Galactic Conformity and Clustering as a Function of sSFR to z~1

Alison Coil
UCSD

Collaborators: Angela Berti, Alex Mendez, Daniel Eisenstein, Peter Behroozi, John Moustakas, Andrew Hearin

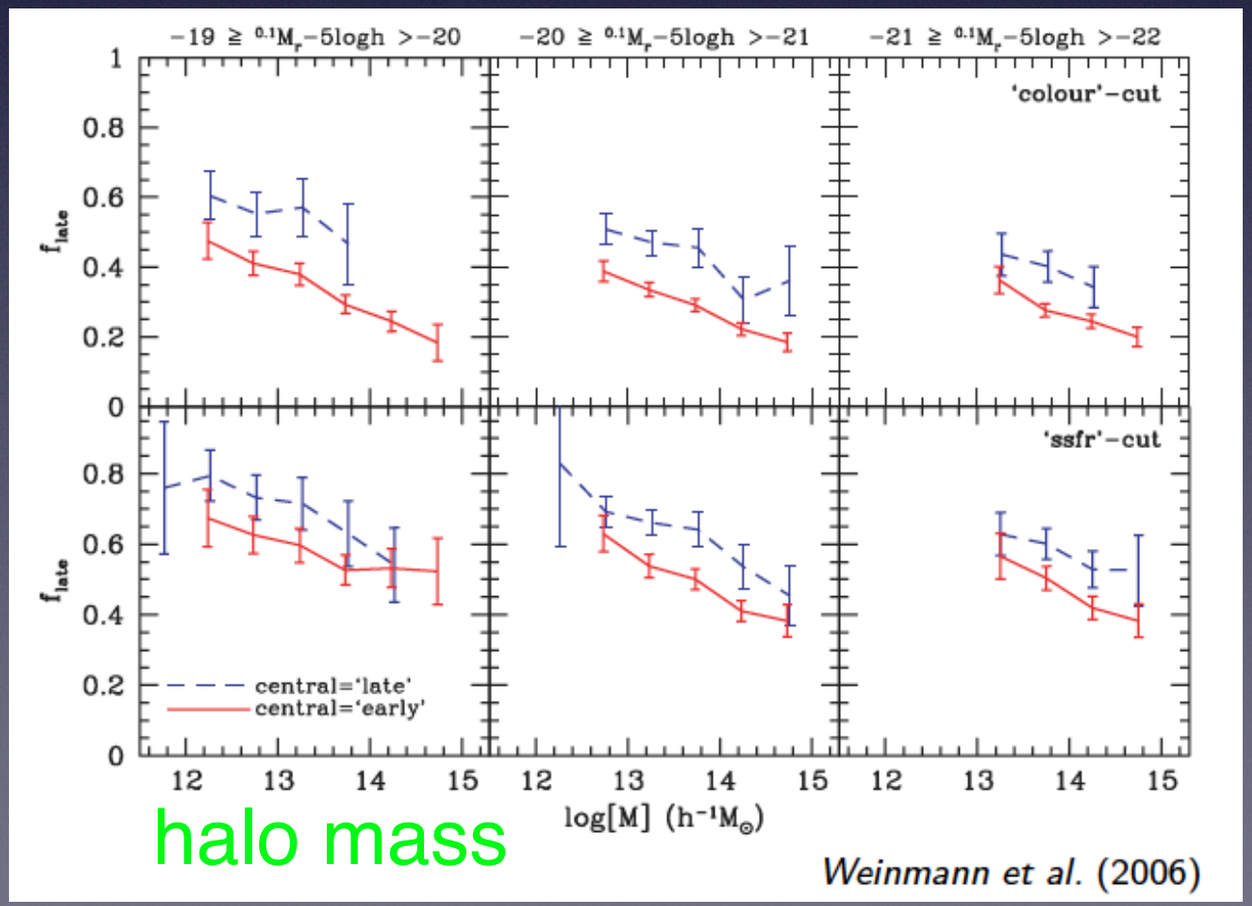
Galactic Conformity

- Observed correlation between whether a "central" galaxy is quenched and its neighbor galaxies are also quenched.
- 1-halo vs 2-halo conformity:
  - 1-halo (*intra-halo*): correlation between central and satellite galaxies being quenched
  - 2-halo (*inter-halo*): correlation between central galaxy and galaxies in *adjacent* halos being quenched

Galactic Conformity

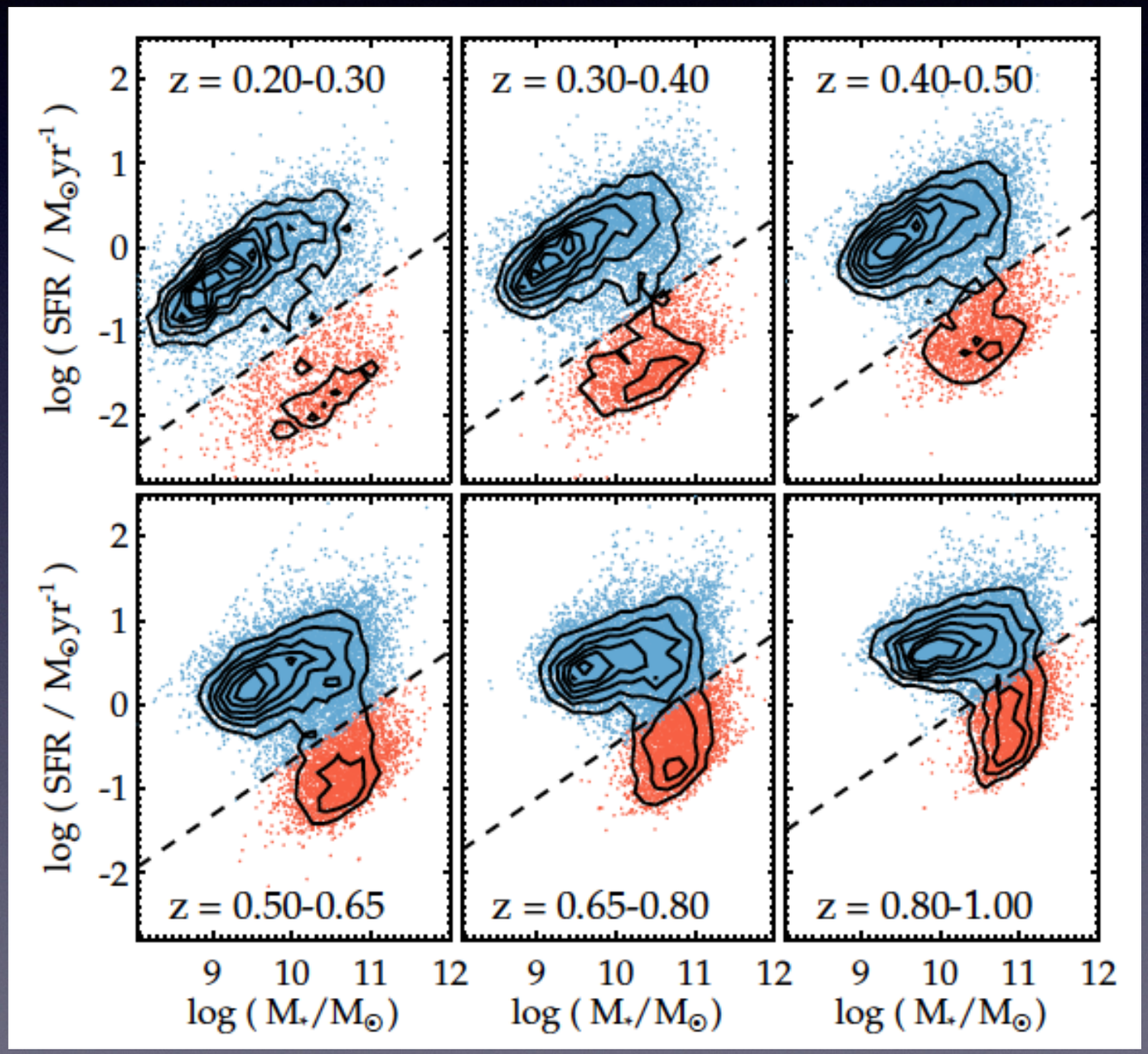
- 1-halo conformity first observed in SDSS (Weinmann et al. 2006)
- 2-halo conformity observed and debated in SDSS (Kauffmann et al. 2013, Sin et al. 2017, Tinker et al. 2017)
- Previous z > 0.2 measurements were 1-halo only and used photometric redshifts (Kawinwanichakij et al. 2015, Hartley et al. 2015)

star forming fraction



PRIMUS Conformity Sample

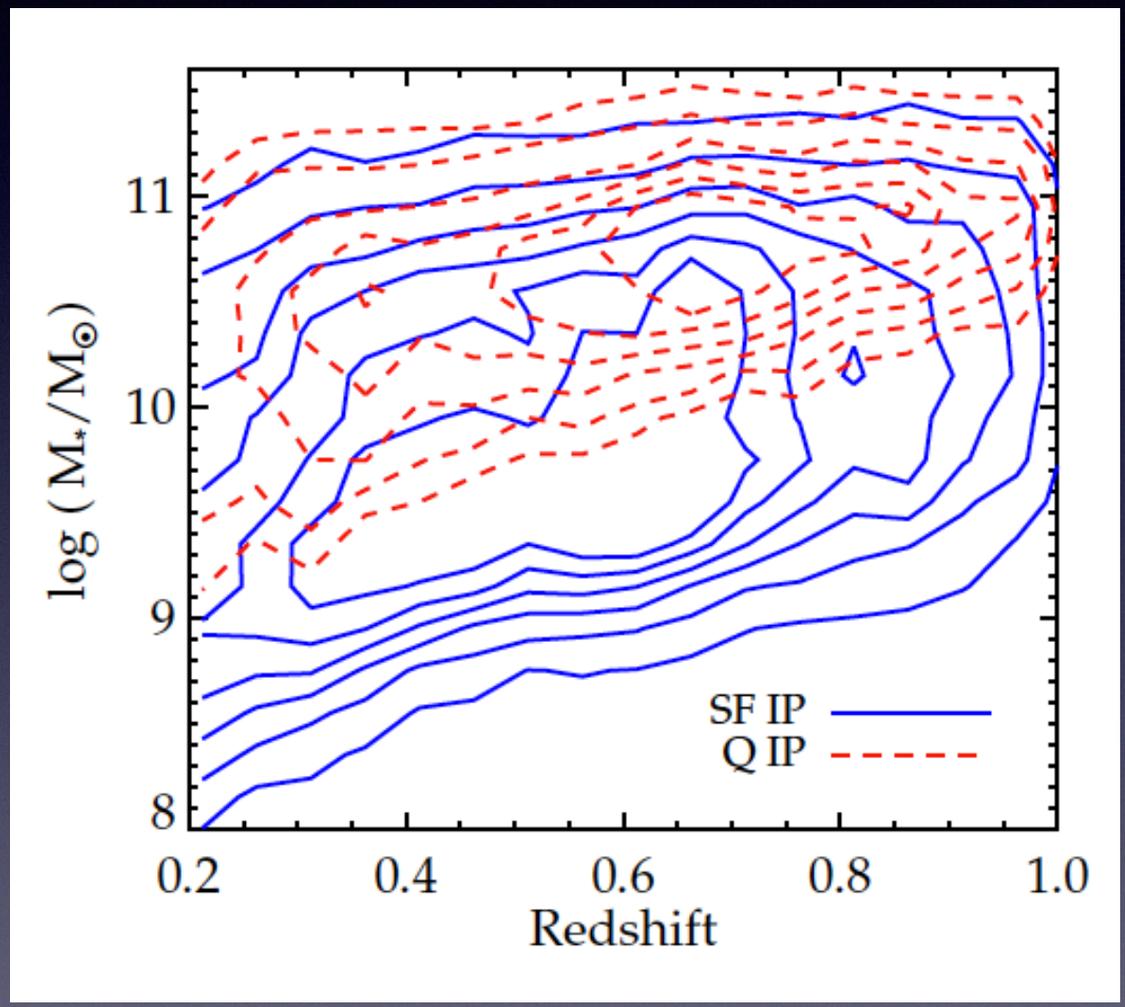
- 4 separate fields covering 5.5 deg^2
- $0.2 < z < 1.0$
- 60,000 galaxies with spectroscopic redshifts
- Split into star forming or quiescent using evolving SFR-M* cut:



Berti, Coil, et al. 2017, ApJ

Isolated Primary Sample

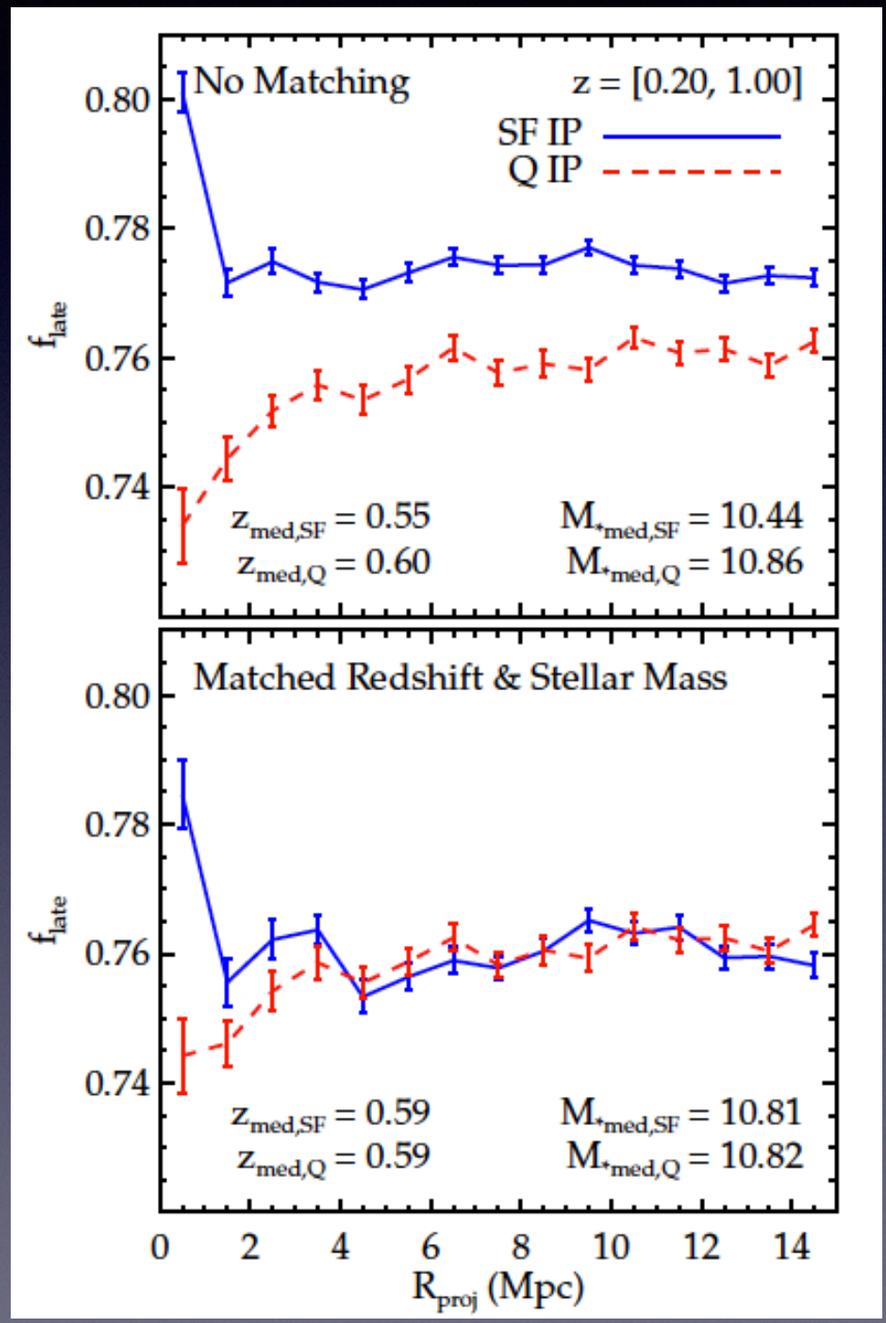
- Stellar mass completeness cut
- Similar isolation (i.e., central) criteria as Kauffmann et al. 2013:
  - Isolated primary (IP) galaxies have no other galaxies within R=500 kpc and $M^* > M^*_{IP}/2$
- ~20,000 IP/central candidates



Berti, Coil, et al. 2017, ApJ

Isolated Primary: Matching M* and z

- Small differences in median M* and z of the SF vs Q isolated primary samples mimics conformity signal!
- We therefore match the M* and z *distributions* of the SF and Q isolated primary galaxies
- Results in ~6,000 Q IPs and ~4,000 SF IPs



SF %

R (Mpc)

Berti, Coil, et al. 2017, ApJ

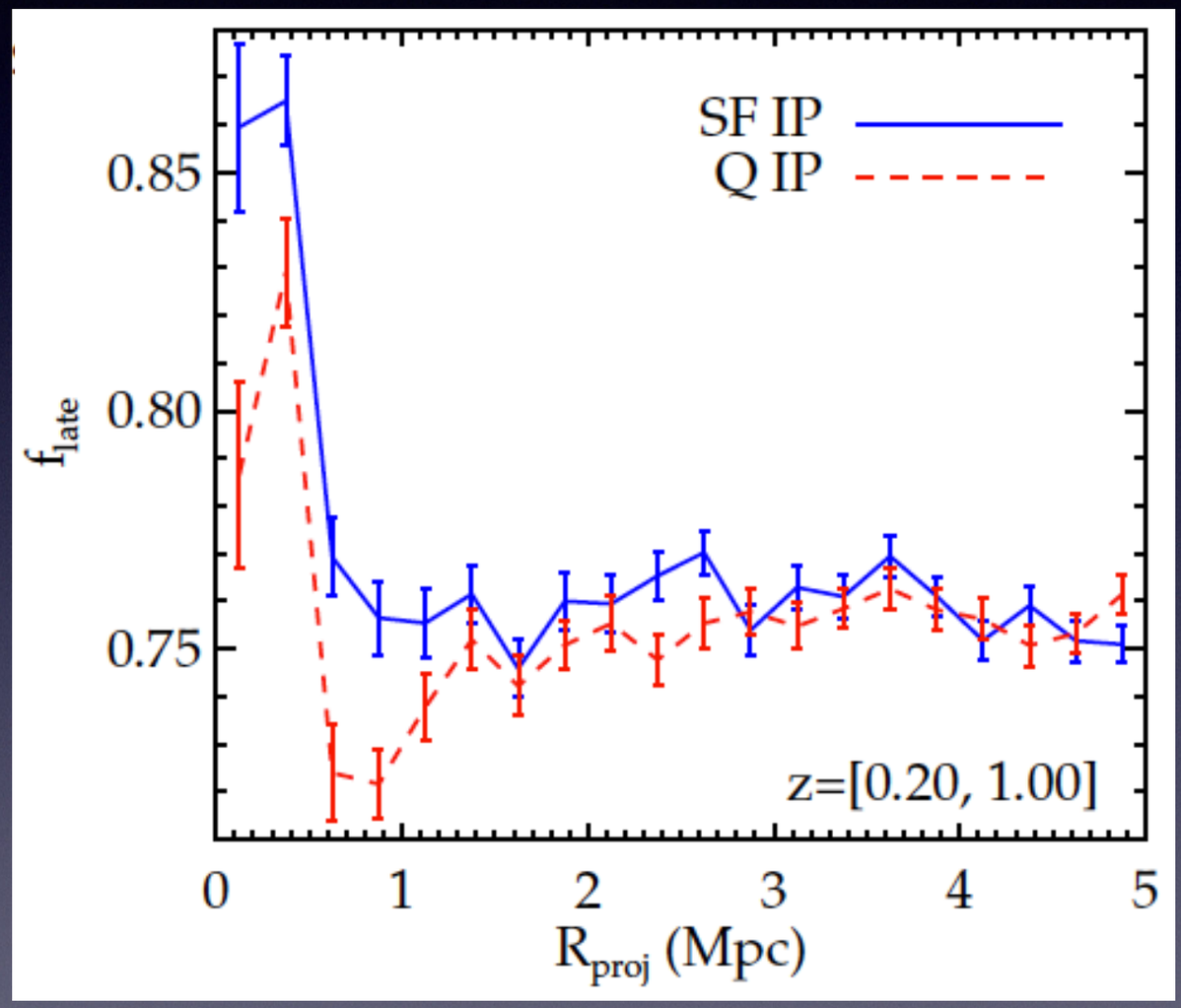
Conformity Signal at z~0.7

- f_{late} = late-type (SF) fraction of satellites / neighbors around SF and Q IPs
- Shown as a function of projected distance (R_{proj})

- Normalized signal:

$$\xi_{\rm norm} = \frac{f_{\rm late}^{\rm SF\text{-}IP} - f_{\rm late}^{\rm Q\text{-}IP}}{\left(f_{\rm late}^{\rm SF\text{-}IP} + f_{\rm late}^{\rm Q\text{-}IP}\right)/2}$$

SF %



R (Mpc)

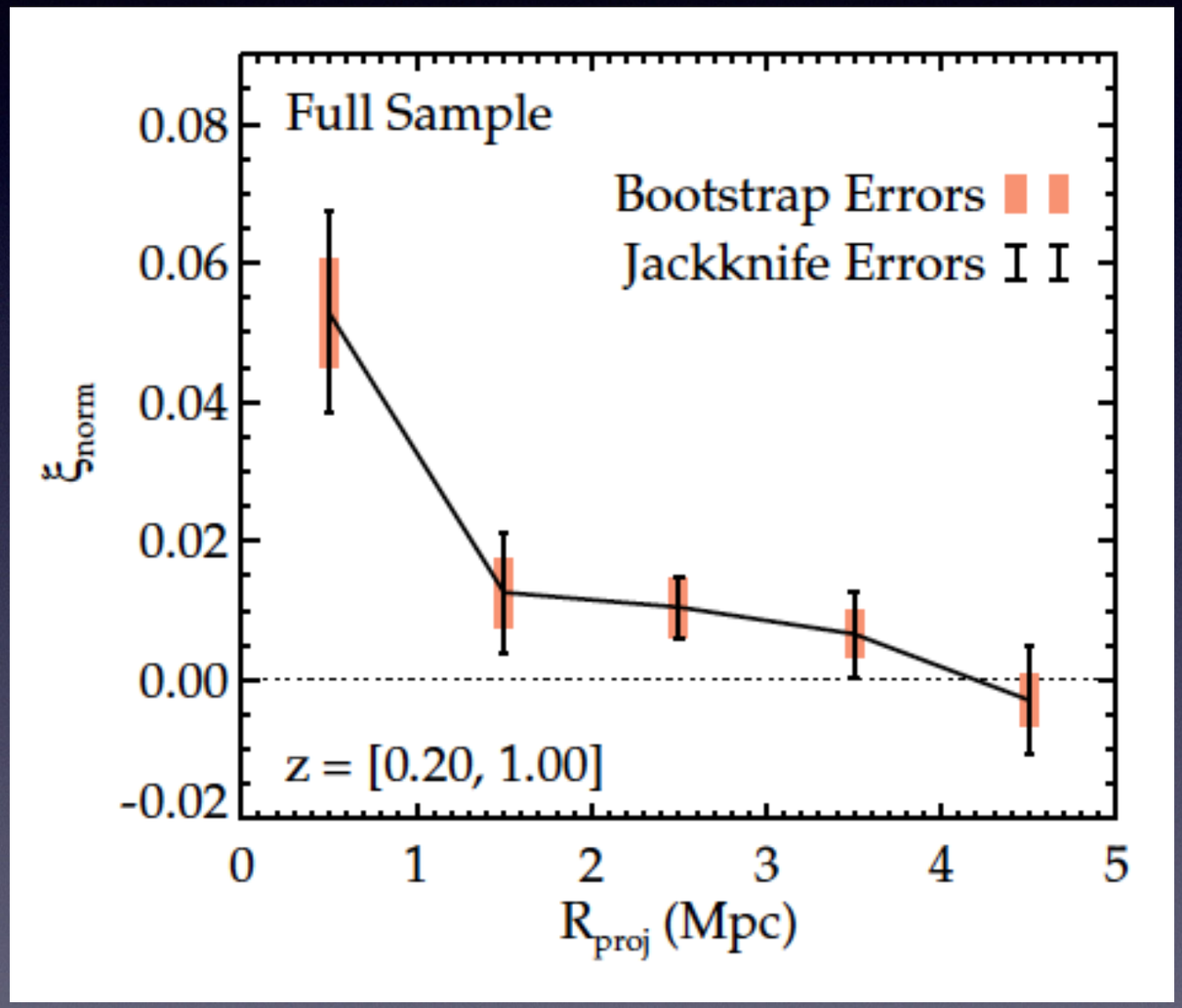
Berti, Coil, et al. 2017, ApJ

Conformity Signal at z~0.7

- 1-halo signal: 5% (3.6σ)
- 2-halo signal: 1% (2.5σ)

% signal

- Using jackknife errors
- Errors are 2x smaller using bootstrap resampling, which does not capture cosmic variance.



R (Mpc)

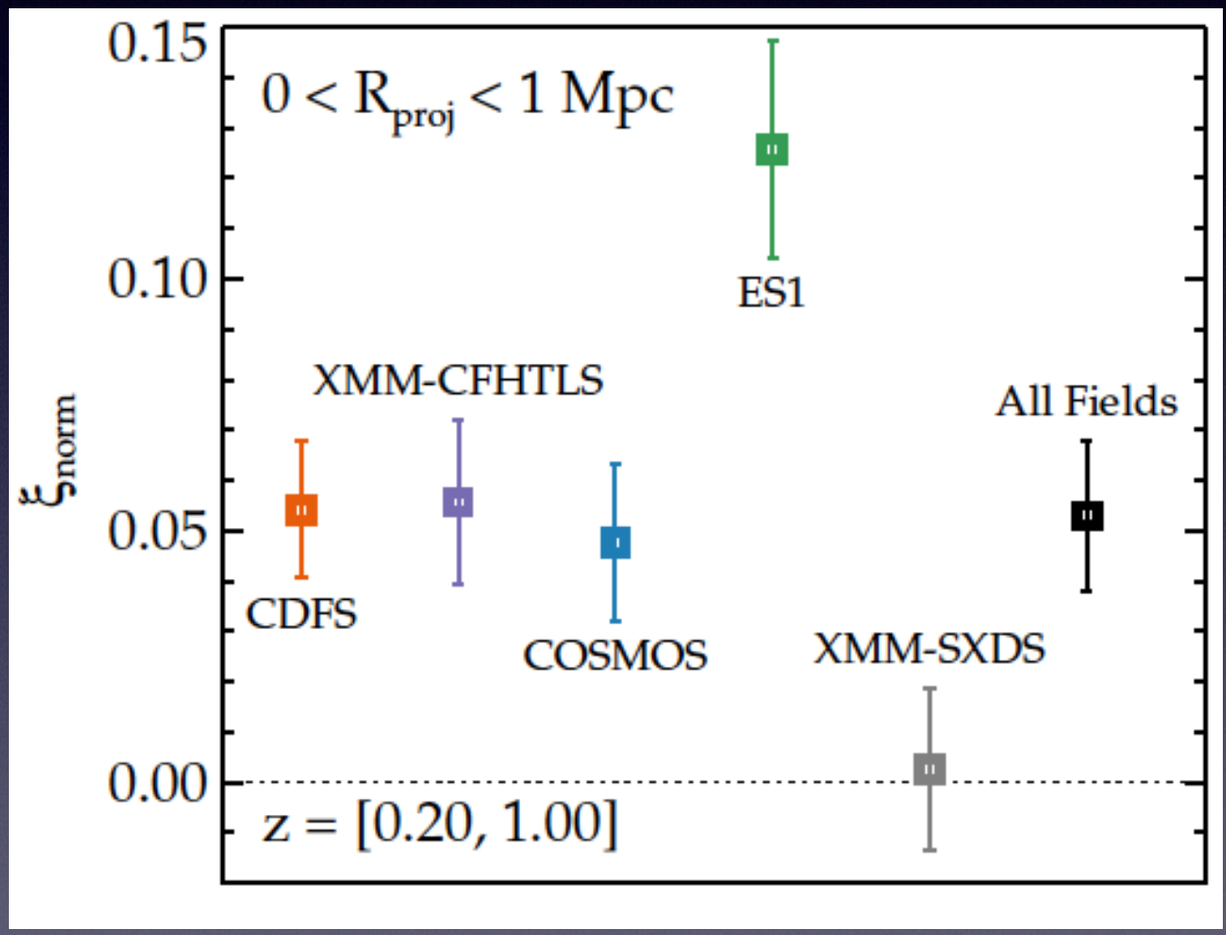
Berti, Coil, et al. 2017, ApJ

Cosmic Variance

- Substantial variation in 1-halo signal among different fields

% signal

- A meaningful measure of conformity at z > 0.2 should include several spatially separate fields



Berti, Coil, et al. 2017, ApJ

Conformity at Intermediate Redshift

- Have to be careful with differences in stellar mass and redshift distributions of SF and Q "centrals", can mimic conformity
- Cosmic variance can be substantial, want to use multiple fields
- The signal is *small*! 5% on 1-halo scales, 1% on 2-halo scales
- We're in the process now of quantifying what the contamination due to satellites is in our measurements at z~0.7, using Halotools
- The 2-halo term could be due to differences in the SMHM relation for SF and Q central galaxies…

Galaxy Clustering as a function of sSFR

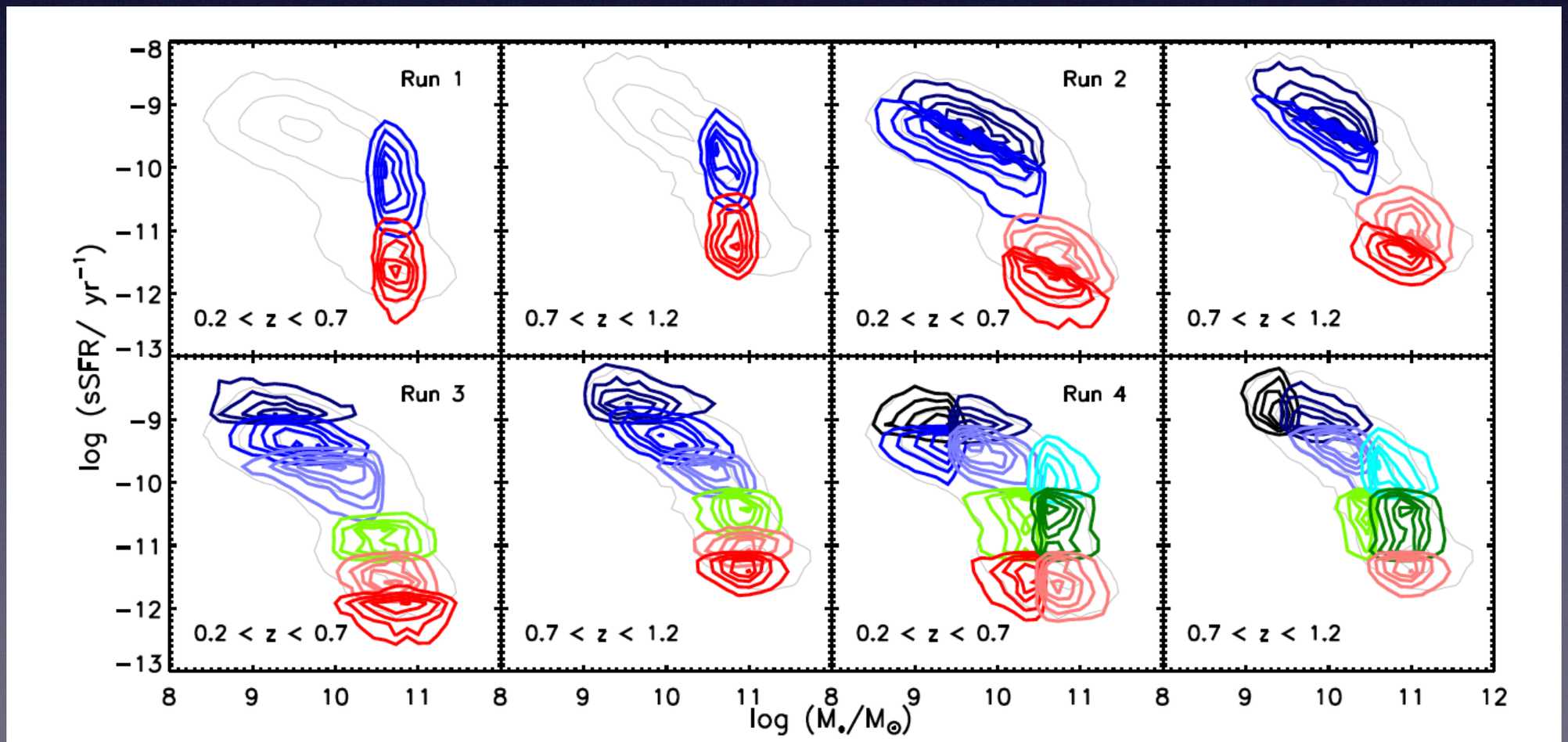
- Lots of papers on galaxy clustering as a function of M*
- Very few papers on clustering as a function of SFR or sSFR
- Interesting to see how galaxy clustering depends on galaxy properties within the SF and Q populations individually, not just between them

- Using DEEP2, Mostek, Coil et al. 2013 found that within a given M* range, star-forming galaxies above the MS of star formation are less clustered than star-forming galaxies below the MS
- Could constrain how galaxies evolve along vs across the star-forming main sequence with time

Galaxy Samples

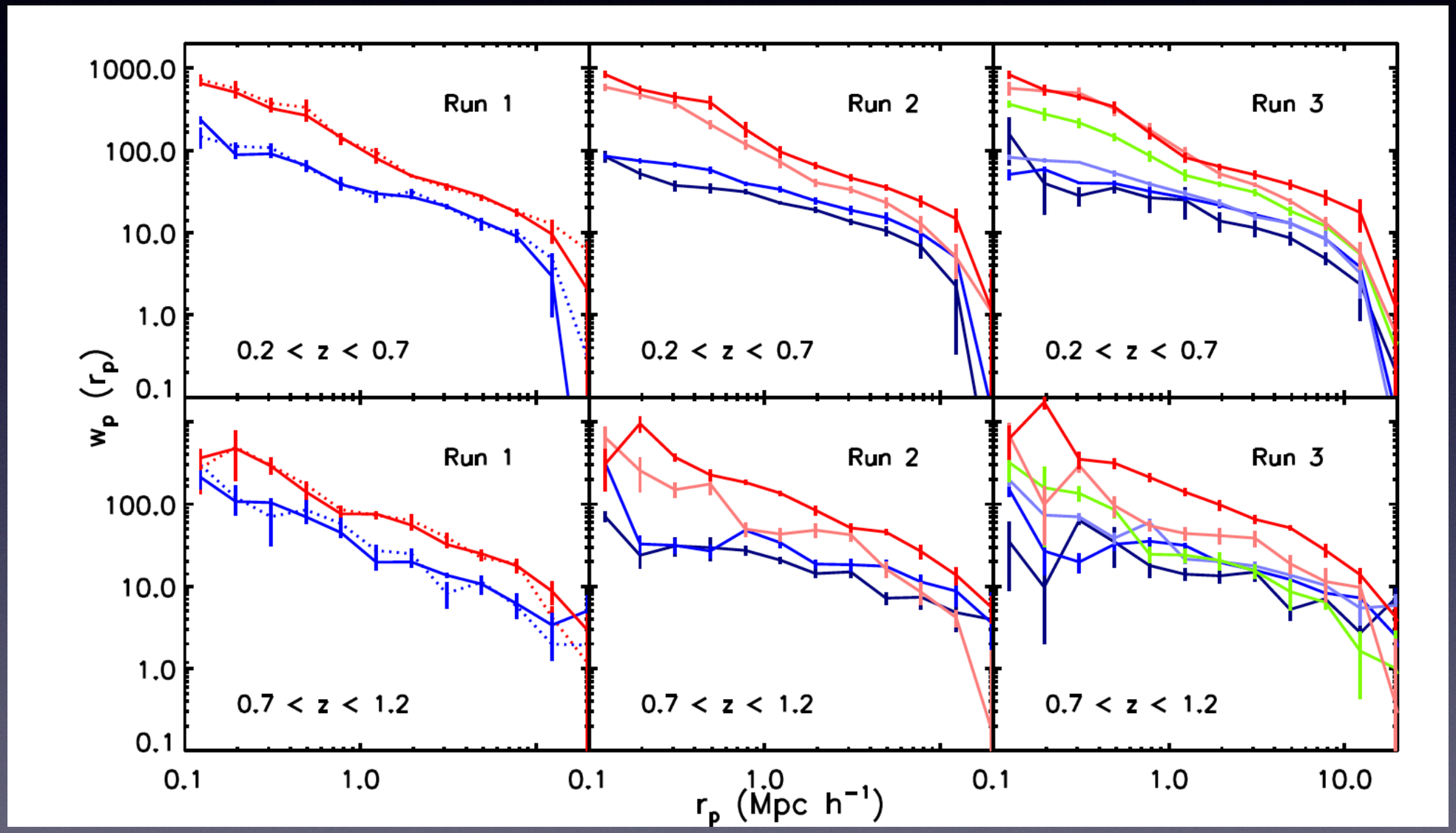
- Using PRIMUS + DEEP2, we slice and dice the galaxy population at z~0.5 and ~0.9 into bins in M* and sSFR:

sSFR



stellar mass

Clustering Results



z~0.5

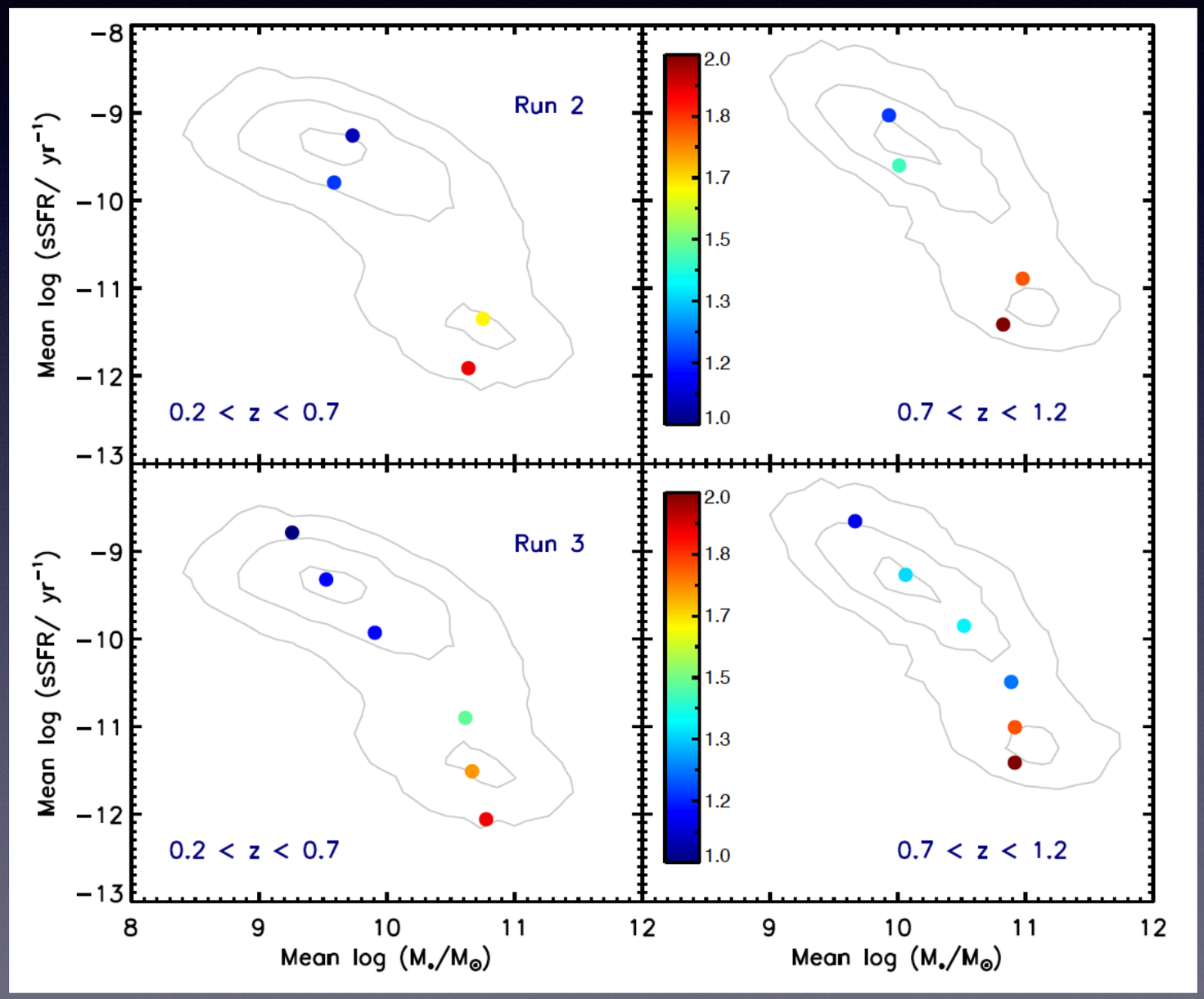
z~0.9

- Clear differences above vs below the SF main sequence, and within the red sequence

Bias Across Galaxy Population

z~0.5 z~0.9

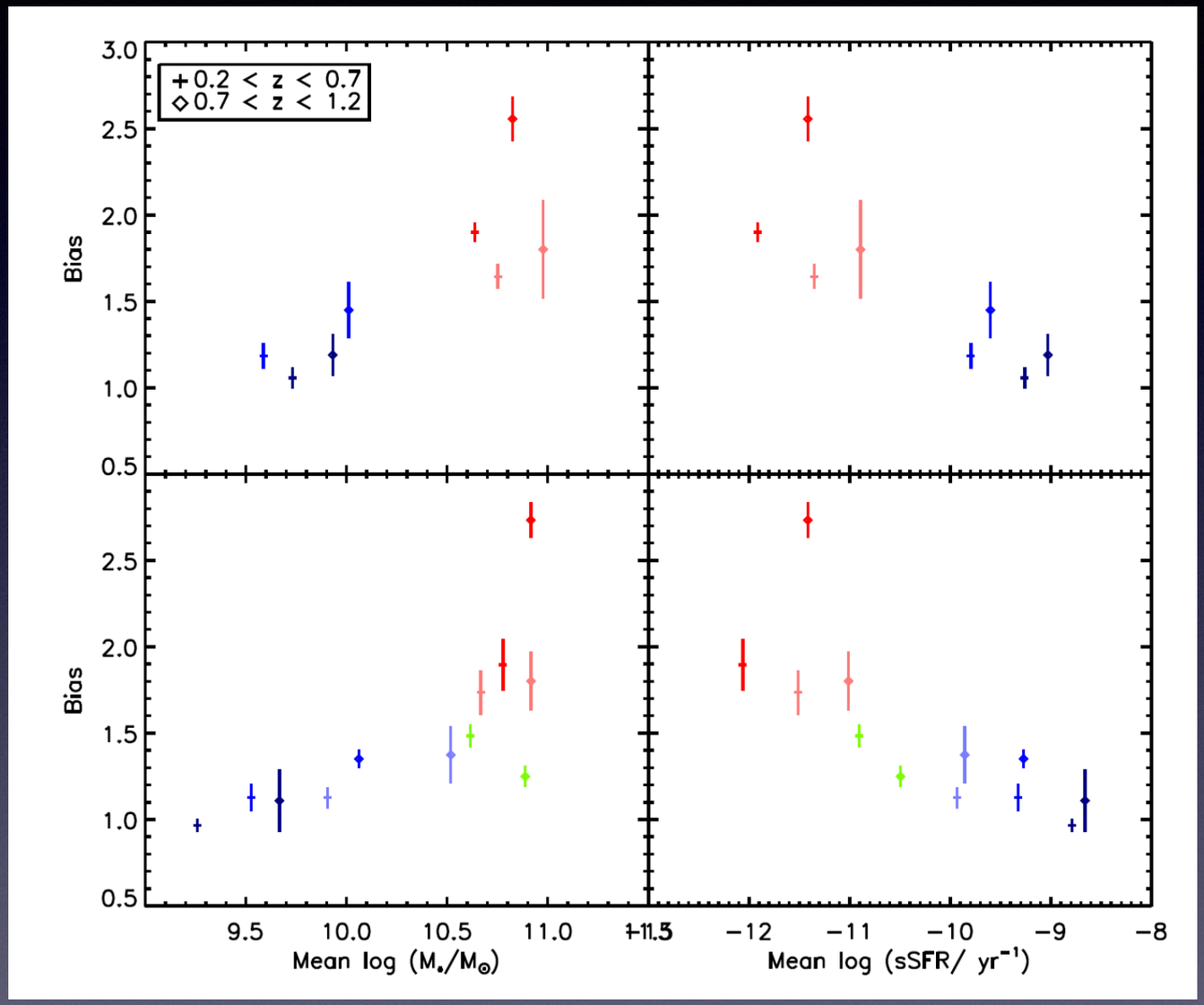
sSFR



stellar mass

Bias Across Galaxy Population

bias

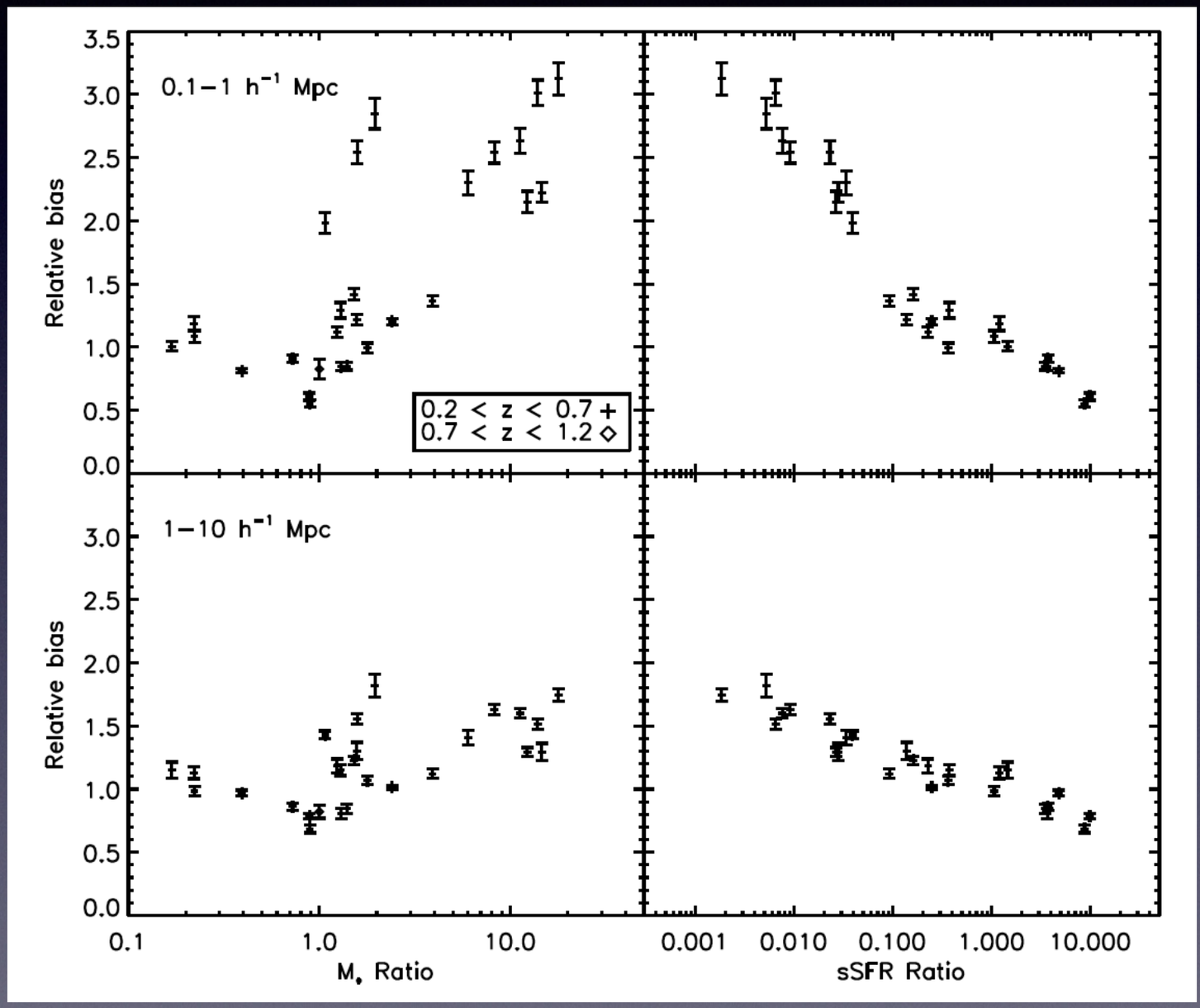


stellar mass sSFR

- The sSFR is often changing along with the stellar mass, as we measure bias(stellar mass).

Relative Bias (M* ratio, sSFR ratio)

relative bias



1 halo scales

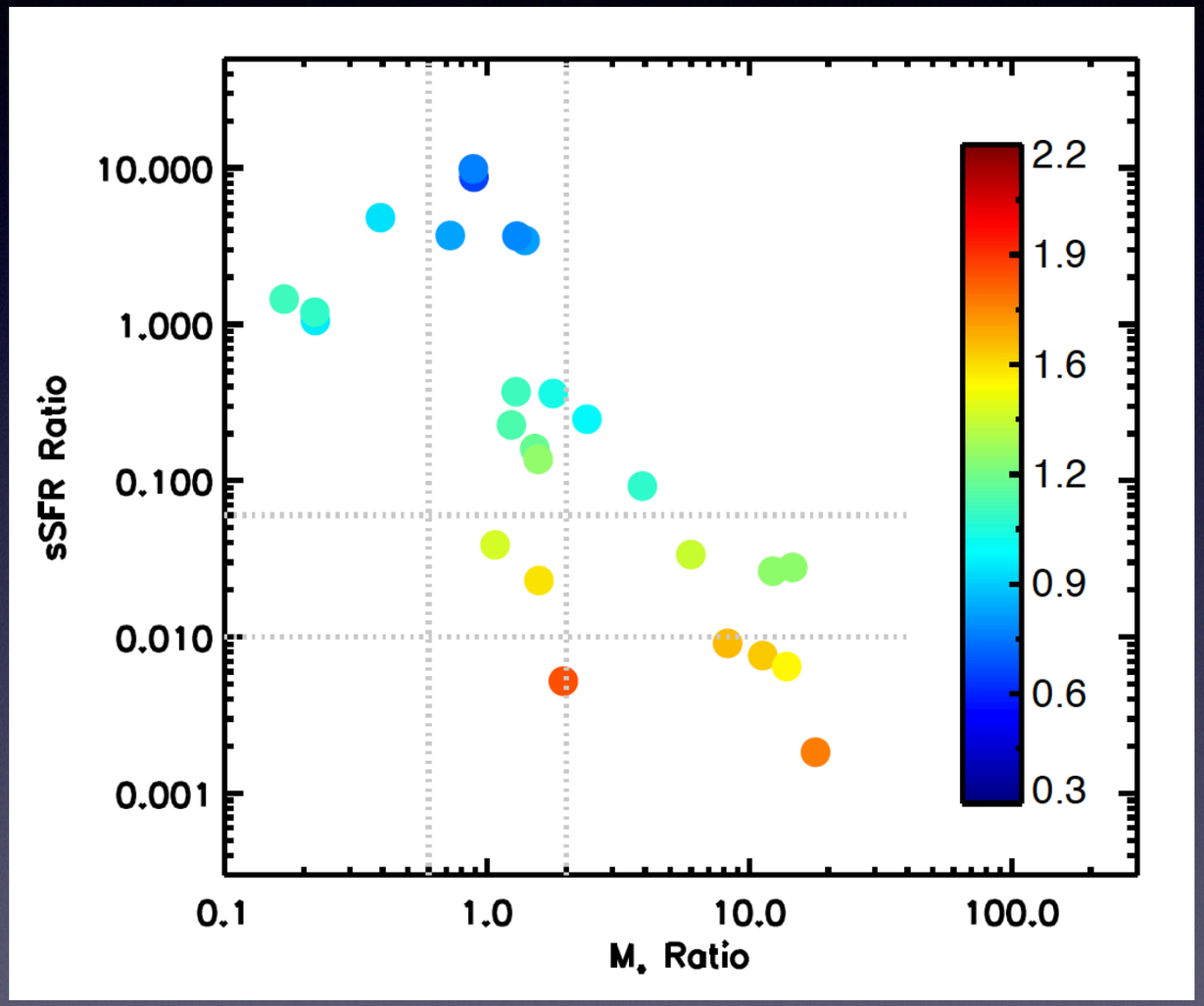
2 halo scales

stellar mass ratio

sSFR ratio

Relative Bias (M* ratio, sSFR ratio)

sSFR ratio



stellar mass ratio

color = relative bias

- At a given stellar mass ratio, the relative bias depends strongly on the sSFR ratio.
- At a given sSFR ratio, the relative bias does NOT depend strongly on the stellar mass ratio.

Clustering Conclusions

Galaxy clustering depends strongly on sSFR, not just stellar mass!

This is true within the star-forming and quiescent populations, individually, not just between them.

Galaxies above the main sequence of star formation are less clustered than star-forming galaxies below the main sequence. The same trend is seen within the quiescent population.

The SMHM relation likely depends on sSFR - we're testing this now with the clustering of "centrals".

These results should constrain how galaxies evolve in the sSFR-M* plane, specifically their evolution along vs across the main sequence.