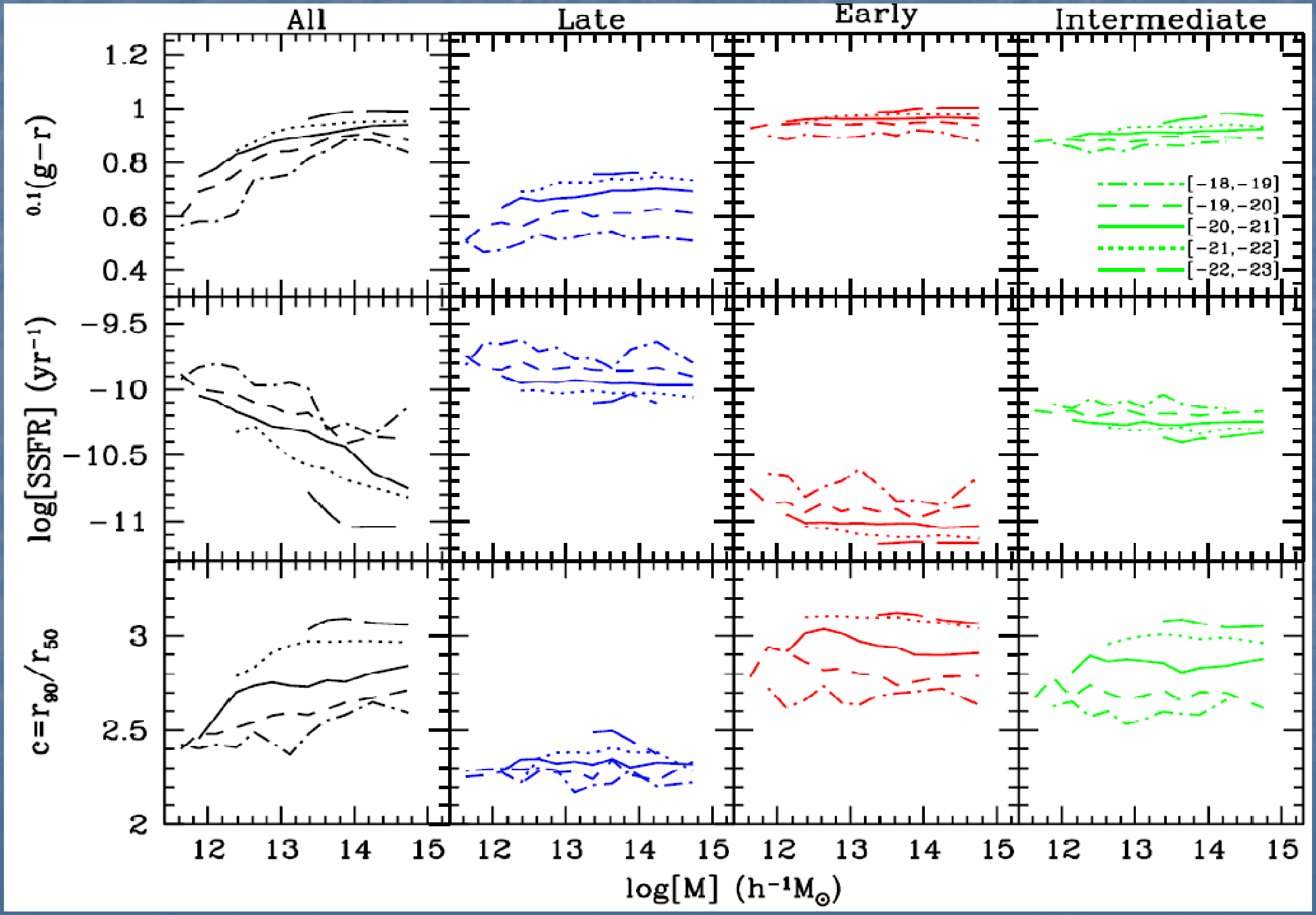
Halo mass and magnitude by galaxy type



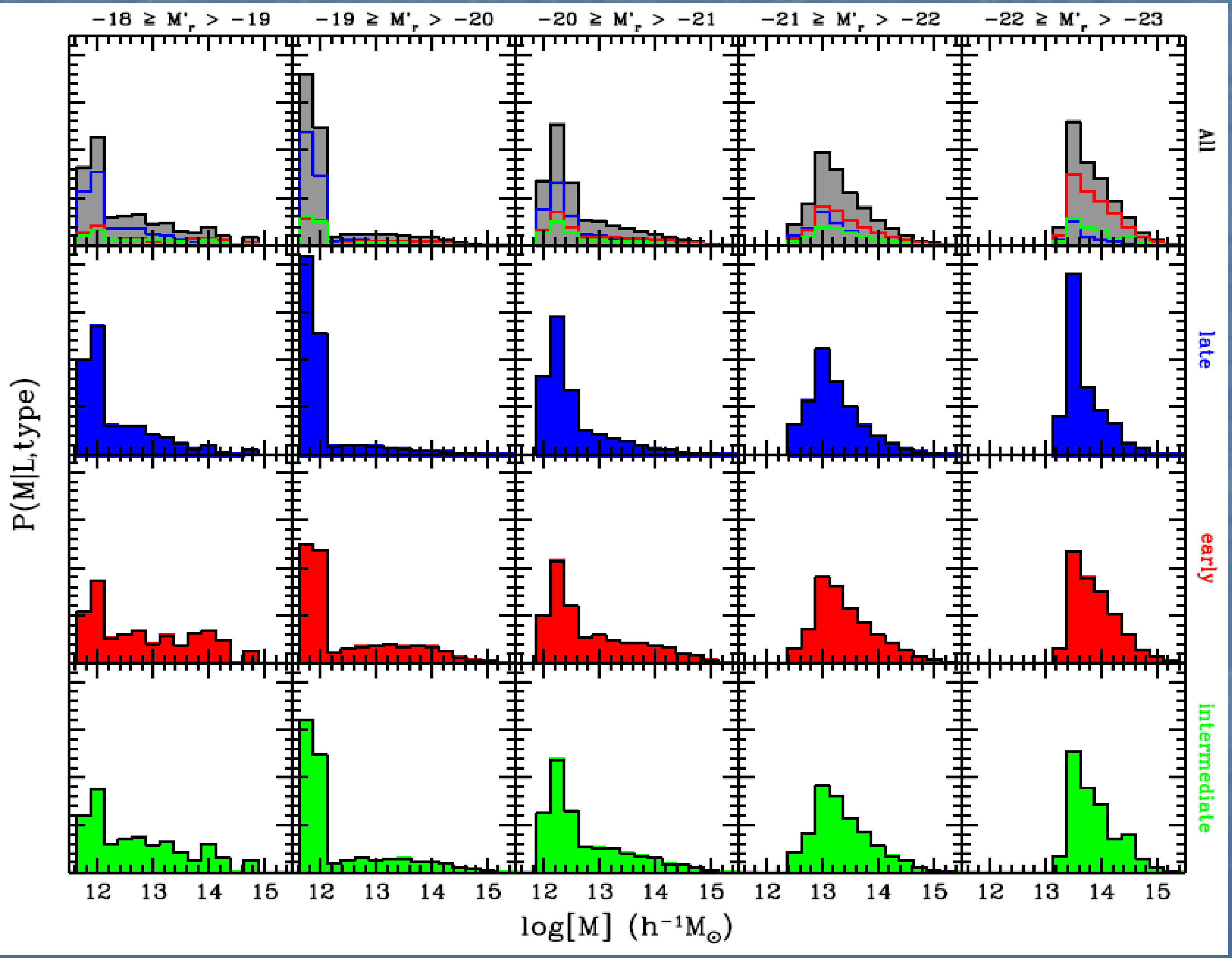
Type fraction of satellite galaxies by halo-centric radius



Median galaxy properties

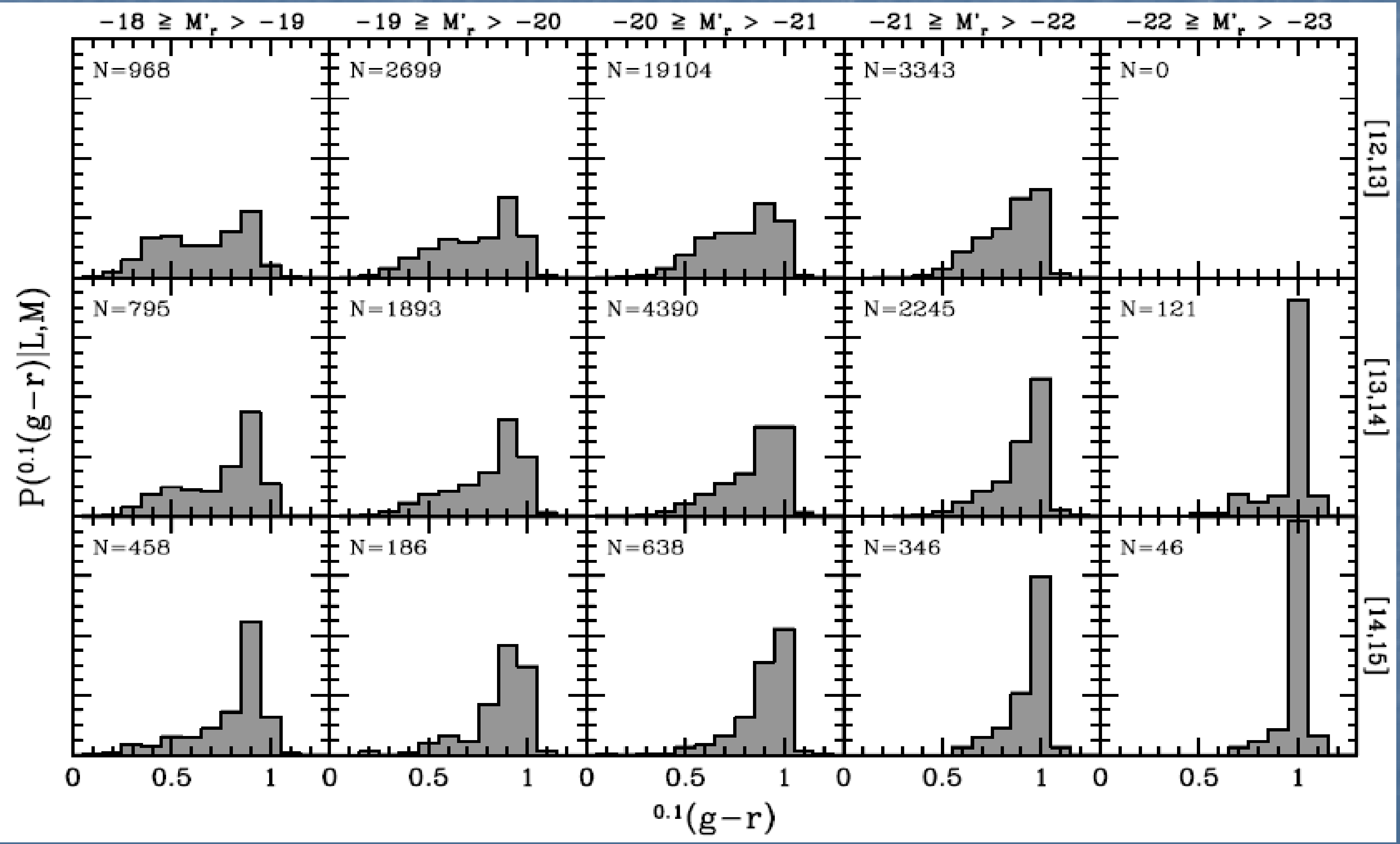


P(M|L,type)



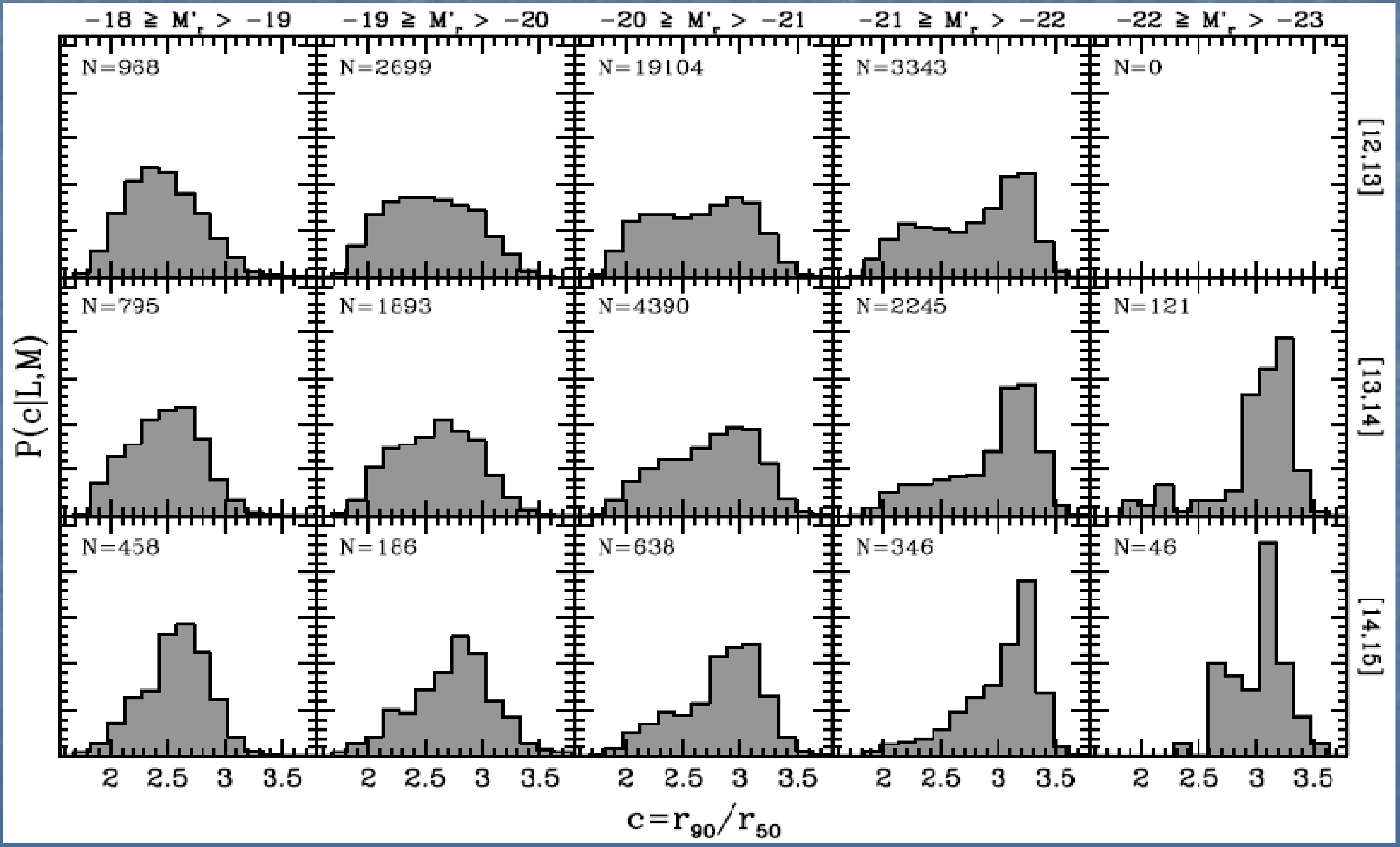
−18 ≥ M'r > −19
−19 ≥ M'r > −20
−20 ≥ M'r > −21
−21 ≥ M'r > −22
−22 ≥ M'r > −23
All
late
early
intermediate
P(M|L,type)
12 13 14 15
log[M] (h⁻¹M☉)

P($^{0.1}$(g-r)|L,M)



−18 ≥ M'r > −19
−19 ≥ M'r > −20
−20 ≥ M'r > −21
−21 ≥ M'r > −22
−22 ≥ M'r > −23
N=968
N=2699
N=19104
N=3343
N=0
[12,13]
N=795
N=1893
N=4390
N=2245
N=121
[13,14]
N=458
N=186
N=638
N=346
N=46
[14,15]
P(0.1(g−r)|L,M)
0
0.5
1
0.1(g−r)

P(c|L,M)



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N=968
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N=2245
N=121
N=458
N=186
N=638
N=346
N=46
[12,13]
[13,14]
[14,15]
P(c|L,M)
2
2.5
3
3.5
c=r90/r50