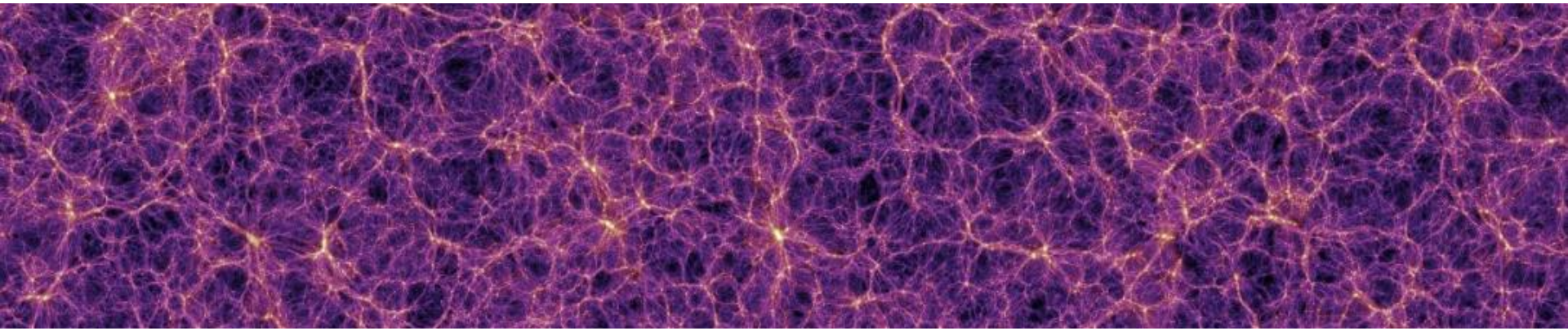
Mapping the real-space distributions of galaxies in SDSS DR7



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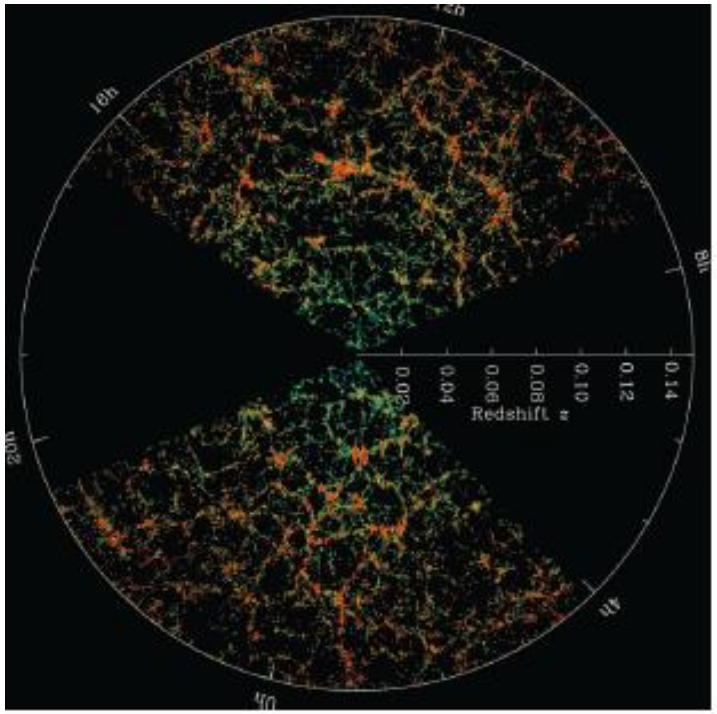
Xiaohu Yang, Huiyuan Wang, Youcai Zhang,
Houjun Mo, Frank C. van den Bosch…

2017-07-04 APRIM

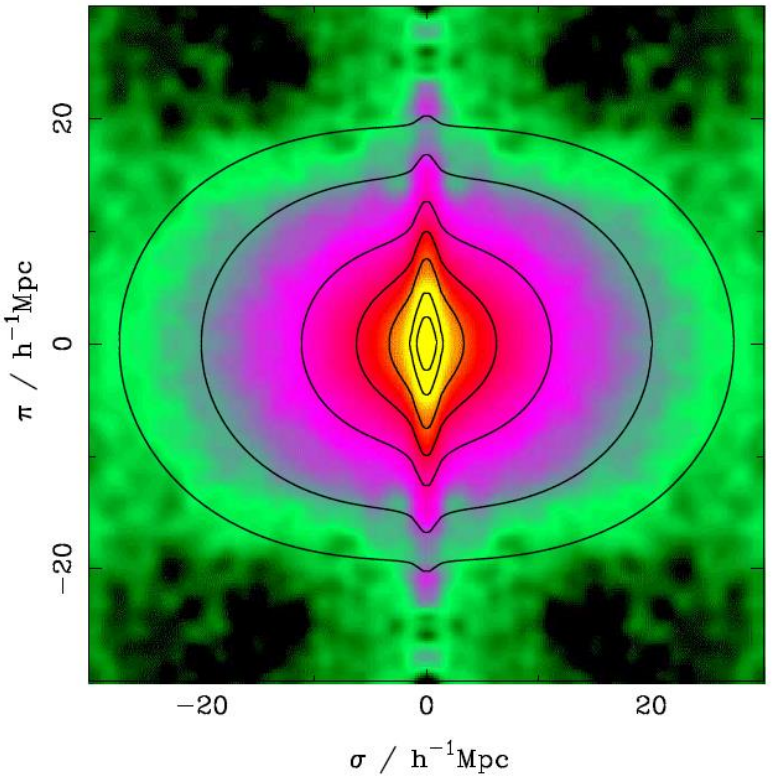
Motivation

What is the galaxies distributions in the Universe?

SDSS DR7



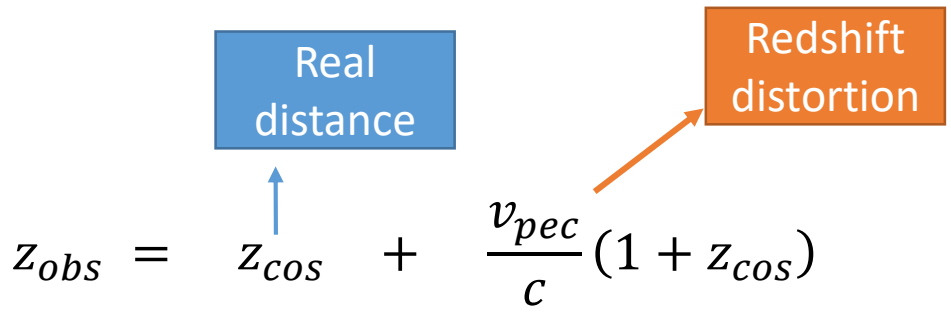
Redshift distortion



Peacock et al. 2001

Method: correct for redshift distortion

For each galaxy :



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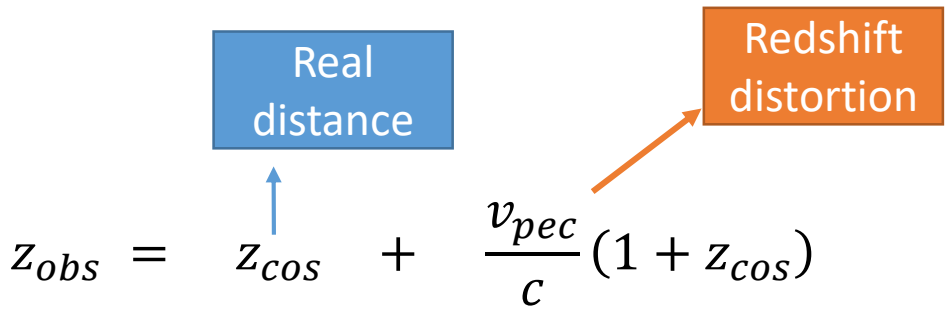

$$v_{pec} = v_{cen} + v_{\sigma}$$

Correct separately :

Kaiser: $$z_{correct} = \frac{z_{obs} - v_{cen}/c}{1 + v_{cen}/c}$$

FOG: $$z_{correct} = \frac{z_{obs} - v_{\sigma}/c}{1 + v_{\sigma}/c}$$

Method: correct for redshift distortion

For each galaxy :

Real distance

Redshift distortion

$$z_{obs} = z_{cos} + \frac{v_{pec}}{c}(1 + z_{cos})$$

$$v_{pec} = v_{cen} + v_{\sigma}$$

Correct separately :

Linear theory

$$\boldsymbol{v}(\boldsymbol{k}) = Haf(\Omega)\frac{i\mathbf{k}}{k^2}\frac{\delta_h(\boldsymbol{k})}{b_{hm}}$$

(Wang et al. 2012)

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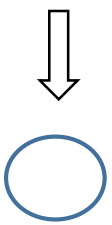
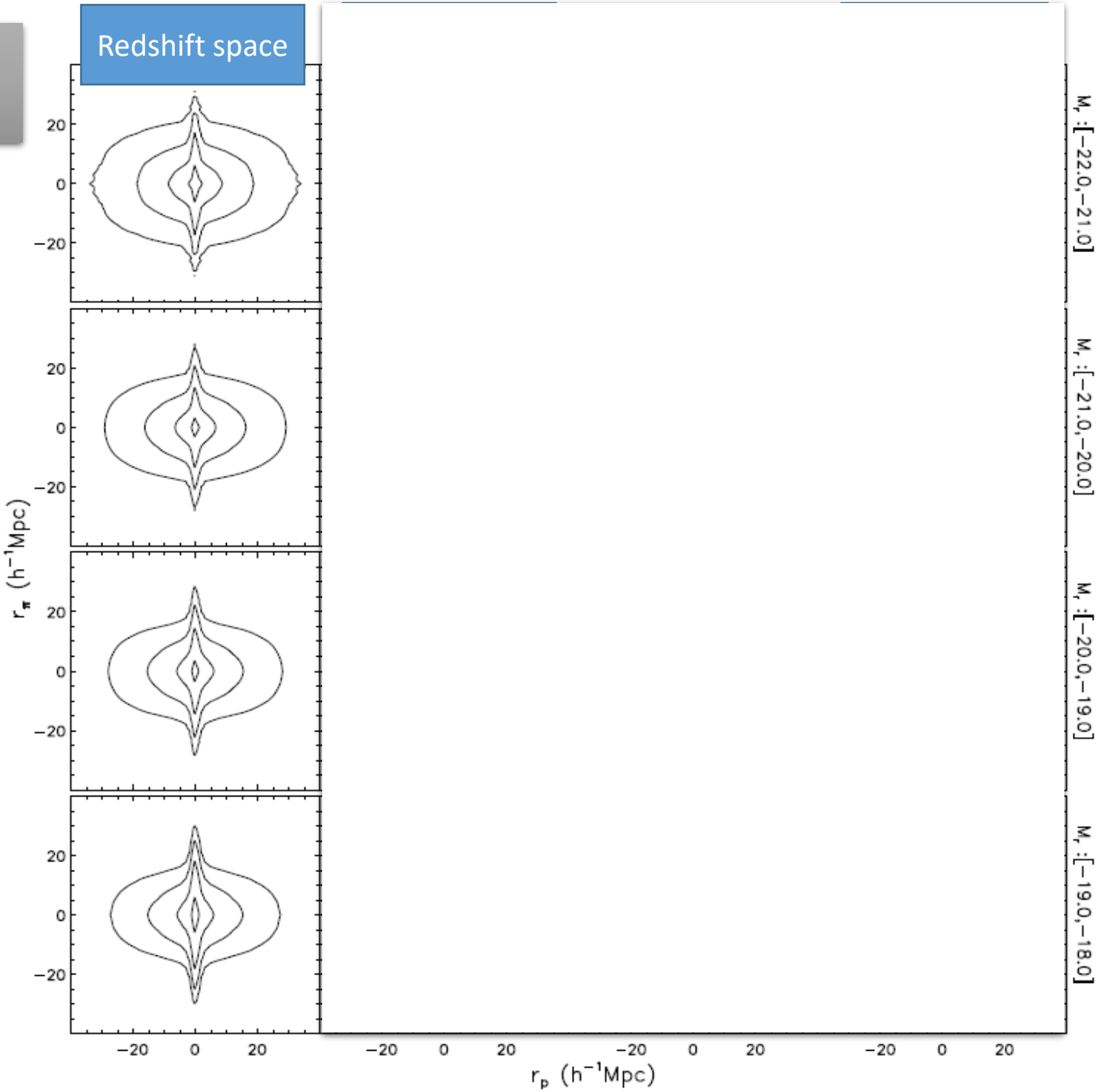
Redshift group

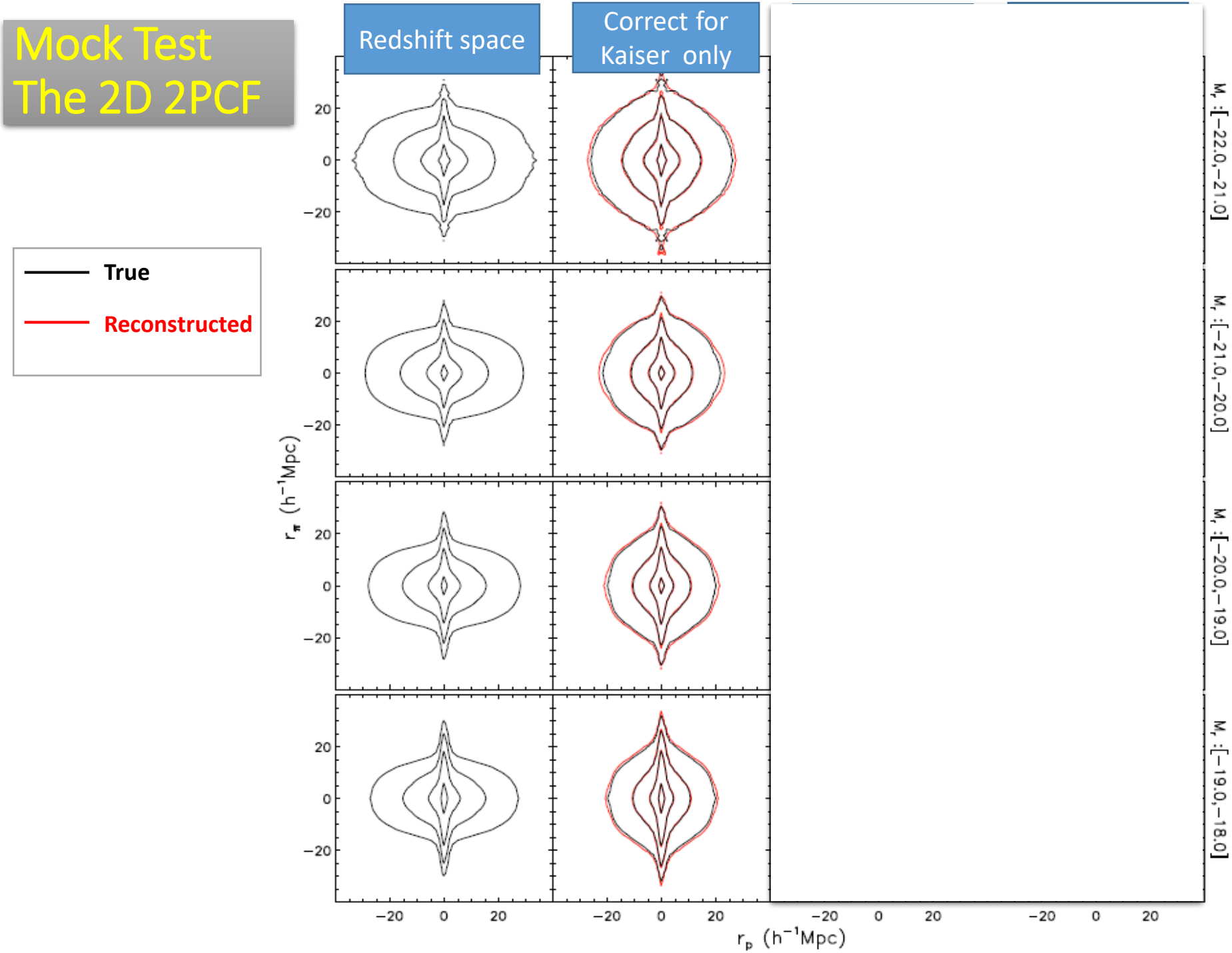


Group galaxies follow the NFW density profile

Mock Test
The 2D 2PCF



Mock Test
The 2D 2PCF



Mock Test
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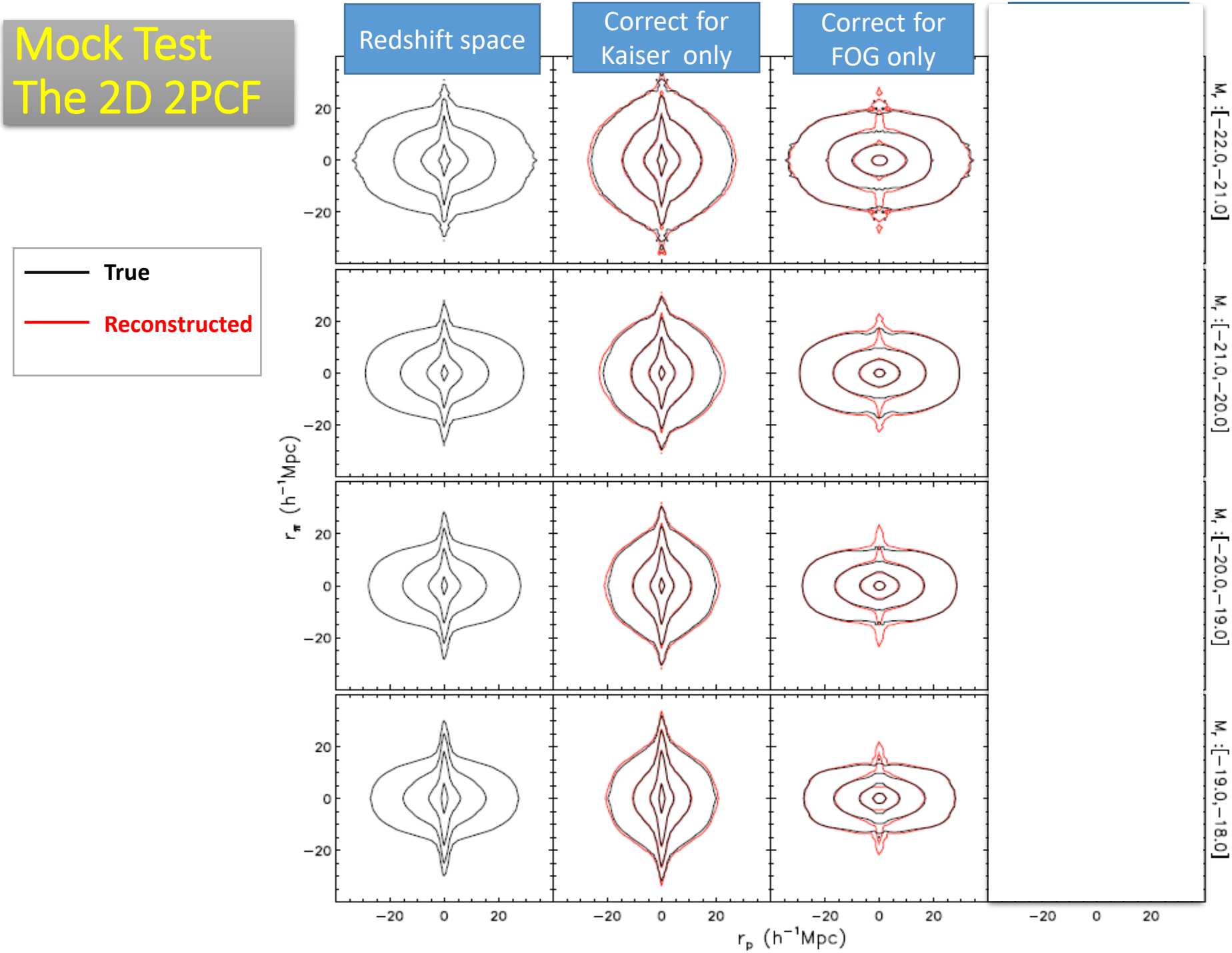
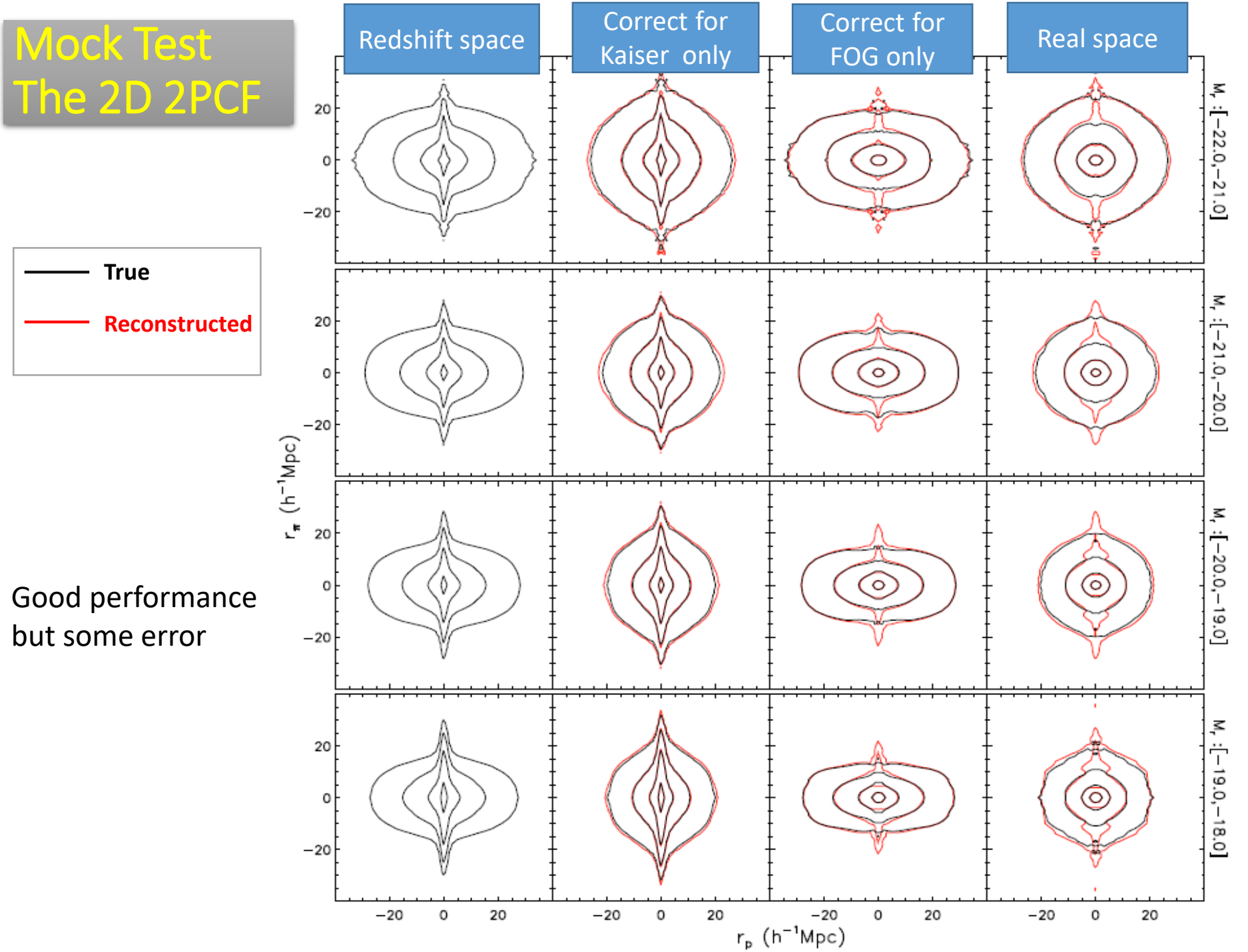


Mock Test
The 2D 2PCF

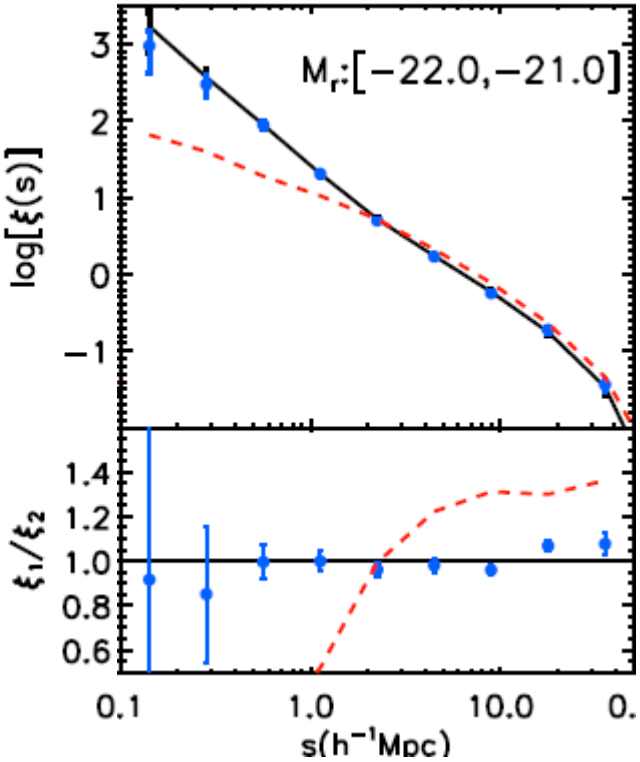


Good performance but some error

Mock Test
The 2PCF $\xi(s)$

Redshift space

True real space vs. Reconstructed real space

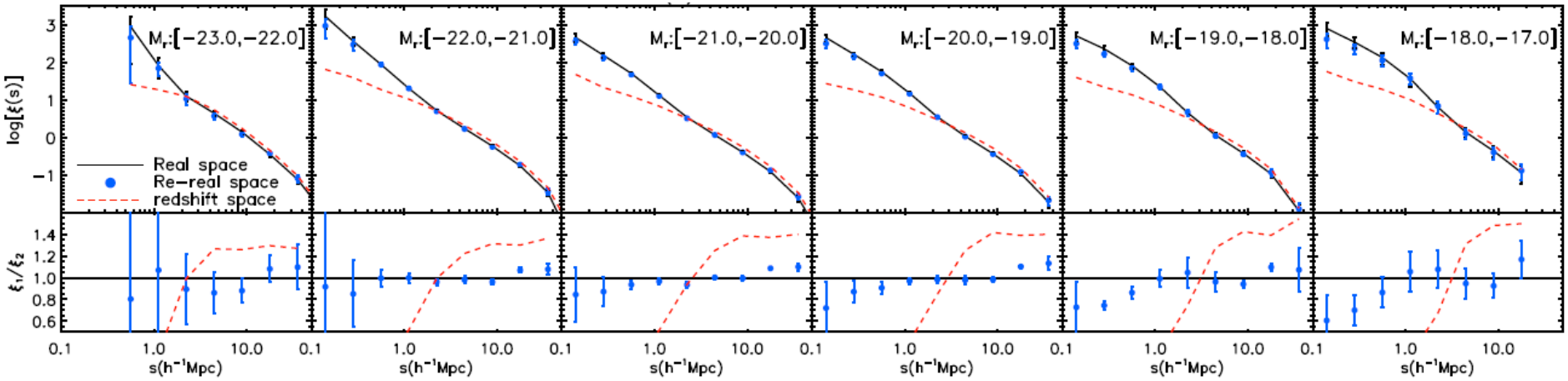


$$\frac{\xi_{reconstruct}}{\xi_{true}}$$

Mock Test
The 2PCF $\xi(s)$

Redshift space

True real space vs. Reconstructed real space



Overall mostly,
the accuracy is better than the measurement error due to the cosmic variance

A real-space galaxy catalog in SDSS DR7

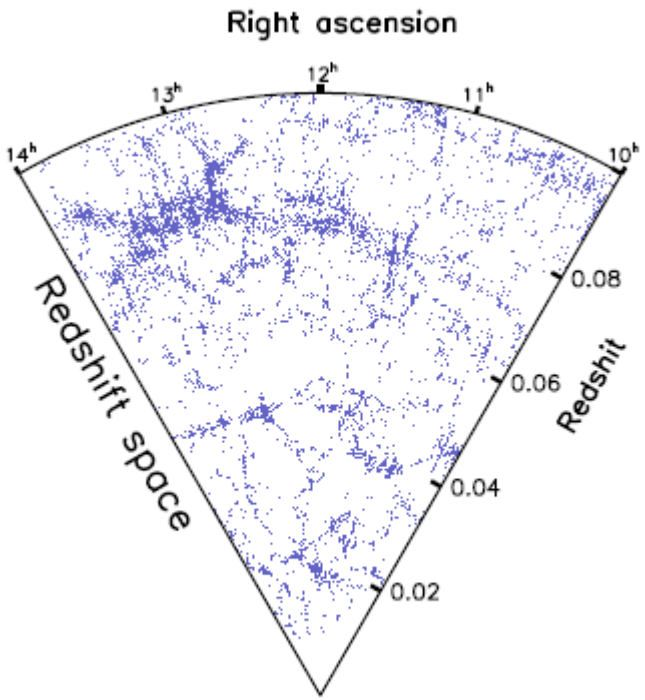
Northern Galactic Cap

$0.01 \leq z \leq 0.12$

396068 galaxies

The galaxy distributions in SDSS DR7

Redshift space



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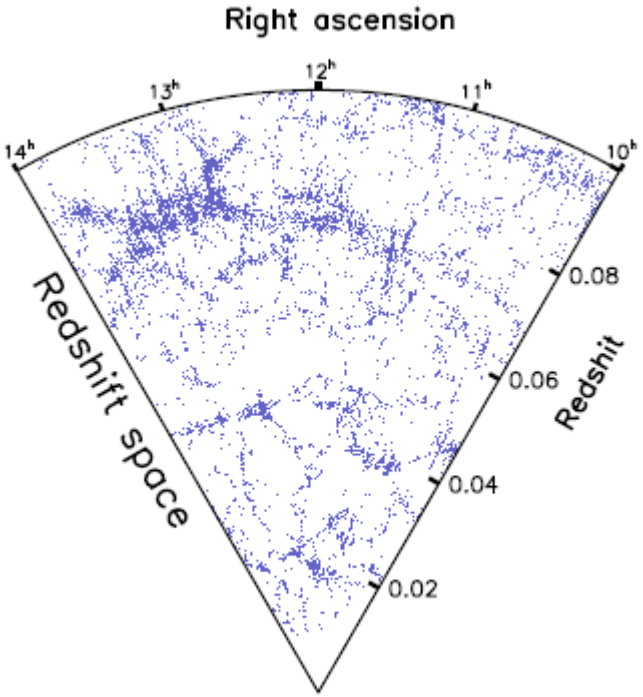
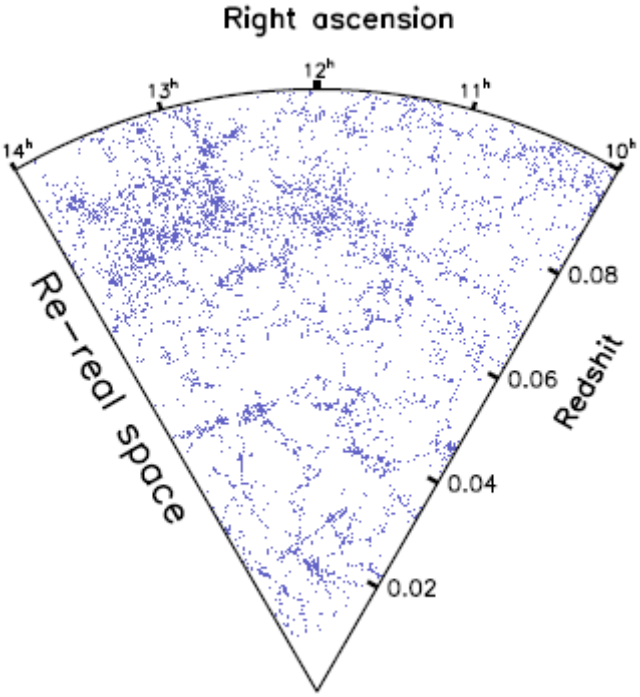


Real space

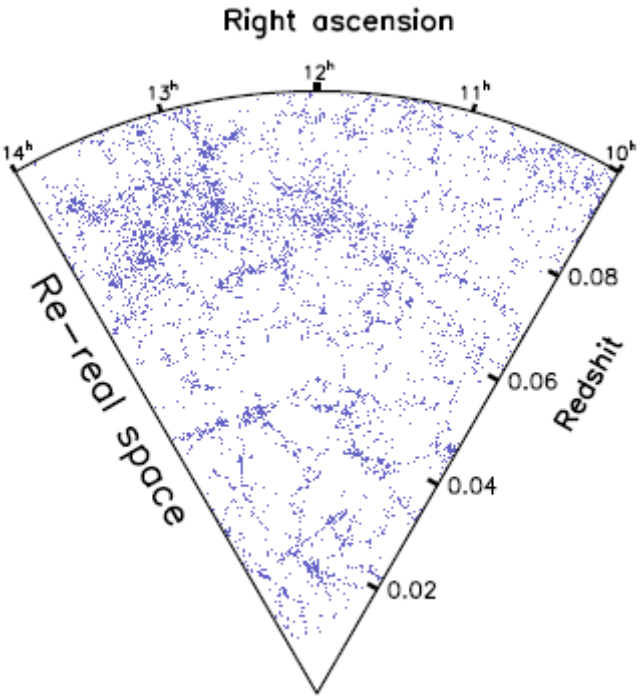


The Sloan Great Wall structure looks to be much weakened !

The galaxy distributions in SDSS DR7

Galaxy clustering in real space

Real space



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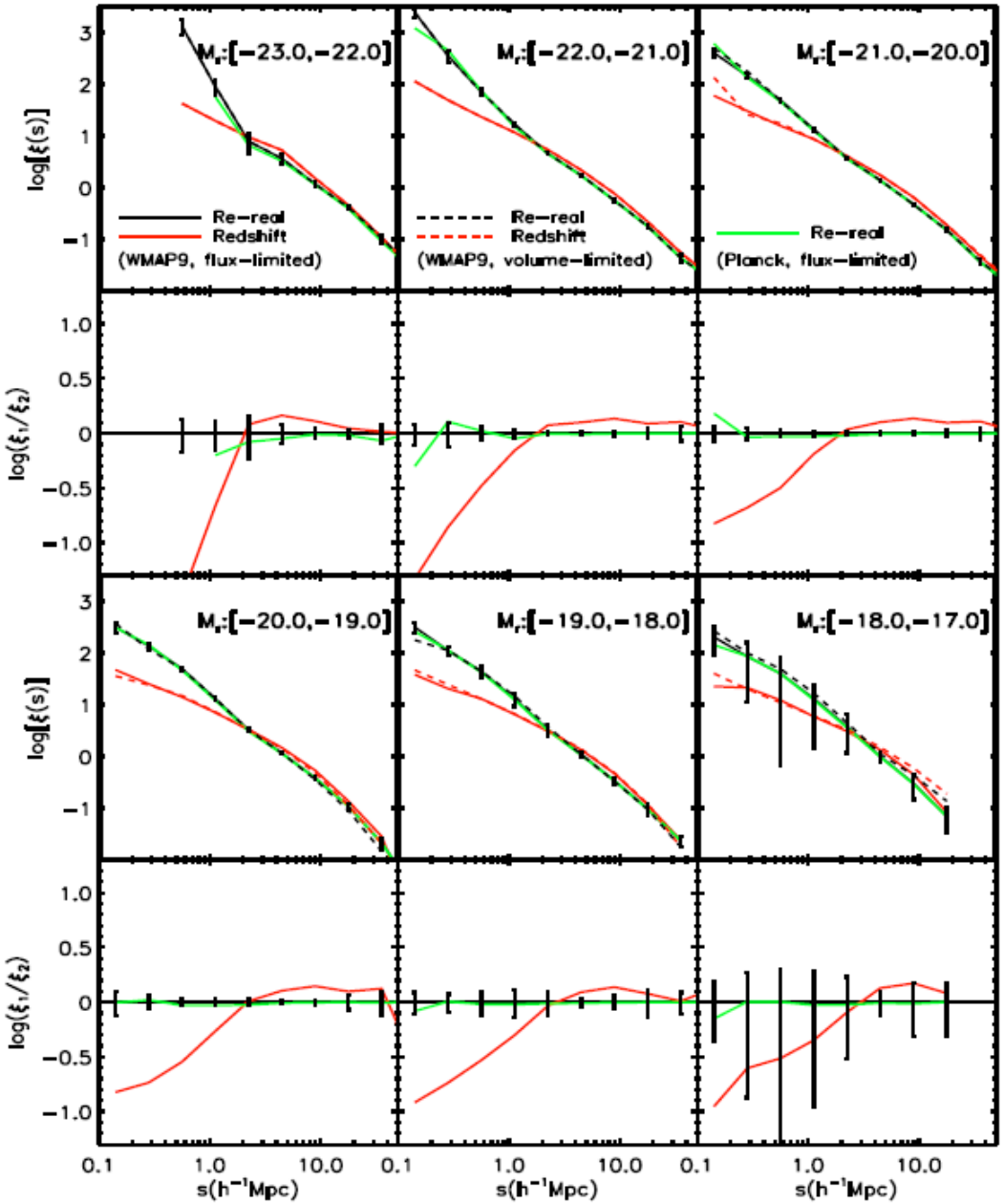
SDSS DR7: 2PCFs $\xi(s)$



- First attempt to measure the real-space $\xi(s)$ directly from a map in the SDSS
- Kaiser: boost 40-50%
  FOG: suppress 70-80%
- $\xi(s)$: a clearer 1-halo to 2-halo transition

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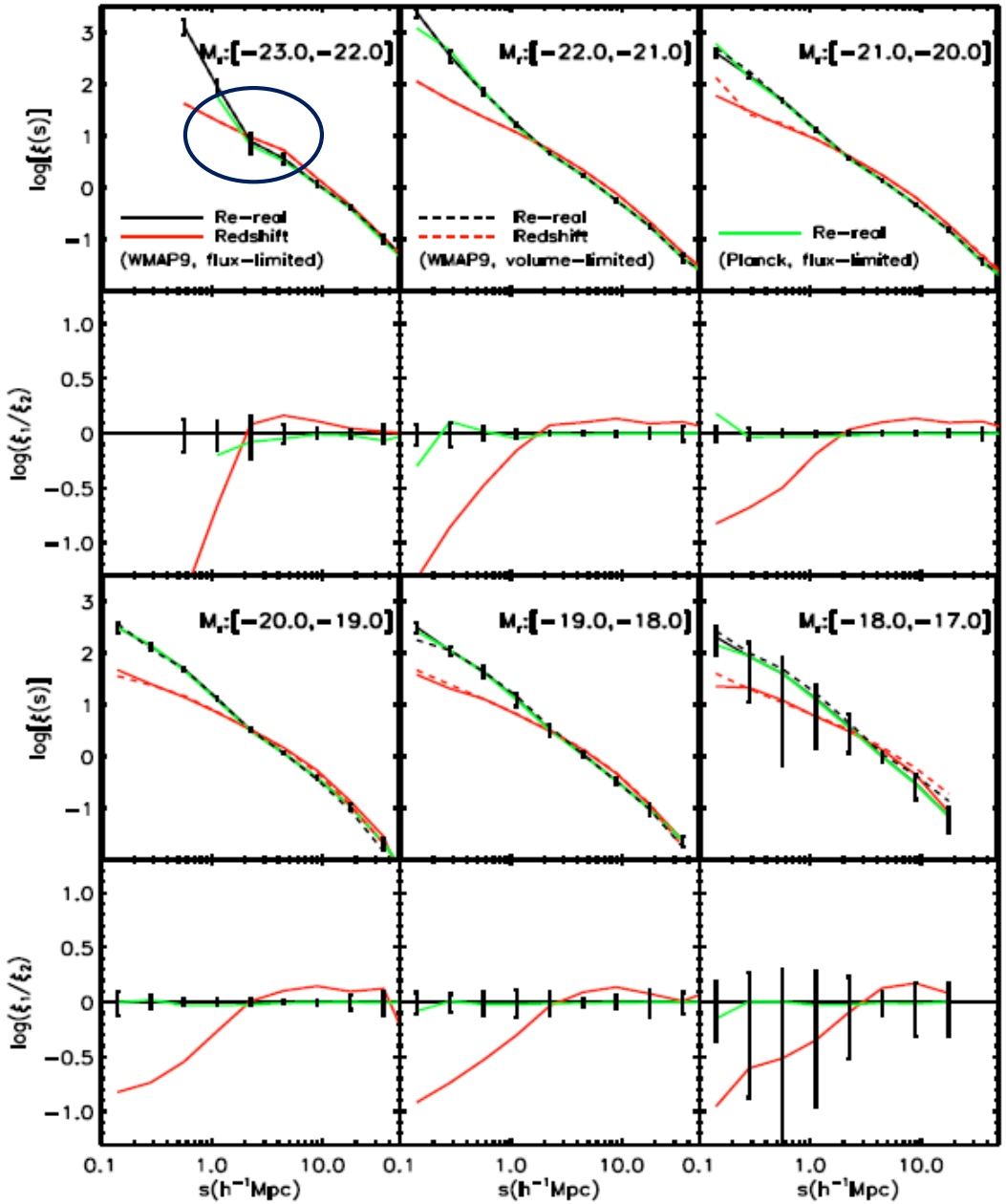

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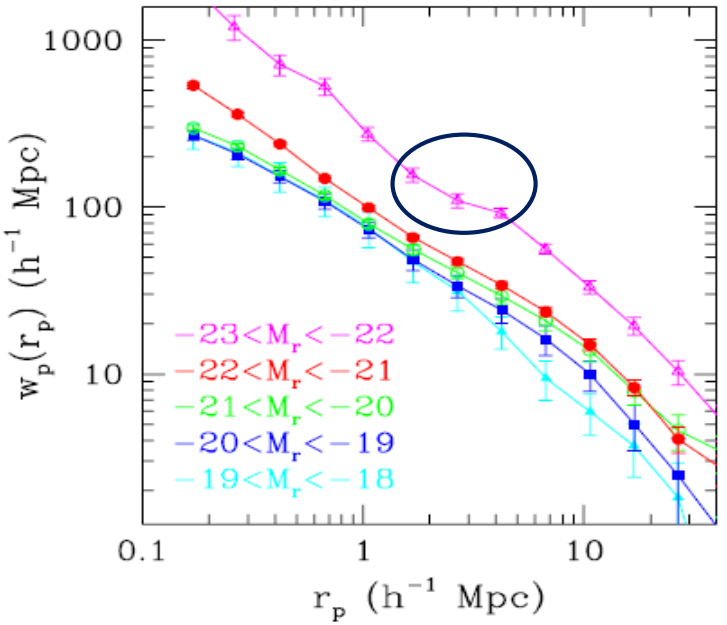
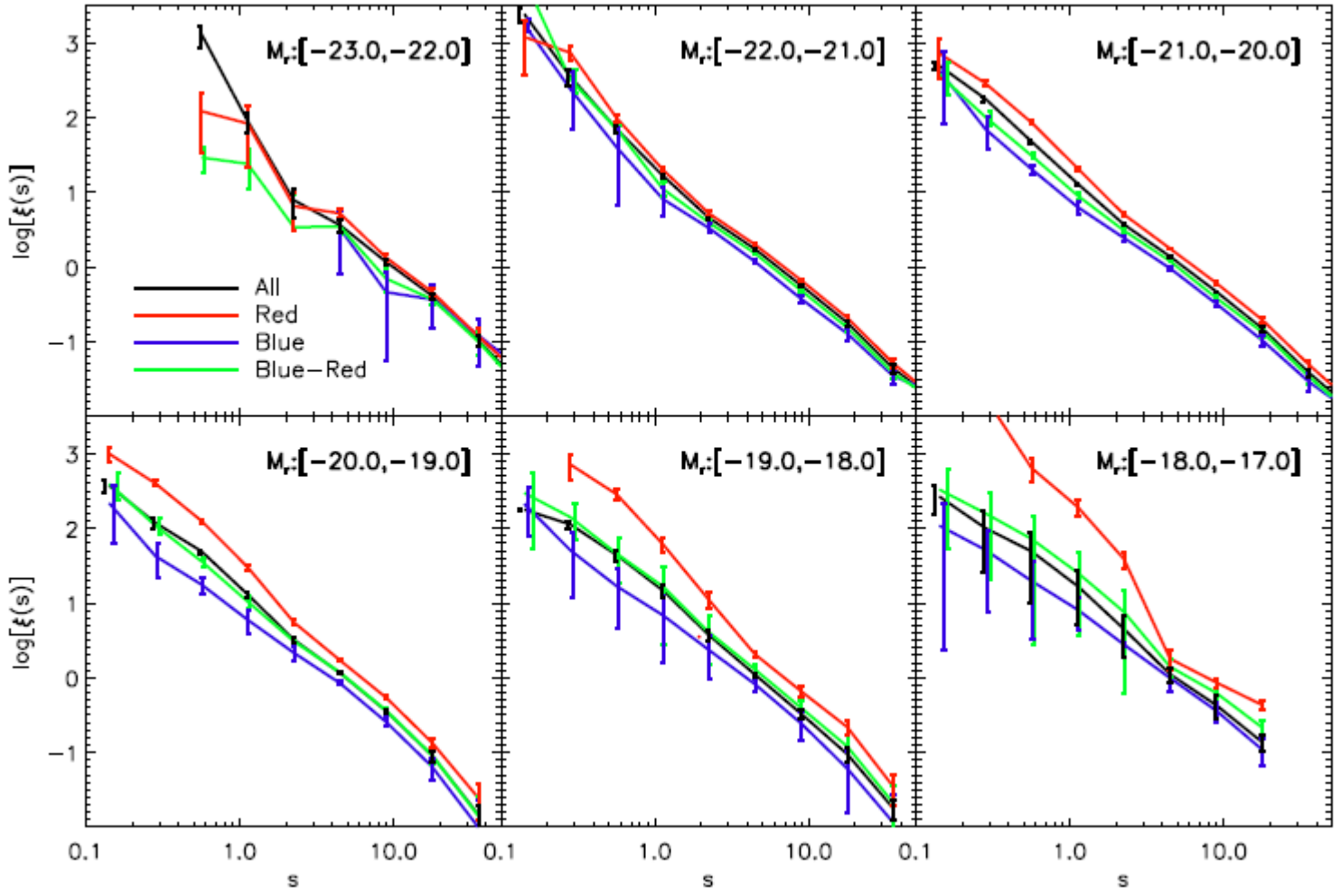
Projected 2PCF



Zehavi et al. 2011

SDSS DR7: 2PCFs $\xi(s)$ on color

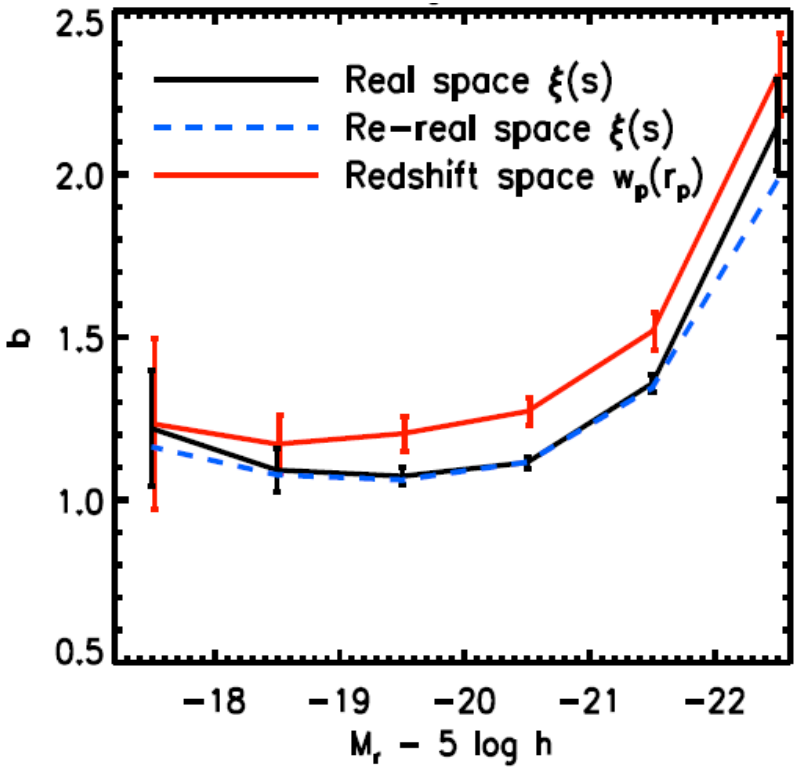


The bias factor *b*

$$\xi_{gg}(s) = b^2 \xi_{mm}(s)$$

$$w_p(r_p)_{gg} = b^2 w_p(r_p)_{mm}$$

Mock Test



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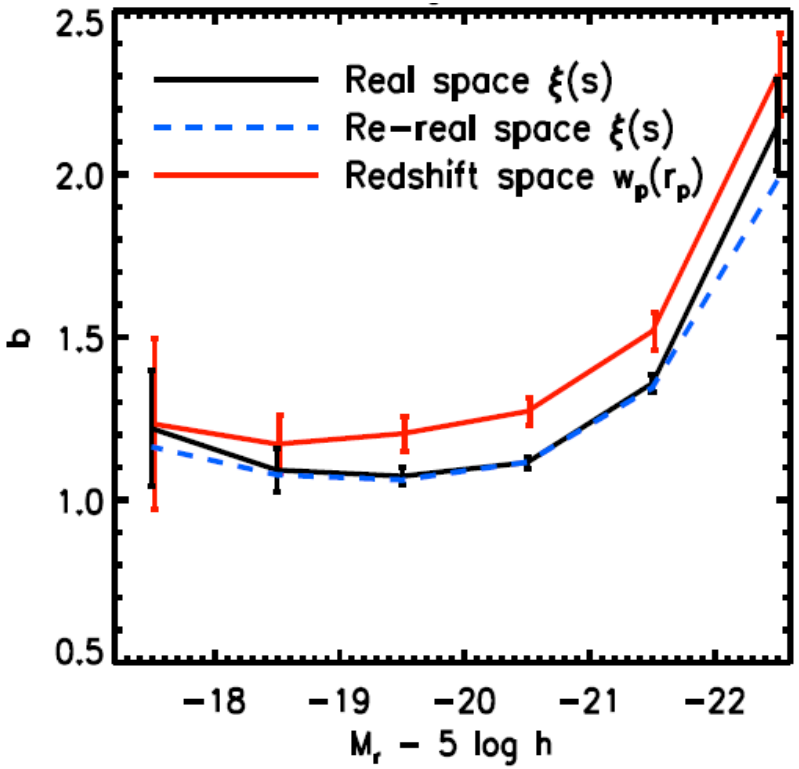

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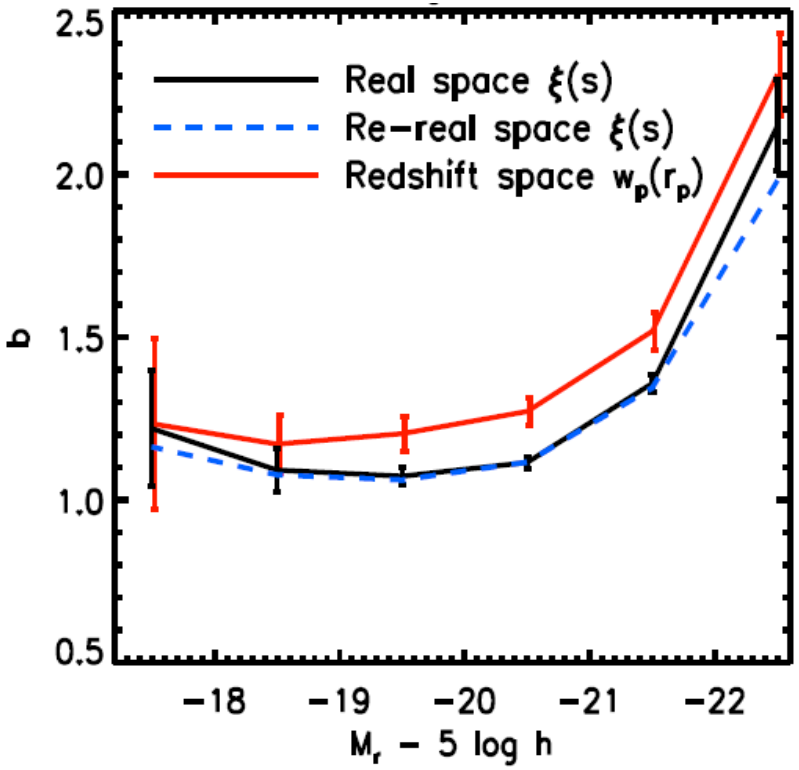
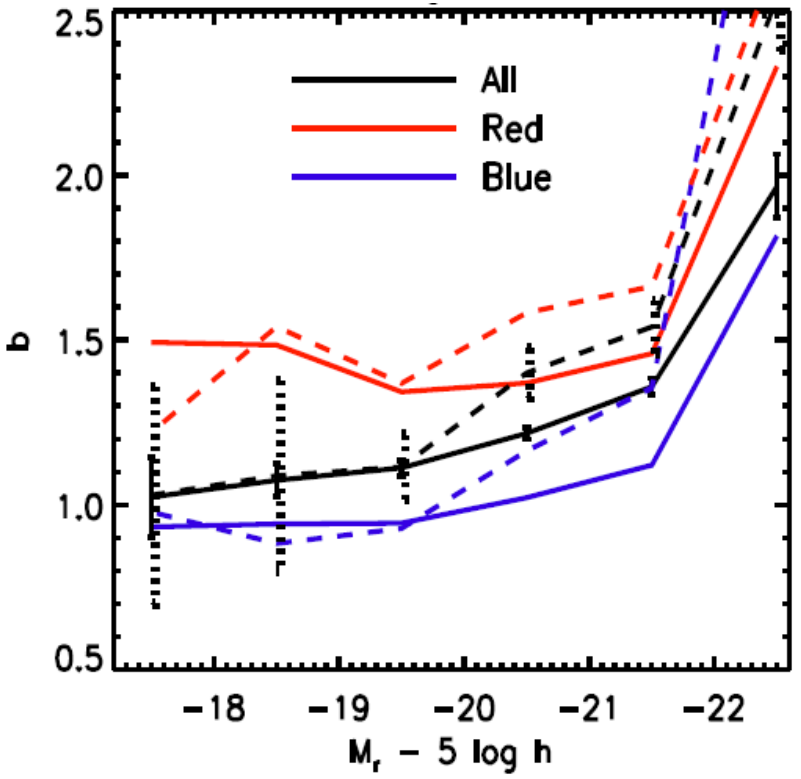


SDSS DR7



New estimation for ***b*** using the re-real space $\xi(s)$

Summary

- A method to correct for the redshift distortions

  Mock test shows a good performance

- Map the real space galaxy distributions in SDSS DR7

  A catalog with $0.01 < z < 0.12$ in the NGC region

  Contain 396068 galaxies

  Available online : http://gax.shao.ac.cn/data/Group.html

- Study the galaxy clustering in re-real space

  The Sloan Great Wall structure is not so dominant as in redshift space

  Measure the 2PCFs for galaxies of different luminosities and colors

  Some applications, such as estimating the bias factor

Shi et al. 2016 Doi:10.3847/1538-4357/833/2/241

Summary

Thank You!

- A method to correct for the redshift distortions

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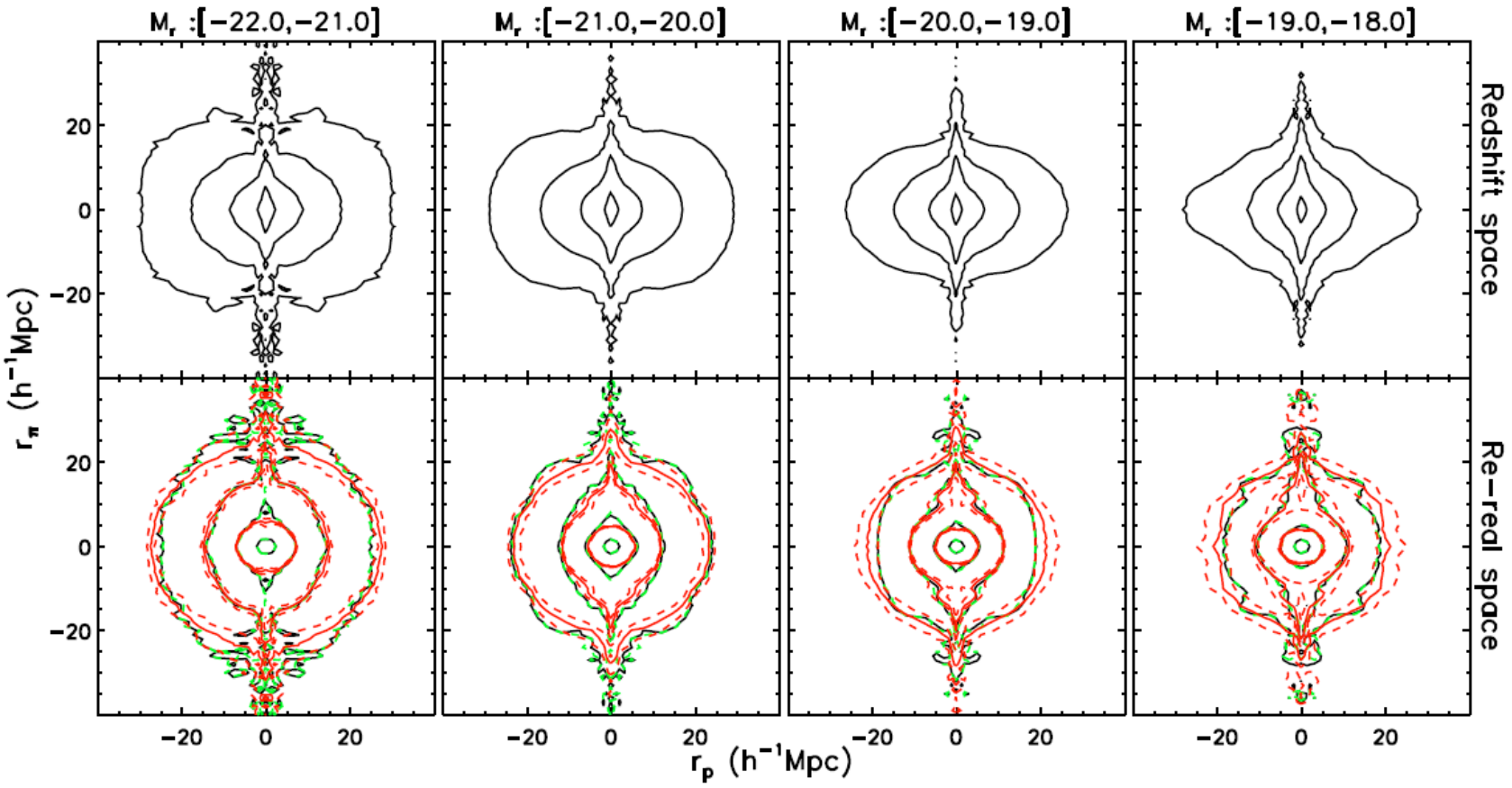
Shi et al. 2016 Doi:10.3847/1538-4357/833/2/241

SDSS DR7 : 2D 2PCF



- Use 10 mock samples to estimate the variance:
  Red solid : average value
  Red dashed : 1σ error

Most contours fall within the 1σ error ranges

Galaxies sample : SDSS DR7

In our work:

- North Galactic Cap (NGC)
- Mass threshold $M_{th} = 10^{12.0} h^{-1} M_{\odot}$
- Redshift range $0.01 \leq z \leq 0.12$
- 396068 galaxies , 286043 groups

TABLE 1
GALAXY SUBSAMPLES

Absolute Magnitude		Flux-limited		Volume-limited		
$^{0.1}M_r - 5\log h$	Redshift	$N_{gal}(N_{blue}/N_{red})$	Averaged Magnitude	Redshift	$N_{gal}(N_{blue}/N_{red})$	Averaged Magnitude
$[-23,-22]$	$[0.01,0.12]$	2200(379/1821)	-22.22	$[0.01,0.12]$	2200(379/1821)	-22.22
$[-22,-21]$	$[0.01,0.12]$	42207(11997/30210)	-21.34	$[0.01,0.12]$	42207(11997/30210)	-21.34
$[-21,-20]$	$[0.01,0.12]$	156765(64956/91809)	-20.44	$[0.01,0.113]$	134801(55572/79229)	-20.43
$[-20,-19]$	$[0.01,0.12]$	127444(71018/56426)	-19.57	$[0.01,0.075]$	73391(41659/31732)	-19.47
$[-19,-18]$	$[0.01,0.12]$	43894(31646/12248)	-18.58	$[0.01,0.045]$	21875(16052/5823)	-18.48
$[-18,-17]$	$[0.01,0.12]$	17259(14327/2932)	-17.57	$[0.01,0.026]$	5618(4818/800)	-17.46

Construct mock samples

- N-body simulation:

  $\mathrm{L} = 500h^{-1}Mpc\ ,\ N = 3072^3,\ \Omega_m = 0.282\ , \Omega_\Lambda = 0.718, \Omega_b = 0.046,$

  $h = 0.697,\ n_s = 0.965,\ \sigma_8 = 0.817$

- Halo finder： FOF , ‘real halo’

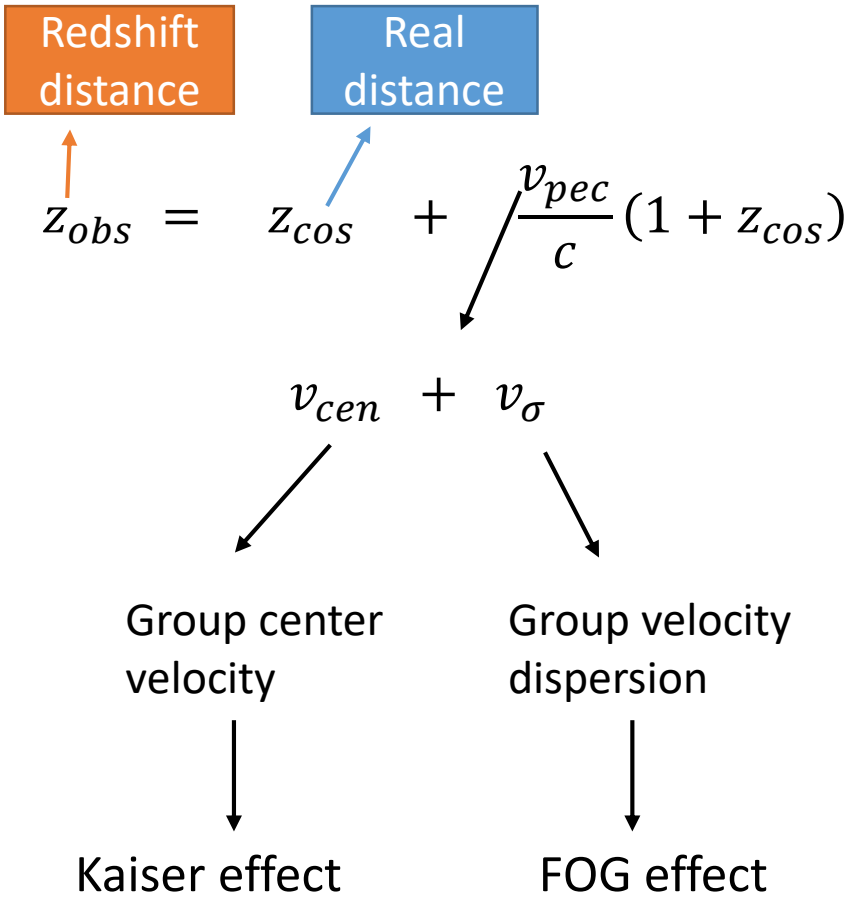
- Galaxies model :

  CLF model from Yang et al. (2003)

  Update here for SDSS DR7

Redshift distortion

For each galaxy :



Redshift distortion

For each galaxy :

Redshift distance

Real distance

$$z_{obs} = z_{cos} + \frac{v_{pec}}{c}(1 + z_{cos})$$

$$v_{cen} + v_{\sigma}$$

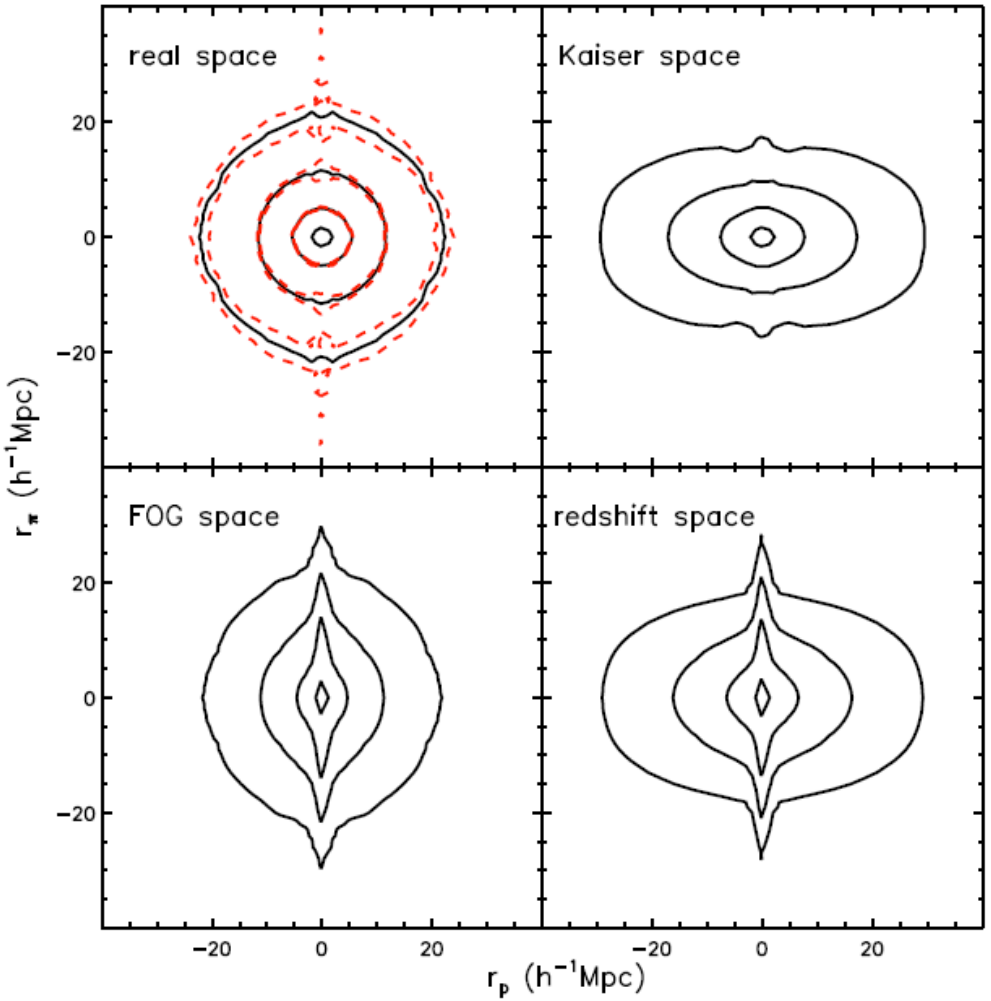
Group center velocity → Kaiser effect

Group velocity dispersion → FOG effect

Mock Samples : 2D 2PCF

z_{cos}

$+\frac{v_{cen}}{c}(1 + z_{cos})$



$+\frac{v_{\sigma}}{c}(1 + z_{cos})$

$+\frac{v_{pec}}{c}(1 + z_{cos})$

Correct for redshift distortion

I. find galaxy group in redshift space

Yang et al. (2005, 2007) developed a adaptive halo-based group finder.

1. Group member : central and satellites
2. The underlying halo mass

True spaces

TABLE 2
DESCRIPTION OF DIFFERENT SPACES.

SPACE	DESCRIPTION
Real space	survey geometry without redshift distortions
FOG space	distorted only by FOG effect: $z_{\rm obs} = z_{\rm cos} + \frac{v_\sigma}{c}(1+z_{\rm cos})$
Kaiser space	distorted only by Kaiser effect: $z_{\rm obs} = z_{\rm cos} + \frac{v_{\rm cen}}{c}(1+z_{\rm cos})$
Redshift space	distorted by both Kaiser and FOG effects: $z_{\rm obs} = z_{\rm cos} + \frac{v_{\rm pec}}{c}(1+z_{\rm cos})$
Re-real space	reconstructed real space; based on correcting redshift space distortions
Re-Kaiser space	reconstructed Kaiser space; based on correcting for FOG effect only
Re-FOG space	reconstructed FOG space; based on correcting for Kaiser effect only

Reconstructed spaces

We have constructed 10 mock samples to estimate the cosmic variance

Our goals

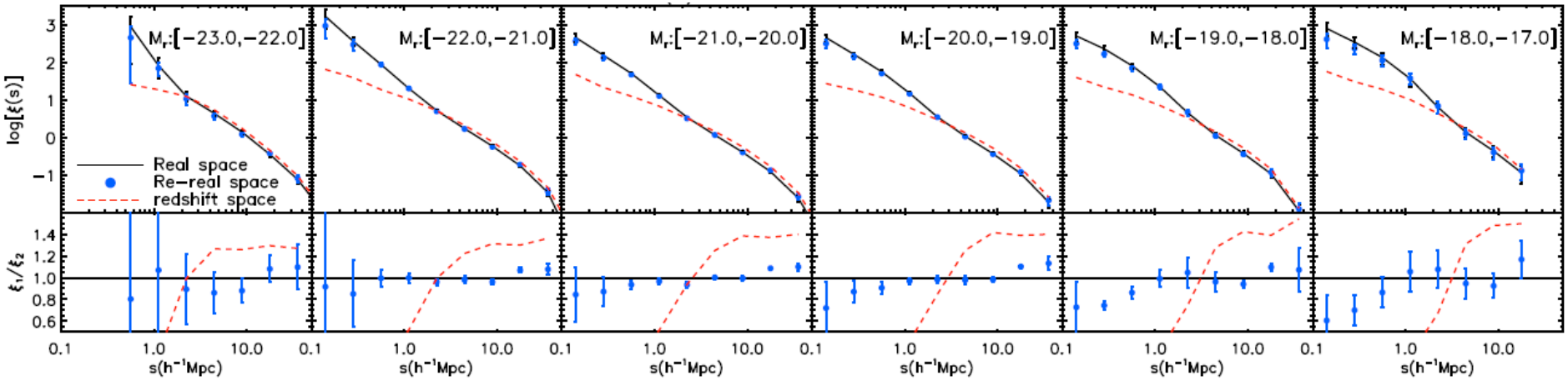
- Map the real space galaxy distribution

- Study the galaxy clustering in real space

  2PCF

Mock Test
The 2PCF $\xi(s)$

True real space — vs. — Reconstructed real space



On average for galaxies brighter than $M_r - 5\ logh = -19$,

$$\frac{\xi(s)_{reconstruct}}{\xi(s)_{true}} = 1.0 \pm 0.05$$

$$0.2 \leq s \leq 20\ (h^{-1}Mpc)$$