The satellite distribution around bright isolated galaxies

Simon White
Max Planck Institute for Astrophysics

Wang & White 2012 MNRAS **424**, 2574
Wang, Sales, Henriques & White 2014 MNRAS, submitted

A Sample of Isolated Galaxies

SDSS/DR7 spectroscopic catalogue:

Extinction-corrected Petrosian magnitude: $r < 16.6$

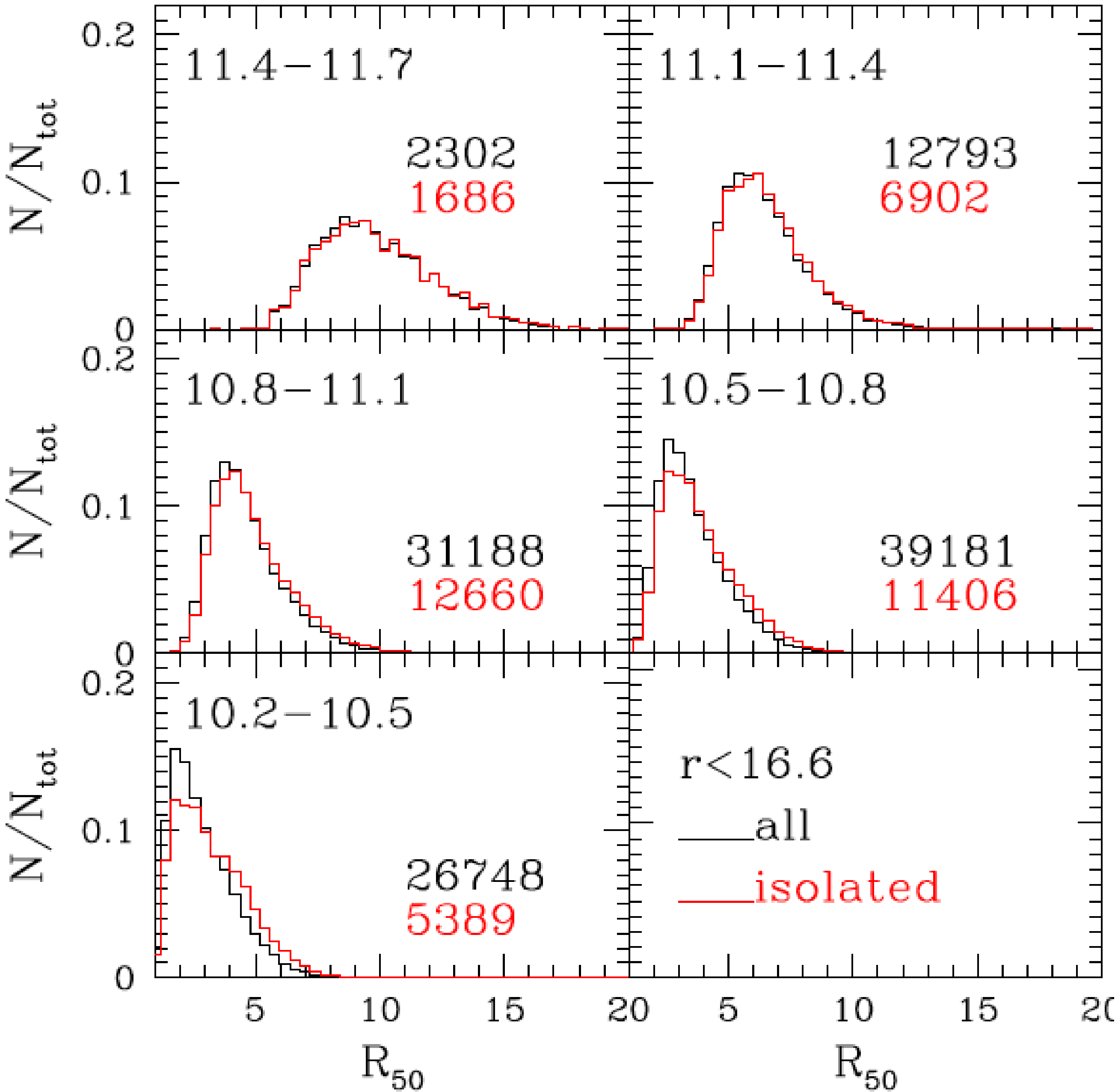
>80% of surrounding area within 1.0 Mpc in SDSS footprint

No brighter galaxy within $\Delta r = 1.0$ Mpc, $\Delta v = 1{,}000$ km/s

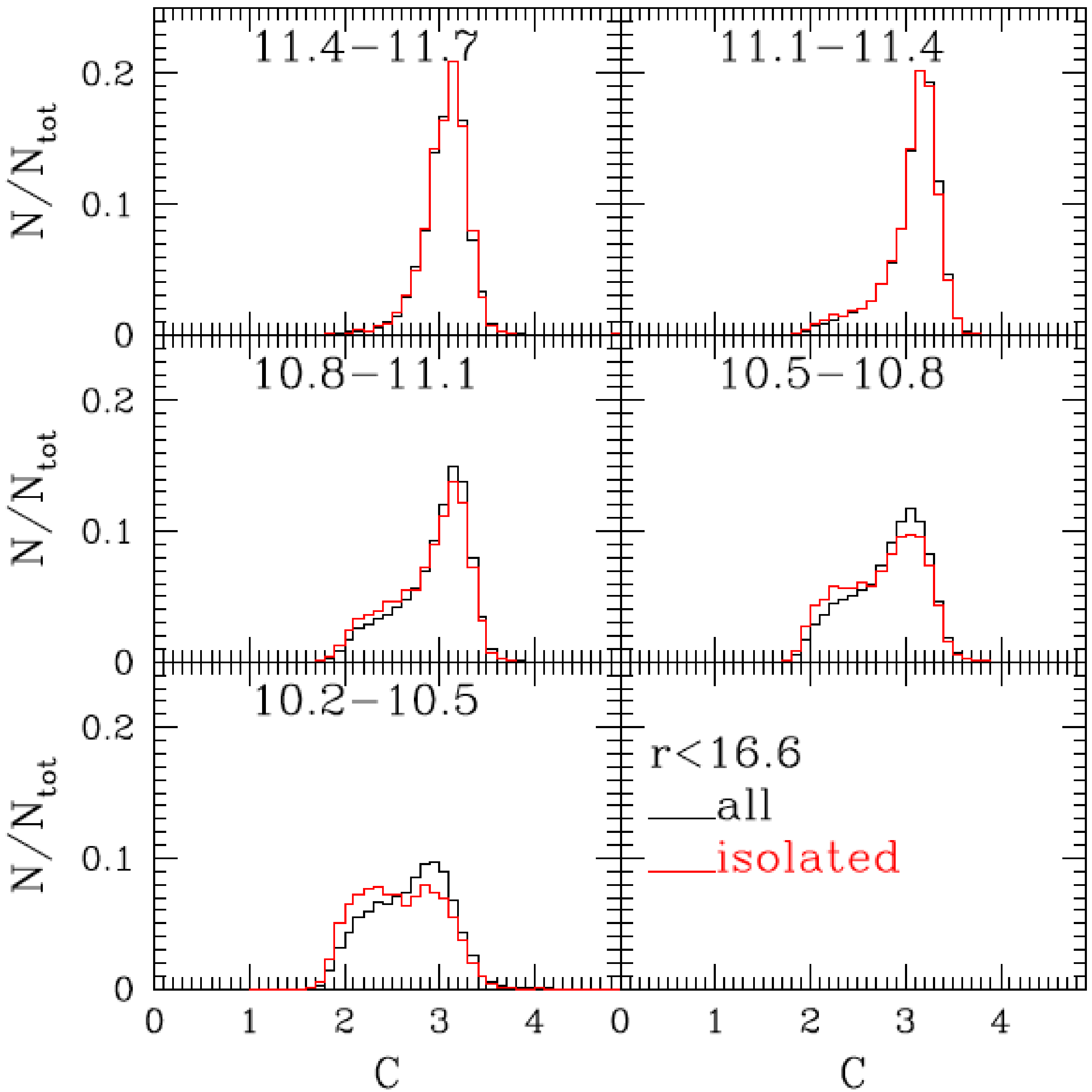
No galaxy brighter than $r + 1$ within $\Delta r = 0.5$ Mpc, $\Delta v = 1{,}000$ km/s

(photometric catalogue checked for objects missed in spectroscopy)

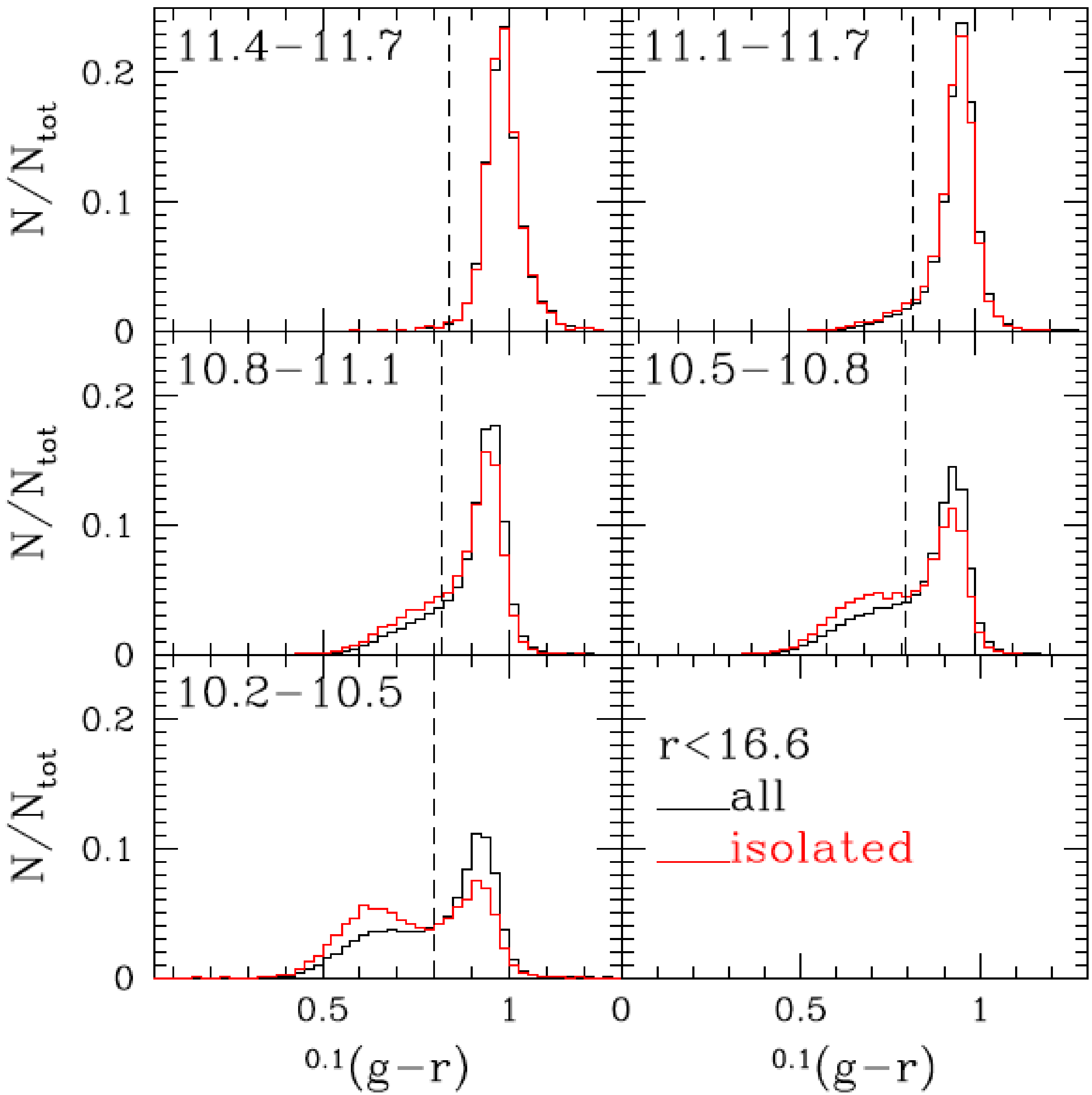
A Sample of Isolated Galaxies



A Sample of Isolated Galaxies

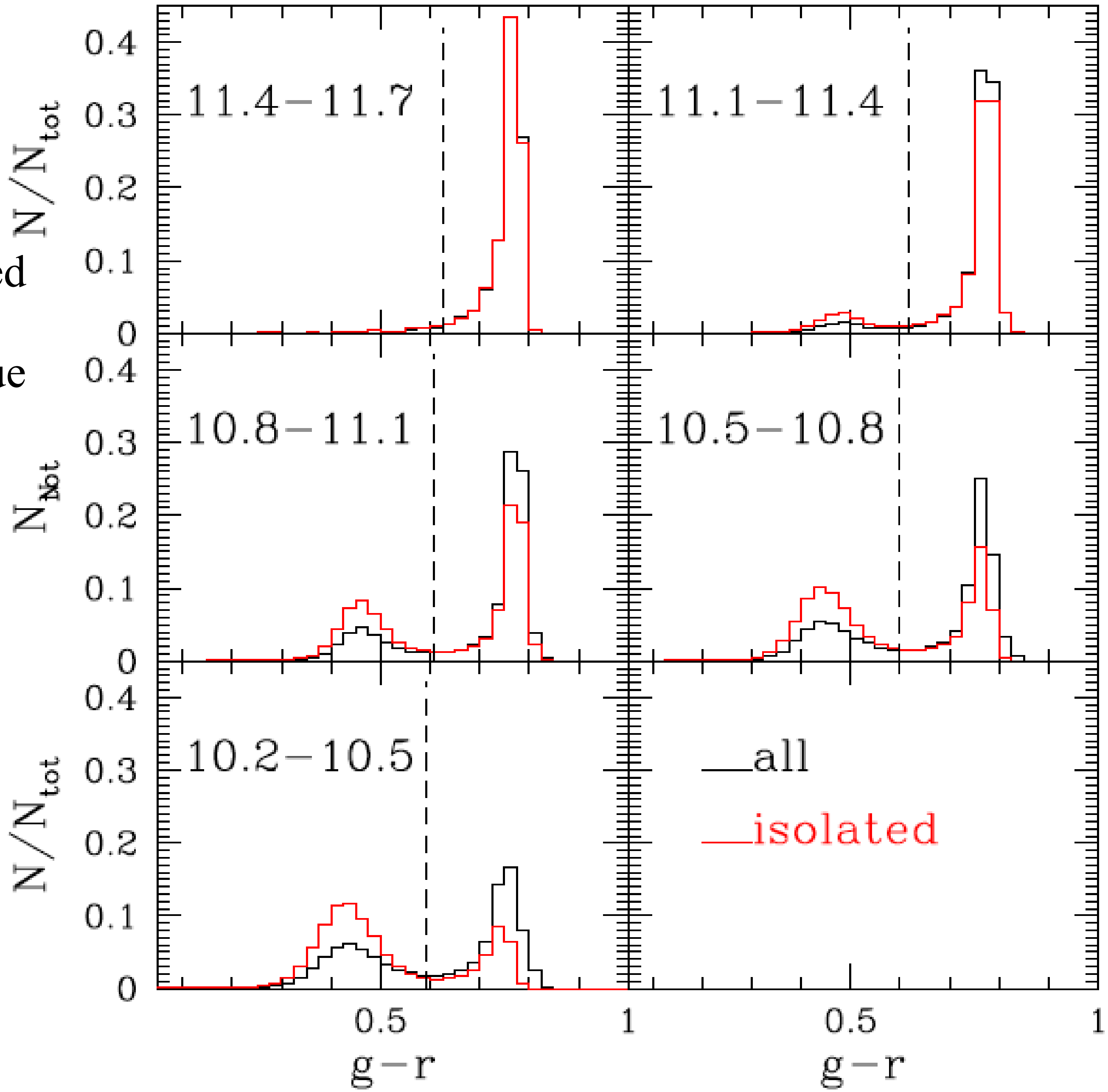


A Sample of Isolated Galaxies



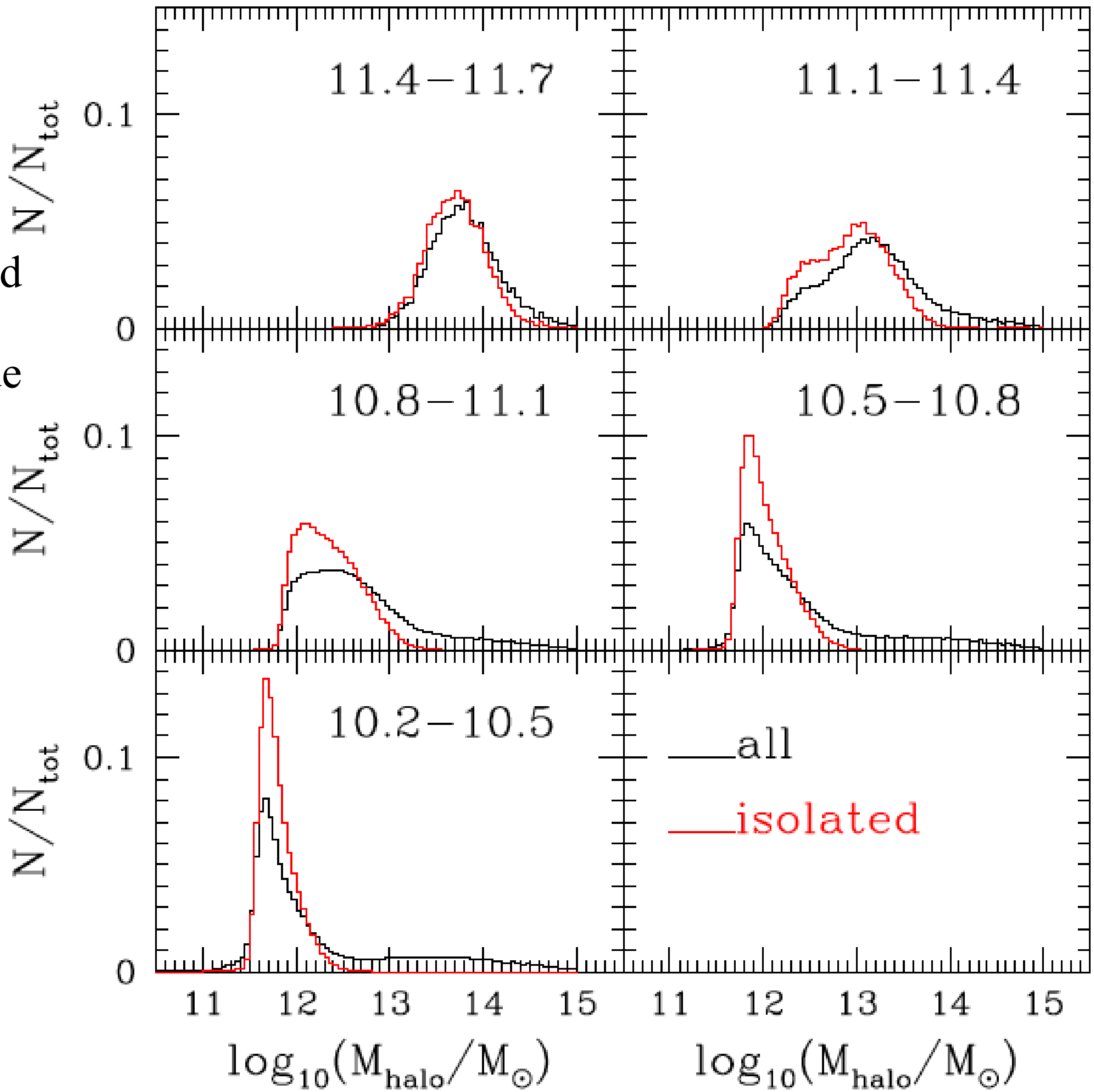
A Sample of Isolated Galaxies

Similarly selected sample from a "mock" catalogue based on Guo et al (2011)



A Sample of Isolated Galaxies

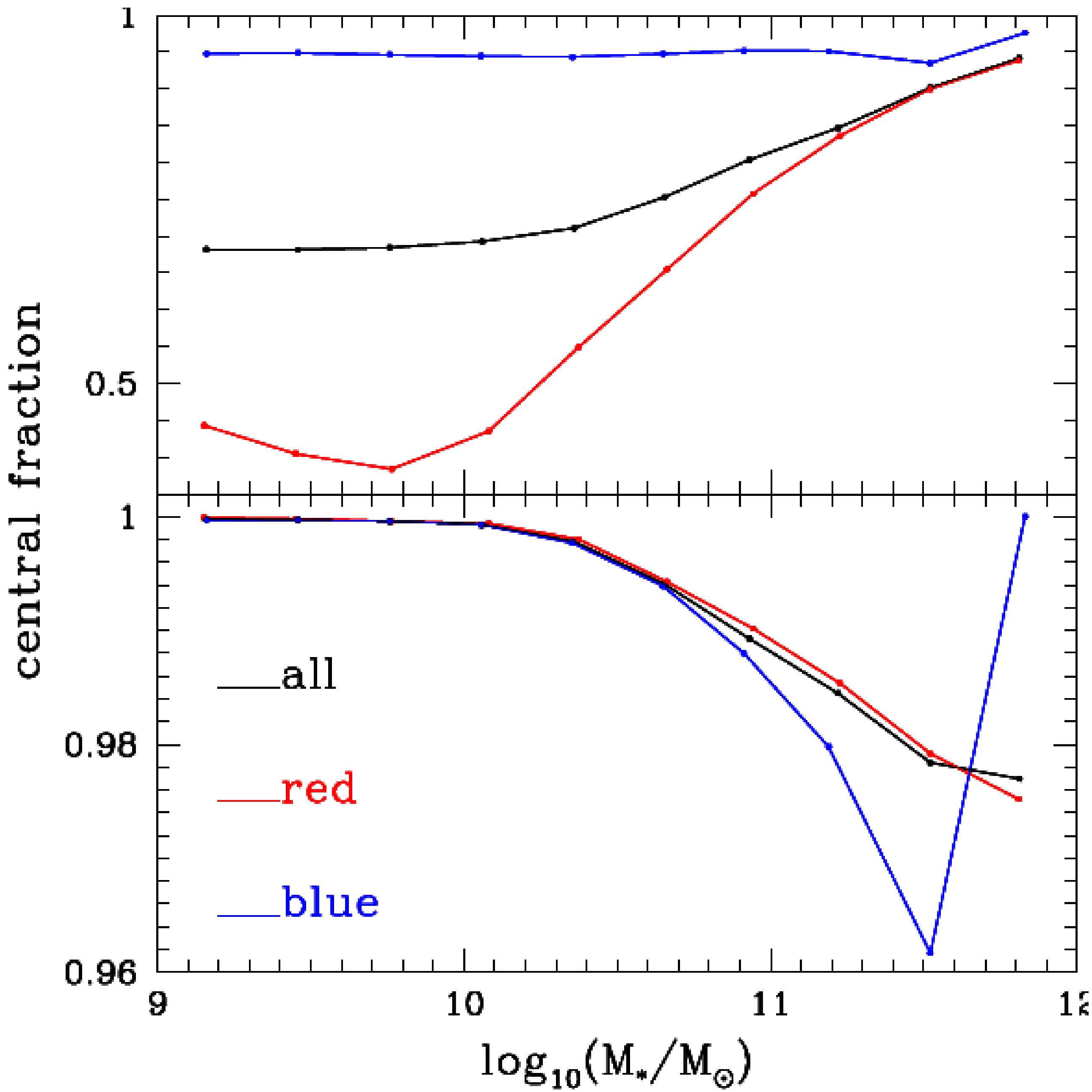
Similarly selected sample from a "mock" catalogue based on Guo et al (2011)



A Sample of Isolated Galaxies

Similarly selected sample from a "mock" catalogue based on Guo et al (2011)

"Satellite" here means non-central galaxy of FoF group **and** within R_{200}



Selecting satellite galaxies

SDSS/DR8 photometric catalogue:

Extinction-corrected model magnitudes: $r < 21.0$

Around each primary:

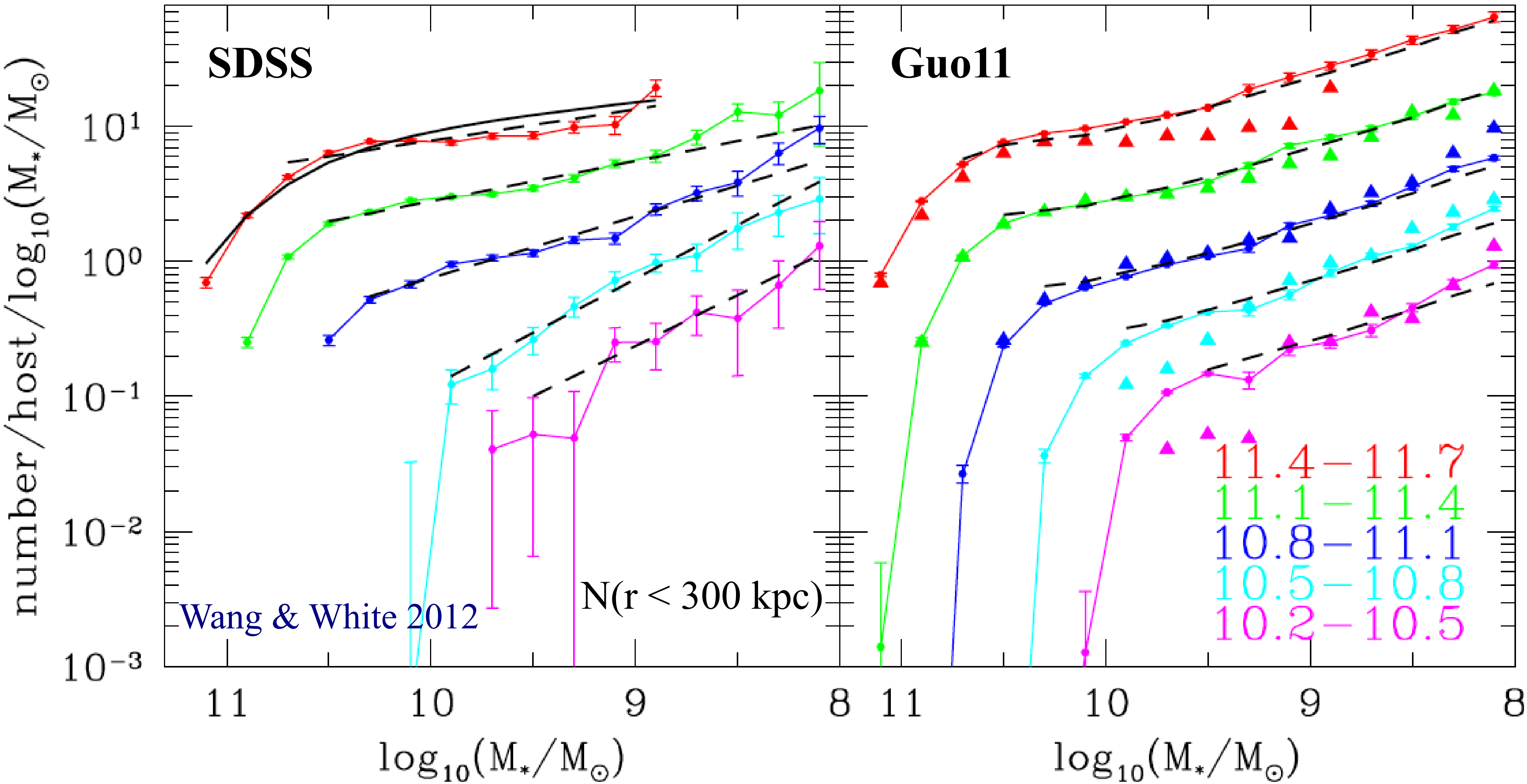
Count photometric companions in bins of log r, r and $g - r$

Background-correct using $n(r,\ g - r)$ for the survey as a whole

Use primary z to convert properties to M_* and rest-frame $(g - r)_o$

Average over all primaries in each primary stellar mass range

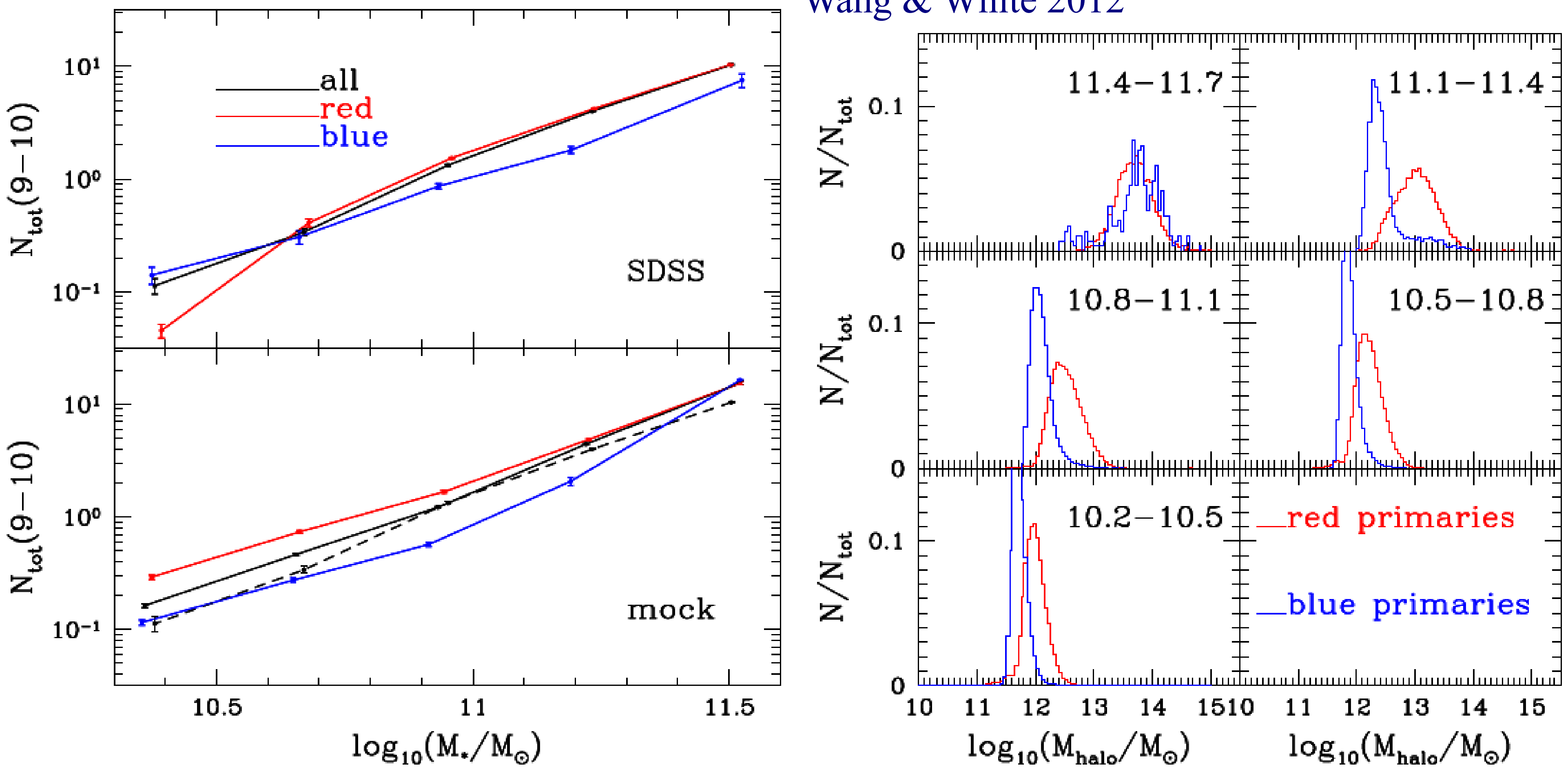
Satellite stellar mass functions



Agreement between SDSS and simulation is quite good
SDSS mass functions get flatter with increasing primary mass
This trend is not present in Guo11 – all functions parallel the field

Red primaries have more satellites

Wang & White 2012

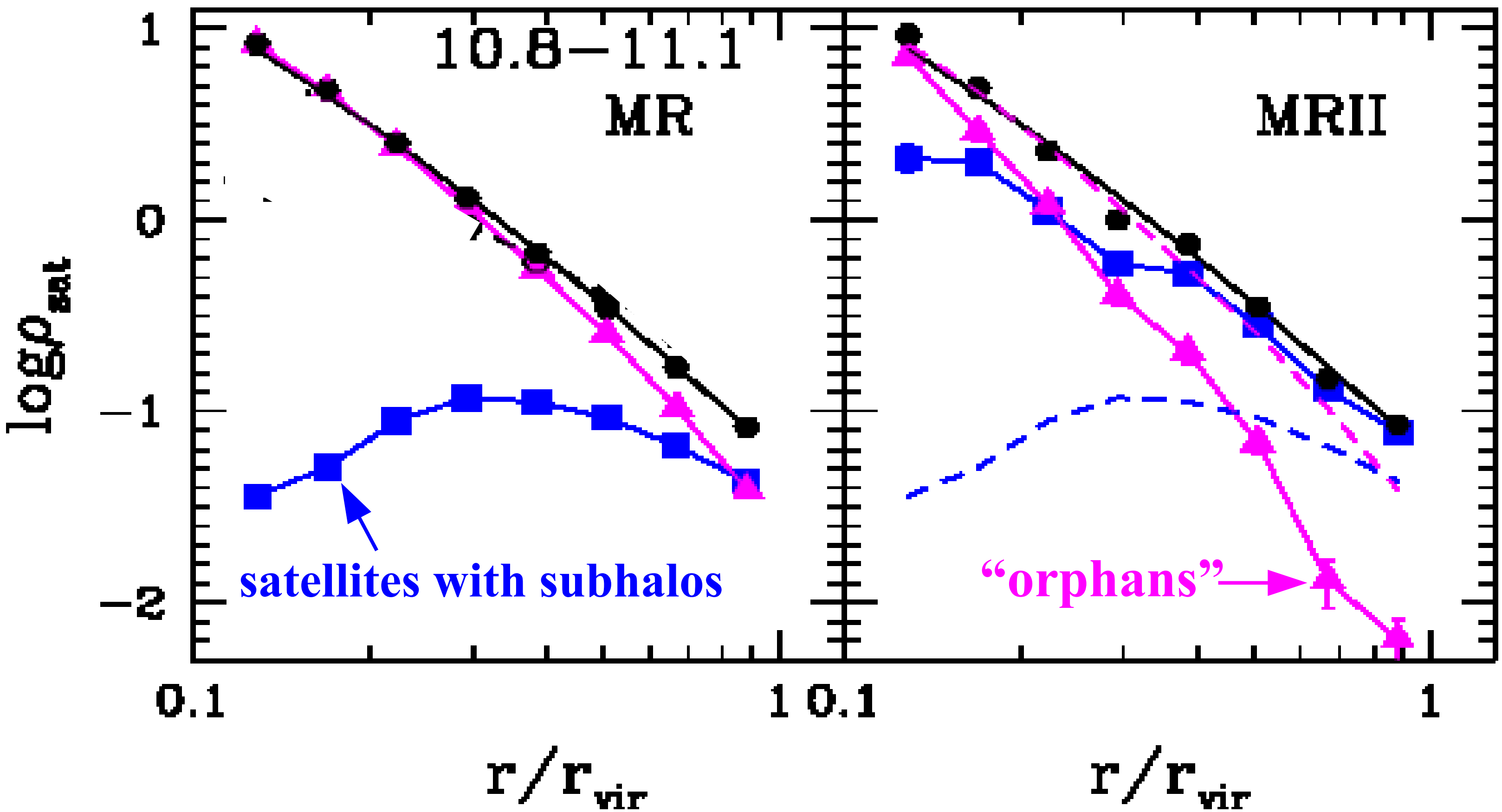


In the simulation, red primaries have more massive halos

This reflects the truncation of star formation in the central galaxy

Satellite galaxy distributions in simulations

Wang et al 2014



Radial distribution of satellites with $\log M_* / M_\odot > 9.0$ around isolated primaries with $\log \langle M_* \rangle / M_\odot \sim 10.95$

Black line is an NFW profile with concentration equal to that of the mean DM profile and is identical in the two panels

Characteristic radii for measuring profiles

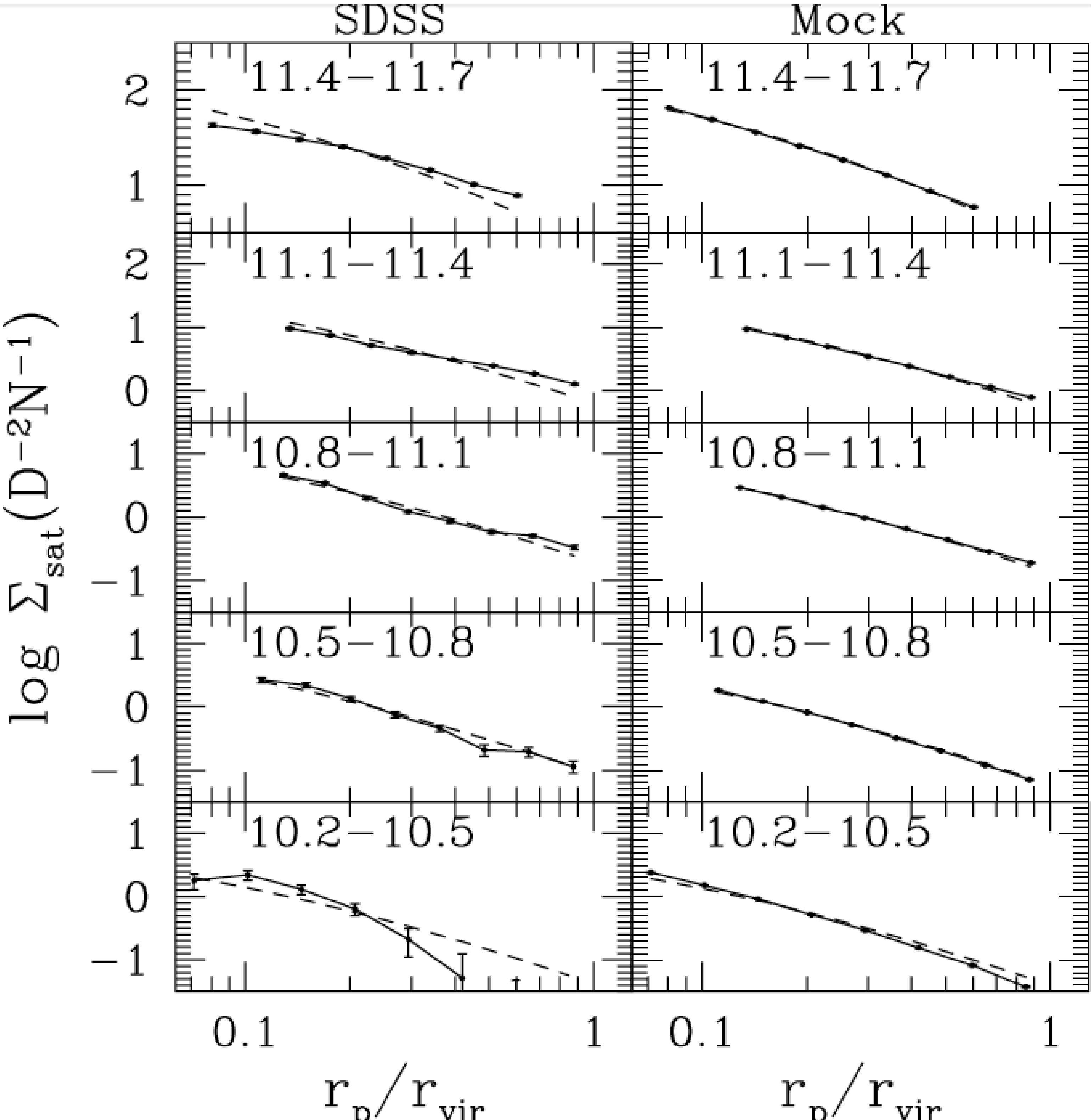
Wang et al 2014

$\log M_*/M_\odot$	11.4-11.7	11.1-11.4	10.8-11.1	10.5-10.8	10.2-10.5
$r_{\rm vir}$ [kpc]	725	430	270	210	170
r_s [kpc]	156.6	74.4	39.3	27.1	21.0
$r_{\rm inner}$ [kpc]	50	50	30	20	10
$(g-r)_{\rm SDSS}$	0.840	0.830	0.820	0.811	0.801
$(g-r)_{\rm mock}$	0.627	0.618	0.609	0.600	0.591
$N_{\rm SDSS}$ [red, blue]	1651, 35	6170, 731	8518, 4142	5453, 5953	1625,3764

Halo virial and scale radii are based on the mean values in Guo11

Inner radii chosen to avoid photometric problems with the primary image

Colour cuts at minima of the “troughs” in SDSS and Guo11 histograms



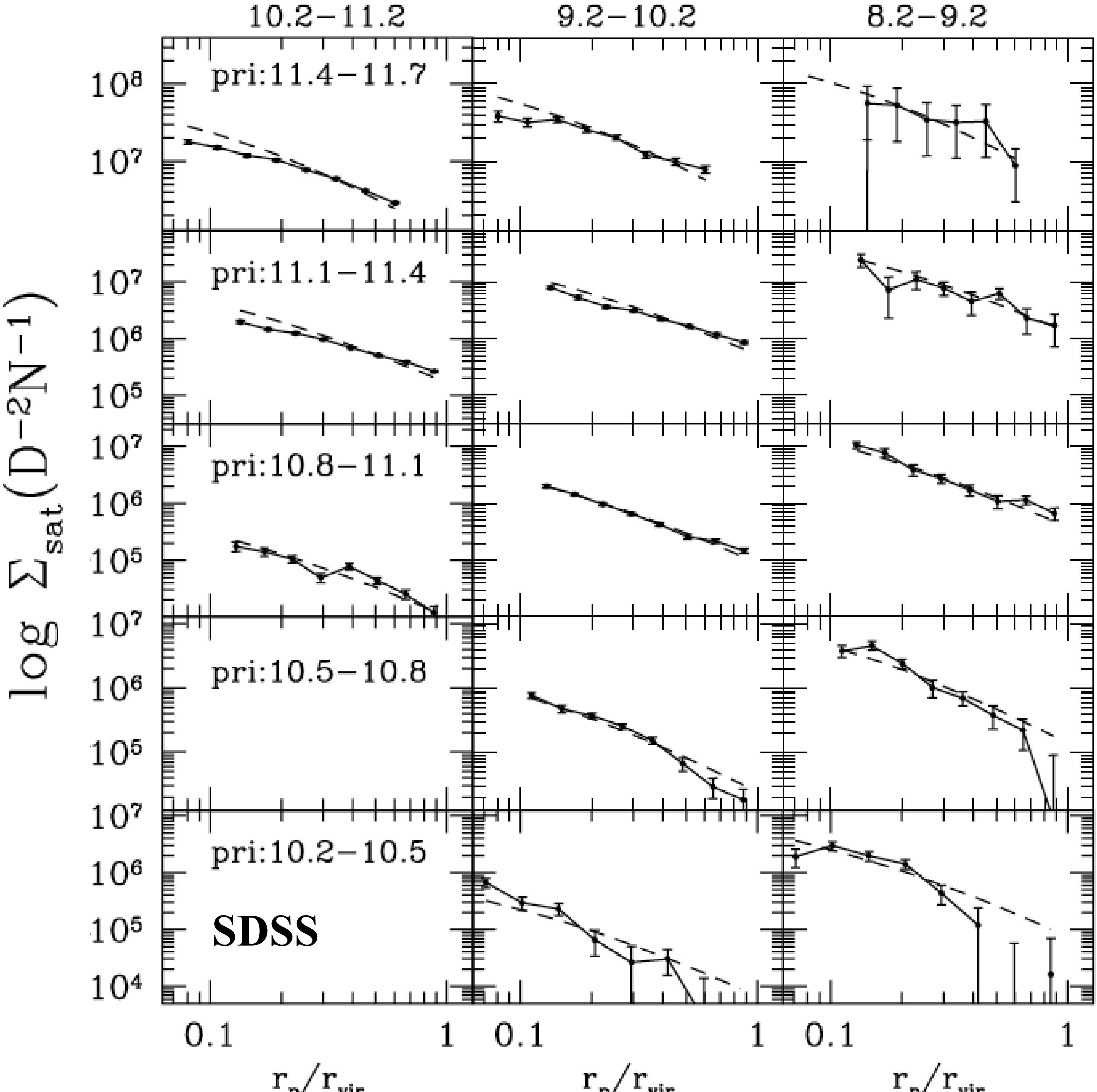
Wang et al 2014

In Guo11 the mean projected satellite profiles follow the mean projected mass profiles accurately

In SDSS, the satellite profiles follow the prediction at MW mass and below but are shallower at high primary masses

At 0.3 of the virial radius there is good agreement in the overall abundance

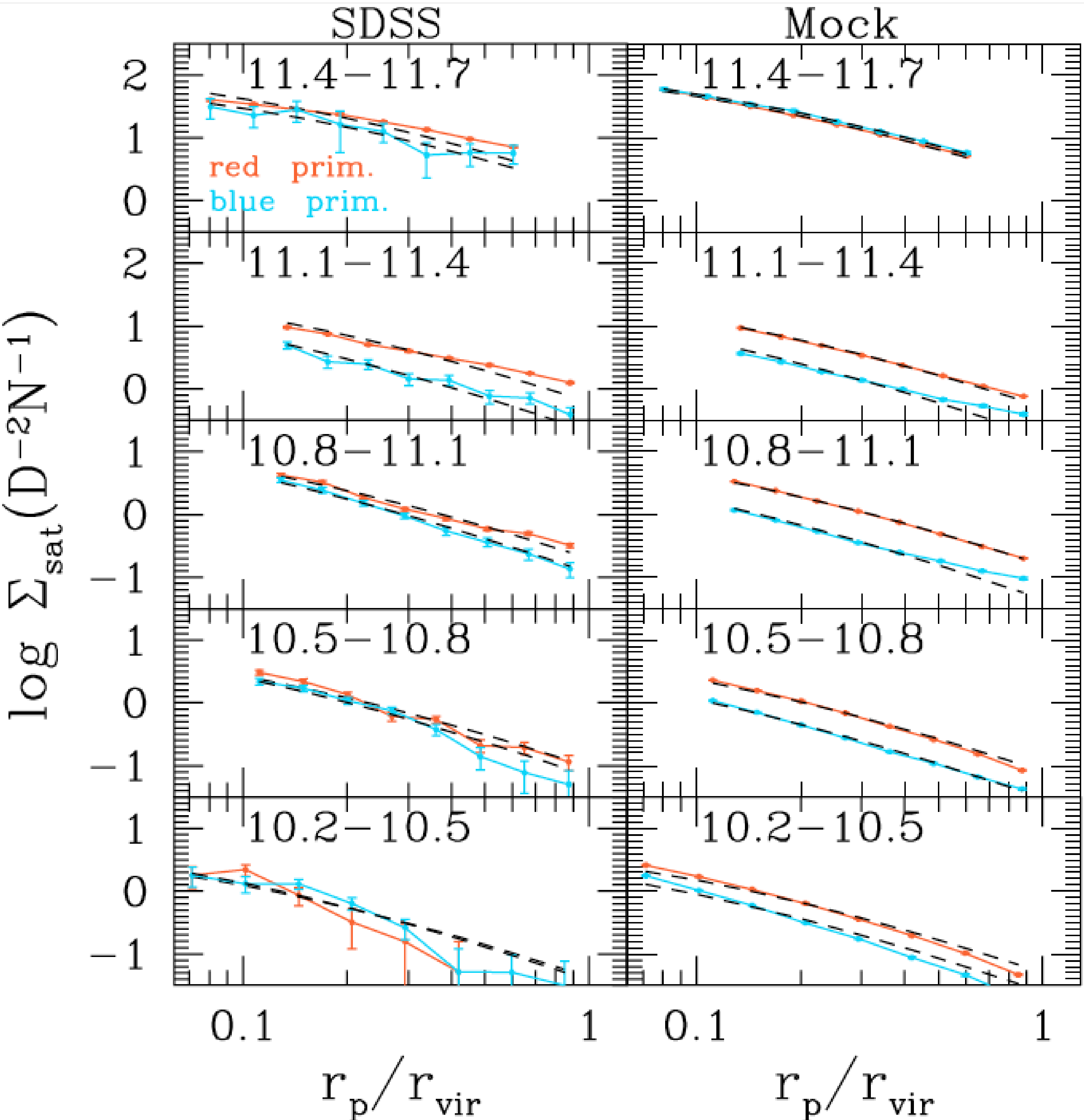
Wang et al 2014



In SDSS the shape of satellite profiles does not depend on satellite mass

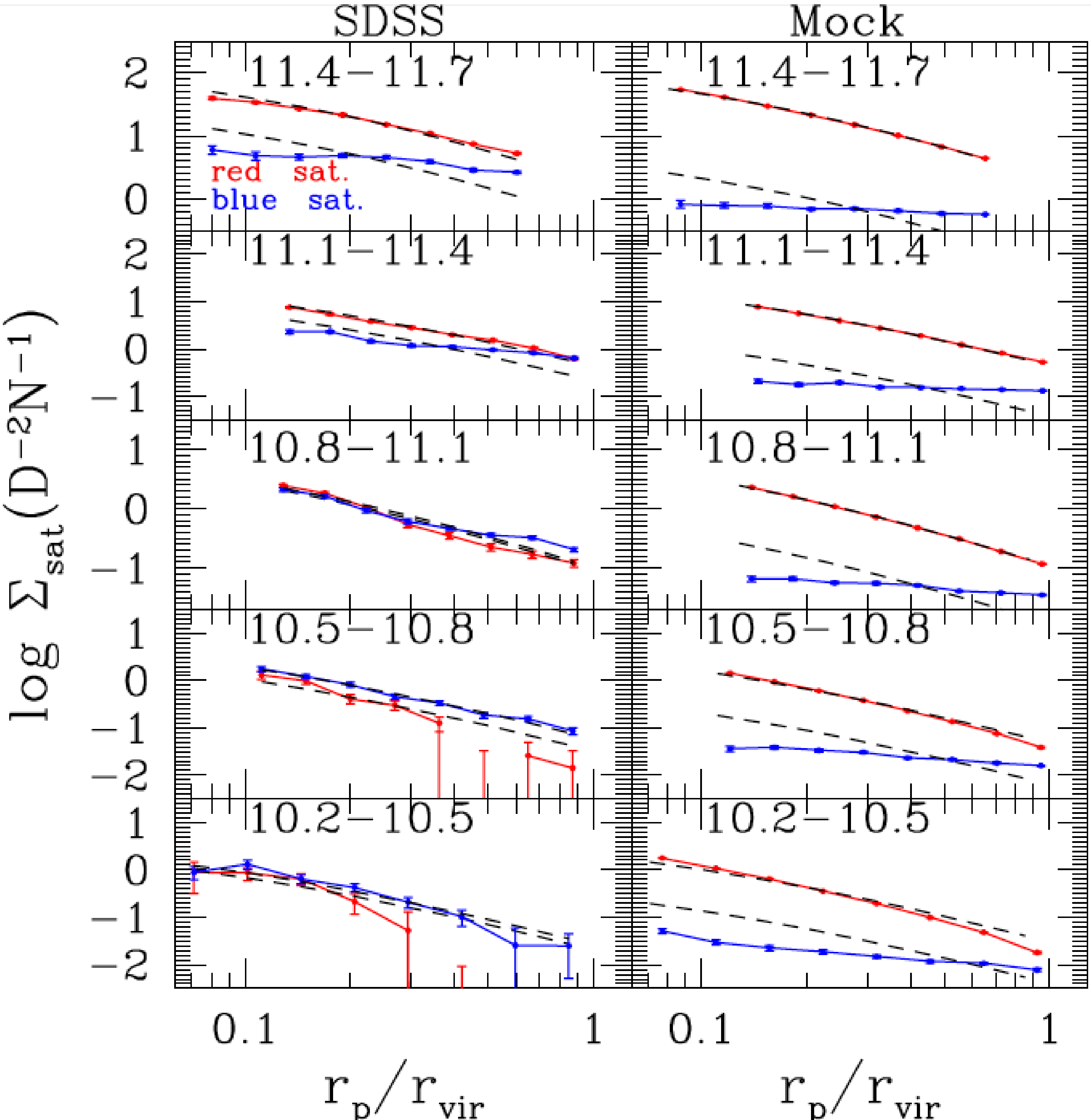
This is true also in Guo11

Wang et al 2014



The profile shapes are similar around red and blue primaries. It is the normalizations which differ.

In SDSS the effect is seen only above MW mass, whereas in Guo11 it is seen at all but the highest masses



Wang et al 2014

In SDSS

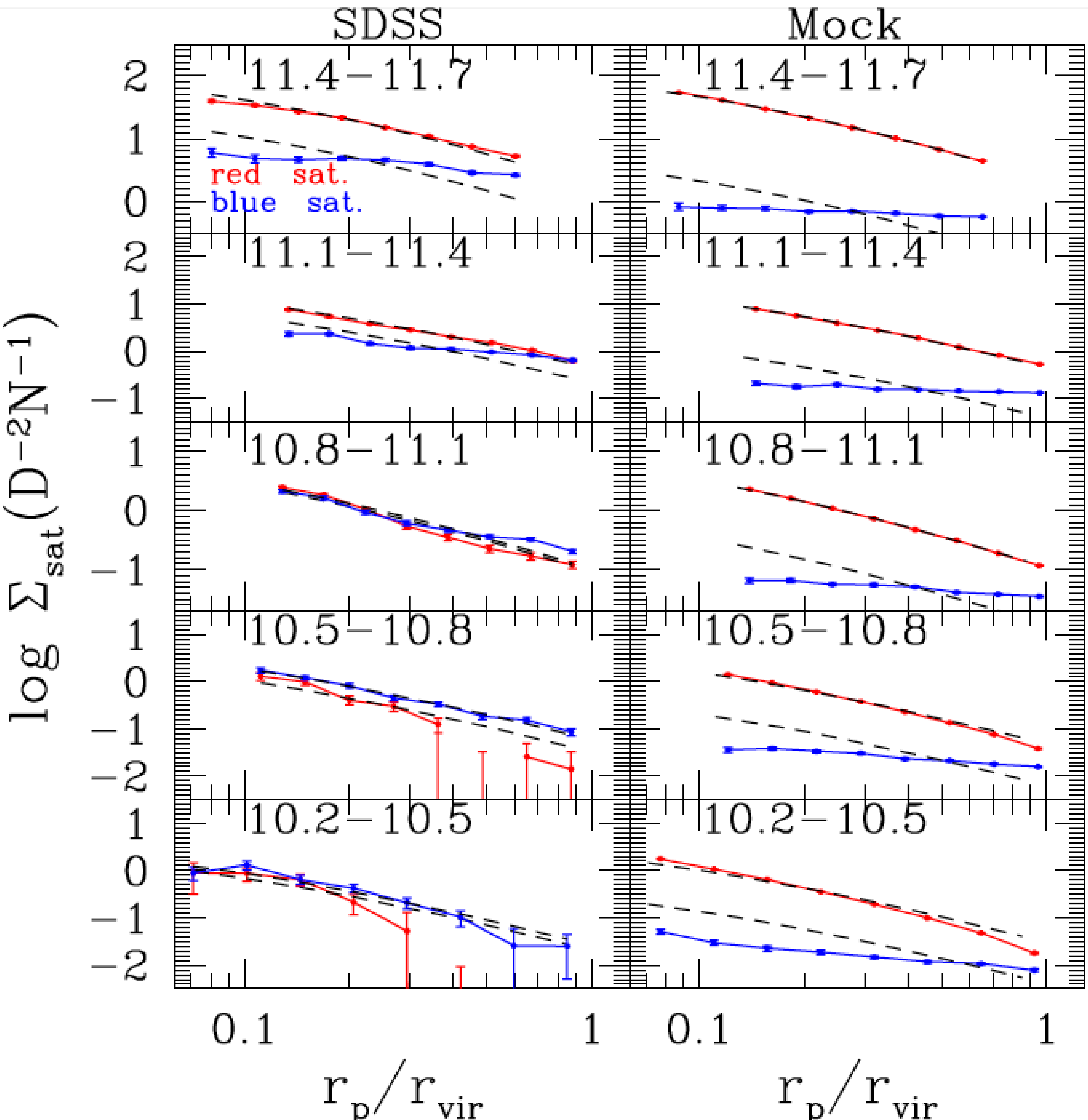
Above MW mass:

- Red satellites dominate at all but the largest radii
- The red satellite profile parallels DM
- The blue satellite profile is shallower

Below MW mass:

- Blue satellites are dominant at **all** radii
- Both profiles parallel the DM

Wang et al 2014

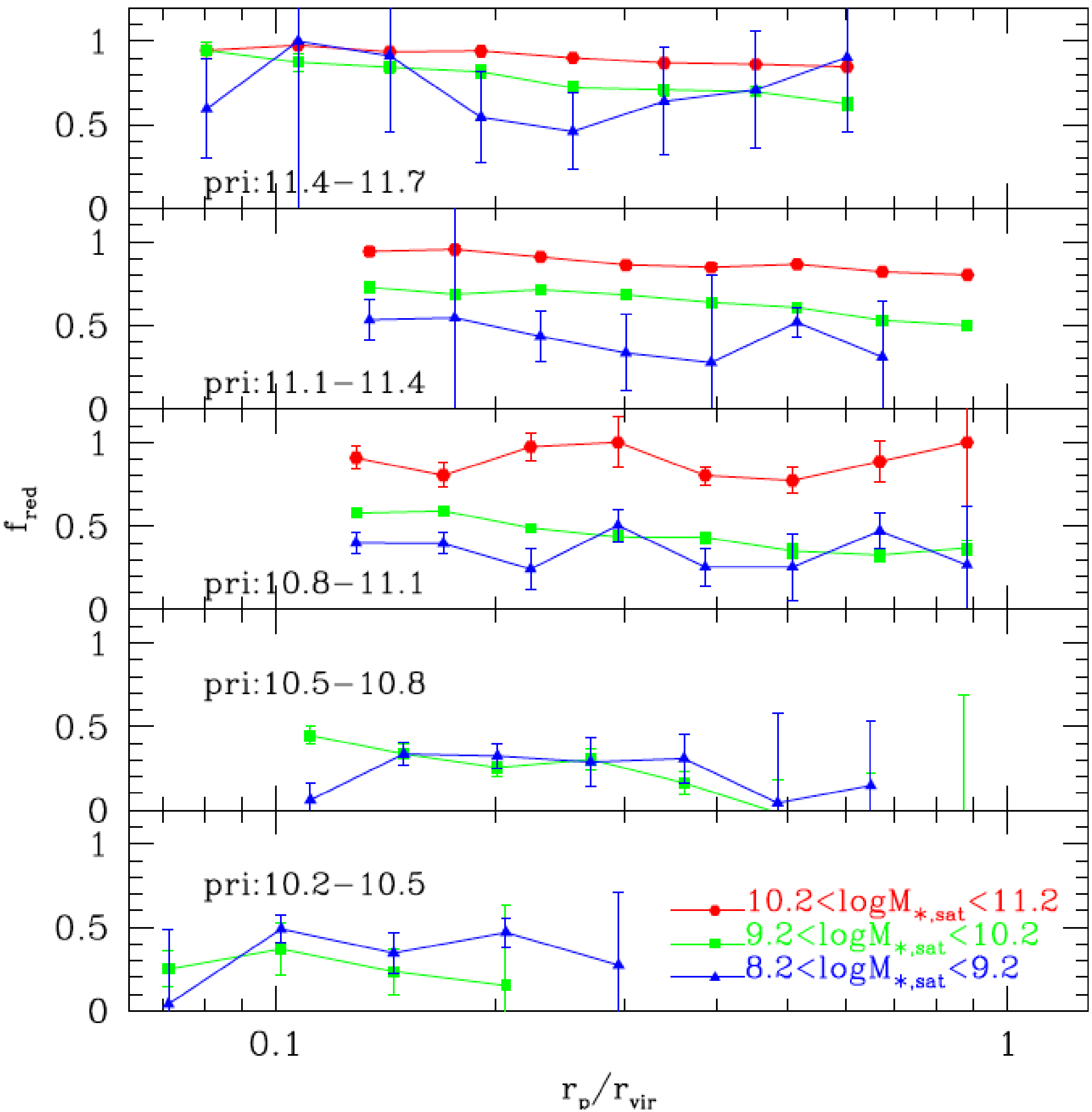


In Guo11

At all masses:

– Red satellites dominate at all radii
– The red satellite profile parallels DM
– The blue satellite profile is shallower
– The blue fraction is (much) lower than in the SDSS

Wang et al 2014



In SDSS

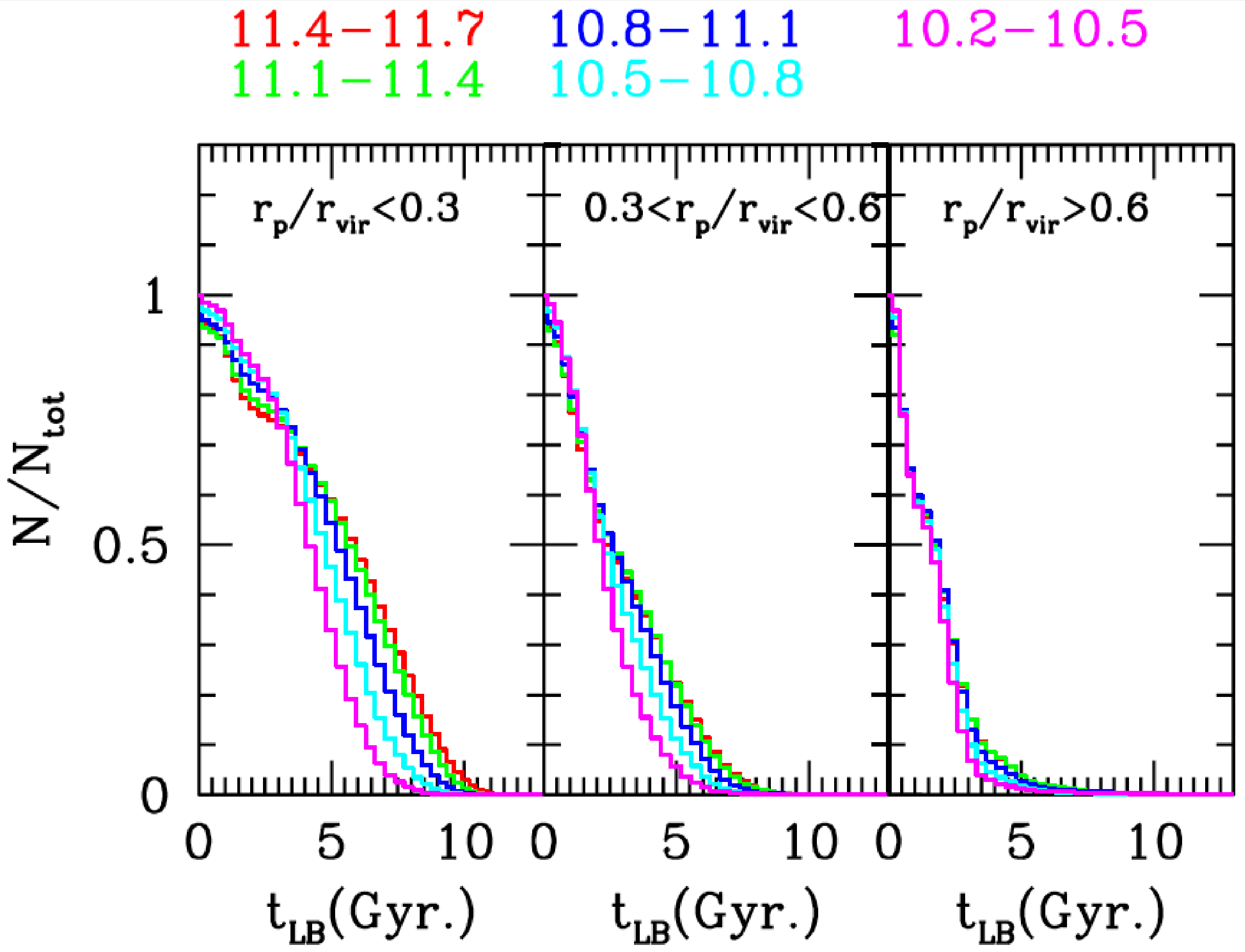
The fraction of satellites which is red (passive) depends:

– on satellite mass (more massive are redder)

– on primary mass (redder for big primaries)

– but **very little** on distance to the primary

How long do satellites need to stay blue?



At small projected radii, more than half of all satellites have been inside the halo virial radius more more than 5 Gyr – at least in Guo11

Wang et al 2014

Conclusions?

- In halos more massive than that of the MW or M31, the satellites are predominantly red and have a shallower mean profile than the dark matter. Blue satellites have a shallower mean profile than red ones
- In less massive halos, the satellites are predominantly blue and the mean profiles of both red and blue satellites parallel the dark matter
- Red central galaxies have more satellites than blue centrals of the same stellar mass
- Current galaxy population simulations reproduces the abundances of satellites as a function of primary mass and colour
- They fail to reproduce the shallower profiles around massive centrals
- They fail to reproduce satellite colour distributions ⟶ environmental effects are too strong, especially in low-mass halos