Galaxy-Dark Matter Halo Connection Revealed by the Subaru/HSC and Hubble Surveys

Harikane et al. 2016 (ApJ 821, 123)
Harikane et al. in prep

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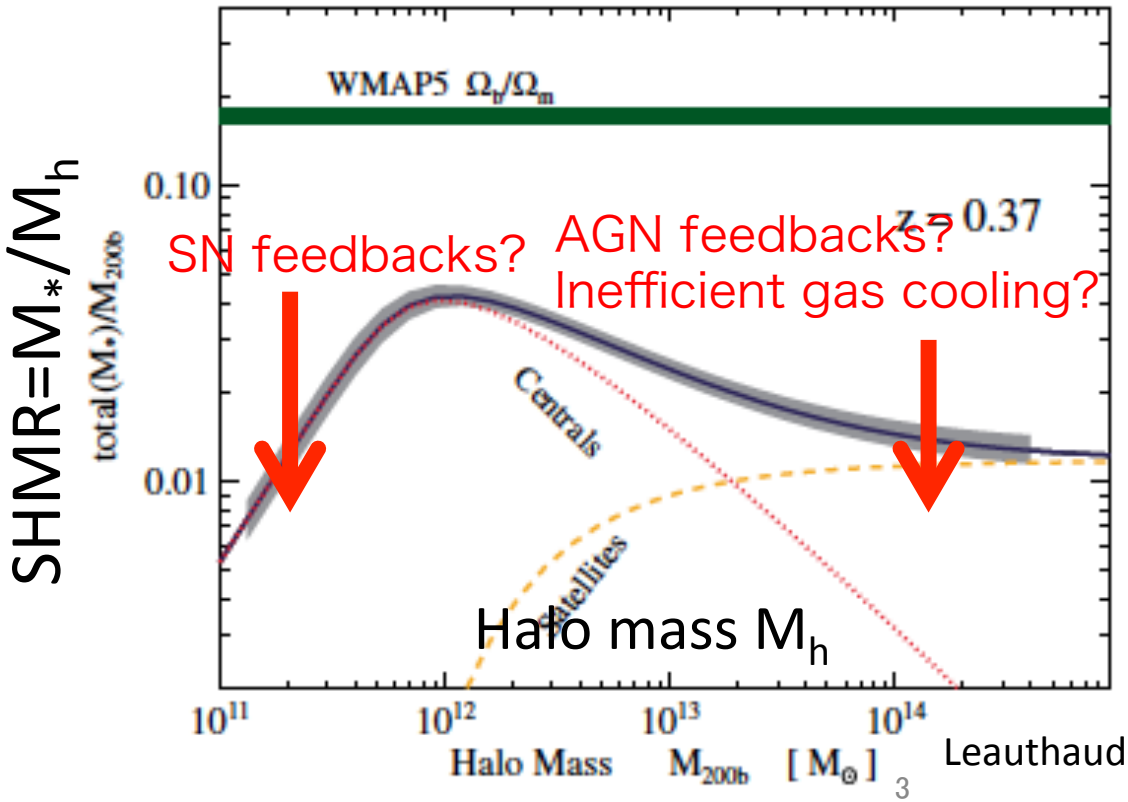
Outline

- Stellar-to-halo mass ratio (SHMR)
- HSC & Hubble Data and LBG Sample
- Clustering Analysis
- Results and Discussion

Galaxy-Dark Matter Halo Connection

- Closely related to gas cooling, feedback, merger...
- Stellar-to-halo mass ratio (SHMR=M_*/M_h)
  - Fraction of mass converted to stars (M_h=~M_{total})

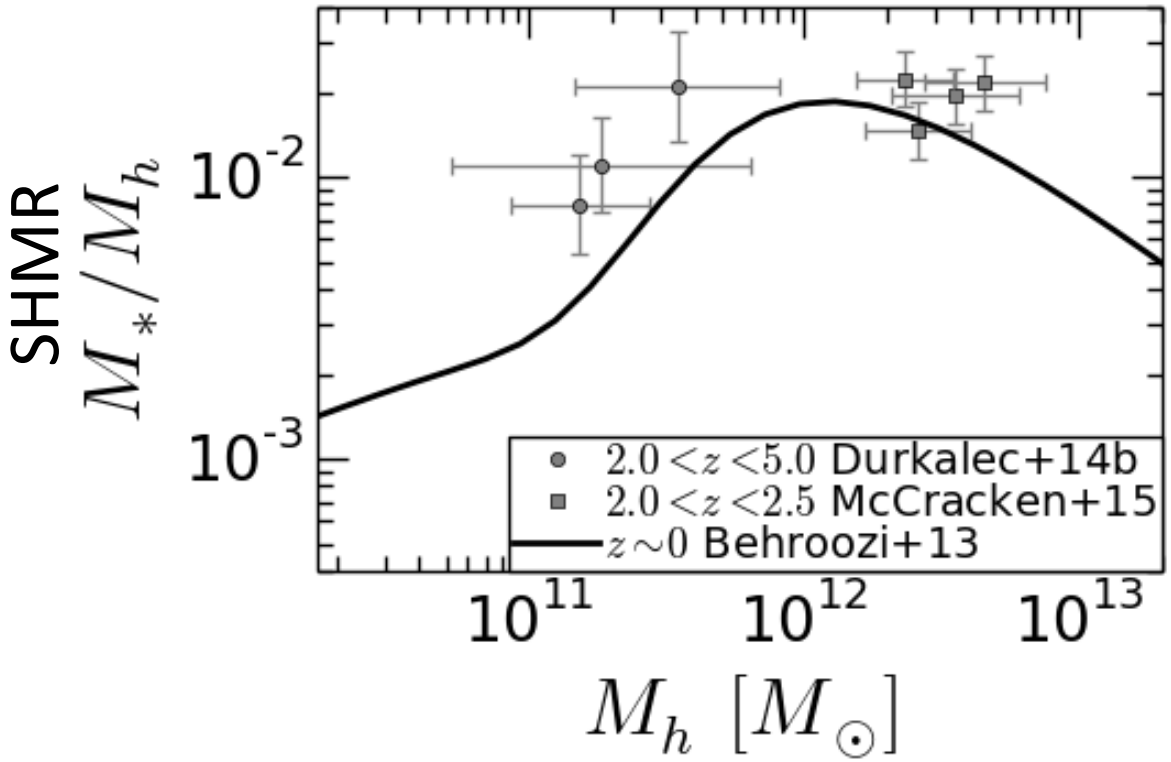


Well constrained in low-z

Leauthaud+12

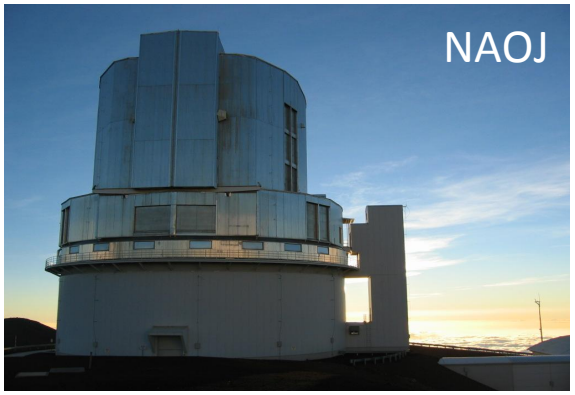
High-z (z>2) SHMR

- Halo mass dependence or redshift evolution are not clear due to large statistical error
- No estimates at z>=5



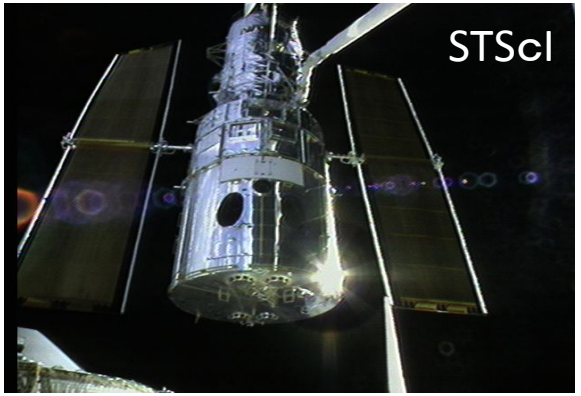
This Study

- Subaru Hyper-Suprime Cam (HSC) wide data
- Hubble deep archival data (m_{lim}~30 mag)



8m Subaru Telescope

+



Hubble Space Telescope

Method: Clustering Analysis

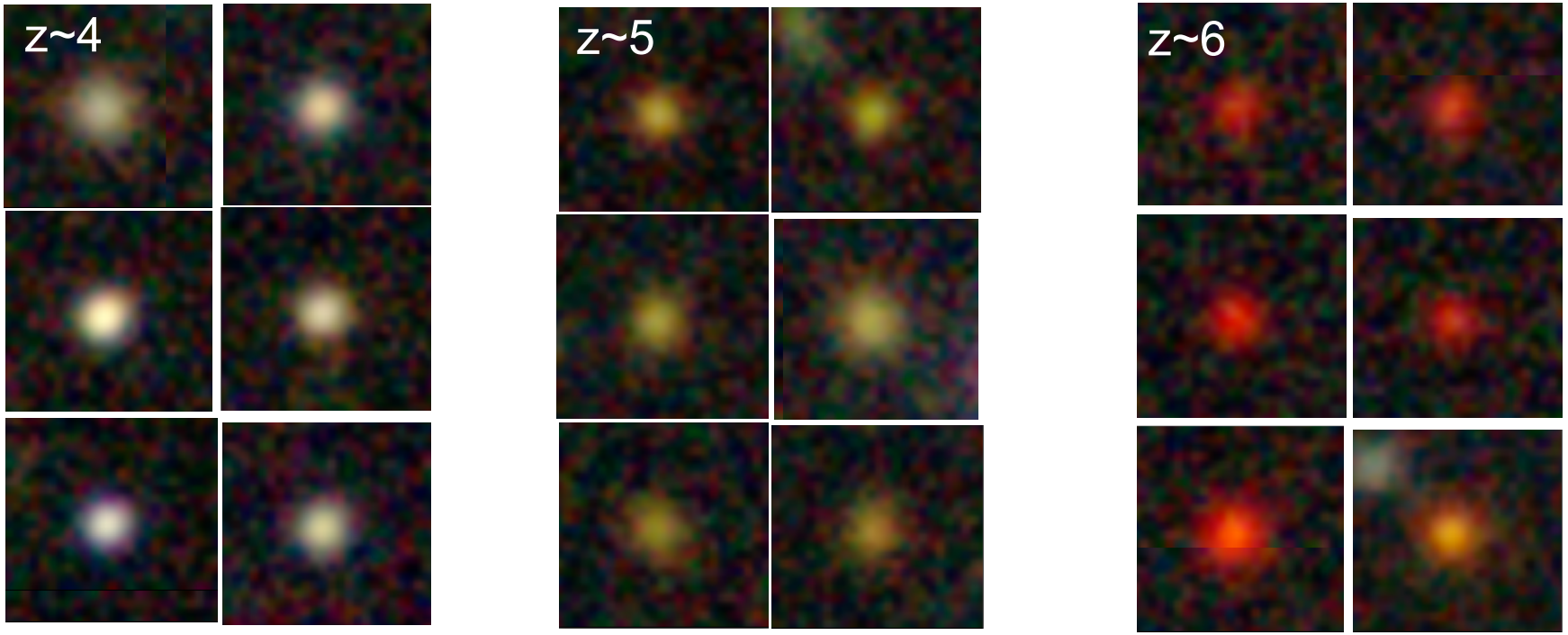
SHMR at high redshift

Sample Selection

Lyman break galaxy (LBG) selection @z~4, 5, 6, 7

Subaru/HSC: 439,586 (m_{UV}=20-26.5 mag)

(see Yoshiaki's talk in this morning)

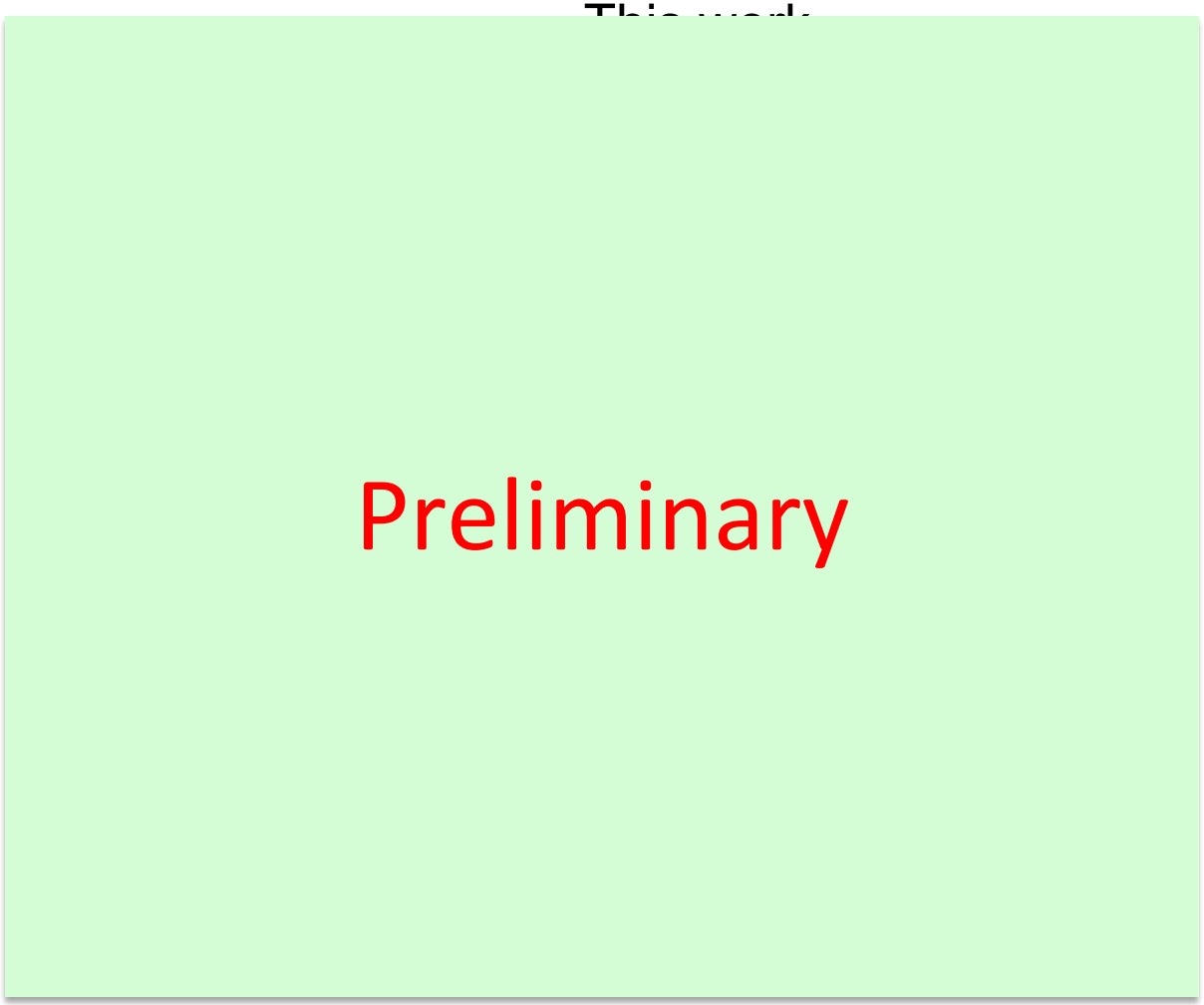


Hubble: 9,651 (m_{UV}=23-30 mag)

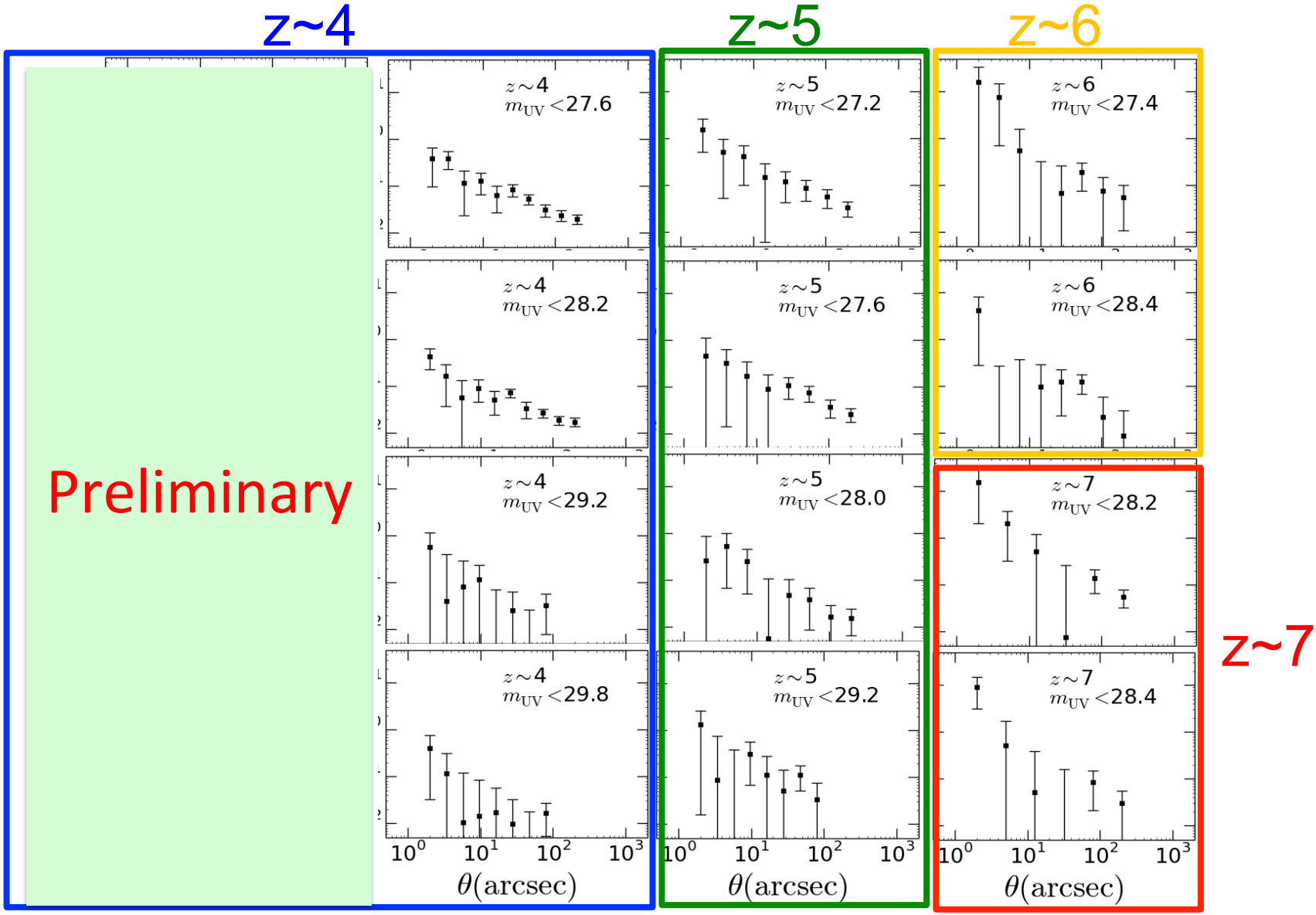
Total of 449,205 LBGs at z=4-7 (M_*~10^8-10^{11} M_o)

Angular Correlation Functions

- High-SN compared with previous S-cam results



Angular Correlation Functions



M_h estimate with HOD Model

Clustering strength -> Dark matter halo mass M_h

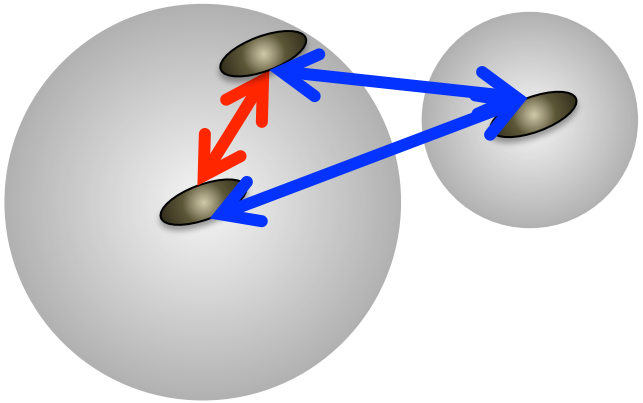
$$\omega(\theta) = \int dz N^2(z) \left(\frac{dr}{dz}\right)^{-1} \int dk \frac{k}{2\pi} P_g(k, z) J_0[r(z)\theta k].$$

Angular correlation function (observed clustering strength)

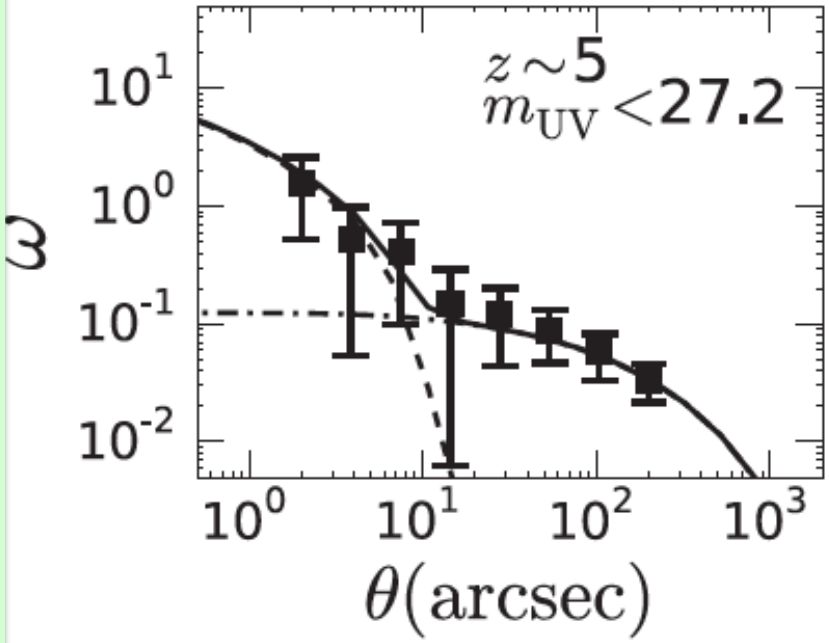
Galaxy power spectrum from halo occupation distribution (HOD) model (function of M_h)

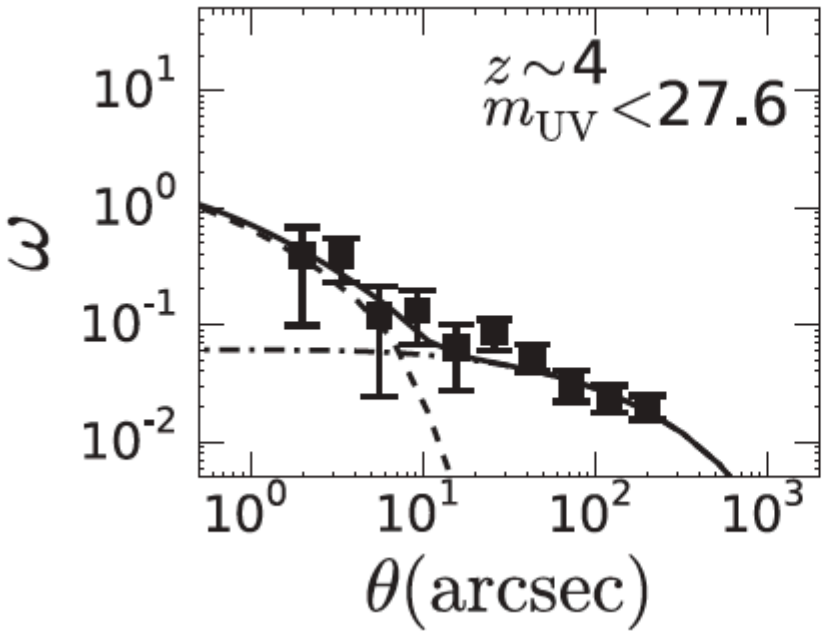
Preliminary

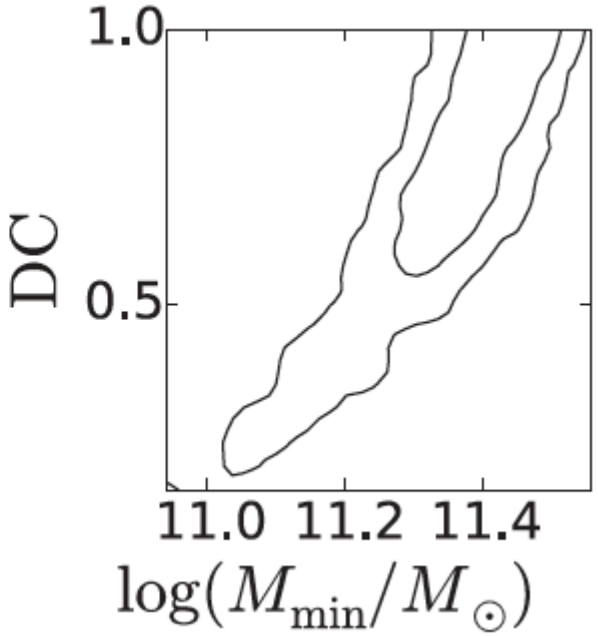
HOD model



Preliminary

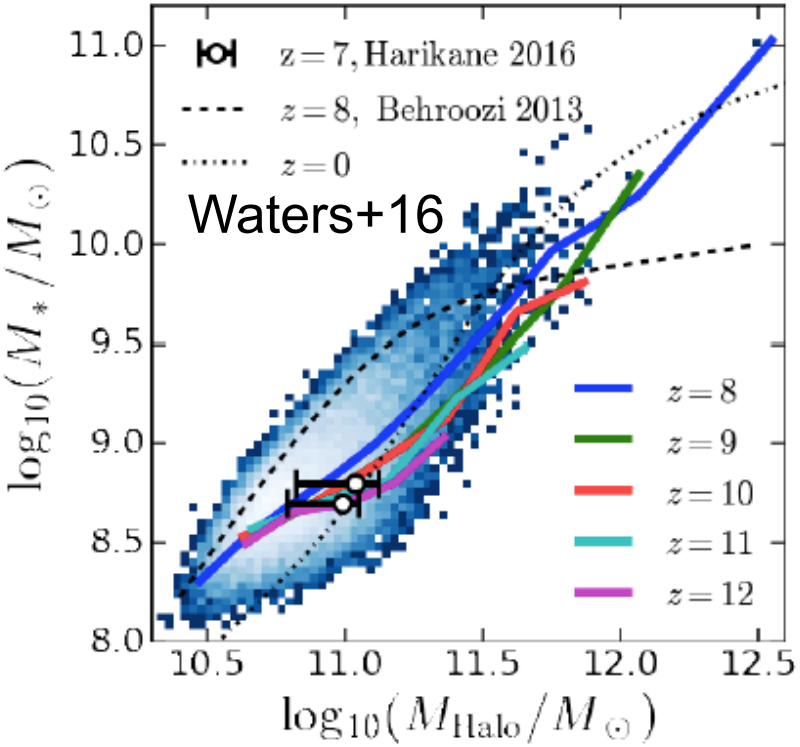


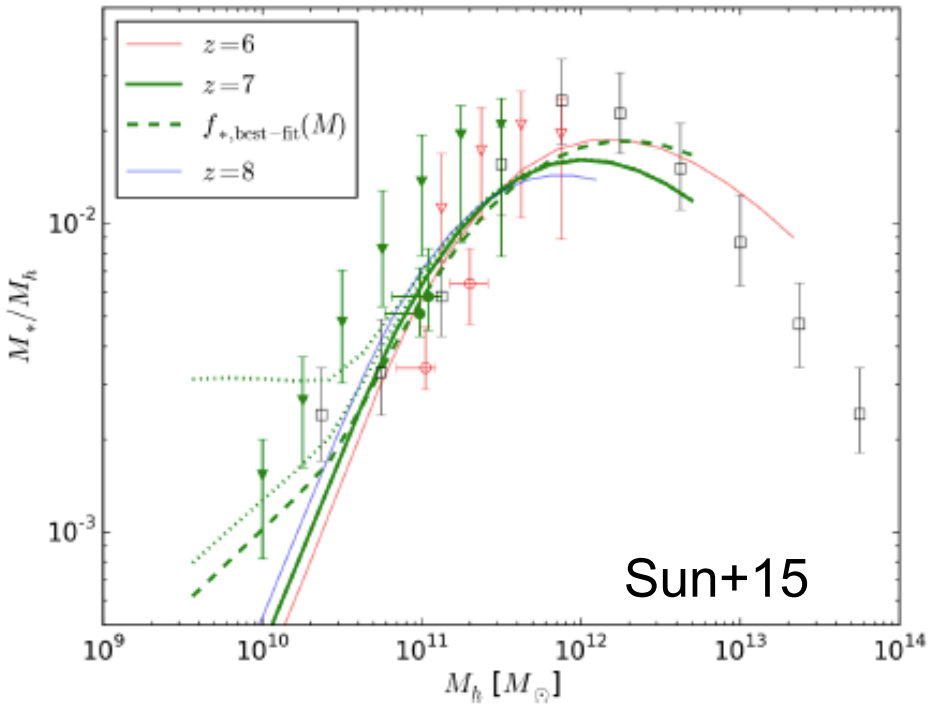


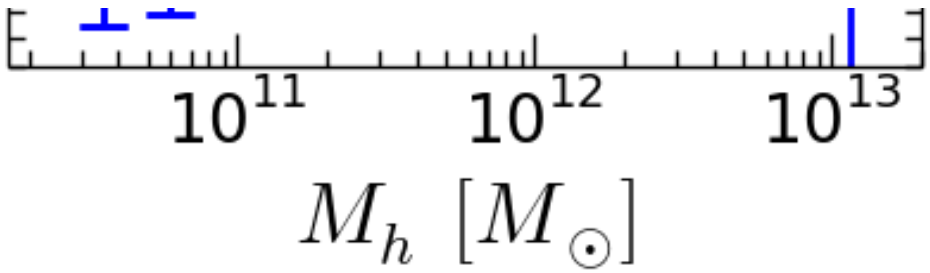


SHMR

- We estimate SHMR=M_*/M_h at z~4-7

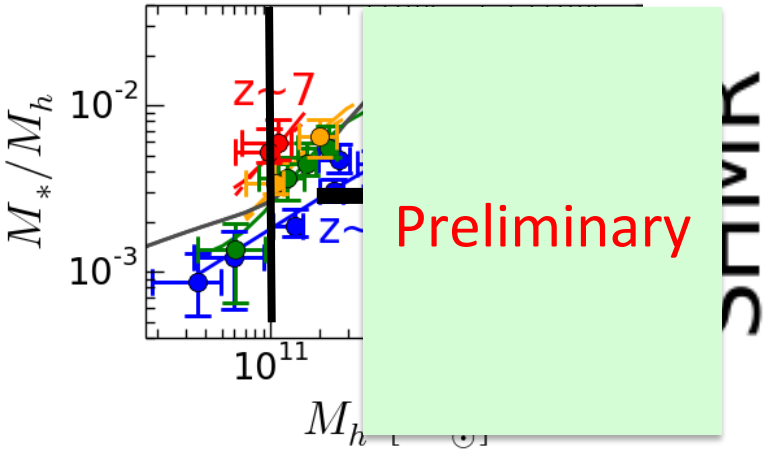




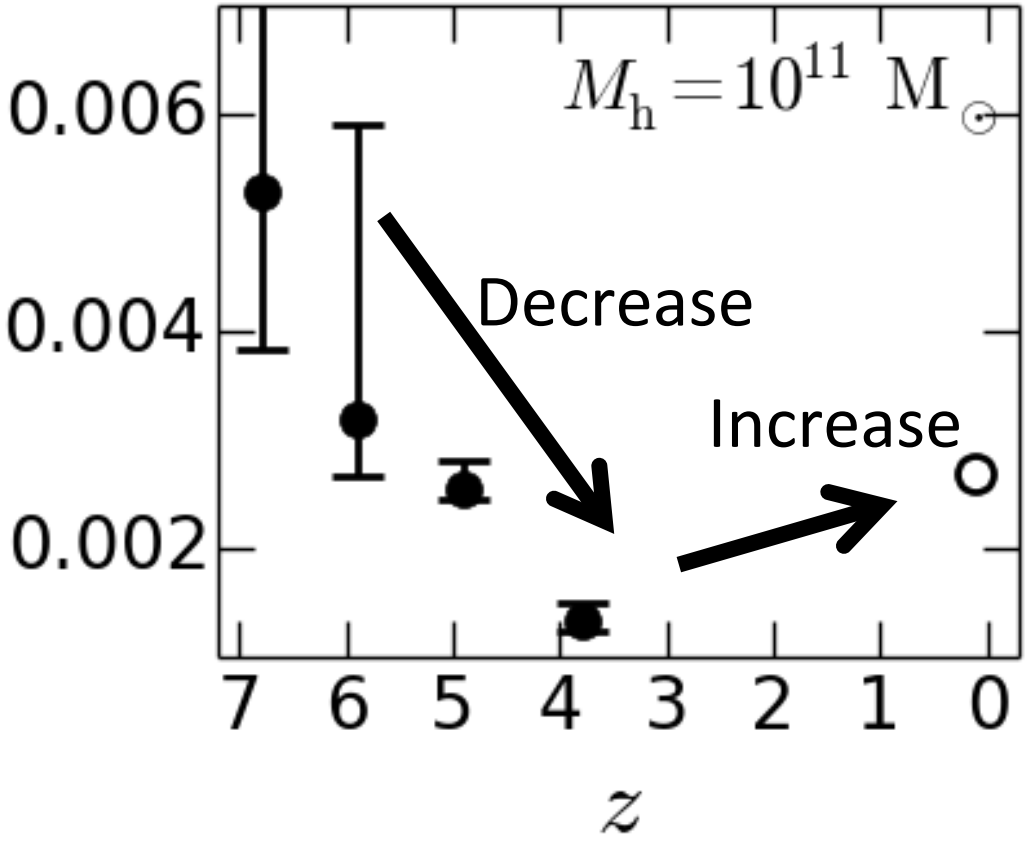


Evolution of SHMR

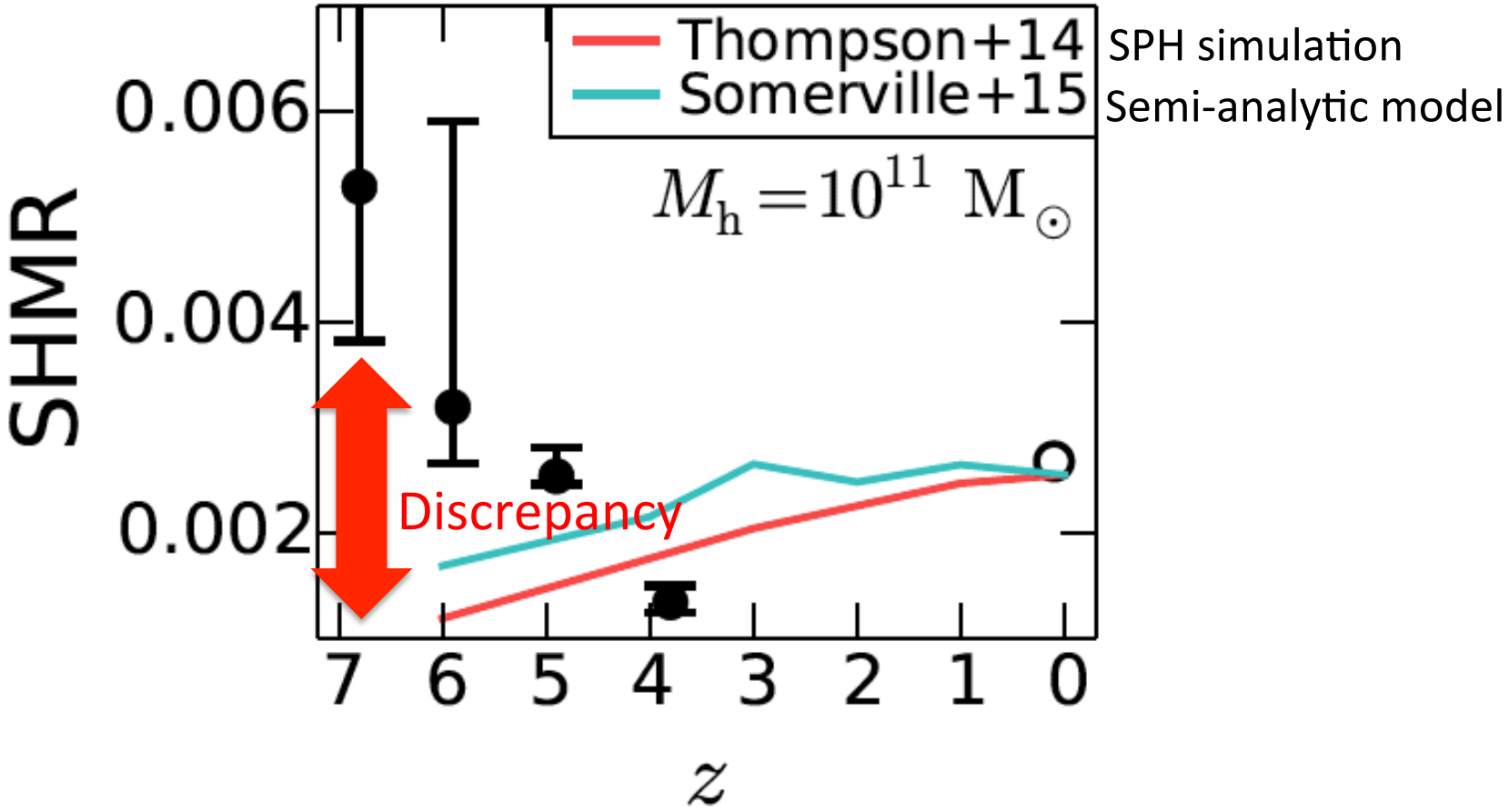
- SHMR (M_h=10^{11} M_o)
  - Decrease from z~7 to 4, increase from z~4 to 0



Preliminary



Comparison with Theoretical Studies



- z~4->0: models reproduce our obs. trend
- z~7->4: models do not explain our obs. results

(star formation efficiency may be higher than predictions at higher-z)

Comparison with Abundance Matching (AM)

- z~4:
  - $M_h<10^{12}$ M_o: ~1σ agreement
  - $M_h>10^{12}$ M_o: ~3σ larger M_h due to the difference in the stellar mass functions we use ?
- z~5-7: <1σ agreement

Preliminary

Summary

We estimate SHMR(=M_*/M_h) at z~4-7 with Subaru/HSC and Hubble survey data

1. A peak around M_h~10^{12} M_o at z~4

2. SHMR evolution:
   decrease from z~7 to 4
   increase from z~4 to 0

3. Theoretical models do not reproduce the SHMR evol at z~4-7.