The Local Galaxy-Halo Connection

arXiv:1207.2160

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Motivation

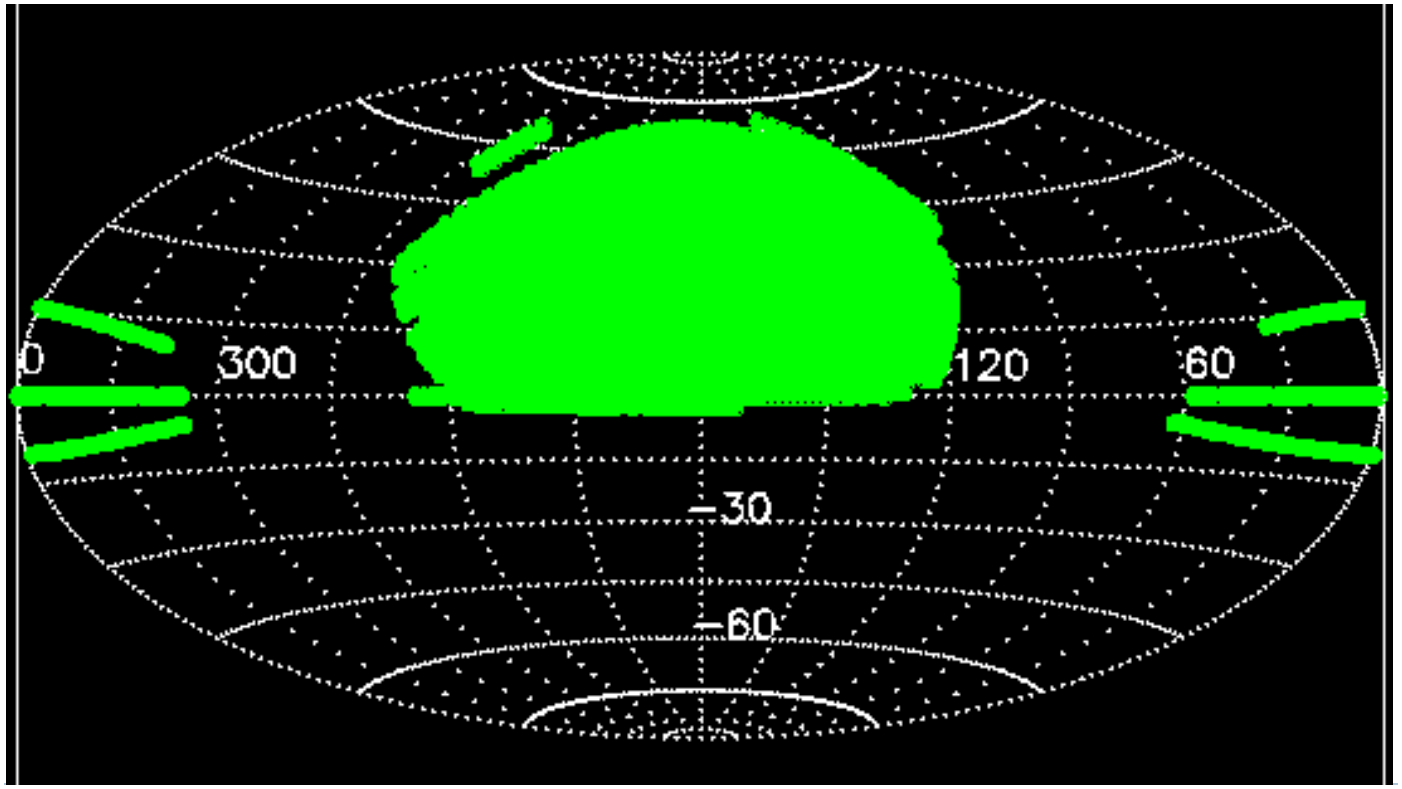
- Galaxies-dark matter halo connection key link between galaxy formation and cosmology
  - Understanding galaxy-halo connection can inform galaxy formation physics
  - Large galaxy surveys (e.g., SDSS, DES) to probe cosmology depend on galaxy-halo connection
  - E.g., clustering of dark matter inferred from galaxy clustering

Our Study

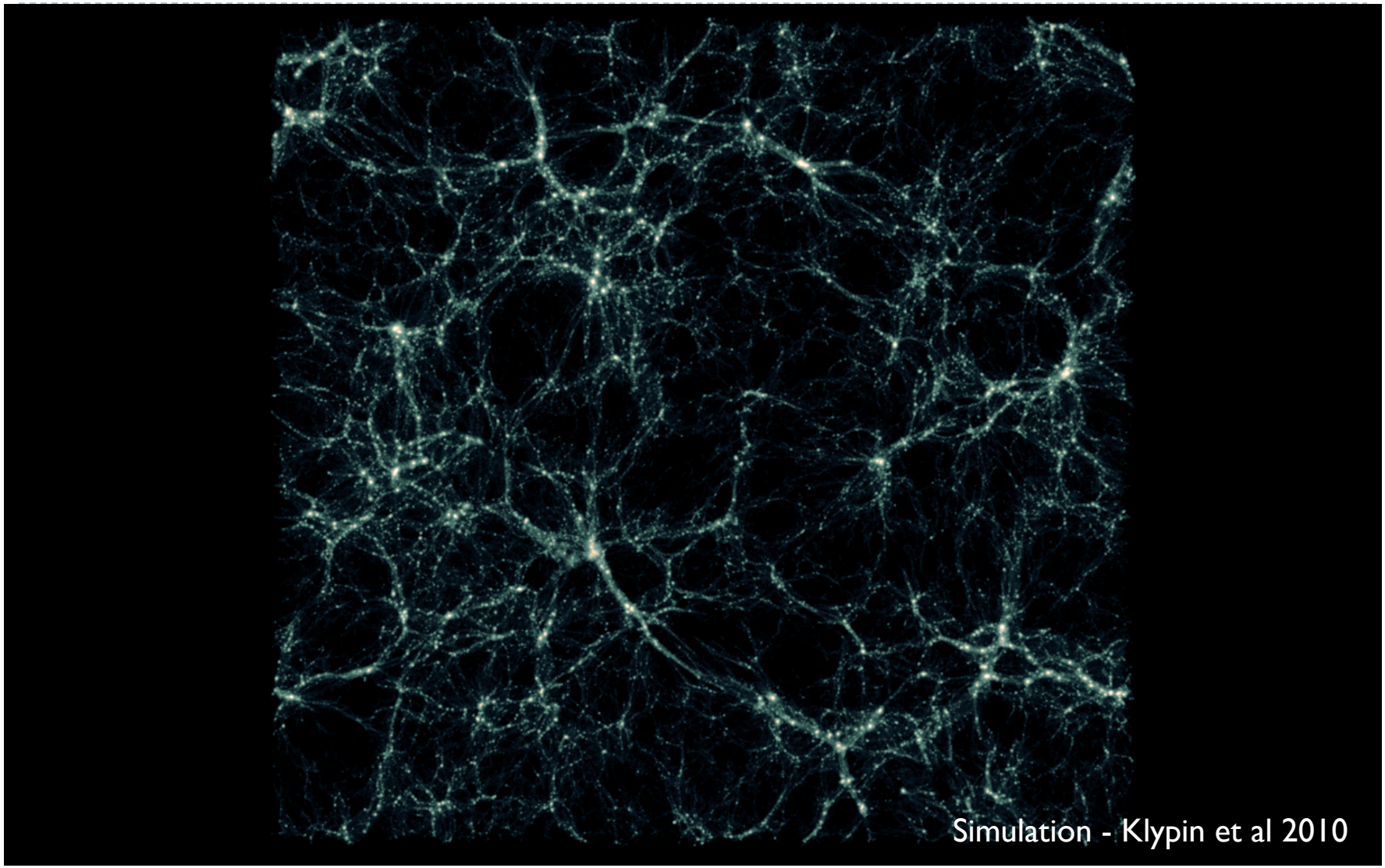
- Populate a high resolution N-body simulation with galaxies using abundance matching
- Test the abundance matching assumptions using precise z=0.05 data from SDSS
- Constrain the (very few) relevant parameters

Sloan Digital Sky Survey

- NYU-VAGC catalog from DR7 spectra
- Includes log(M*)>9.8 to z=0.063
- Volume 4.8×10^6 (Mpc/h)^3

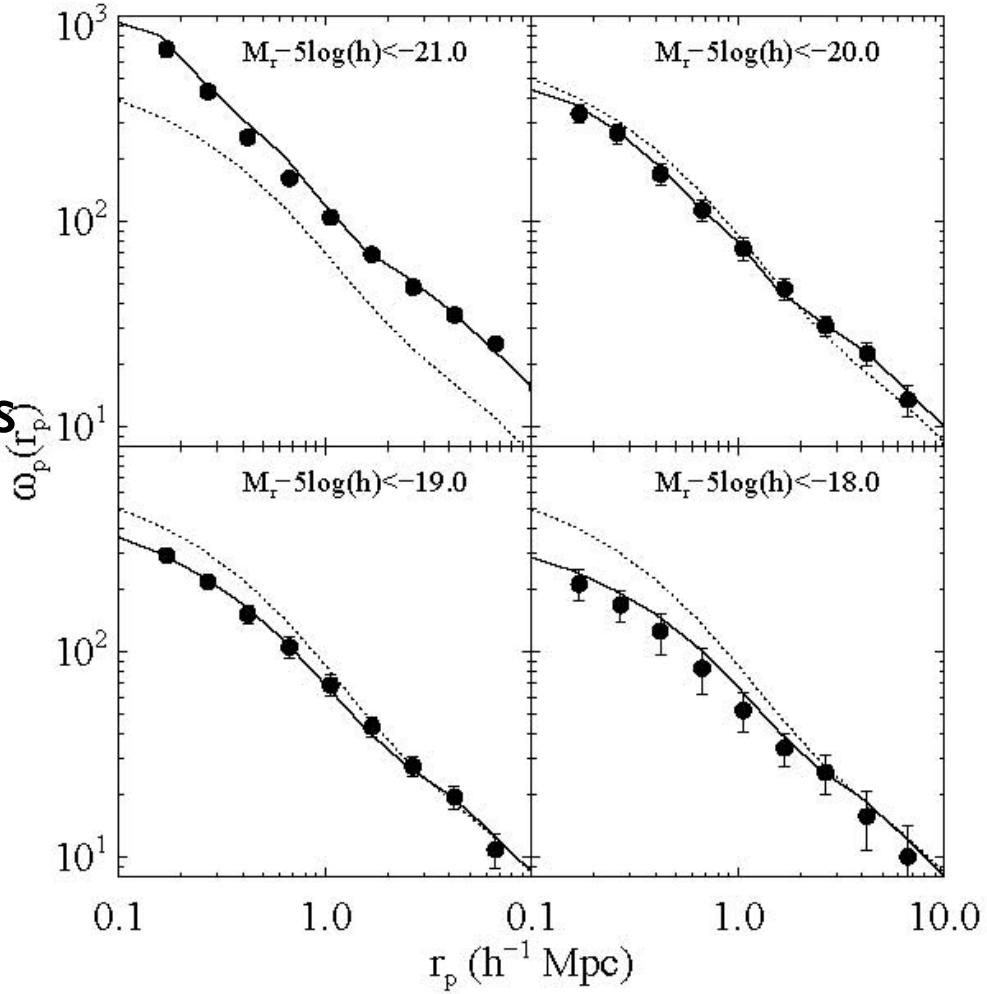


Bolshoi Simulation



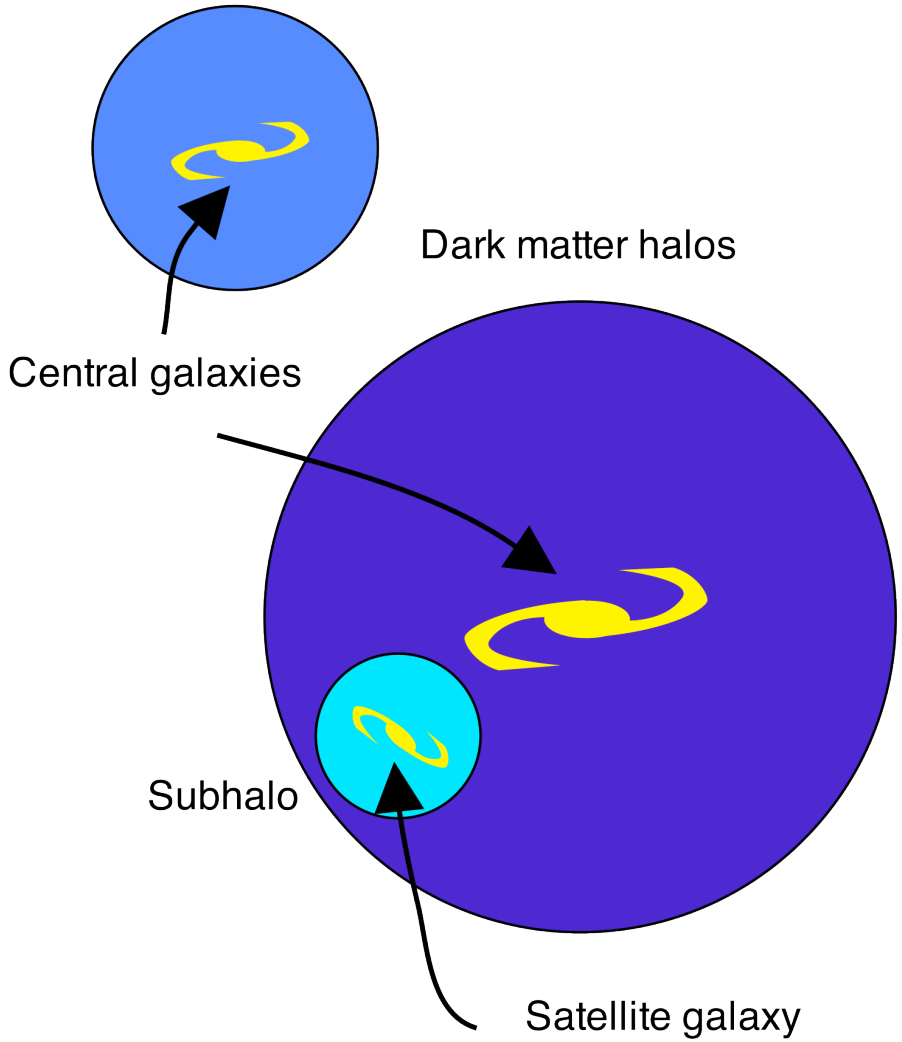
Where are the galaxies?

- SHAM avoids additional assumptions of more complex models
- Single assumption: galaxies reside in dark matter halos
  - And galaxy properties depend on halo properties



Conroy, Wechsler, & Kravstov, 2006

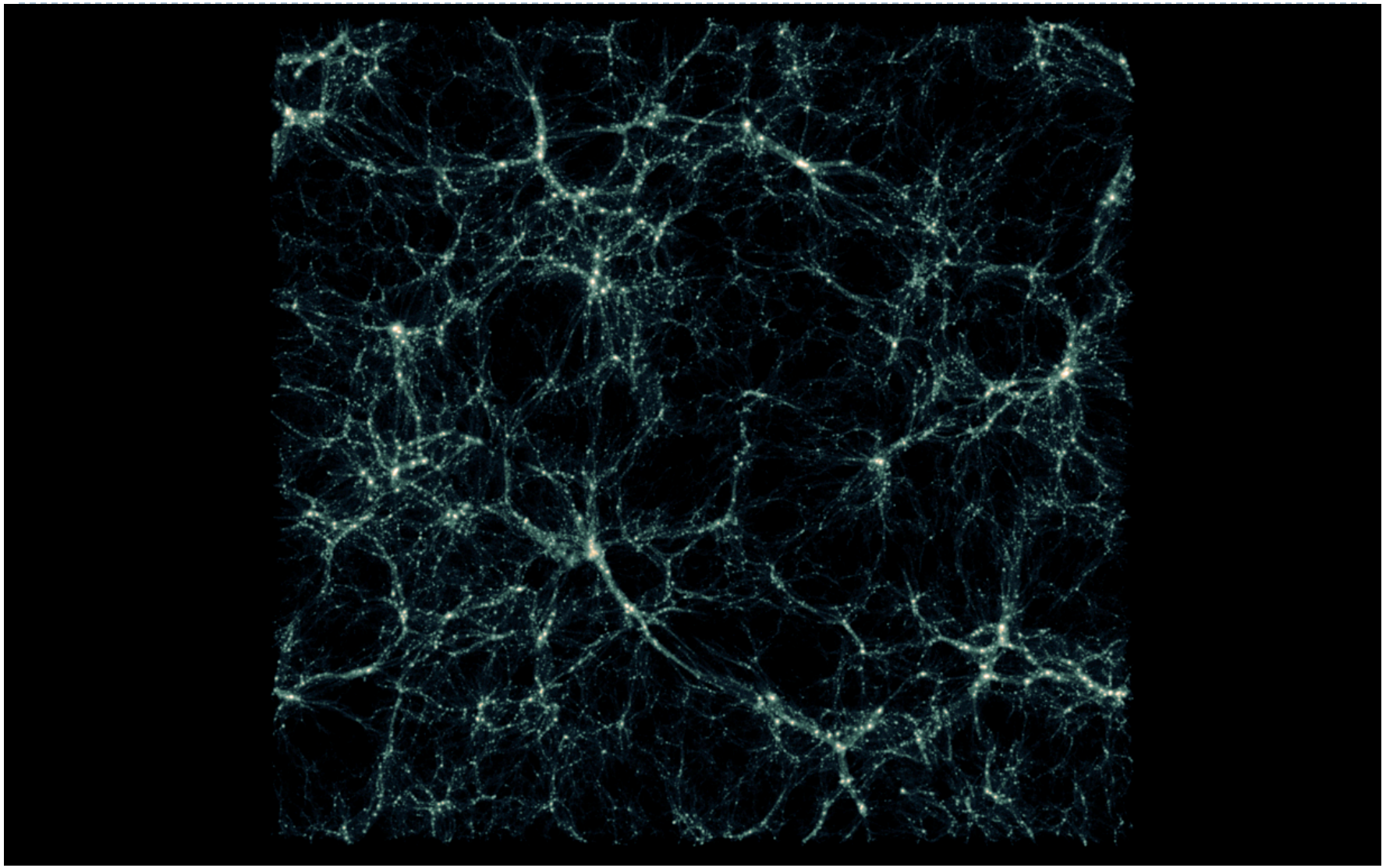
Sub-Halo Abundance Matching



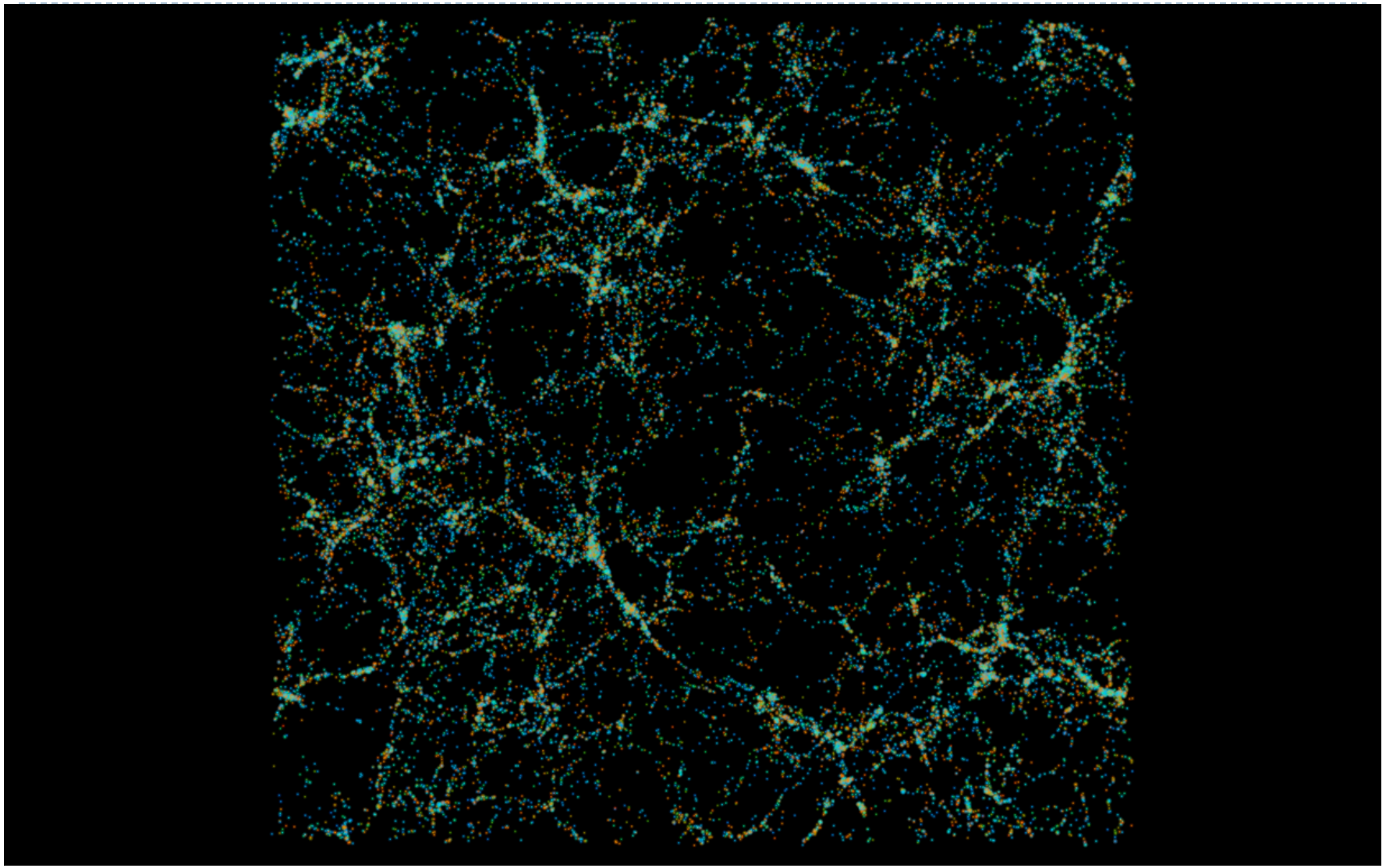
Model Requirements

- Requires an input stellar mass function
- What matching parameter – Vnow, Vpeak, Macc…
- Scatter in stellar mass
  - Log-normal in stellar mass at fixed halo "mass" (vpeak)
  - Width (scatter) assumed to be constant
- Galaxy disruption – μ_{cut}
  - Considers possibility that galaxy is disrupted before subhalo
  - Satellites considered disrupted when Mnow < μ_{cut}* Mpeak

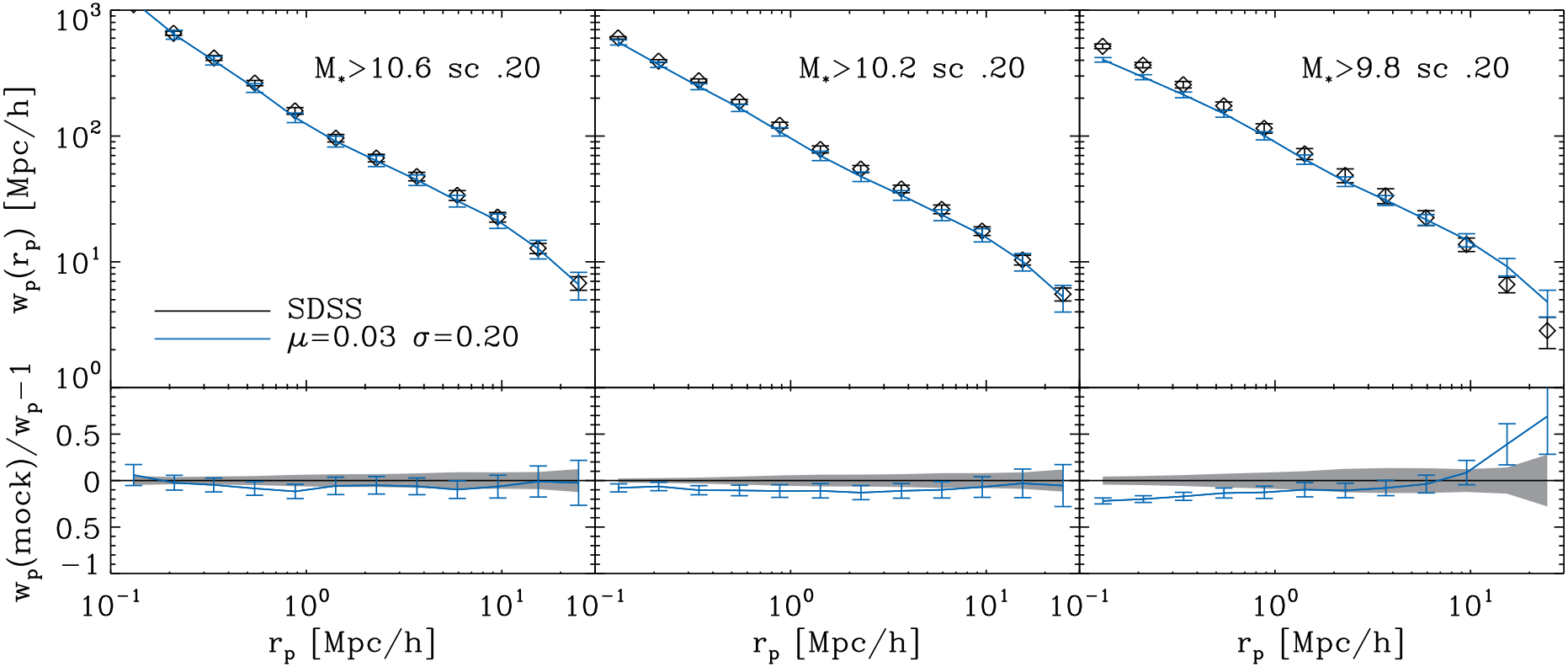
Bolshoi Simulation



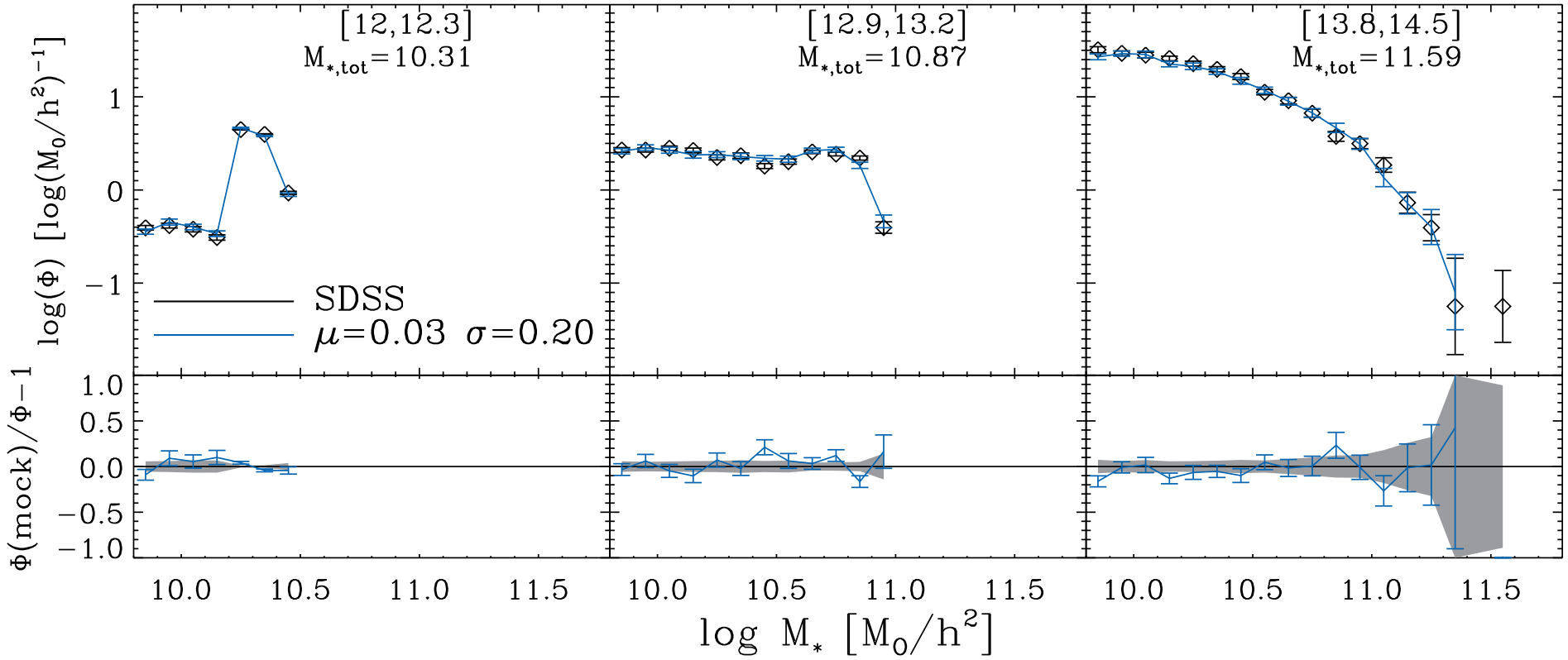
Subhalo Abundance Matching



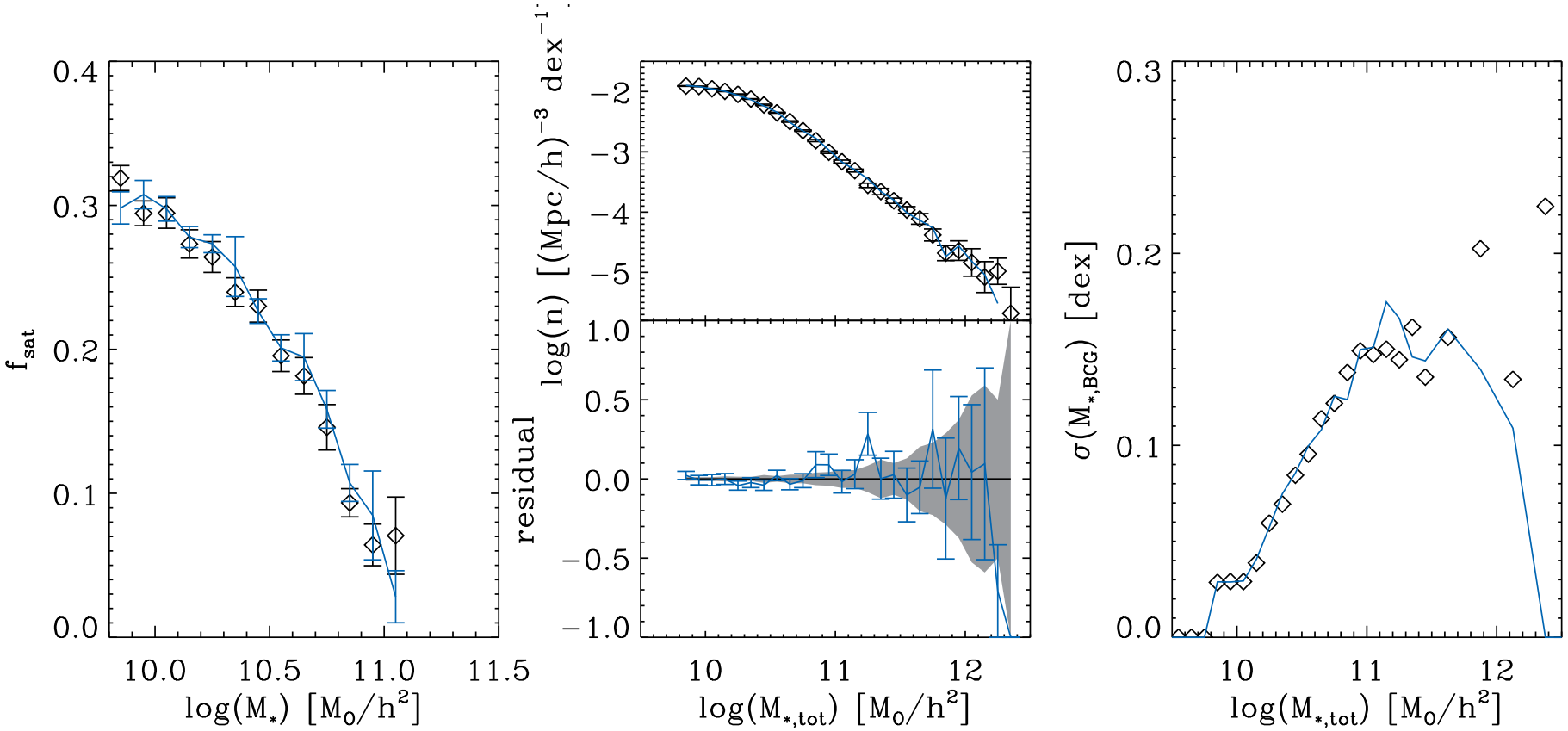
Results – Correlation Function



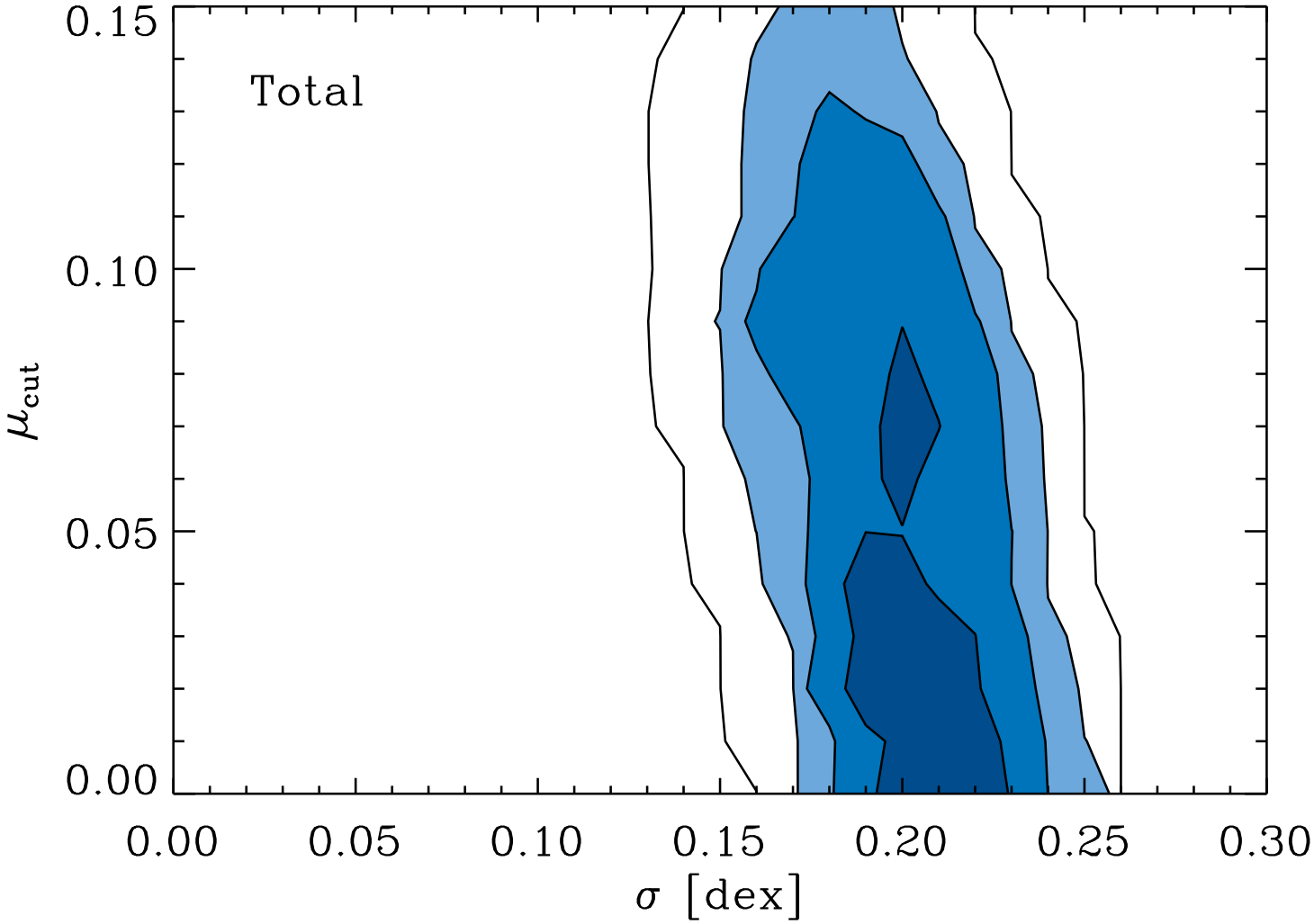
Results – CSMF



Results – satellite fraction



Constraints



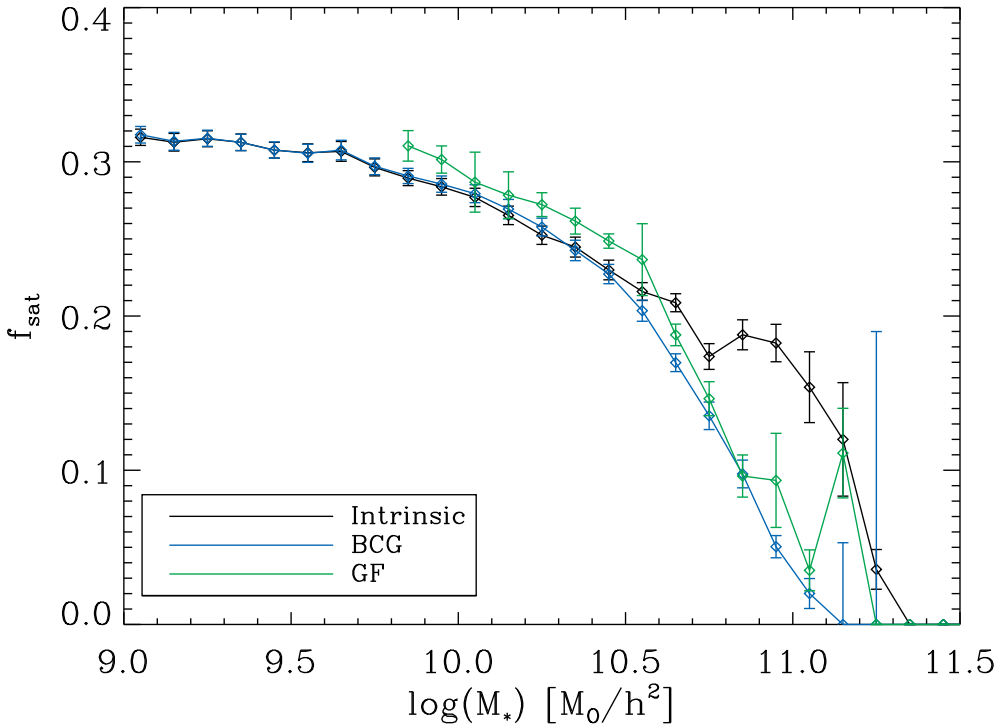
Conclusions

- Abundance matching is a simple (and accurate) model for log(M*)>10
  - Abundance matching assumptions are very good at producing galaxy populations using vpeak only
  - Depth of halo potential is primary driver of galaxy properties
  - Implies halos (but not galaxies!) are stripped significantly before infall at Rvir
  - Also implies moderate, but constant (~0.20 dex) scatter
- Useful for constraining (low-redshift) SAMs

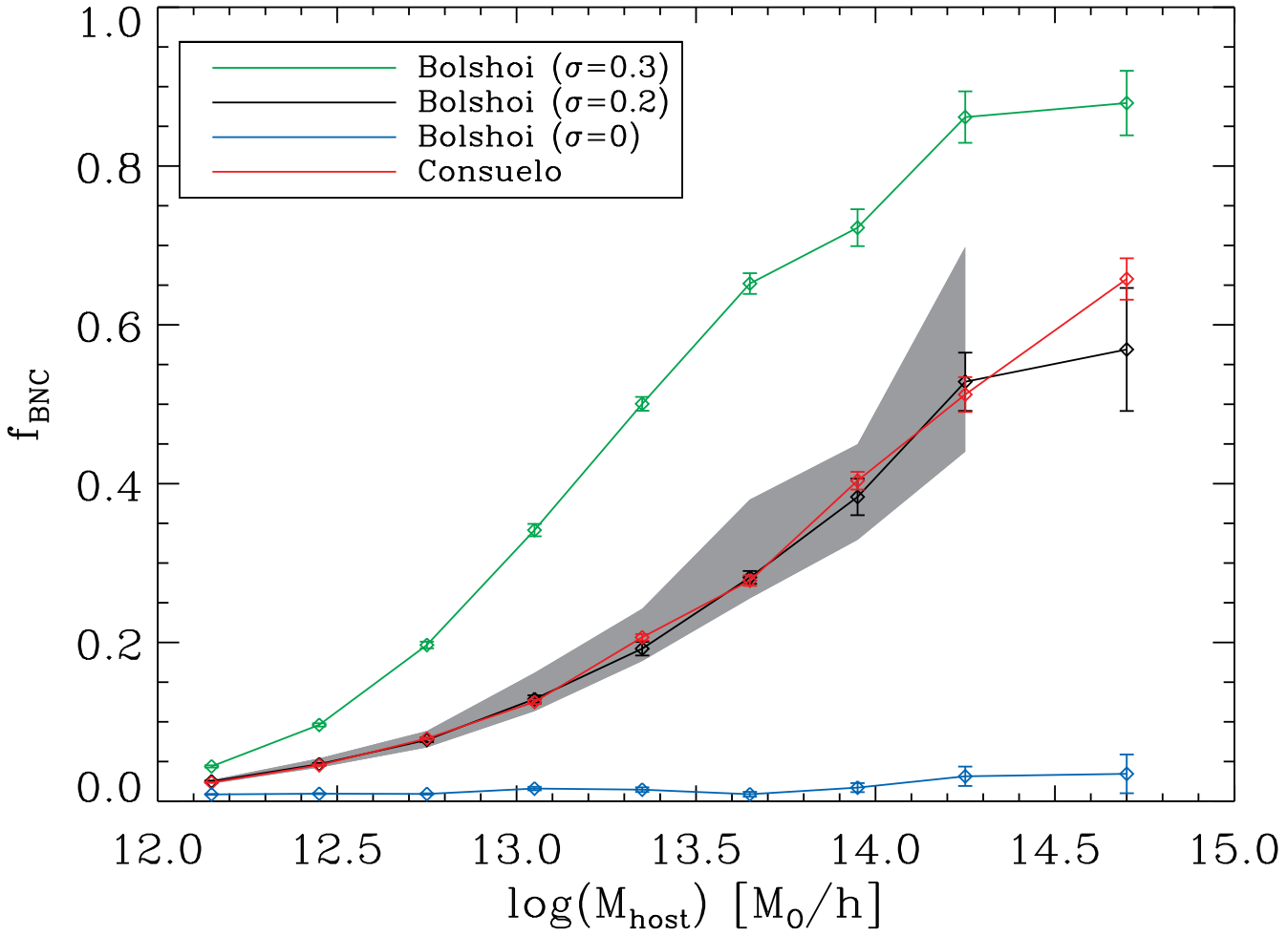
- See Reddick et al, arXiv:1207.2160 (ApJ submitted)

Group Finding

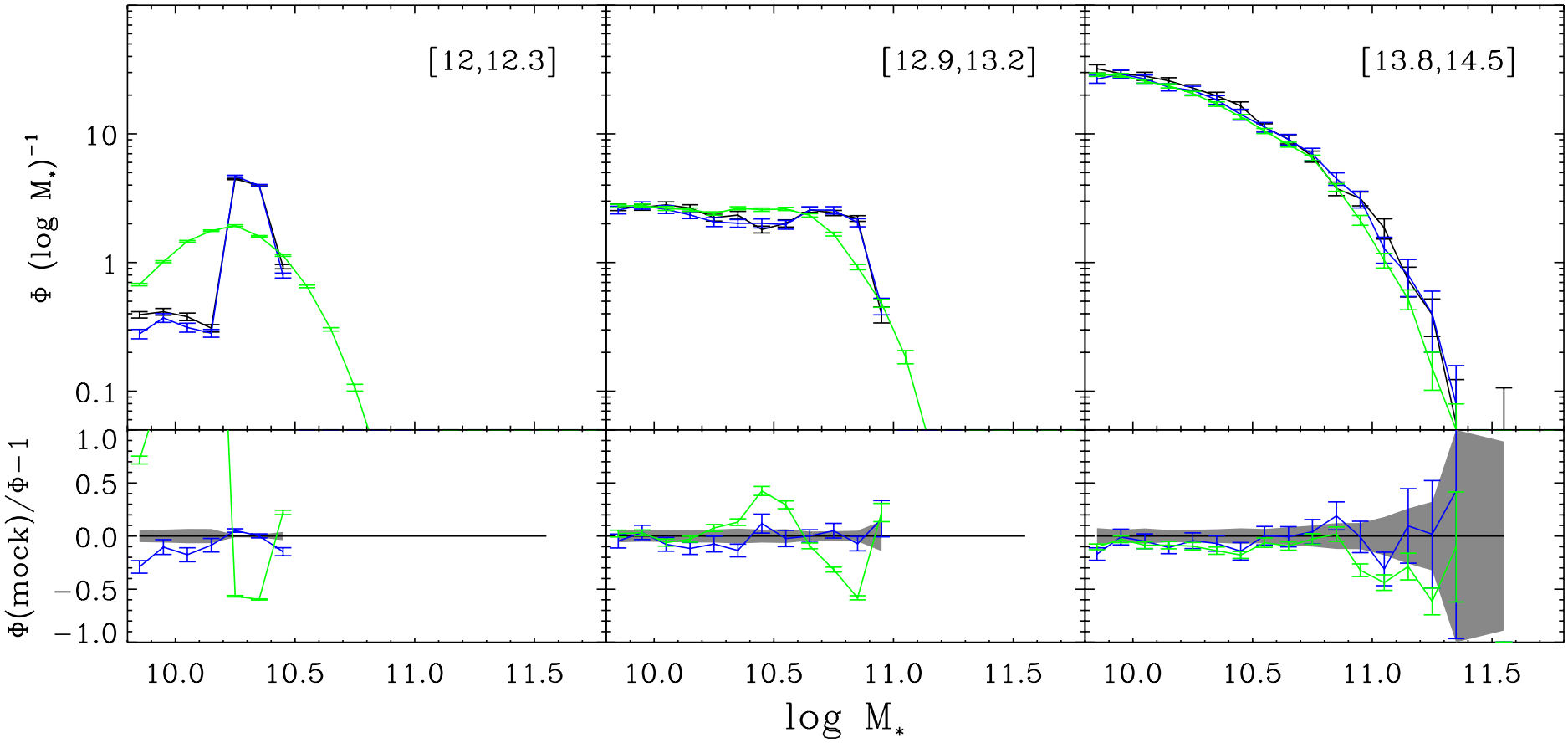
- Needed for measurement of group statistics (e.g., CSMF)
- Assigns halo mass based on total stellar mass of group
- Most massive galaxy => central



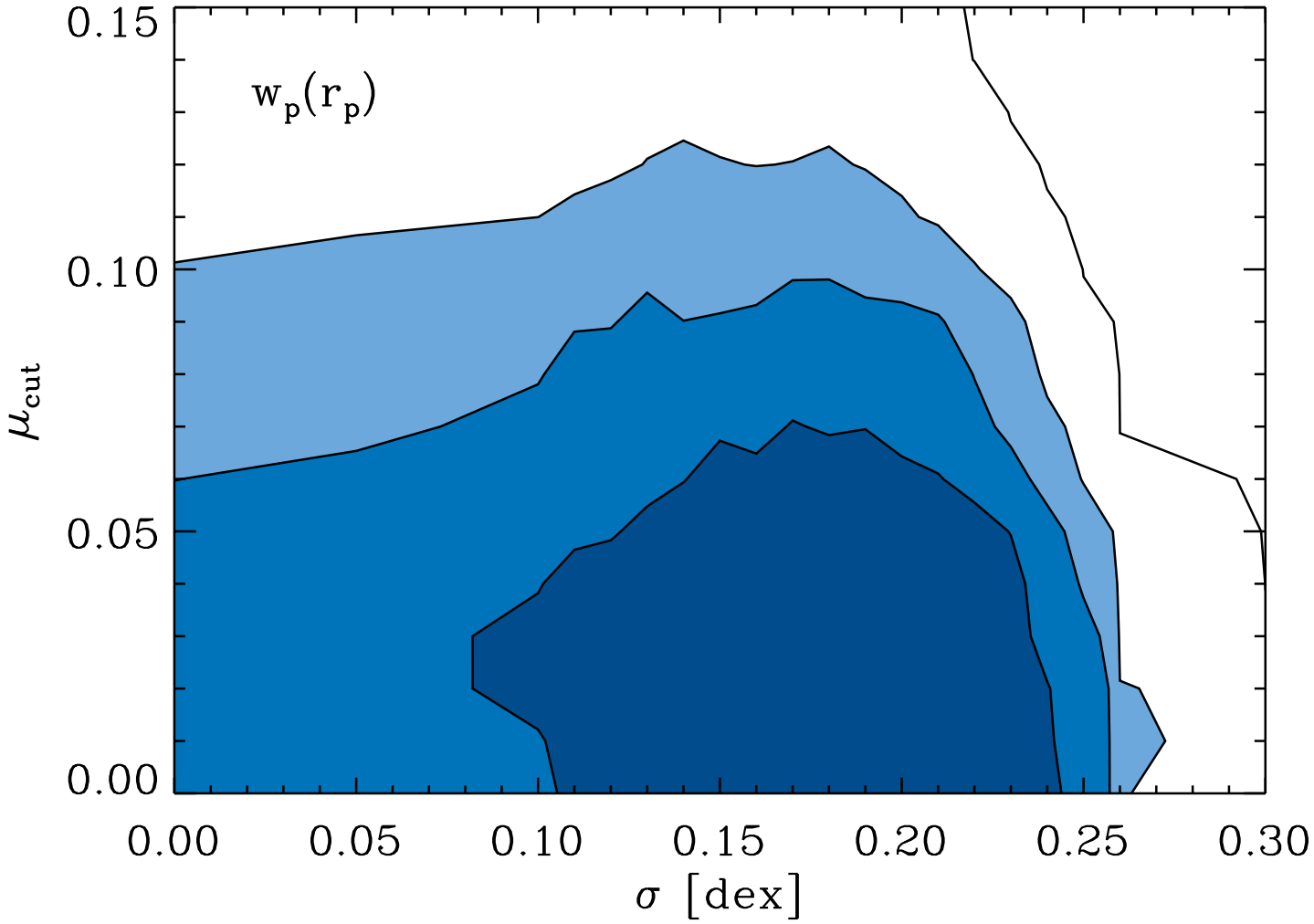
Brightest != Central Fraction



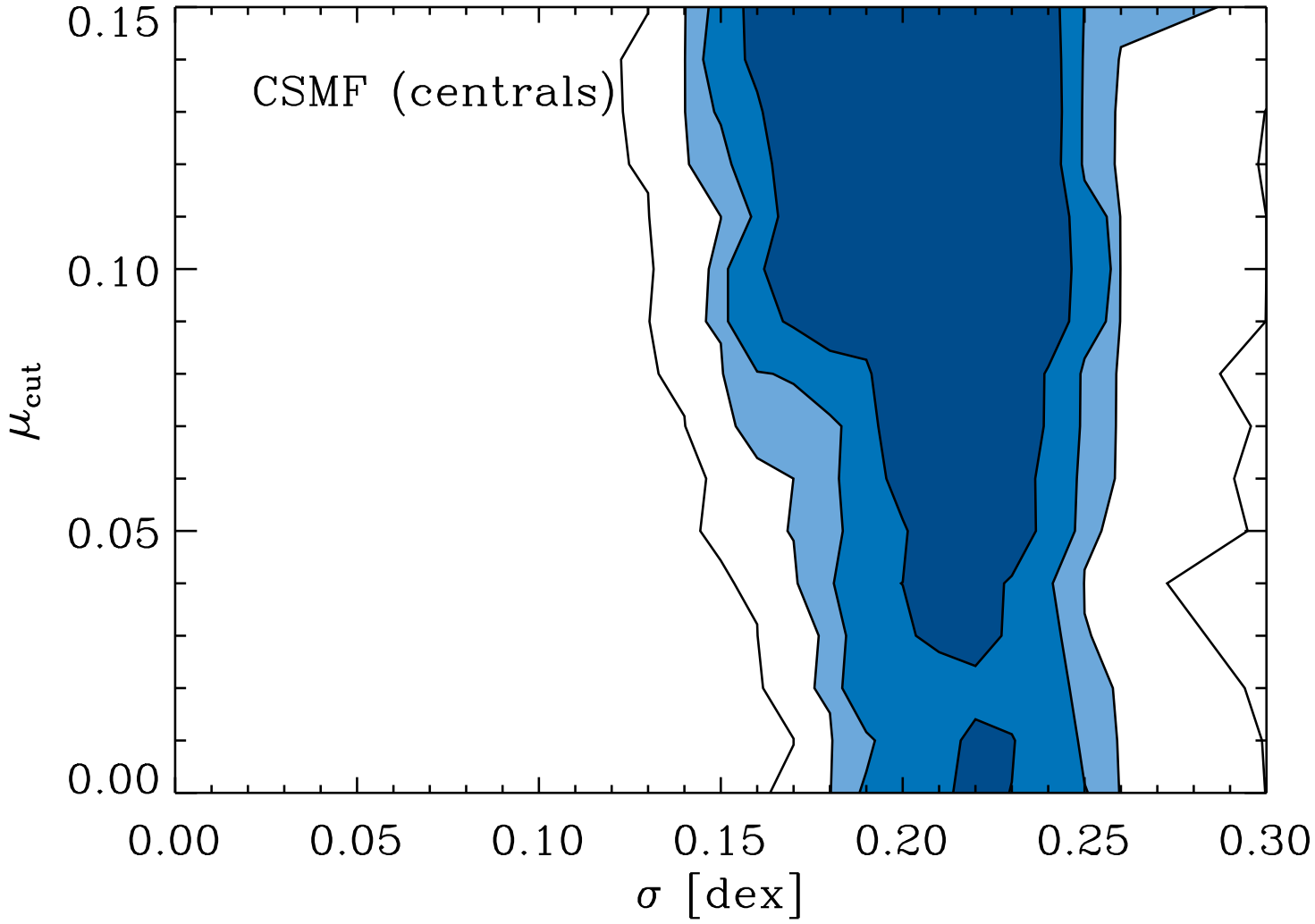
Group Finding – CSMF



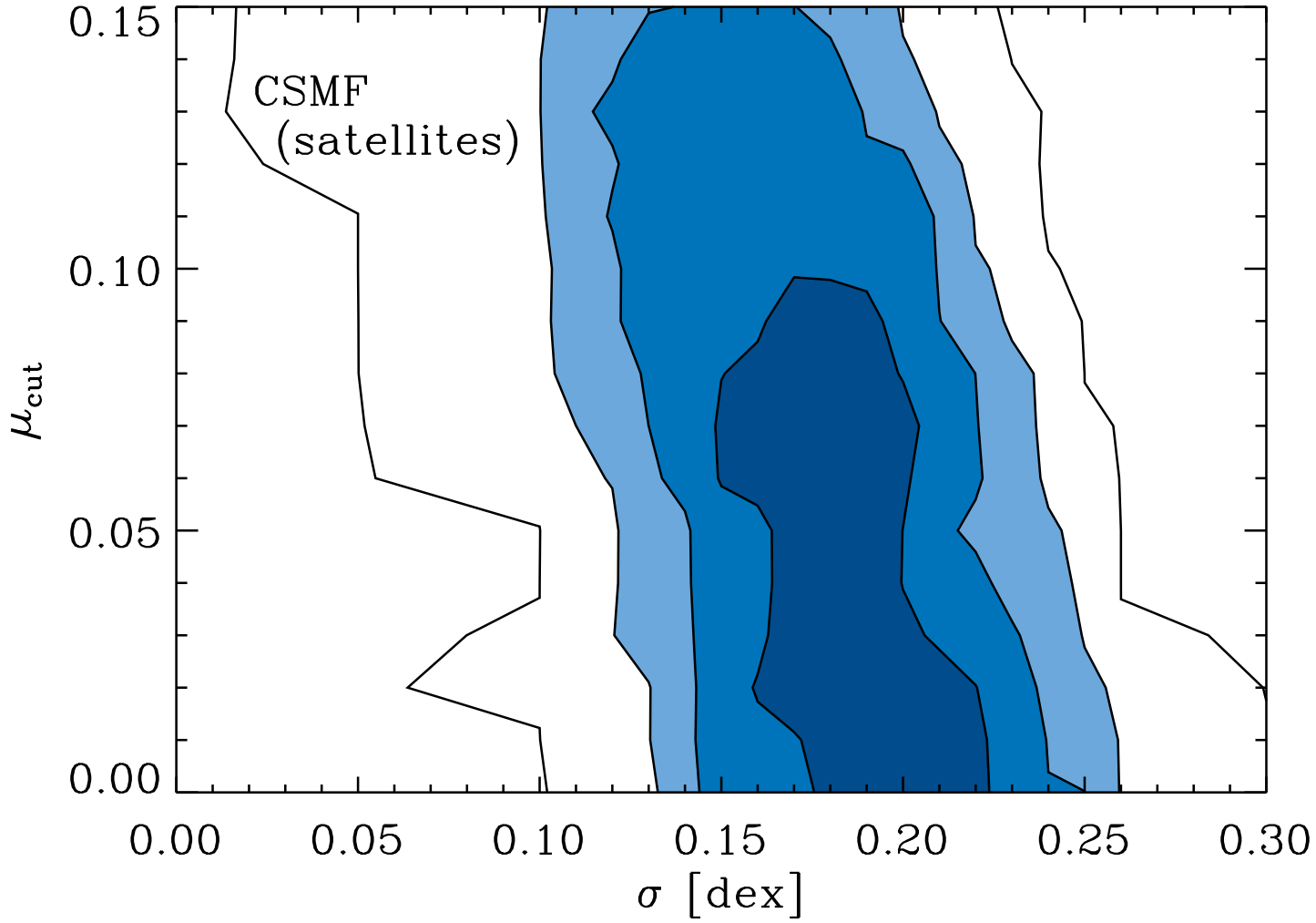
Constraints - vpeak



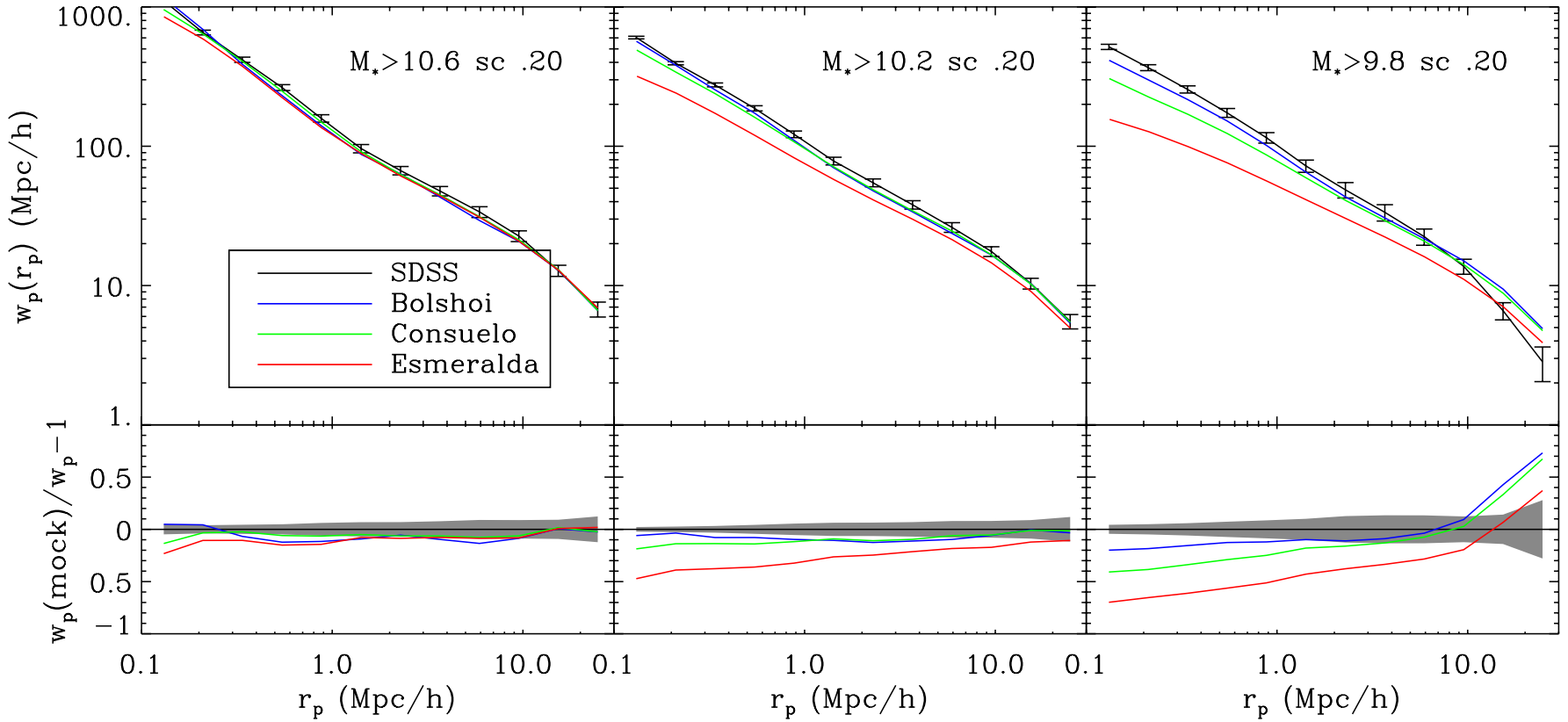
Constraints - vpeak



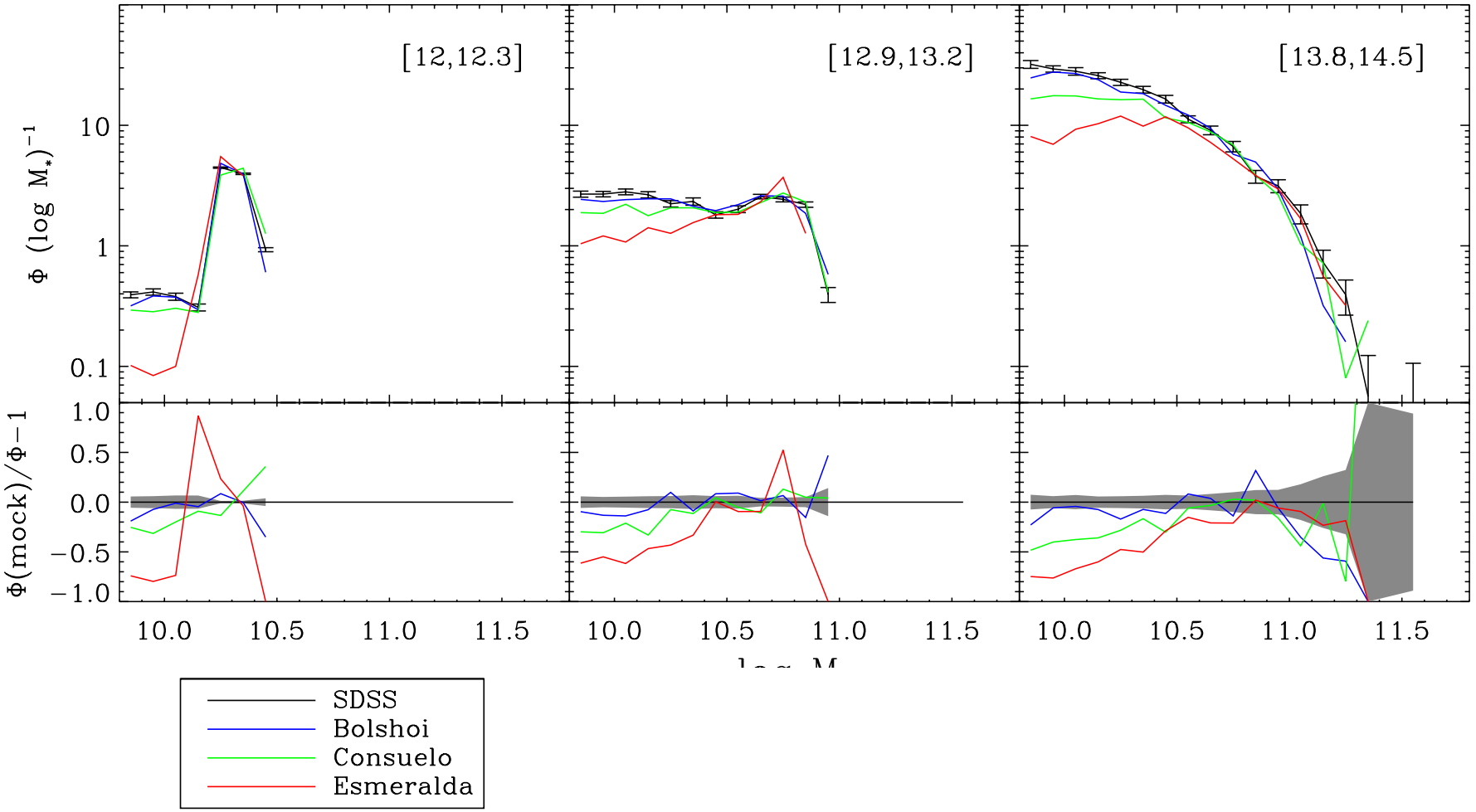
Constraints - vpeak



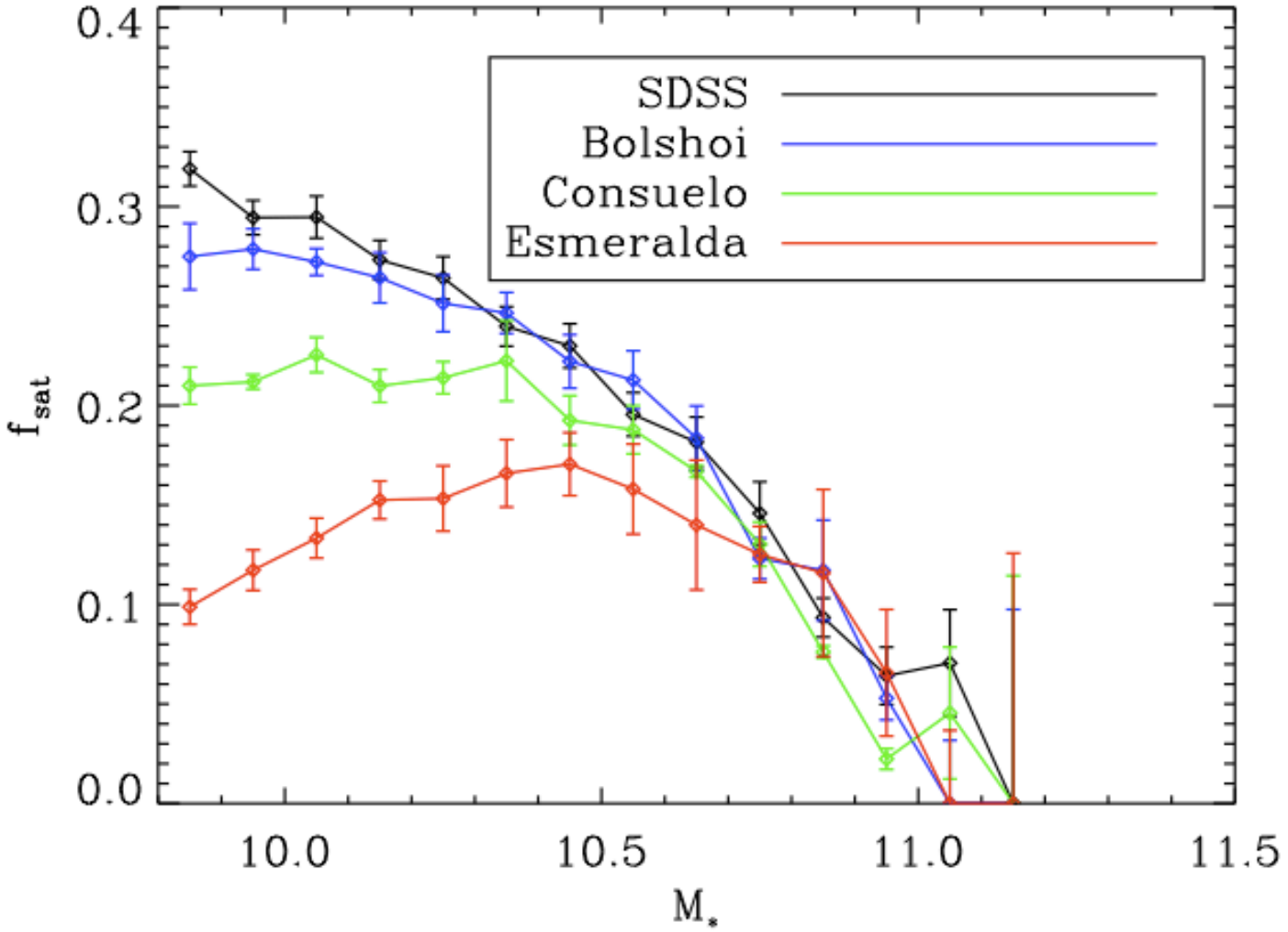
Resolution


M*>10.6 sc .20
M*>10.2 sc .20
M*>9.8 sc .20
SDSS
Bolshoi
Consuelo
Esmeralda
wp(rp) (Mpc/h)
wp(mock)/wp − 1
rp (Mpc/h)
1000.
100.
10.
1.
0.5
0
0.5
−1
0.1
1.0
10.0

Resolution


[12,12.3]
[12.9,13.2]
[13.8,14.5]
Φ (log M*)^-1
Φ(mock)/Φ−1
10
1
0.1
1.0
0.5
0.0
−0.5
−1.0
10.0
10.5
11.0
11.5
SDSS
Bolshoi
Consuelo
Esmeralda

Resolution


SDSS
Bolshoi
Consuelo
Esmeralda
0.4
0.3
0.2
0.1
0.0
f_{sat}
10.0
10.5
11.0
11.5
M_*