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Connecting galaxies and haloes across cosmic time

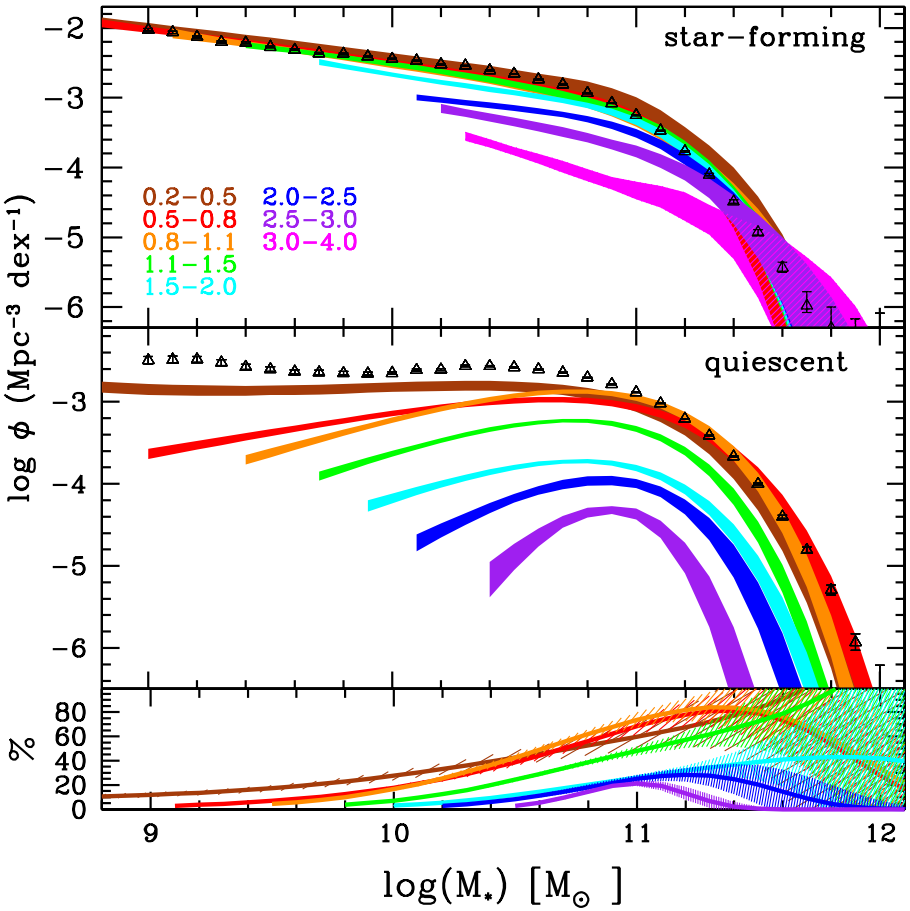
Collaborators: O. Ilbert, S. Peirani, S. Colombi, M. Wolk, C. Laigle, M. Kilbinger, J. Coupon + TERAPIX + COSMOS

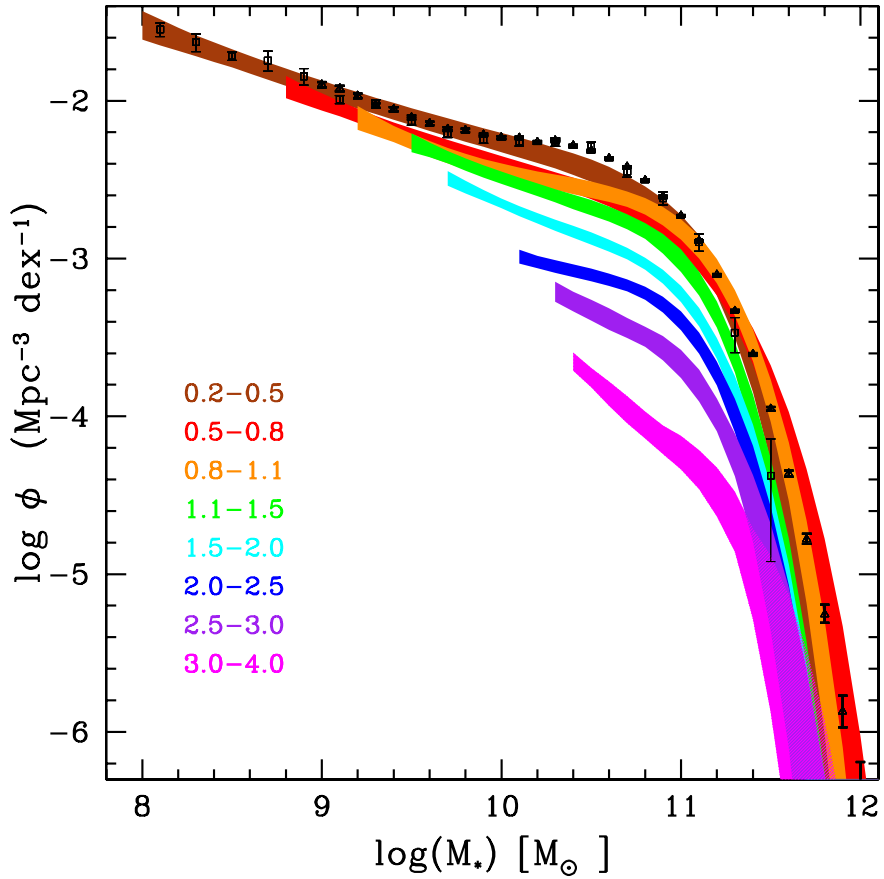
Mc Cracken et al. arXiv:1411.4983
Ilbert et al. A&A, 2013
McCracken et al. A&A 2012

Galaxies and haloes: key to understanding galaxy formation

- Halo mass is a key driver in galaxy evolution.
  - Host halo mass controls halo star-formation rate: least massive and more massive haloes have different star-formation efficiencies
  - Origin and nature of these physical processes uncertain and greatly debated (is AGN feedback, supernovae et al.)
- Want to understand **how host halo mass relates to key observables: star formation and galaxy clustering**

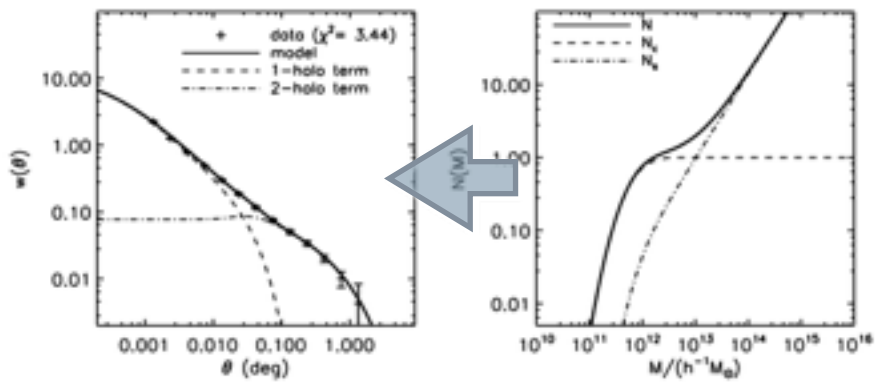
Galaxies and haloes: key to understanding galaxy formation

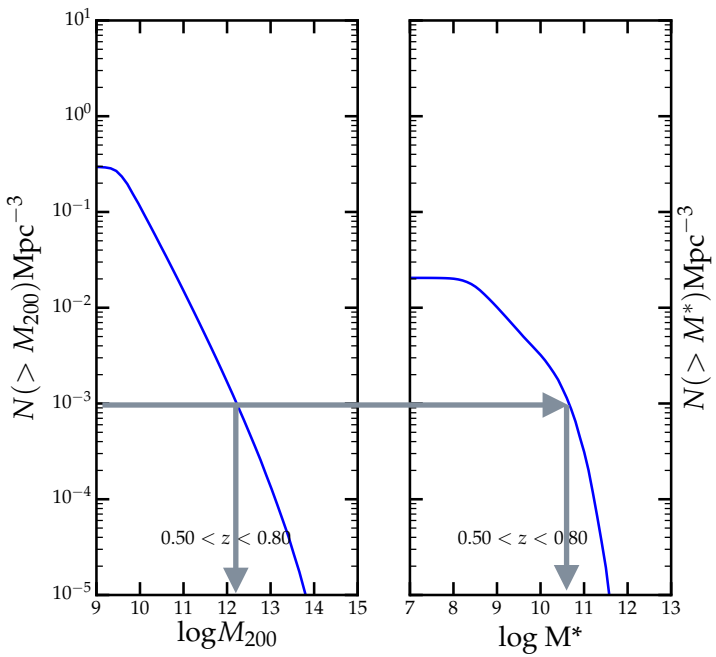




How to measure halo masses?

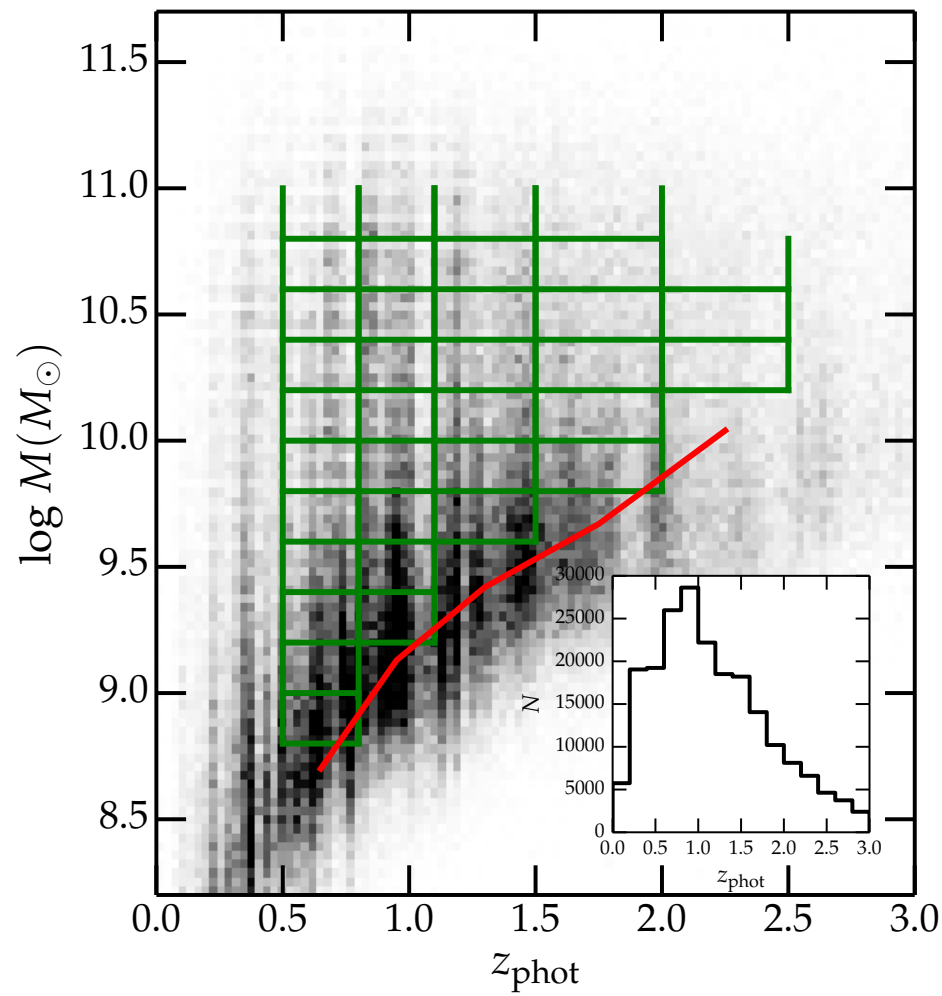
- Phenomenological models: **halo model**
  - Find parameters of halo occupation distribution (HOD) which can reproduce observed **abundance** and **clustering**
- Shortcut: **Sub-halo abundance matching** using N-body simulation
  - Approximately equivalent. Less information (e.g., satellite fraction)





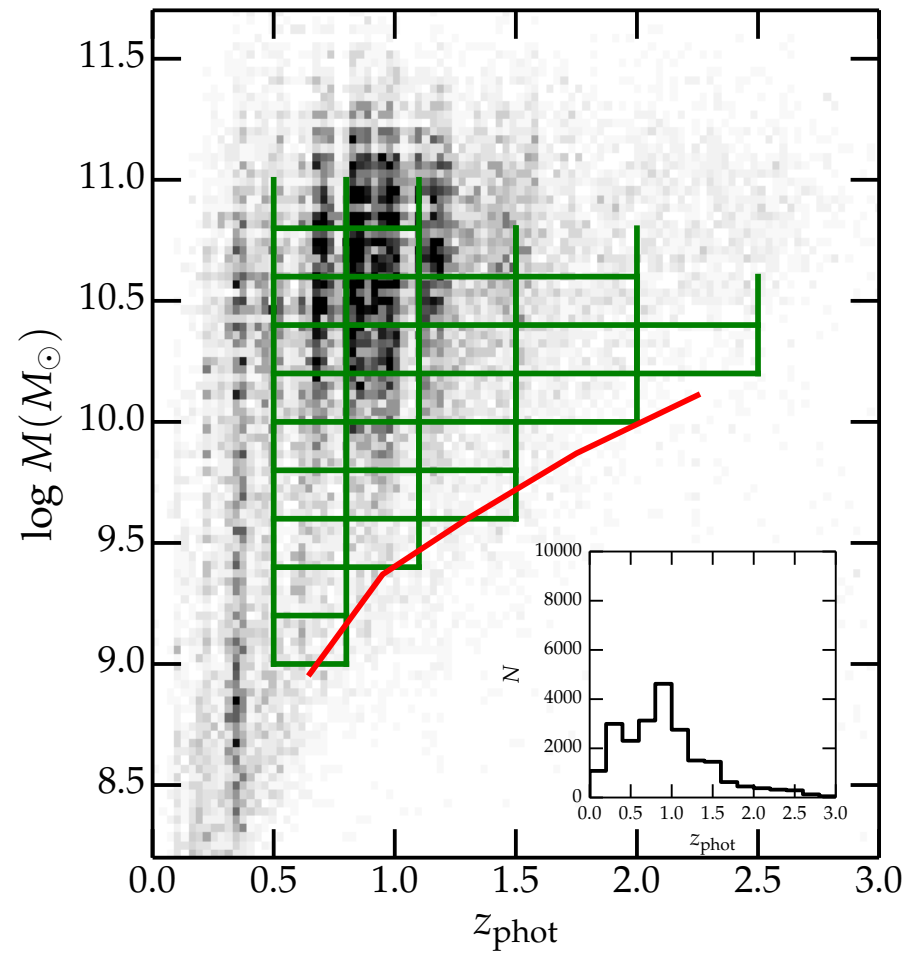
UltraVISTA-COSMOS DR1

- A unique **mass-selected** sample of 200,000 galaxies in the COSMOS field
  - Highly precise photometric redshifts
  - **Ultra-deep** YJHK NIR data means we can measure precise (log sigma M ~ 0.3) stellar masses at least until z~2-3
  - Very large dynamic range: **can easily see M* galaxies until z~2**

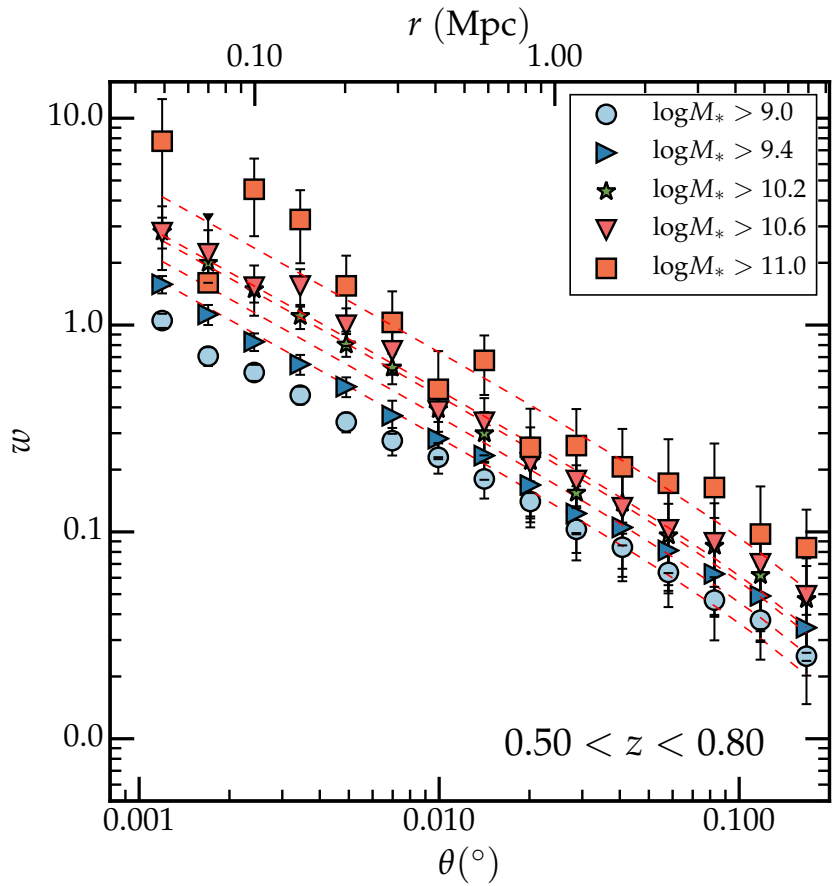


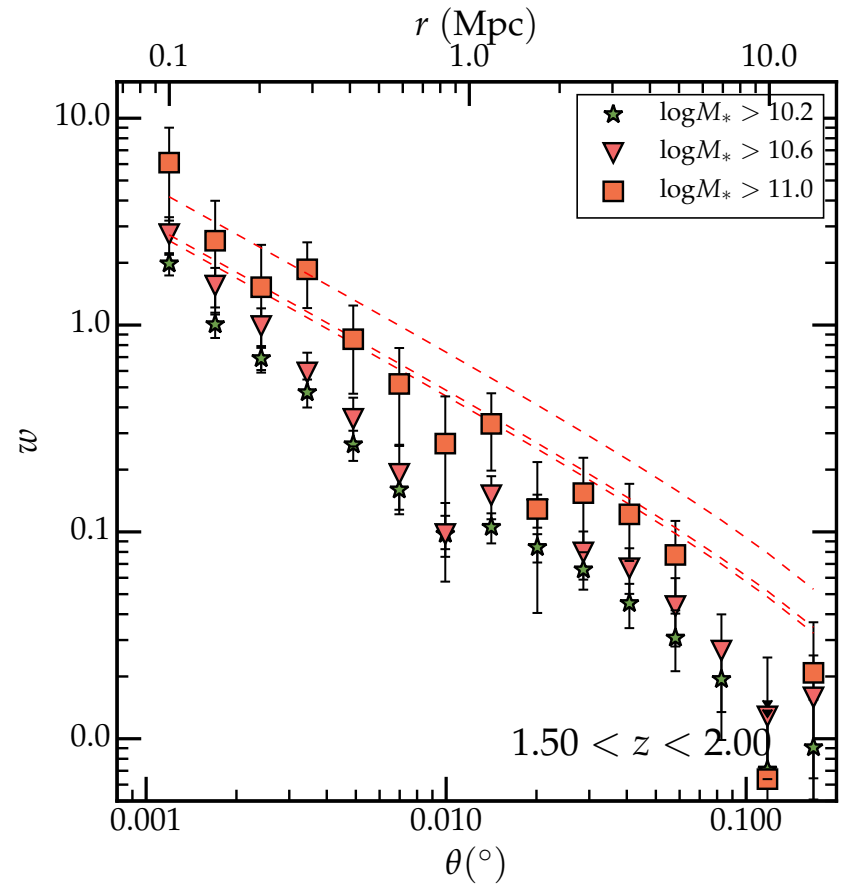
Passive galaxy sample

- Large mass-selected sample of passive galaxies
- Can investigate in the detail the clustering and abundance of the passive galaxy sample

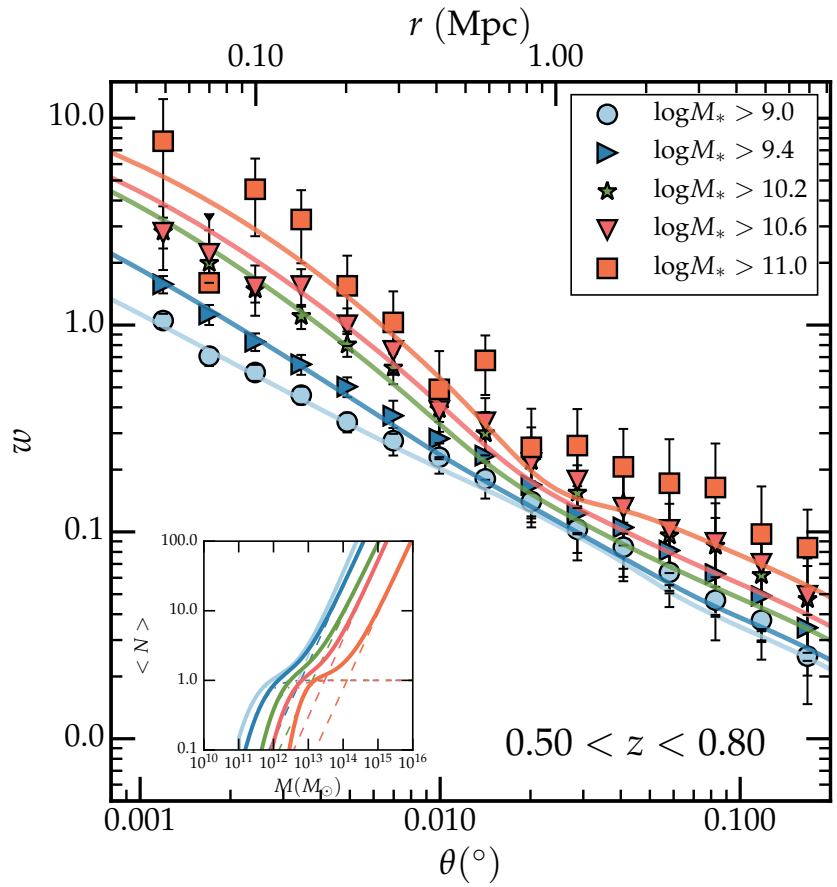


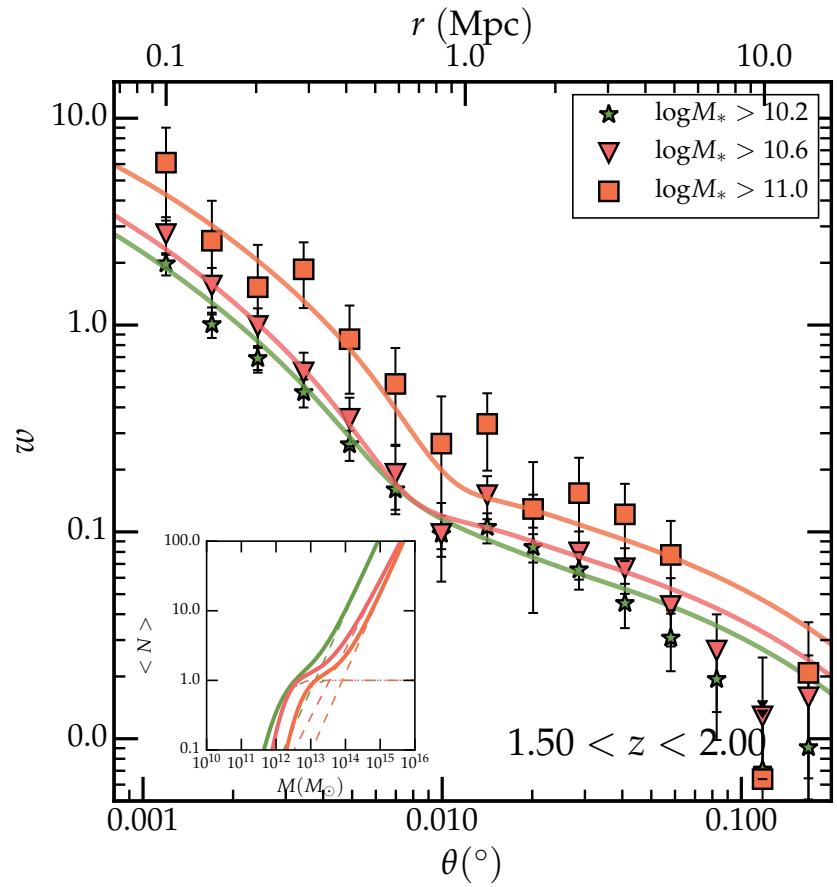
(example) w measurements



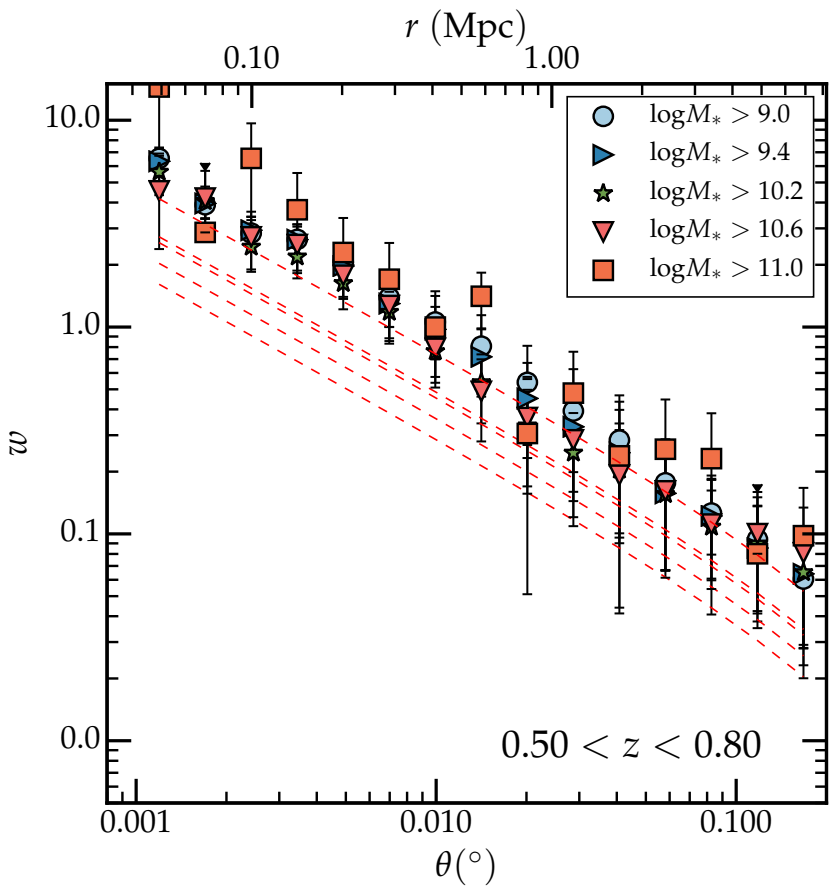


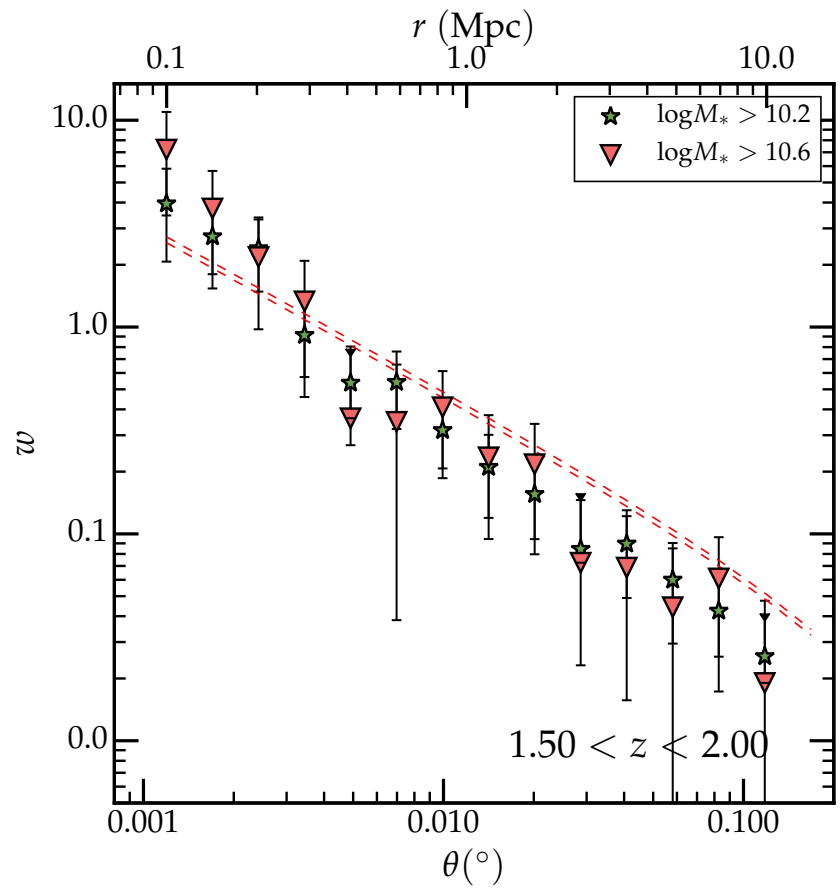
Halo-model fits



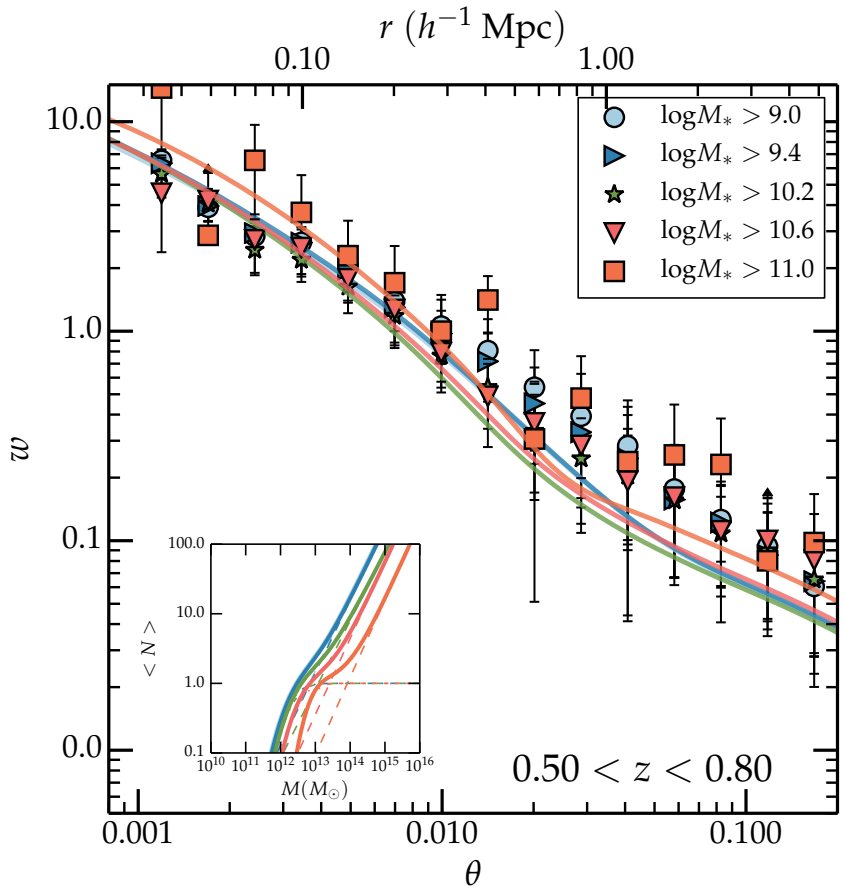


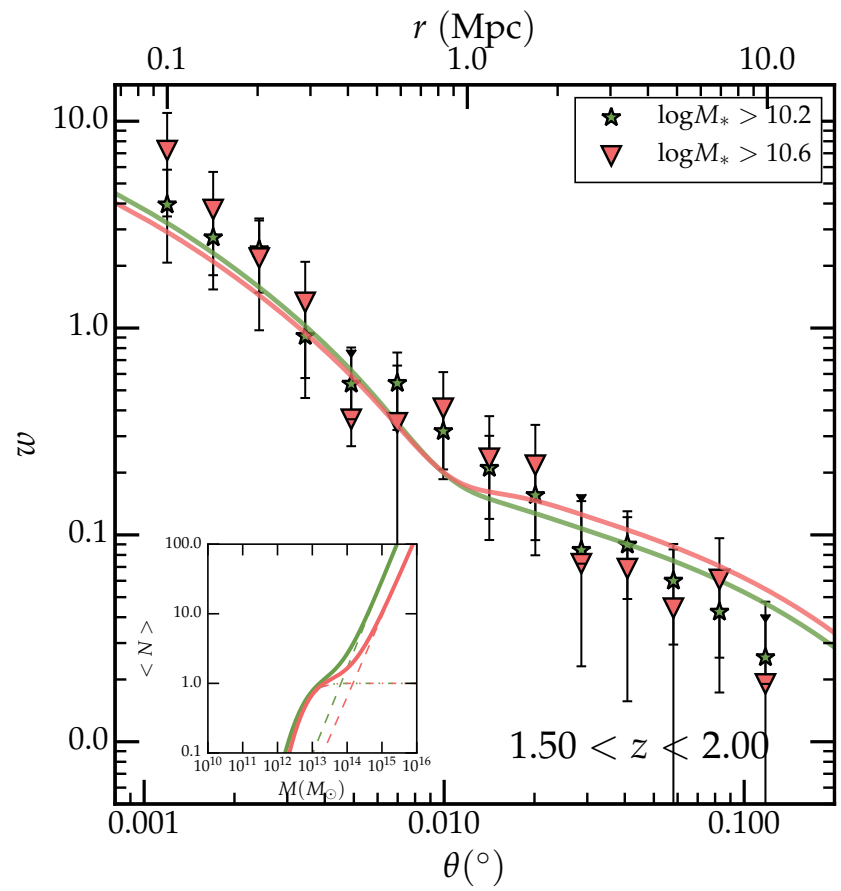
Passive sample



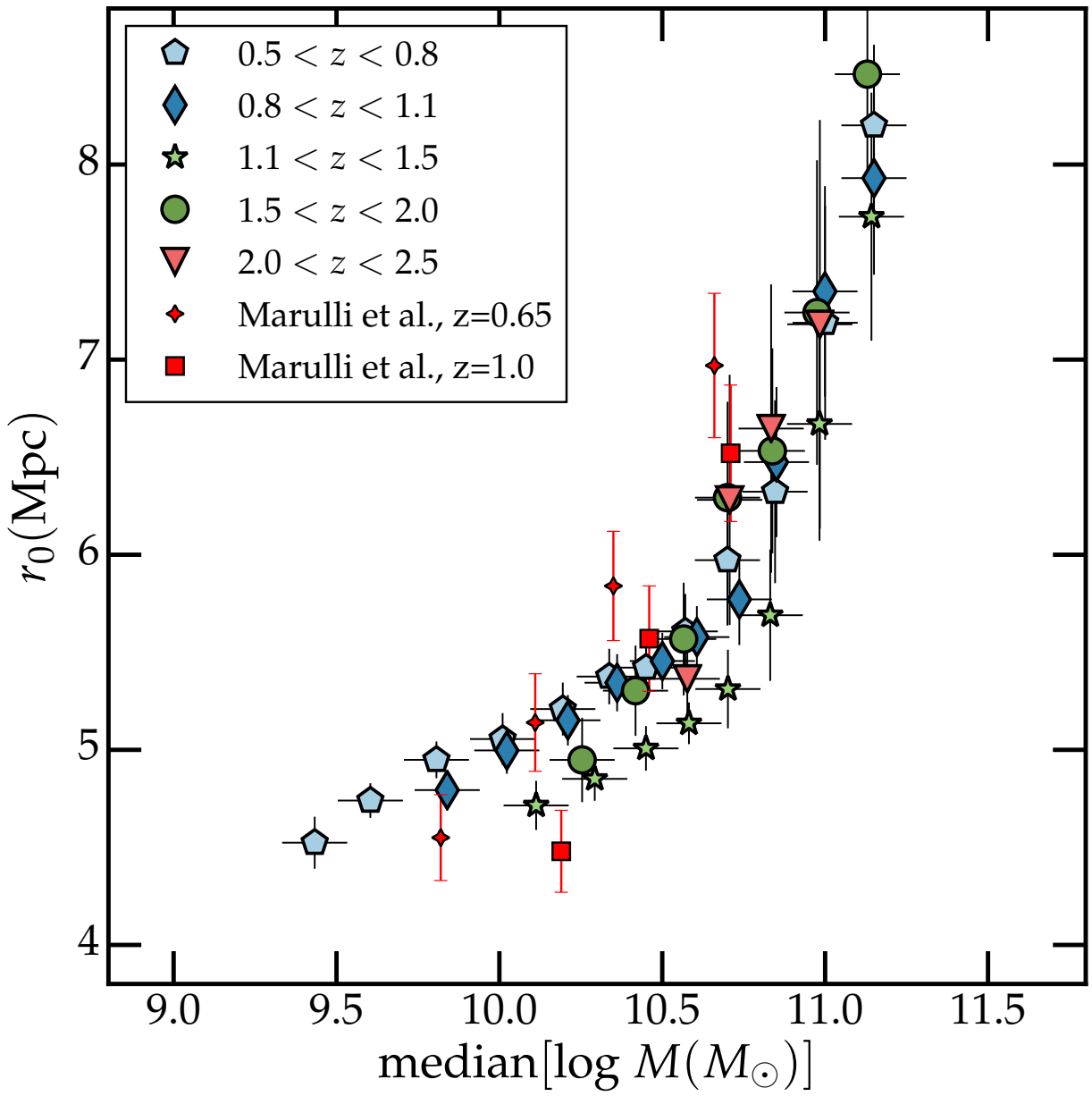


Halo model fits



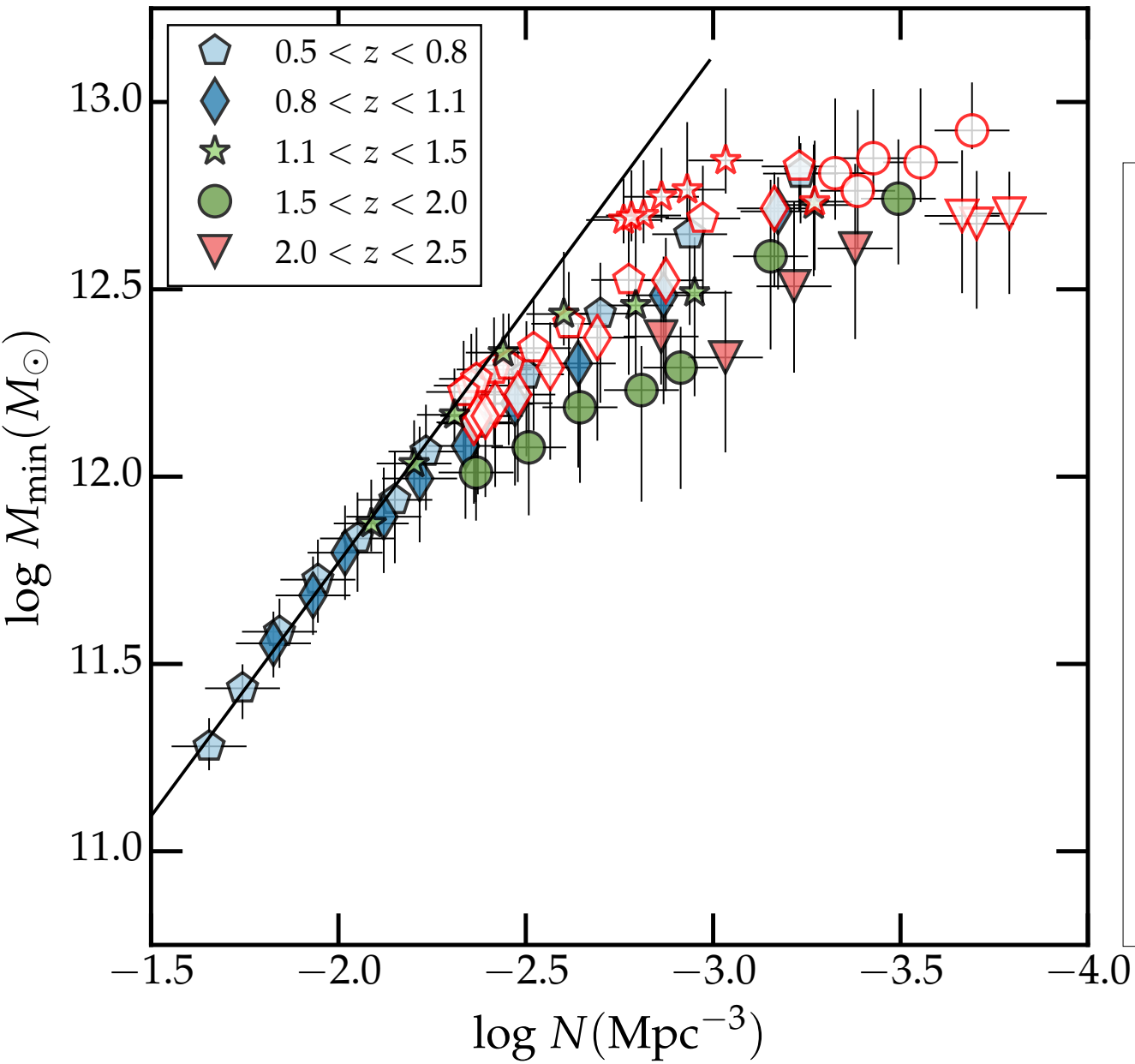


Clustering strength



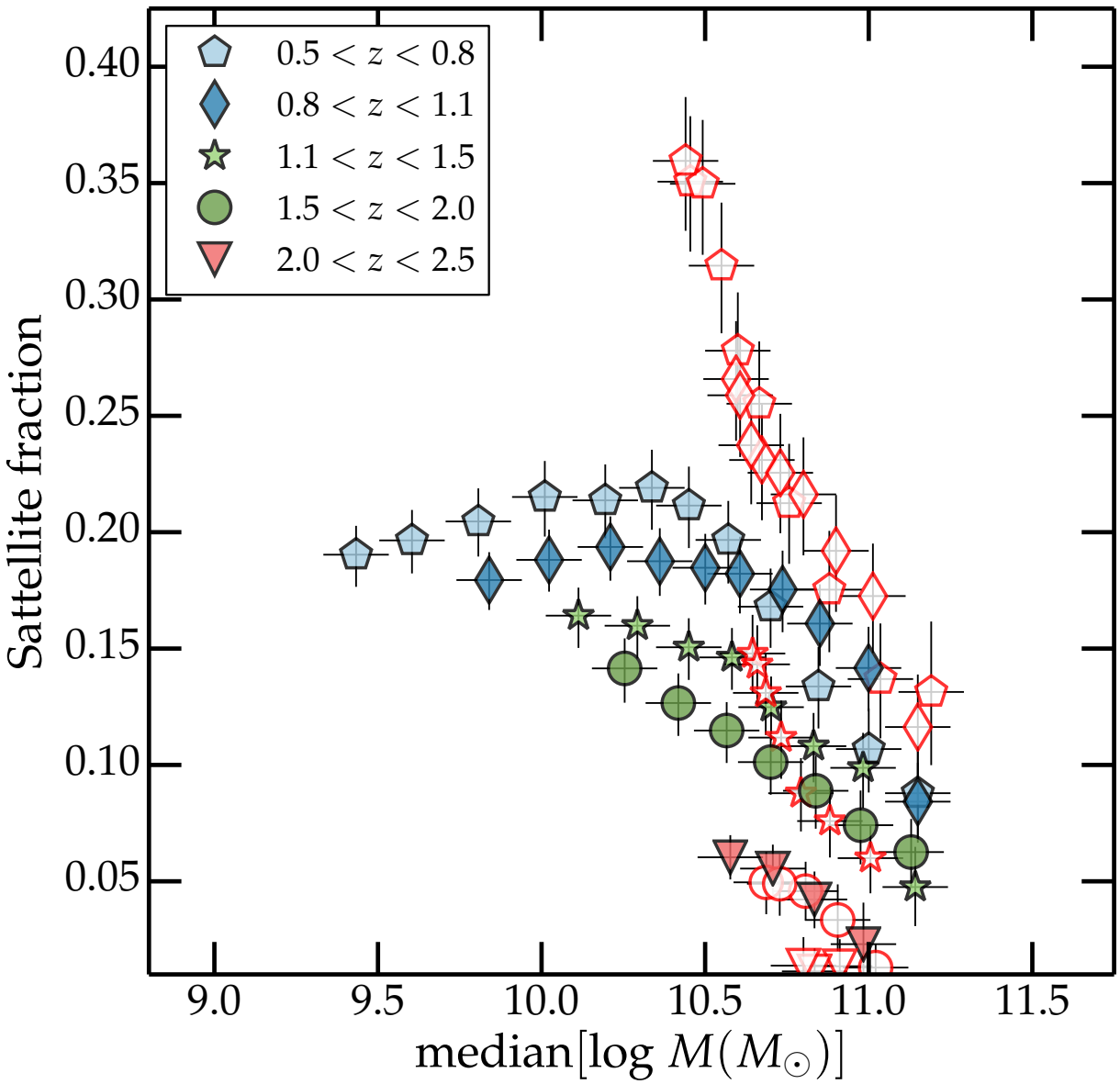
- With HOD model, can estimate xi(r) **more reliably** than with simple power-law fits
- There is **no change** in clustering strength with redshift
  - There is a **clear dependence** on stellar mass threshold on clustering strength.

Abundance and halo mass

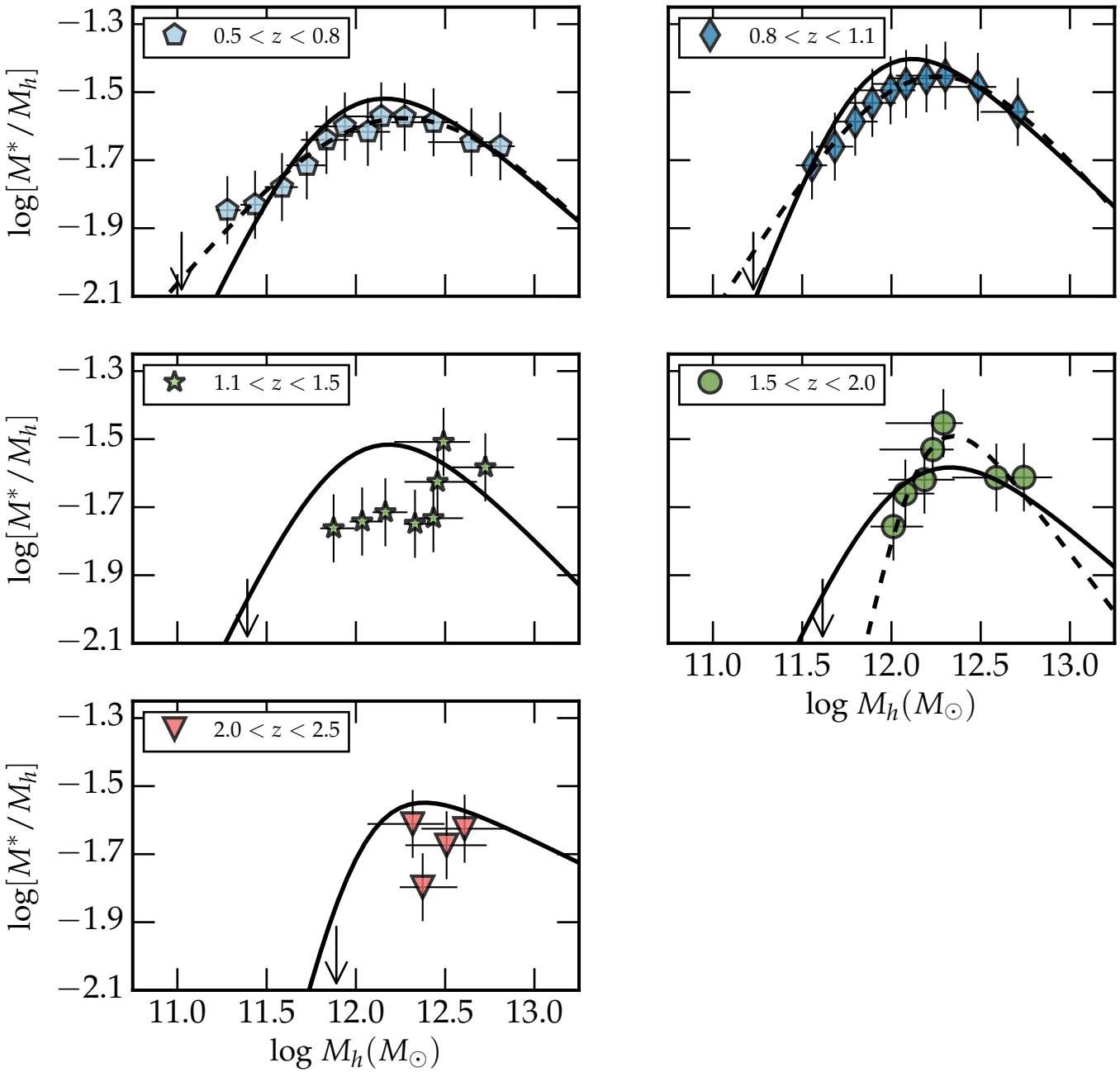


- More massive haloes are less abundant
- There is some evidence that slope of the stellar mass / halo mass relationship evolves with redshift
- Note the same “inflection point”” we already saw in the previous plots

The history of satellites in haloes



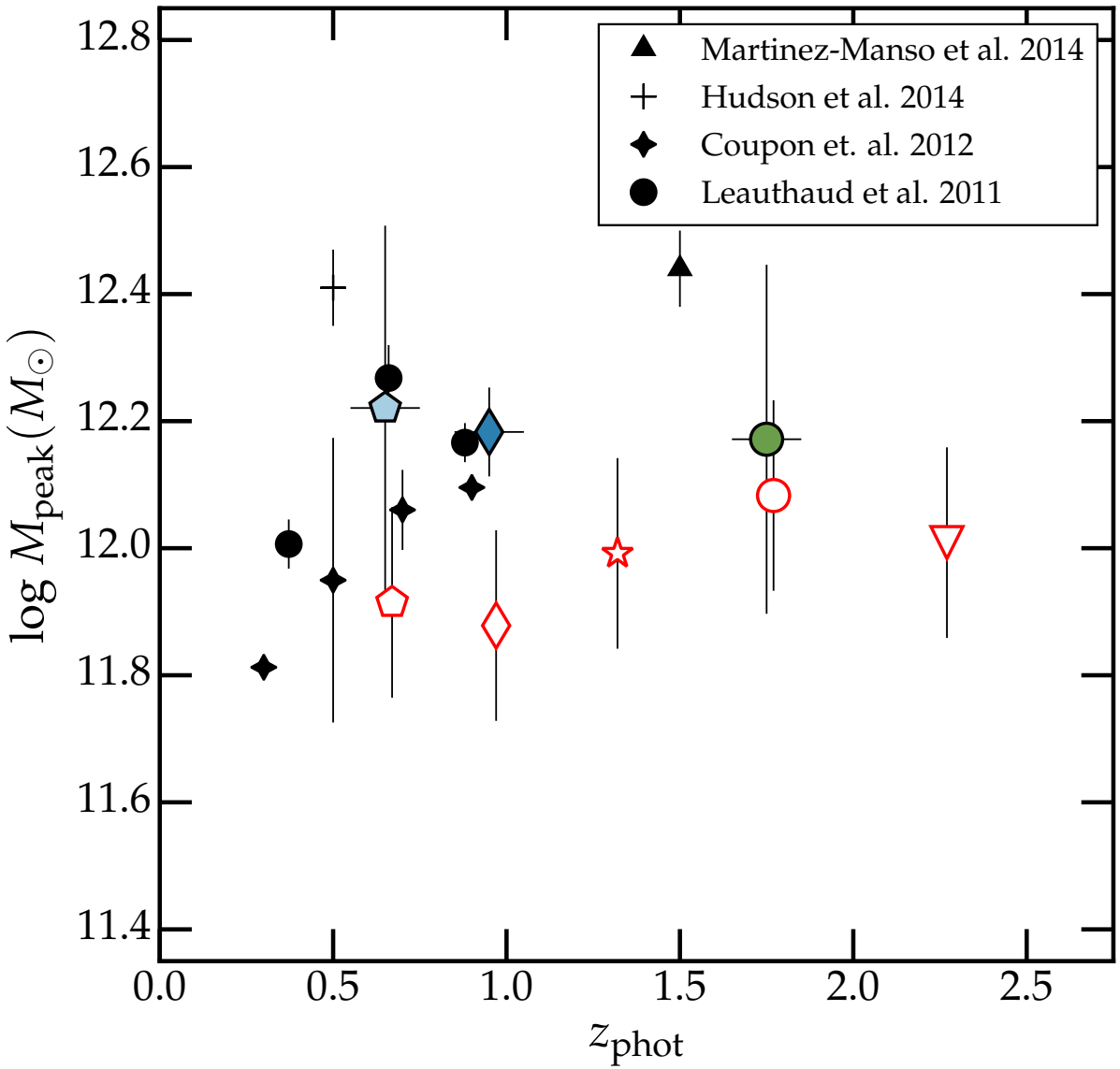
- With HOD model, can measure the fraction of satellite galaxies in haloes
  - At high redshift the satellite fraction is zero
  - Satellite fraction is a strong function of stellar mass threshold.



The SHMR relationship to z~2

- Can measure M^*/M_h using halo model
- Also check results with abundance matching (solid lines)

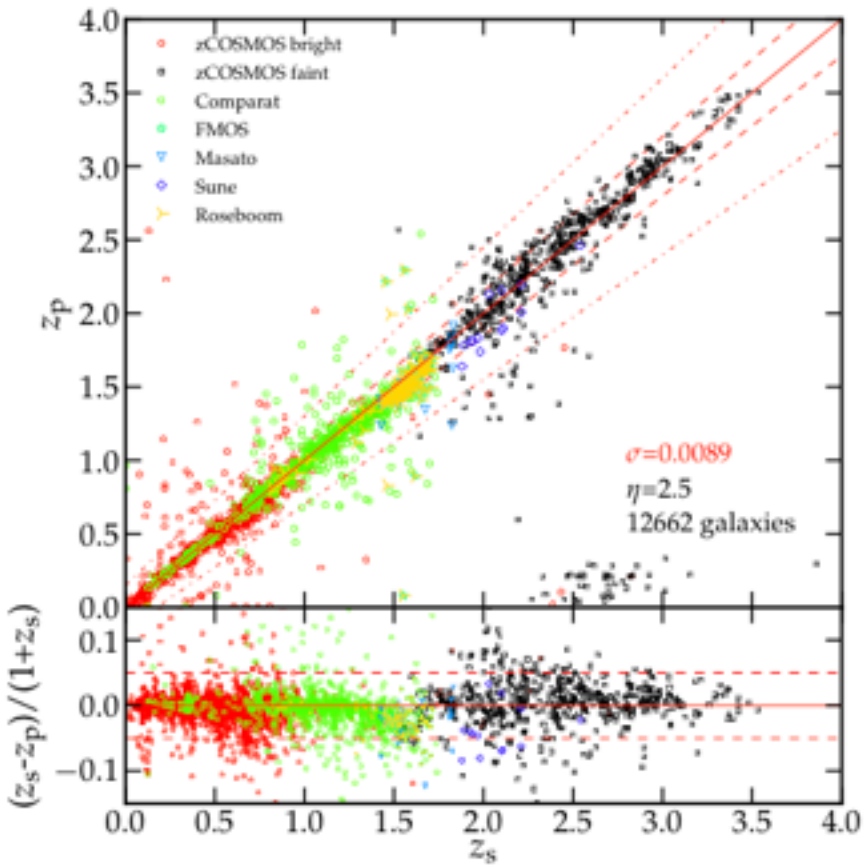
The SHMR relationship to z~2



- The position of the peak in the SHMR relationship only slowly evolves with redshift
  - Can understand this as a consequence of the slow evolution of M* in the stellar mass function

High redshifts: SPLASH+DR2

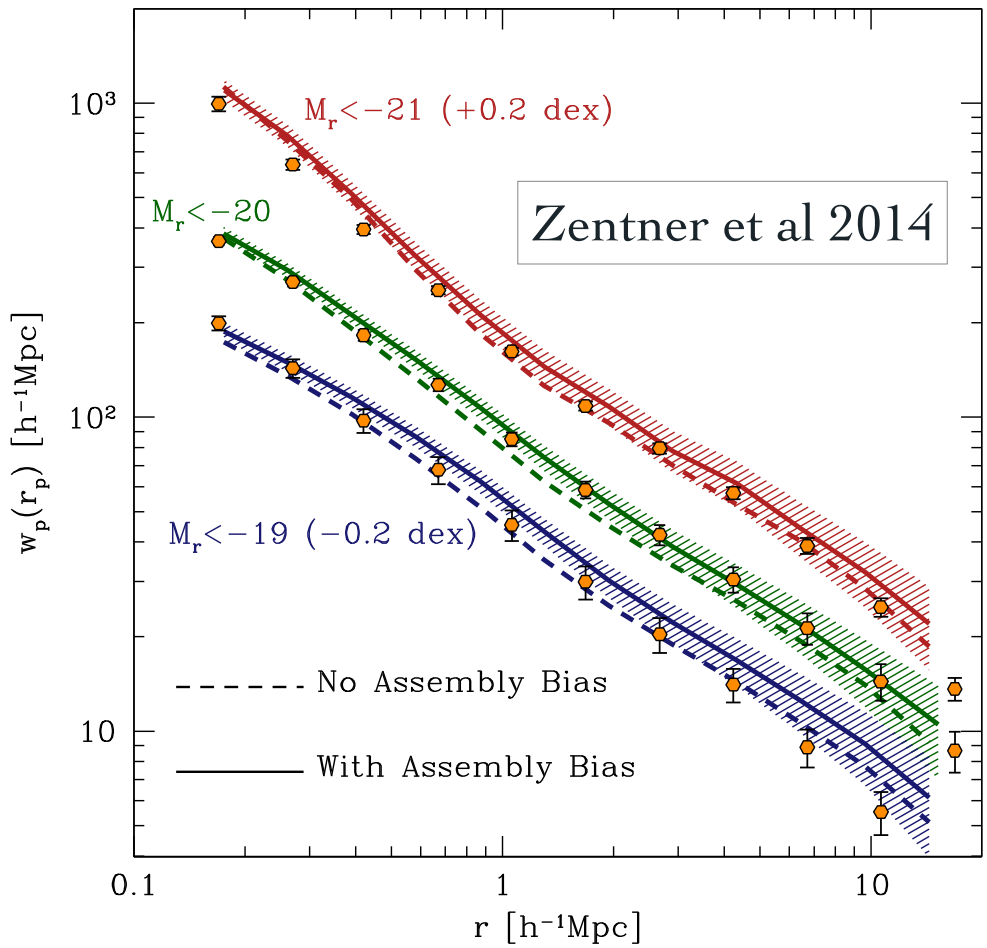
- **NEW** UltraVISTA **DR2** data +NEW COMOS data + Splash IRAC, **new PSF homogenisation**
- **Catalogue + photometric redshifts + stellar masses will be made public**
- We will produce the largest most precise **stellar-mass selected catalogue** at 2<z<4
- HORIZON-AGN



Laigle et al. 2015 in prep.

Is there “assembly bias”?

- Assembly bias is a generic feature of abundance matching simulations
- Attempts have been been made model it at fit to sloan data at z=0
- But maybe the effect is much stronger at higher redshifts?
  - Can check with hydro simulations?



Summary

- There is only very slow evolution of in the peak of the M^*/M_h relation
  - No evidence for “Halo downsizing”
  - It seems that the uncertainties in the halo mass functions are underestimated
- Bias evolves in such a way to counteract almost perfectly the reduction of clustering strength caused by projection effects: correlation lengths are constant.