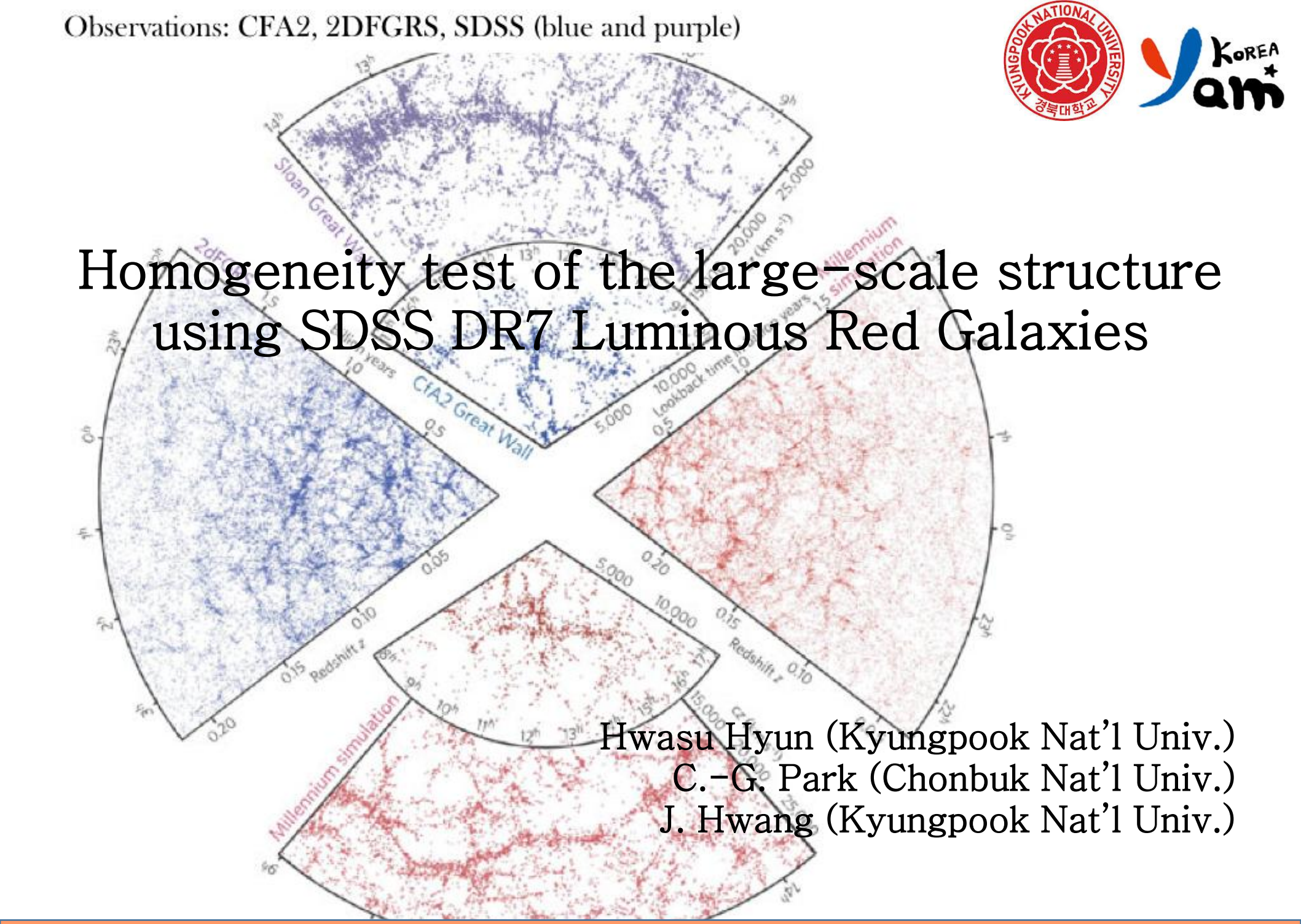


Homogeneity test of the large-scale structure using SDSS DR7 Luminous Red Galaxies

Hwasu Hyun (Kyungpook Nat'l Univ.)
C.-G. Park (Chonbuk Nat'l Univ.)
J. Hwang (Kyungpook Nat'l Univ.)

Contents

1. Cosmological principle

2. Data
- SDSS DR7 LRG catalog
- Halo mock catalog
- Random catalog

3. Data analysis
- Redshift slice (2D)
- Statistical method

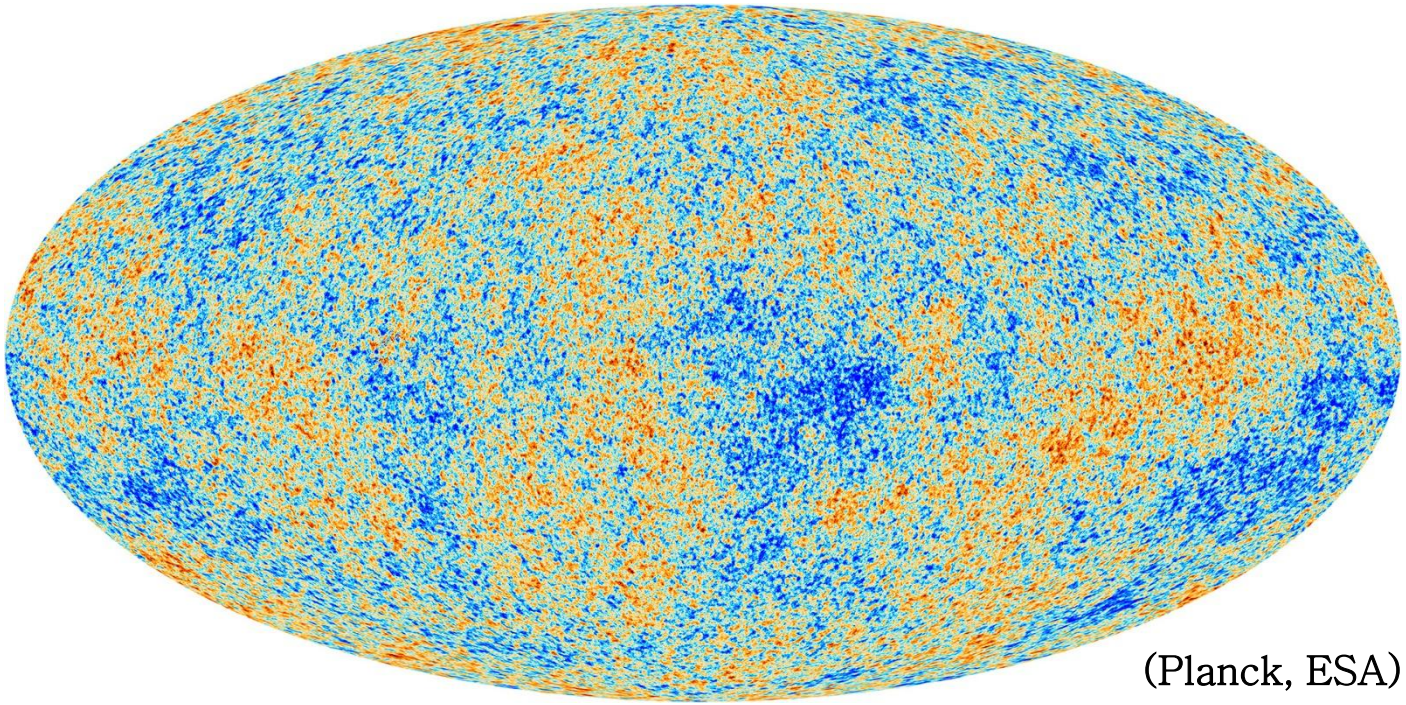
4. Results

5. Summary

6. Future works

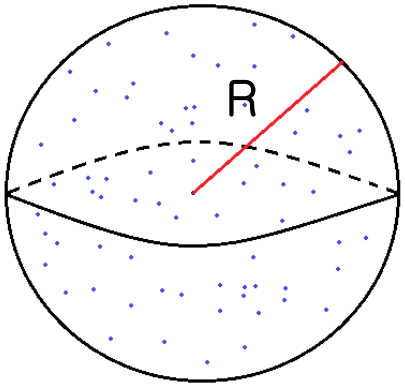
1. Cosmological principle

The standard model of the cosmology assumes that the matter distribution on sufficiently large scale is statistically homogeneous and isotropic.



(Planck, ESA)

Homogeneity test



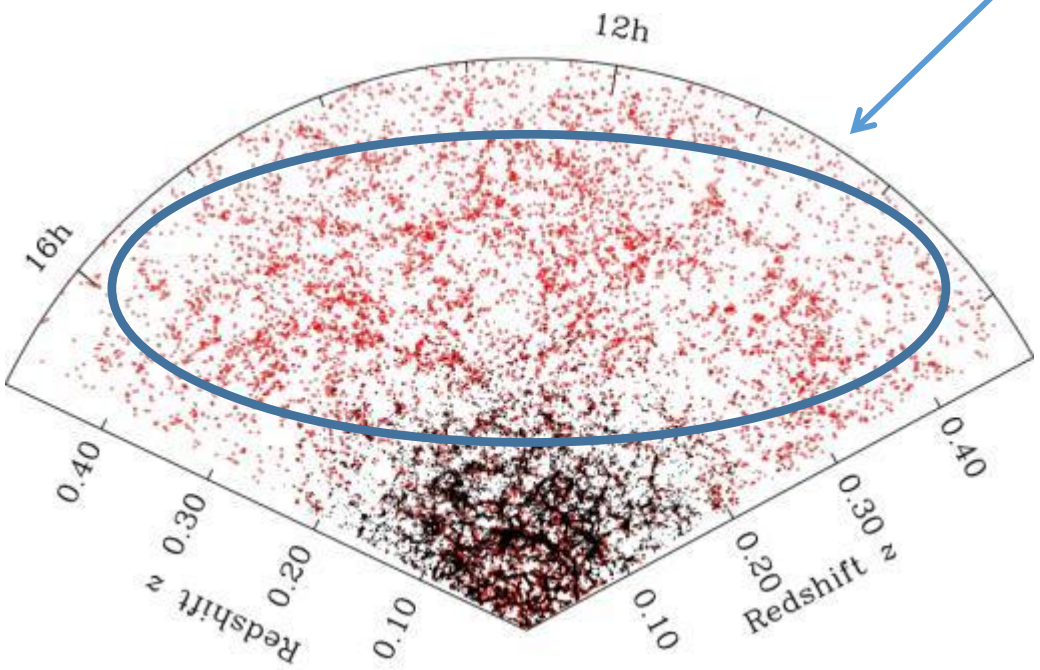
- Homogeneity test of galaxies have been studied by using fractal dimension that is counting the number of galaxies at galaxy centered sphere.
- If fractal dimension is 3, that means galaxy distribution is homogeneous.
- Radius is larger than 70Mpc/h, fractal dimension is approximately 3. (Hogg et al. 2004)
- The Universe continues to look fractal(not homogeneous) as far out as our telescopes can see. (Labini et al. 2009)

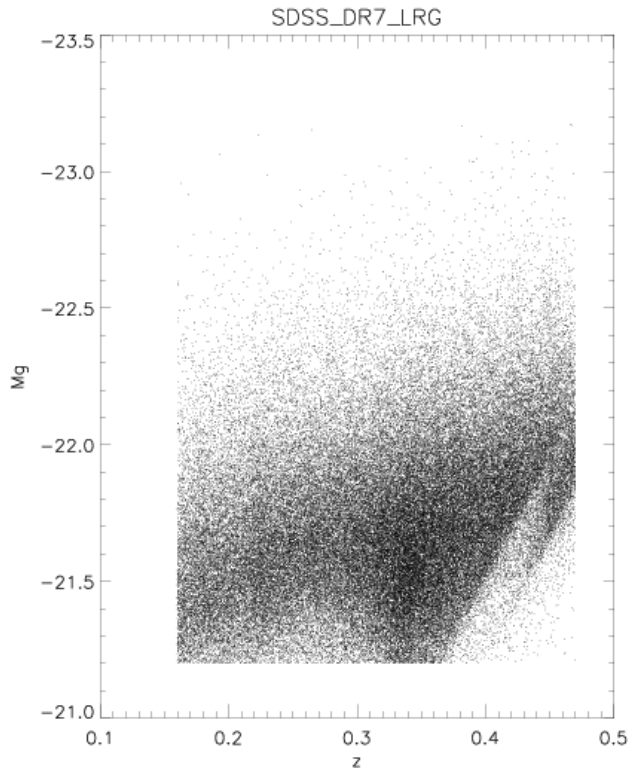
$$R^D = \frac{N_{LRGs}}{N_{Random}}$$

$$D \sim 3$$

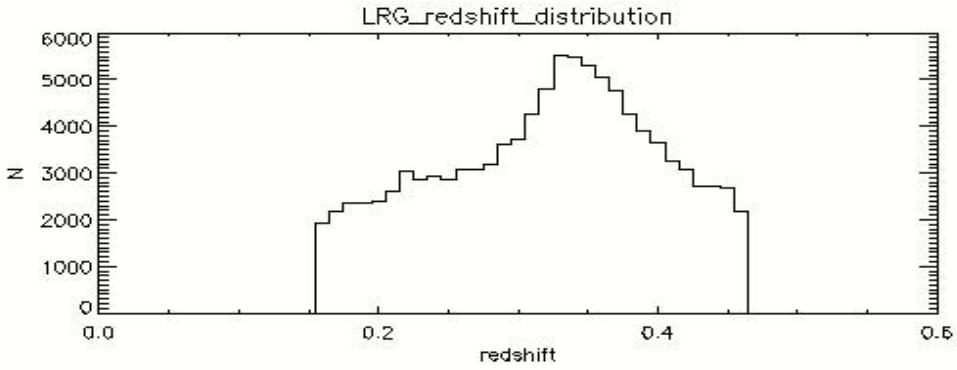
2. Data
– SDSS DR7 LRGs

Luminous Red Galaxies (LRGs)

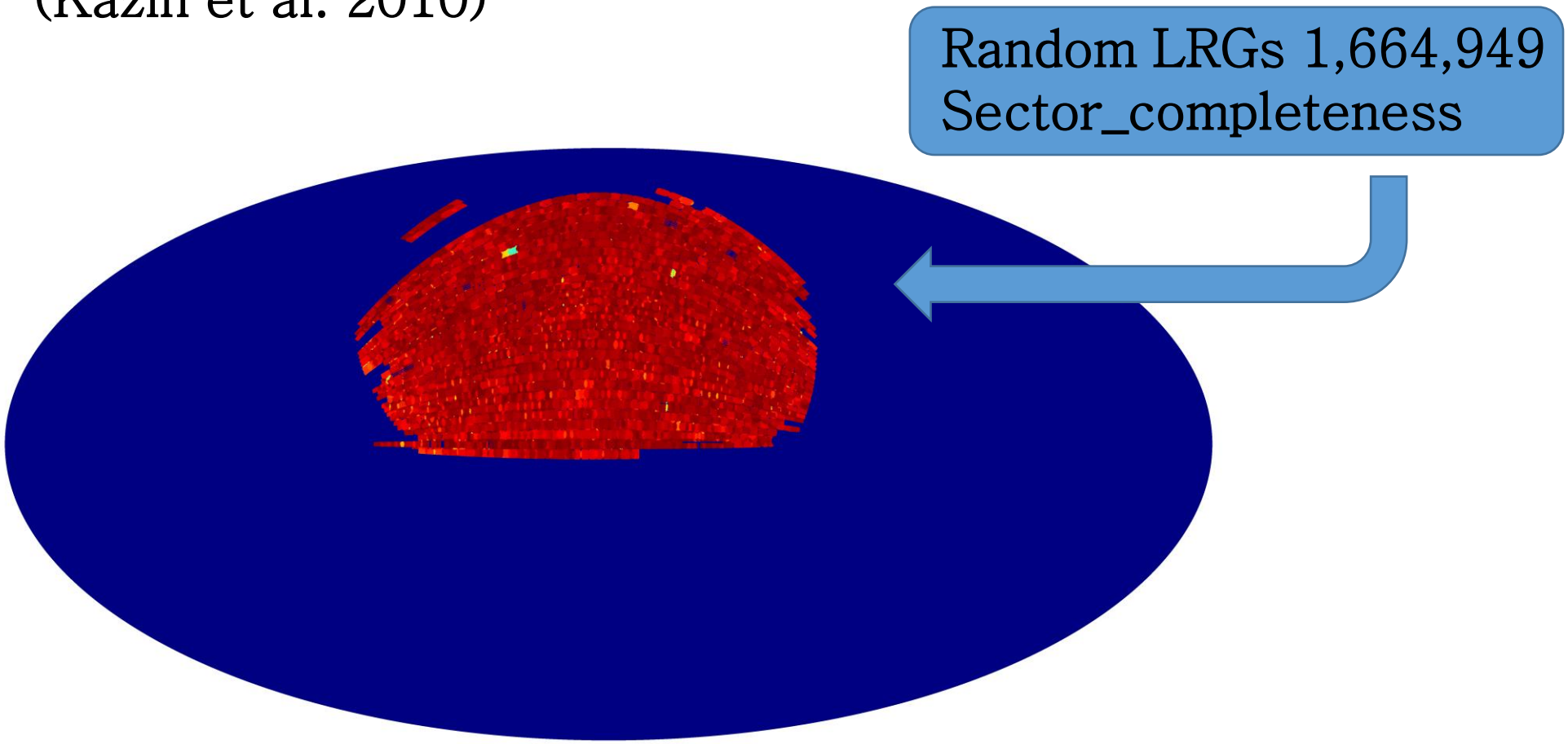




- 105,831 galaxies
- $0.16 < z < 0.47$
- $M_g = (-23.2, -21.2)$
  (Kazin et al. 2010)



LRG Angular selection function
(Kazin et al. 2010)



- Observed area is calculated by LRG Angular selection function
  Observed area ~ 1
  Not observed area ~ 0

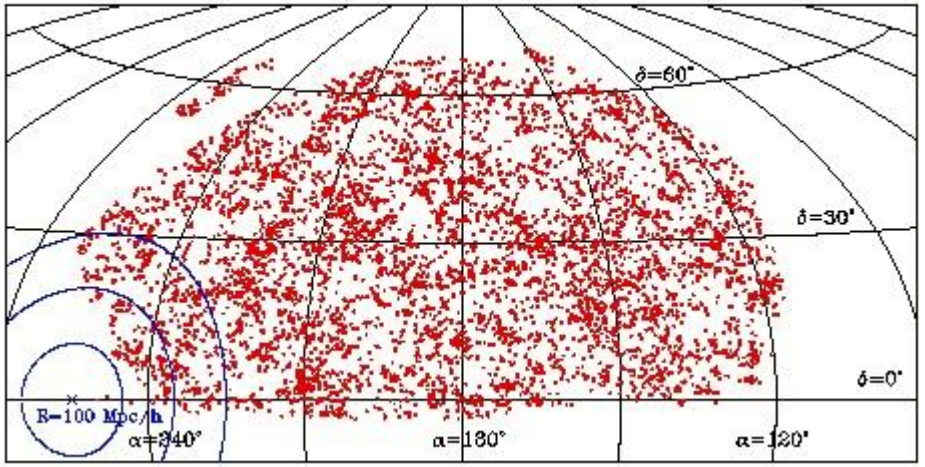
2. Data

Mock catalogs	Random catalogs
Mock SDSS-III survey N-body simulation, HR3 (Kim, J. et al. 2012)	Using SDSS DR7 LRGs catalog (Kazin et al. 2010)
All-sky(4π)	Observed area ~ π
$0 < z < 0.7$	$0.16 < z < 0.47$
Generate 1,000 mock catalogs considering angular and radial selection function	Generate 1,000 random catalogs considering angular and radial selection function

$0.237 < z < 0.263$

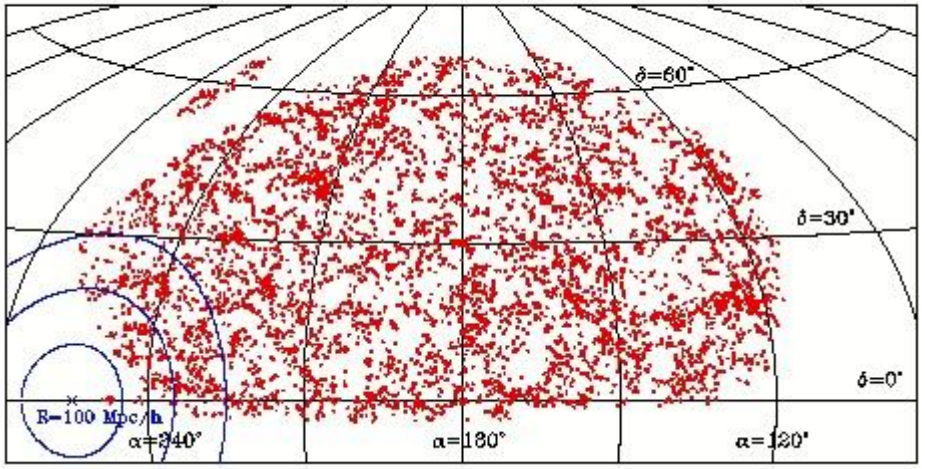
SDSS DR7 LRGs

(N=6972)



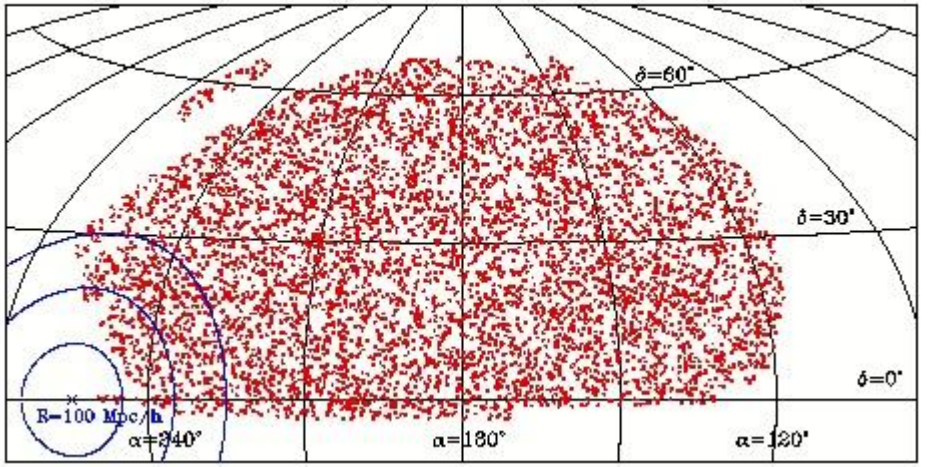
Mock catalog

(N=6957)



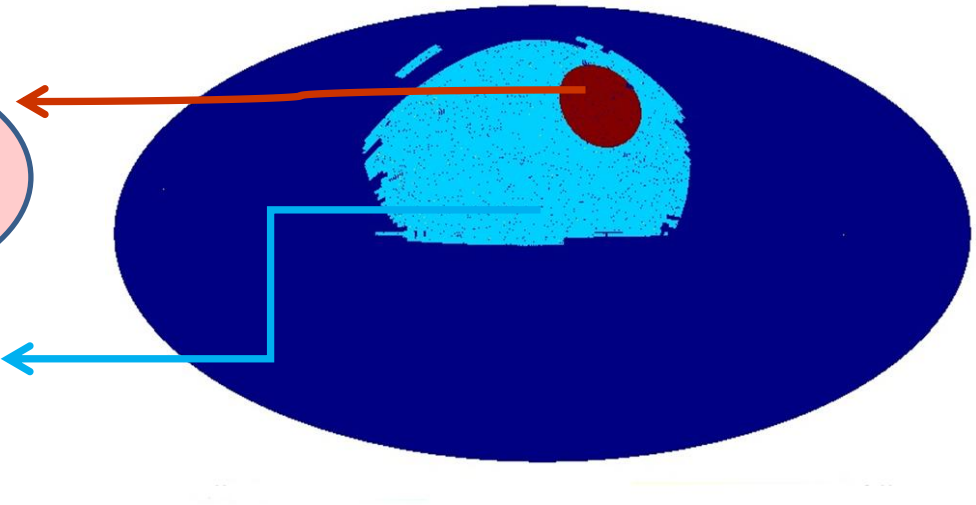
Random catalog

(N=6813)



3. Data analysis

$$\xi = \frac{N_{circle}/A_{circle}}{N_{tot}/A_{tot}}$$

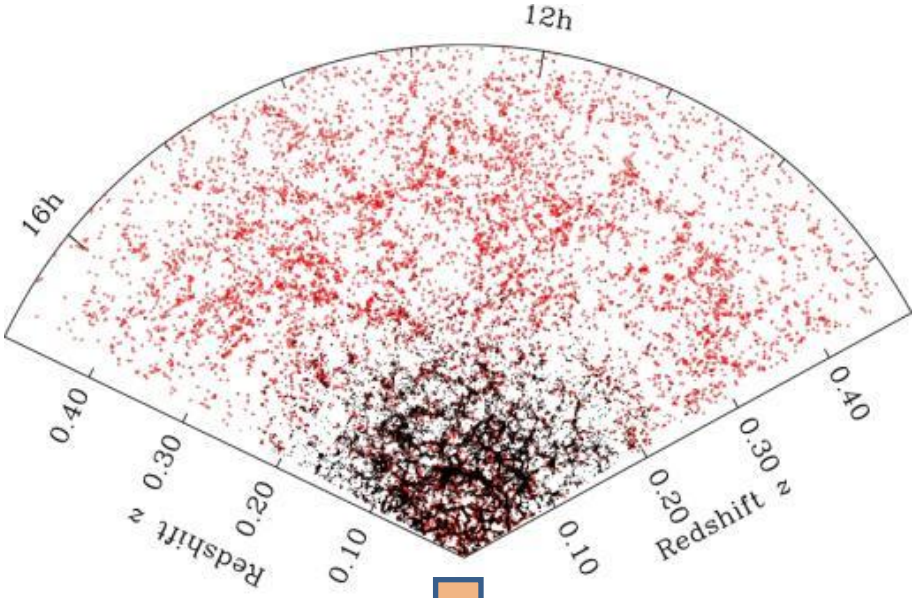


ξ =1 → homogeneous!!

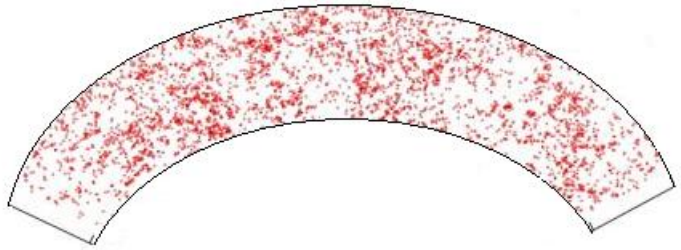
where N_{circle} : number of galaxies within circle
A_{circle} : area of circle
N_{tot} : total number of galaxies in redshift slice
A_{tot} : area of observed region

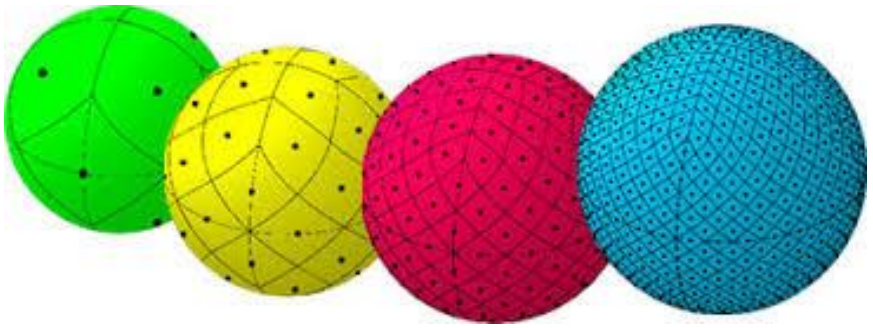
$R^D = \frac{N_{LRGs}}{N_{Random}}$	$\xi = \frac{N_{circle}/A_{circle}}{N_{tot}/A_{tot}}$
Previous study	Our study
Mean number of neighbors of a given galaxy within a spherical volume of radius R is proportional to R^D	Test is conducted by counting the number of galaxies within galaxy centered 2-dimensional space.
Highly affected by cosmological model	Less-affected by cosmological model

3. Data analysis



Redshift cut
2D analysis





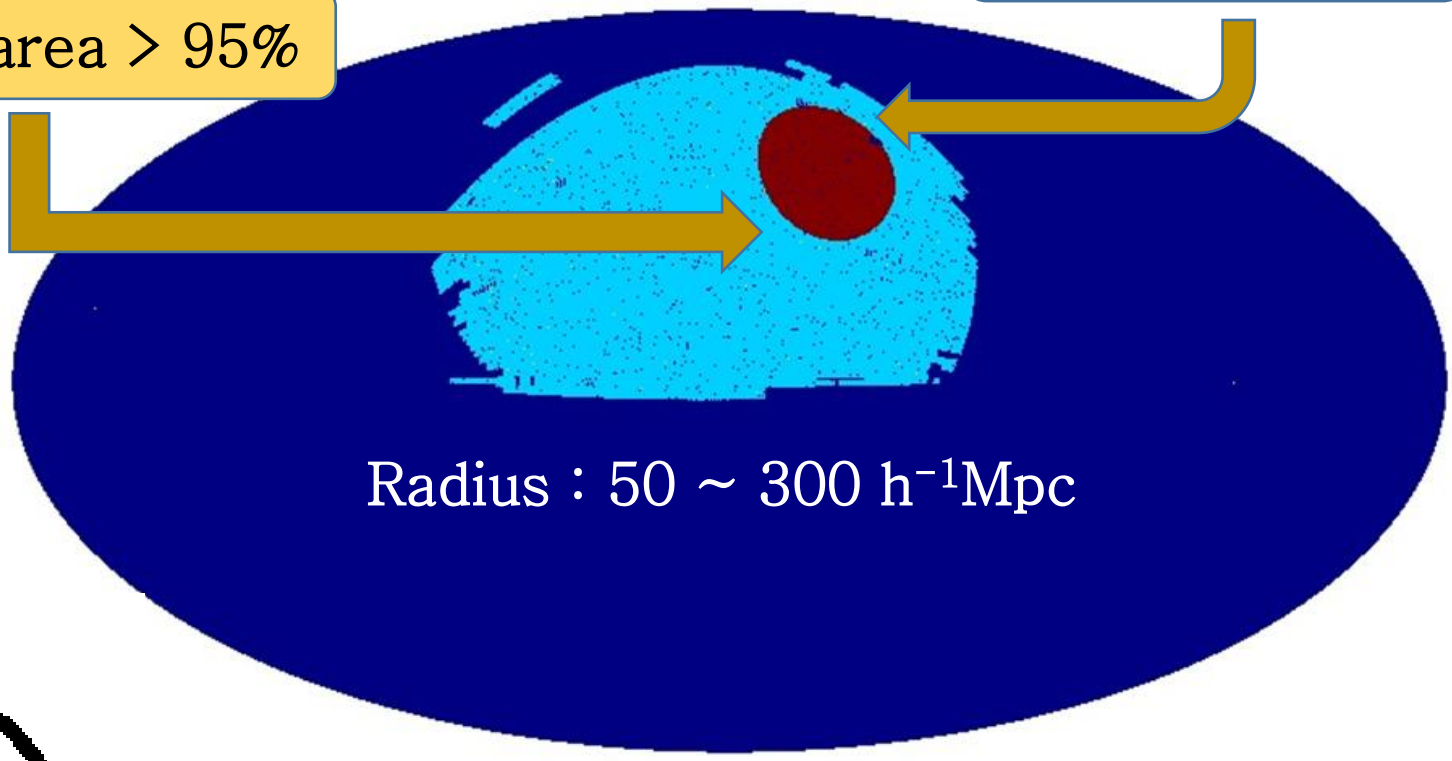
HEALPix-
The Hierarchical Equal Area iso-Latitude Pixelization
(Gorski et al. 2005)

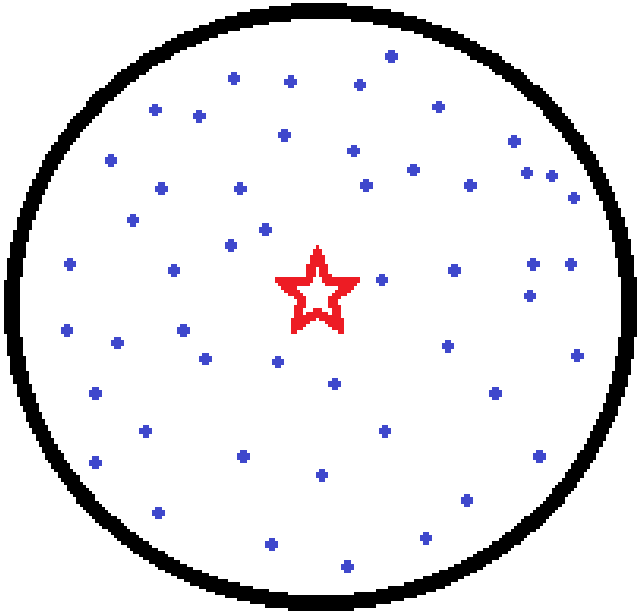
- LRGs correspond to each pixel
- Observed area of LRGs is obtained by the number counting of each pixel

3. Data analysis

$z \sim 0.225$
$R = 100\ h^{-1}$Mpc

Observed area > 95%

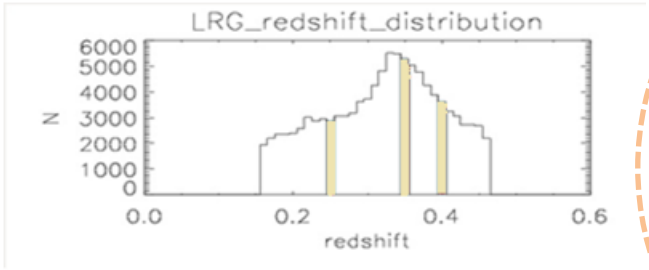




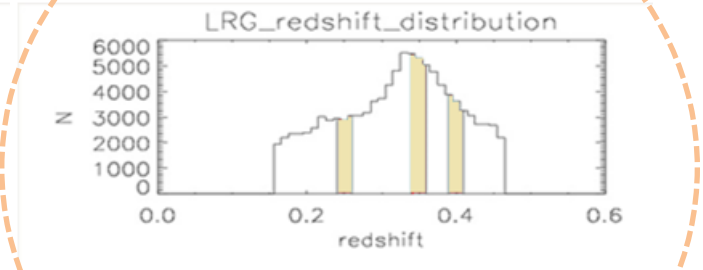
Galaxy centered circle

- 2-Dimensional Homogeneity test

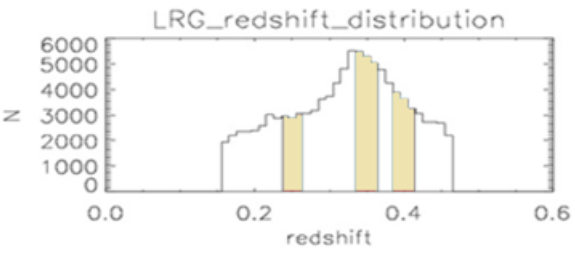
3. Data analysis



30Mpc/h



50Mpc/h



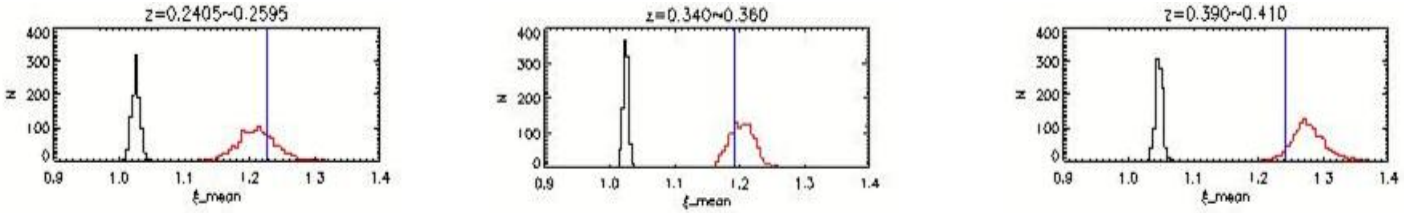
70Mpc/h

- Redshifts are sliced for 2D analysis
- In order to find out how the thickness of redshifts can affect the result.

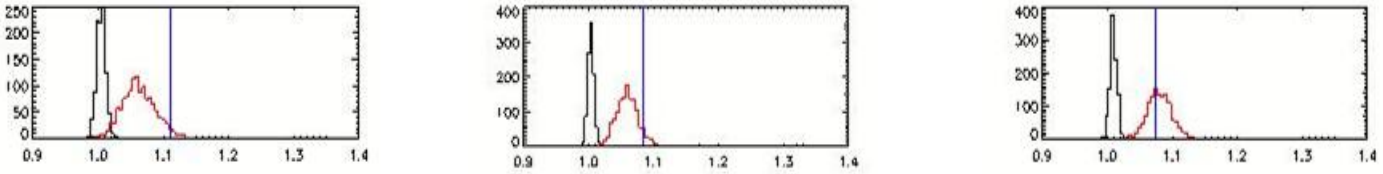
4. Results

z ~ 0.25 | z ~ 0.35 | z ~ 0.40

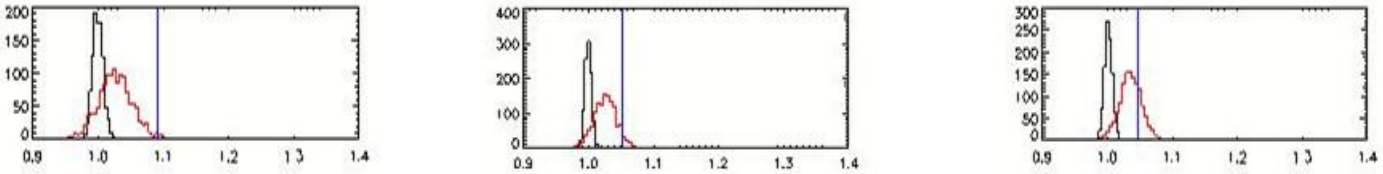
R=50Mpc/h



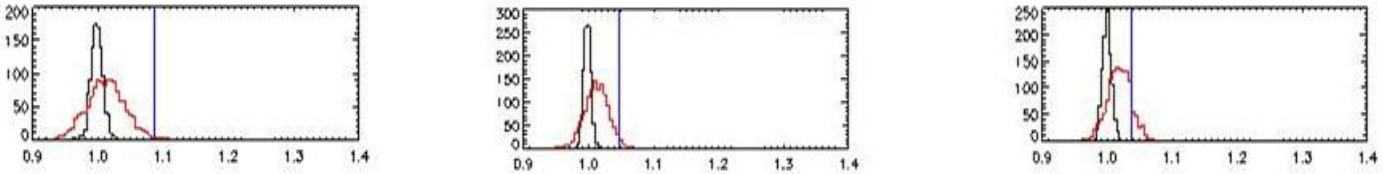
R=100Mpc/h



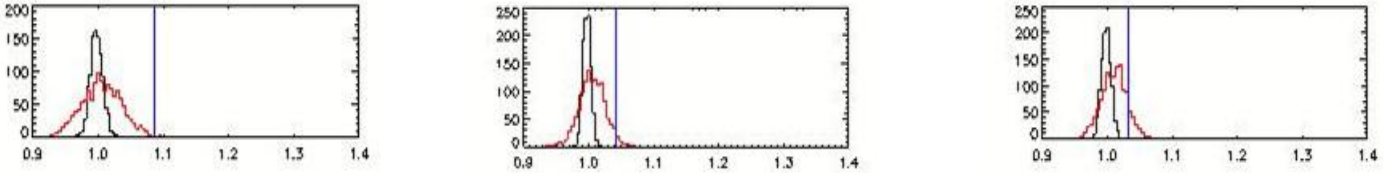
R=150Mpc/h



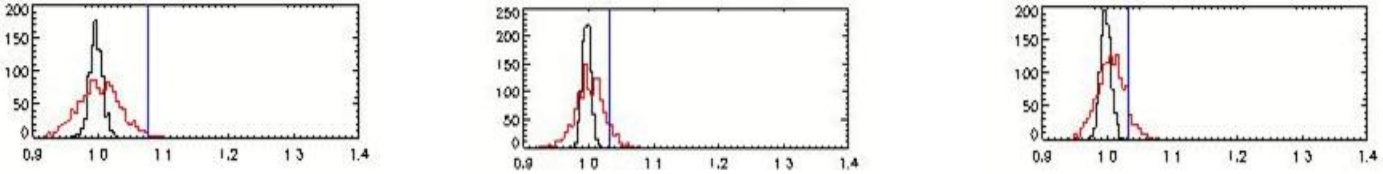
R=200Mpc/h



R=250Mpc/h



R=300Mpc/h



< ξ > | < ξ > | < ξ >

5. Summary

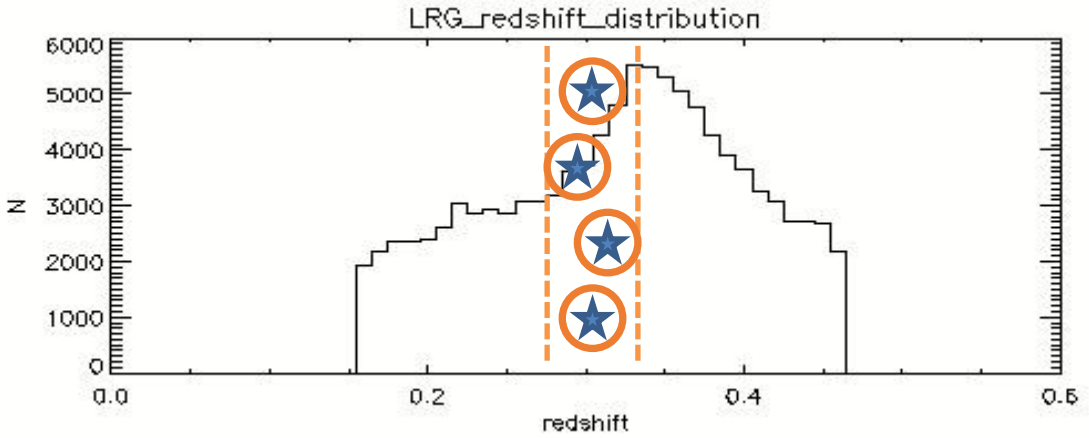
(1) The <ξ> distribution of mock data approaches to that of Random data at the radius of circular disk increases.

(2) <ξ> distribution of LRGs data tends to overlap with that of Mock data, but significant deviation from the prediction of Random data.

(3) Our results are robust because the behavior of ξ statistics is insensitive to the redshift and the thickness of redshift-slice.

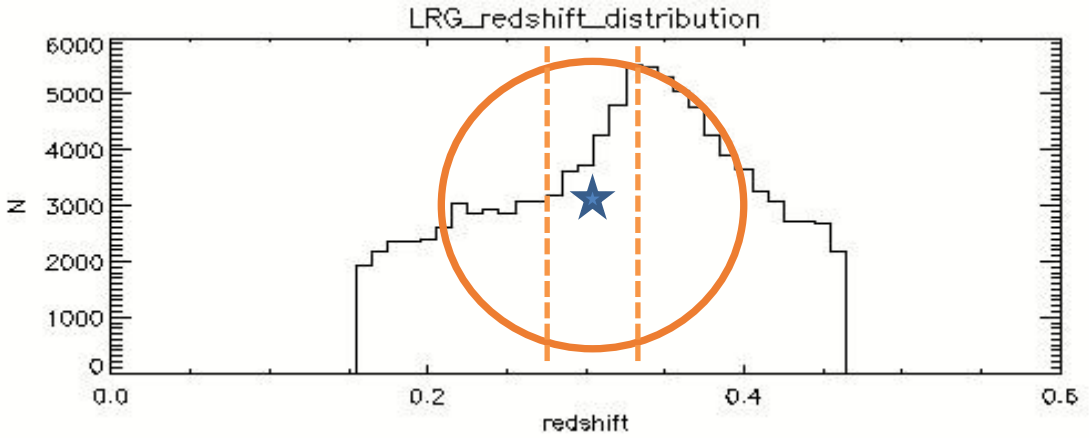
The large-scale structure is consistent with mock data but not consistent with random data as the radius approaches $300h^{-1}$Mpc.

6. Future works (2D+ 3D)



• Center galaxies selected in redshift-slice(2D)

• Counting the number of galaxies in circle at radius R within redshift-slice(2D)



• Center galaxies selected in redshift-slice(2D)

• Counting the number of galaxies in sphere at radius R(3D)

Korea Astronomy and Space Science Institute

Thank you !

This presentation is supported by Korea Yam(KYAM) and KASI