Horizon Run 4 Mock Galaxy Catalog
Application I. Repeatability of Large-scale Structures

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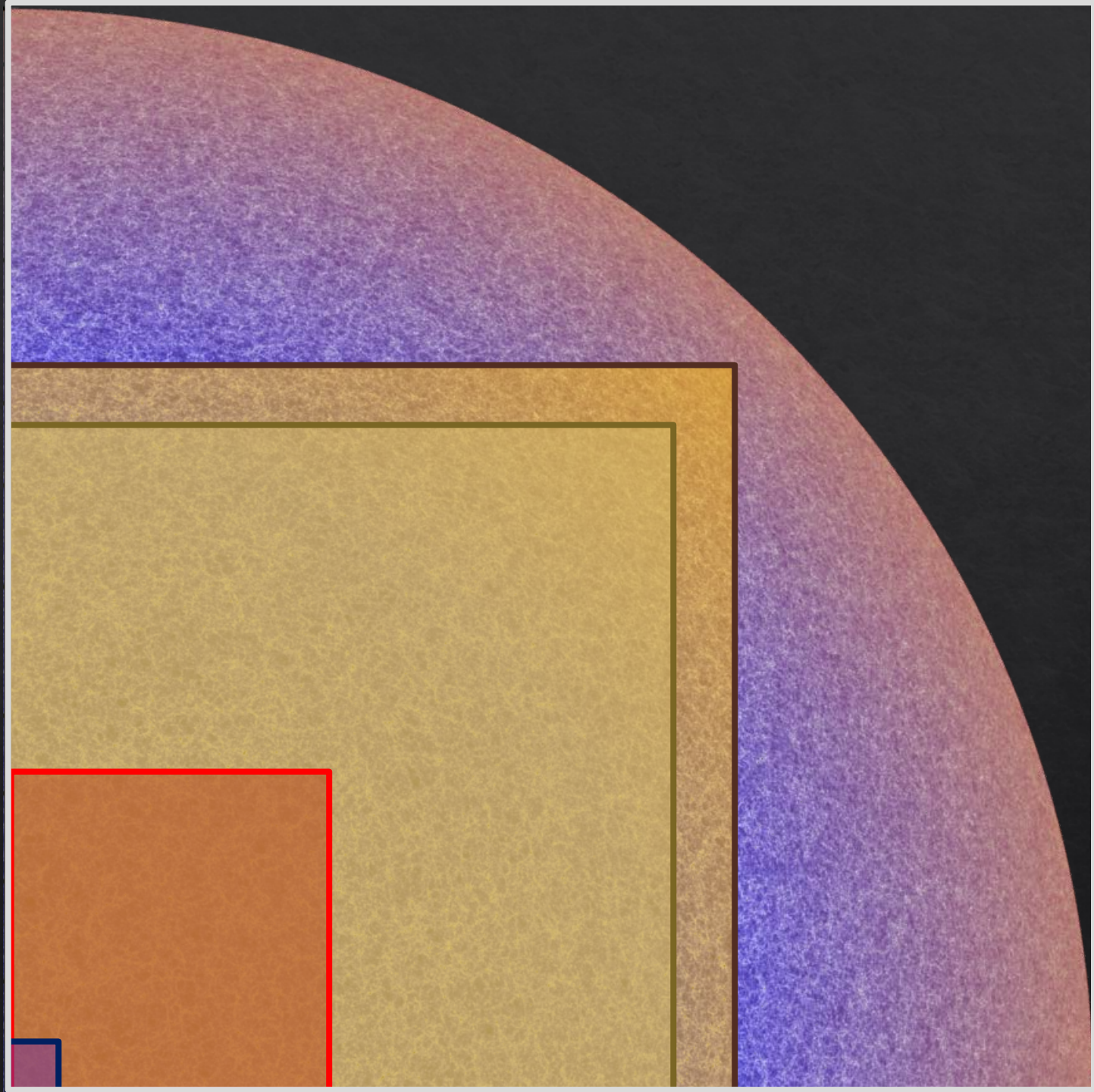*@ The 7th SSG Meeting, High-One Resort, Korea, Jan. 17th, 2018*

Horizon Run 3:
$10,815\ h^{-1}\mathrm{Mpc}$

Horizon Run 2:
$7,200\ h^{-1}\mathrm{Mpc}$
$(z \sim 12)$

Horizon Run 1:
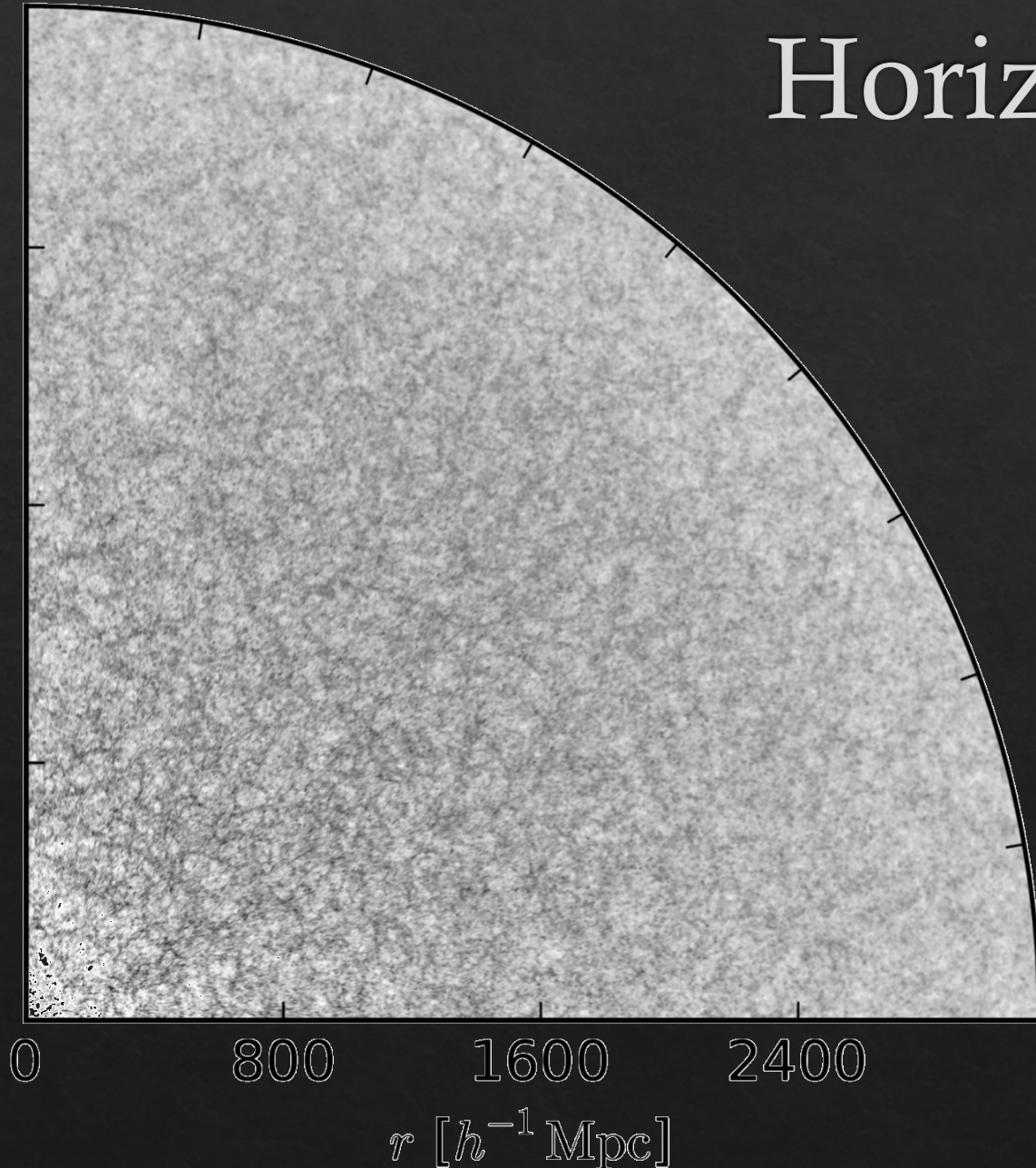$6,592\ h^{-1}\mathrm{Mpc}$
$(z \sim 8)$

Horizon Run 4:
$3,150\ h^{-1}\mathrm{Mpc}$
$(z \sim 1.5)$

Millenium:
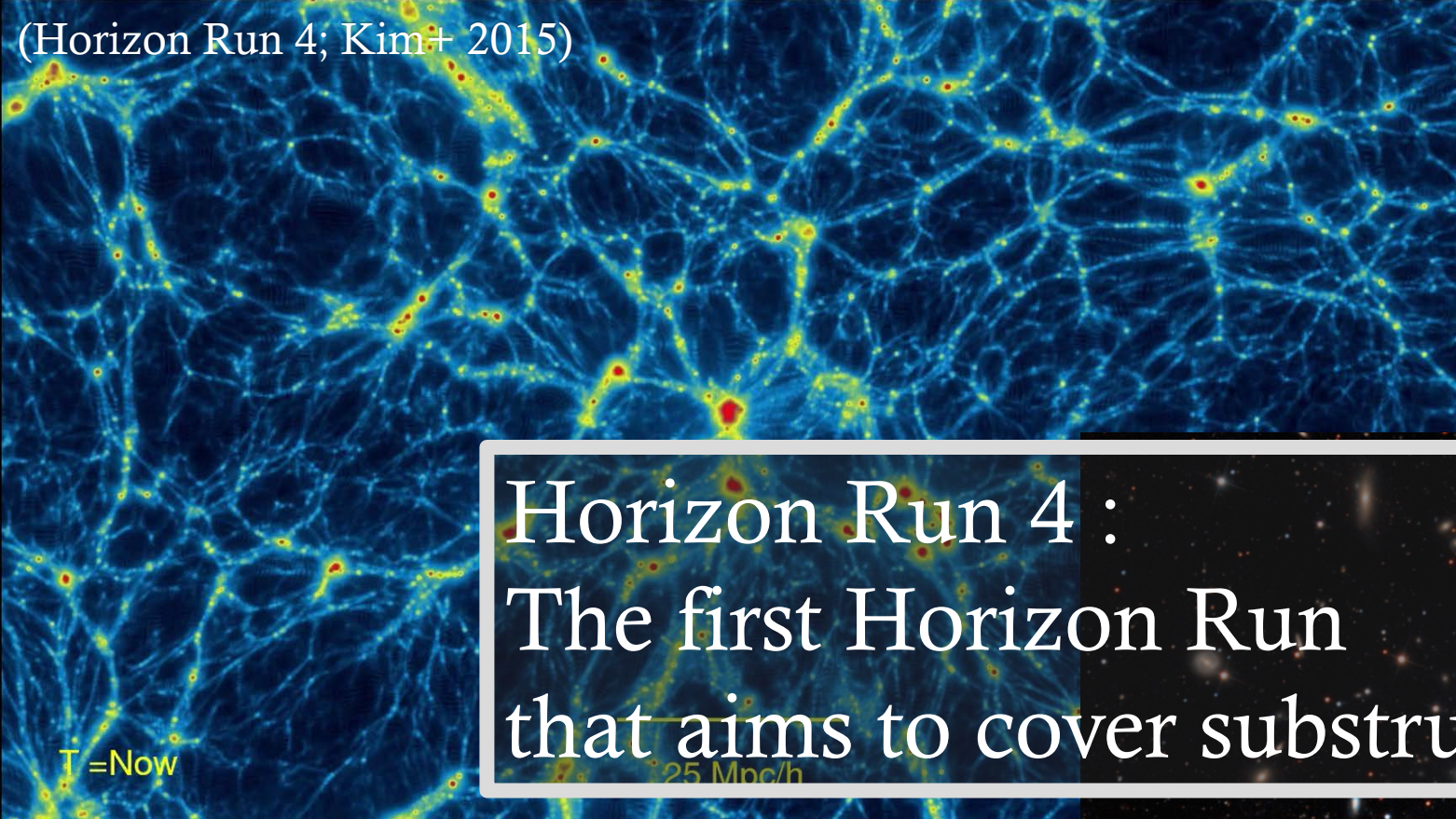$500\ h^{-1}\mathrm{Mpc}$
$(z \sim 0.17)$
(Springel+2005)

Horizon Run 4 Simulation

(Kim, Park, L'Huillier & **SEH**, 2015)

◇ $6,300^3$ DM particles
   in $3,150 h^{-1}$Mpc box

◇ WMAP5 ΛCDM cosmology

◇ Lowest halo mass:
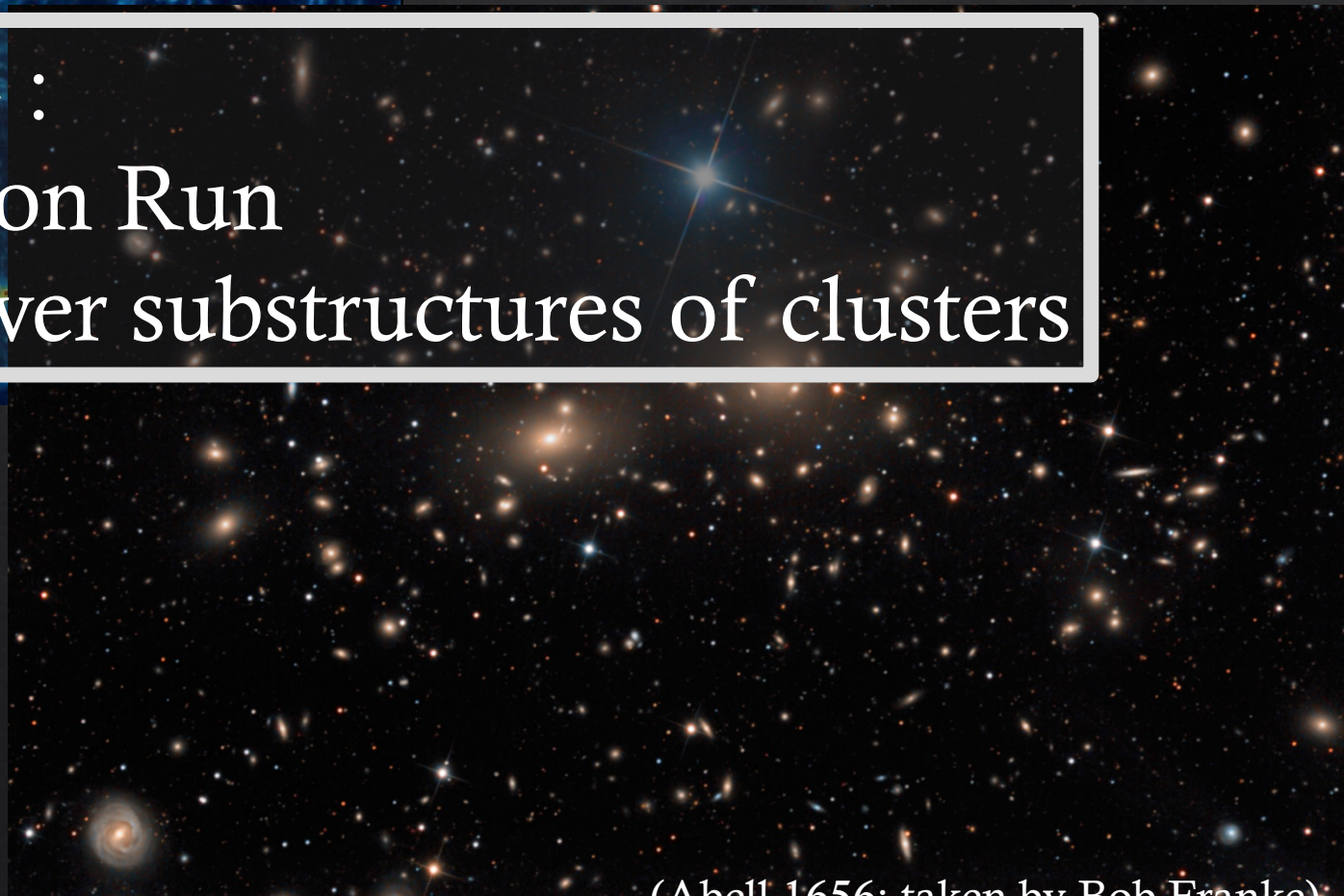 $2.7 \times 10^{11}\ h^{-1} M_\odot$

◇ Full-sky lightcone up to $z = 1.5$

(Horizon Run 4; Kim+ 2015)

T =Now

25 Mpc/h

Horizon Run 4 :
The first Horizon Run
that aims to cover substructures of clusters
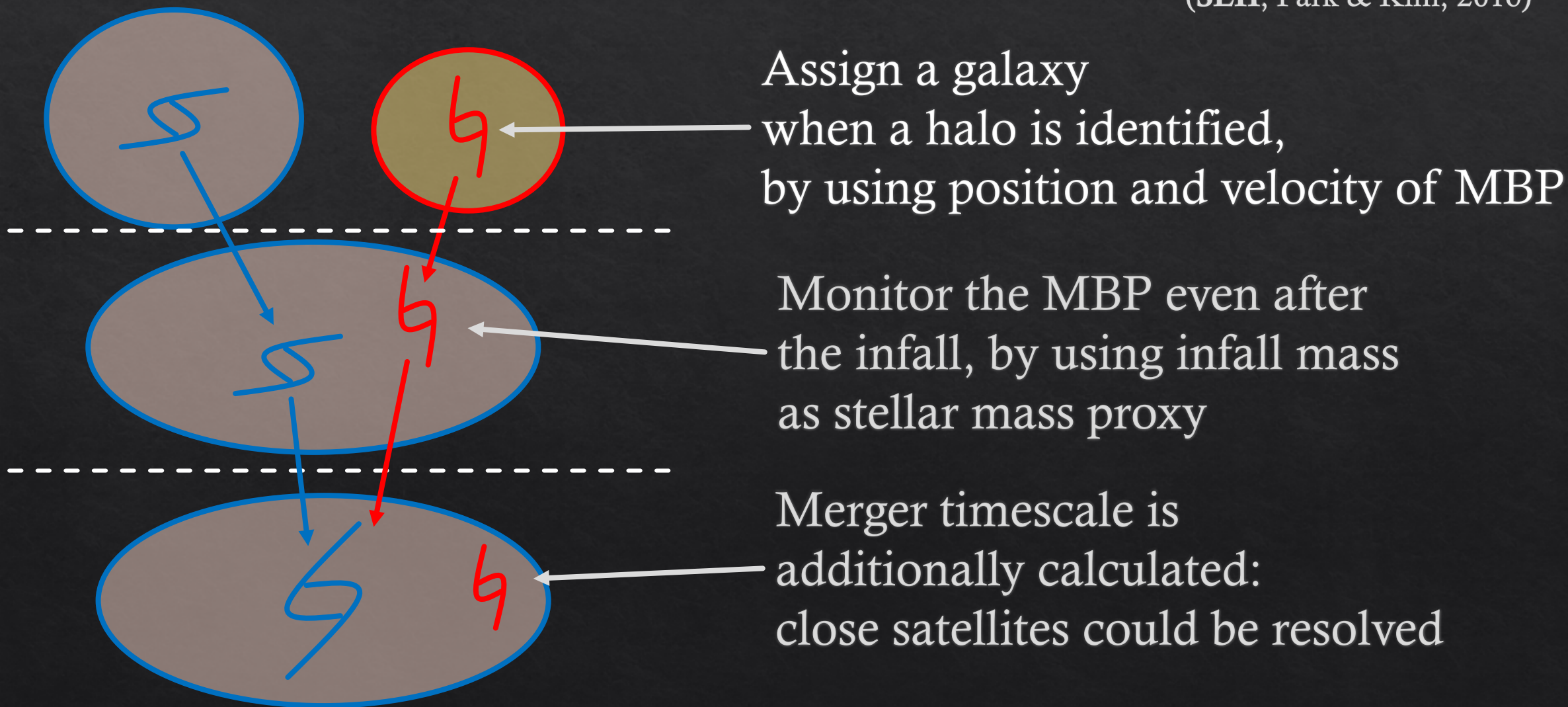
STAY TUNED:
Horizon Run 5 !

(Abell 1656; taken by Bob Franke)

Galaxy Assignment :
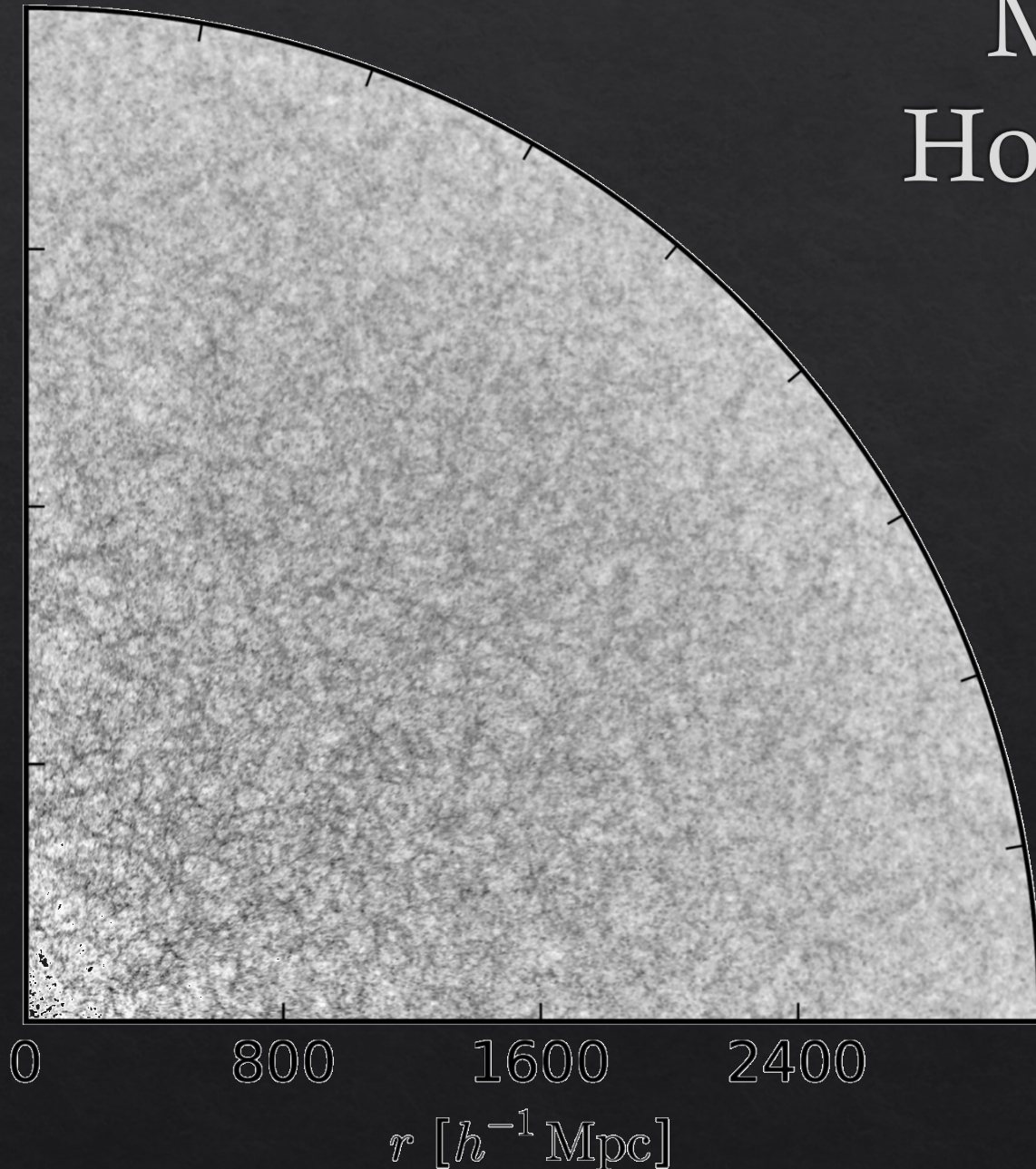# Most Bound Halo Particle-Galaxy Correspondence
(**SEH**, Park & Kim, 2016)
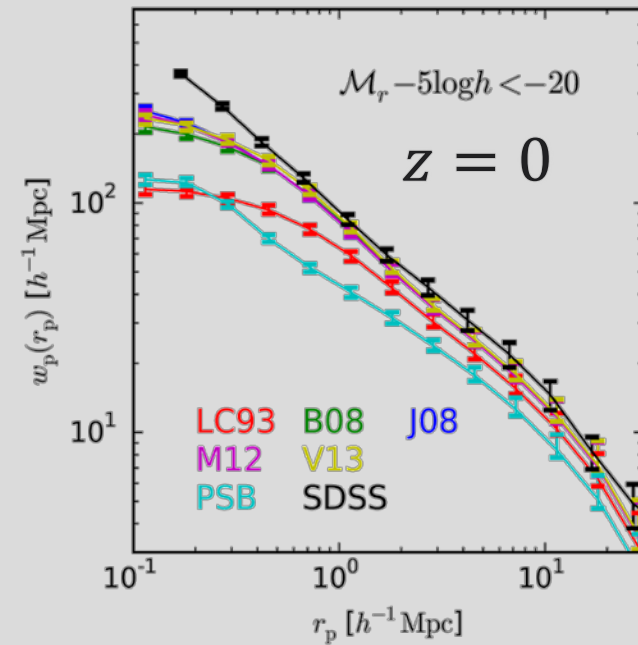
Assign a galaxy
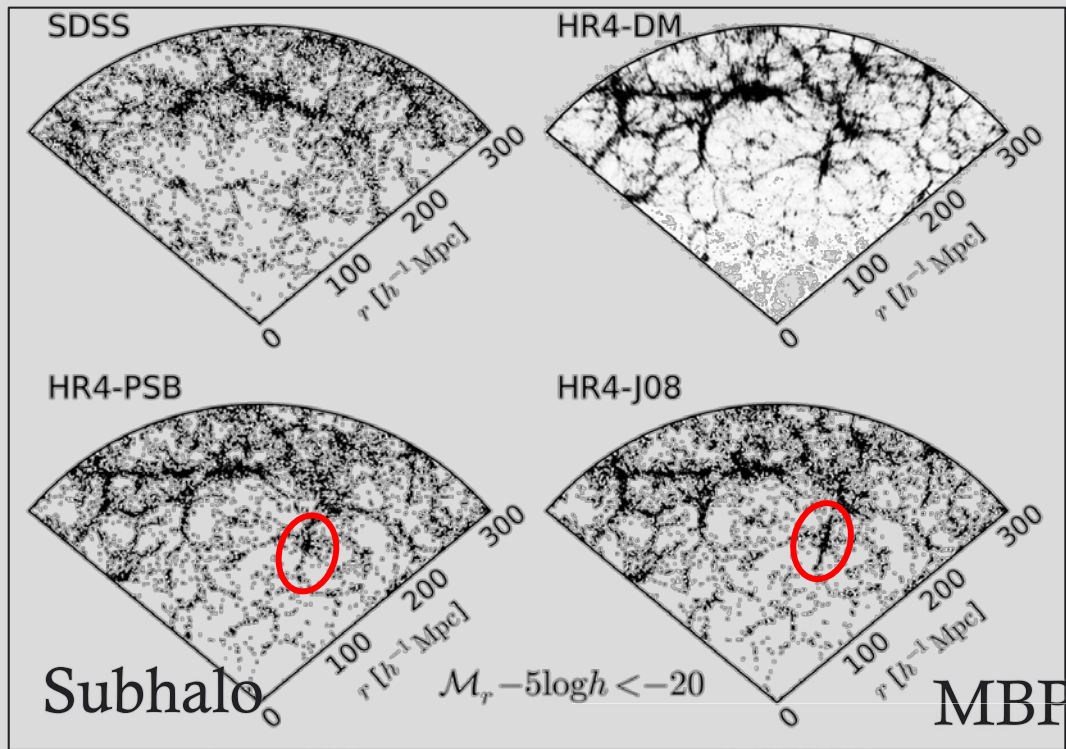when a halo is identified,
by using position and velocity of MBP

Monitor the MBP even after
the infall, by using infall mass
as stellar mass proxy

Merger timescale is
additionally calculated:
close satellites could be resolved

Mock Galaxy Catalog in Horizon Run 4 Simulation

◈ Snapshot data for z = 0, 0.5, 1, ...

◈ Full-sky lightcone up to z = 1.5

◈ 10^9 galaxies at z = 0,
within $(3150h^{-1}\mathrm{Gpc})^3$

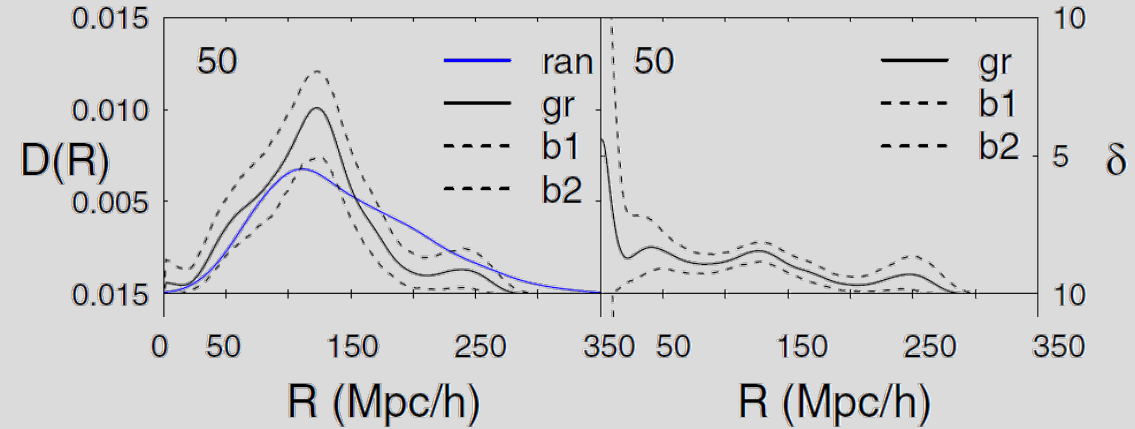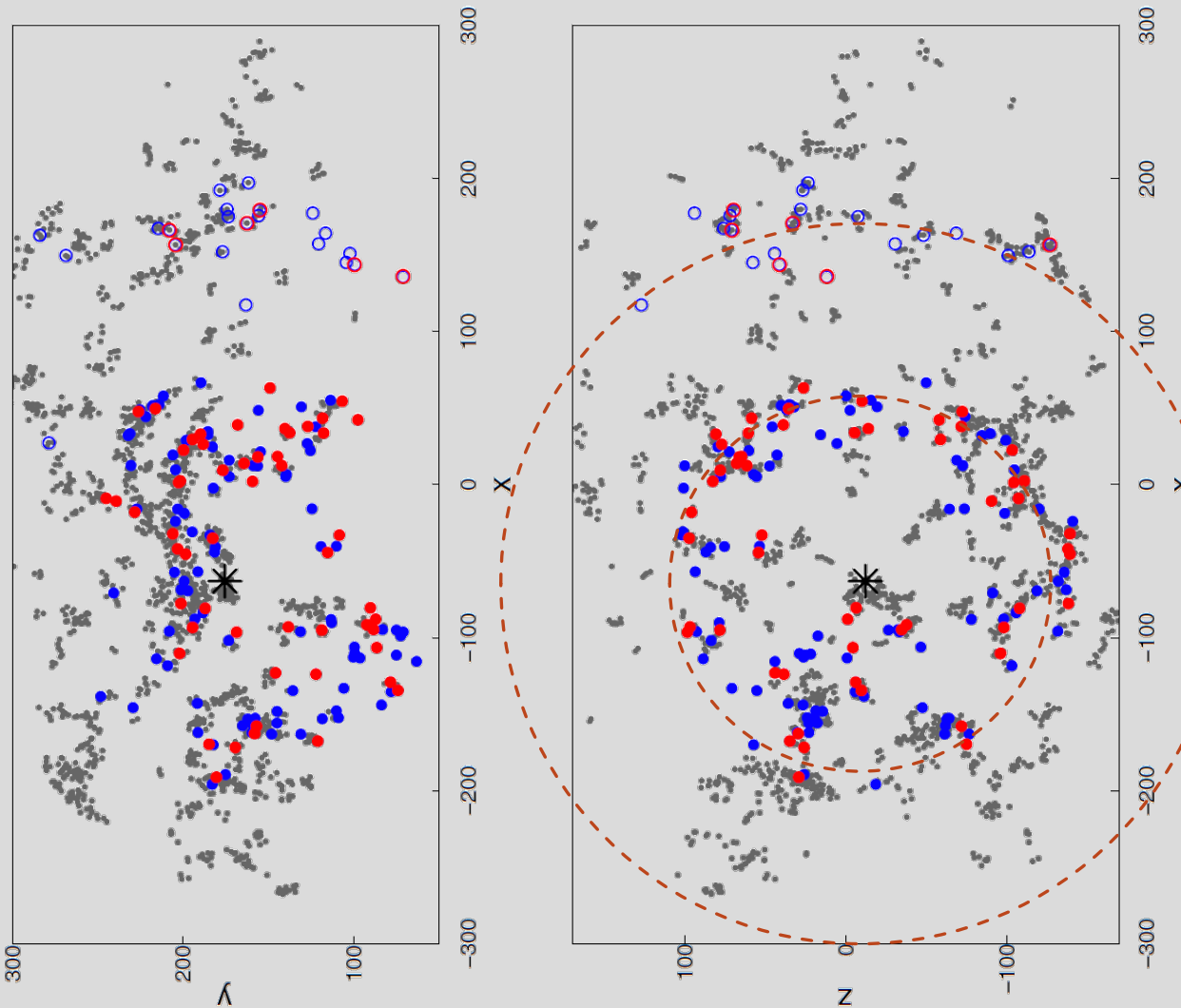$r\ [h^{-1}\,\mathrm{Mpc}]$

0   800   1600   2400

SDSS

HR4-DM

300

200

100

0

$r\,[h^{-1}\mathrm{Mpc}]$

300

200

100

0

$r\,[h^{-1}\mathrm{Mpc}]$

HR4-PSB

HR4-J08

300

200

100

0

$r\,[h^{-1}\mathrm{Mpc}]$

$\mathcal{M}_r - 5\log h < -20$

300

200

100

0

$r\,[h^{-1}\mathrm{Mpc}]$

Subhalo

MBP

$\mathcal{M}_r - 5\log h < -20$

$z = 0$

$w_{\mathrm{p}}(r_{\mathrm{p}})\,[h^{-1}\mathrm{Mpc}]$

10^2

10^1

LC93 B08 J08
M12 V13
PSB SDSS

10^{-1} 10^0 10^1

$r_{\mathrm{p}}\,[h^{-1}\mathrm{Mpc}]$

(**SEH**, Park & Kim, 2016)

This work, predicted constraints from 1,749 million galaxies
Alcock−Paczynski test using 1.4 million BOSS DR12 galaxies
CMB TT, TE, EE+lowP (*Planck*)
CMB TT, TE, EE, lowP (*Planck*) + JLA SNIa + H_0 +
BAO + AP from BOSS DR12 galaxies

-0.4

-0.6

-0.8

w -1.0

-1.2

-1.4

-1.6

(Li+, 2017)

0.10 0.15 0.20 0.25 0.30 0.35 0.40

Ω_m

Repeatability of Large-scale Structure?



Einasto+ (2016) claims:
- Found a few shell-like structure of galaxy groups
- Shell radius is $119 - 135h^{-1}$Mpc, which is different from BAO scale ($109h^{-1}$Mpc)

- Is it false pattern recognition or coincidence?
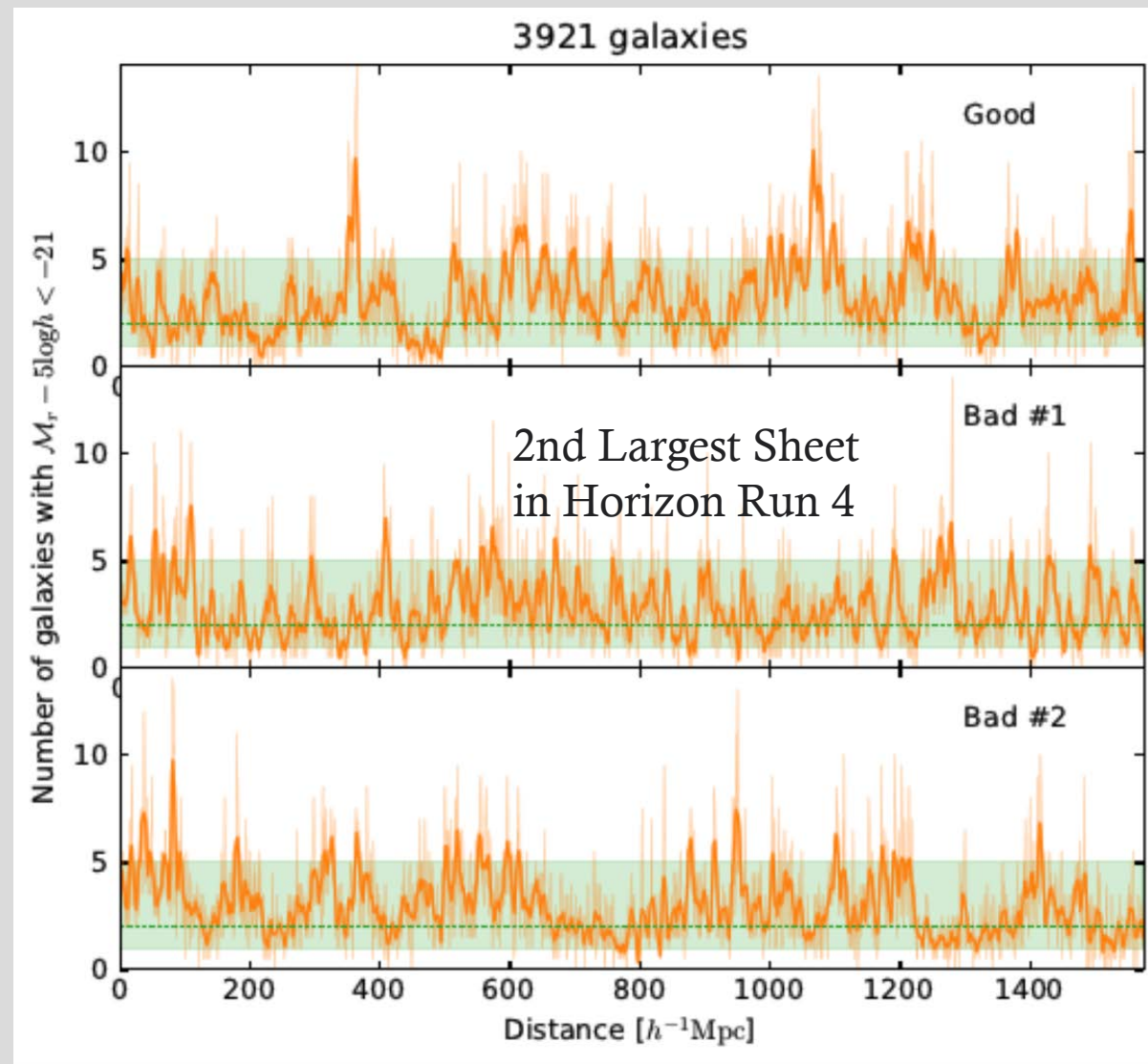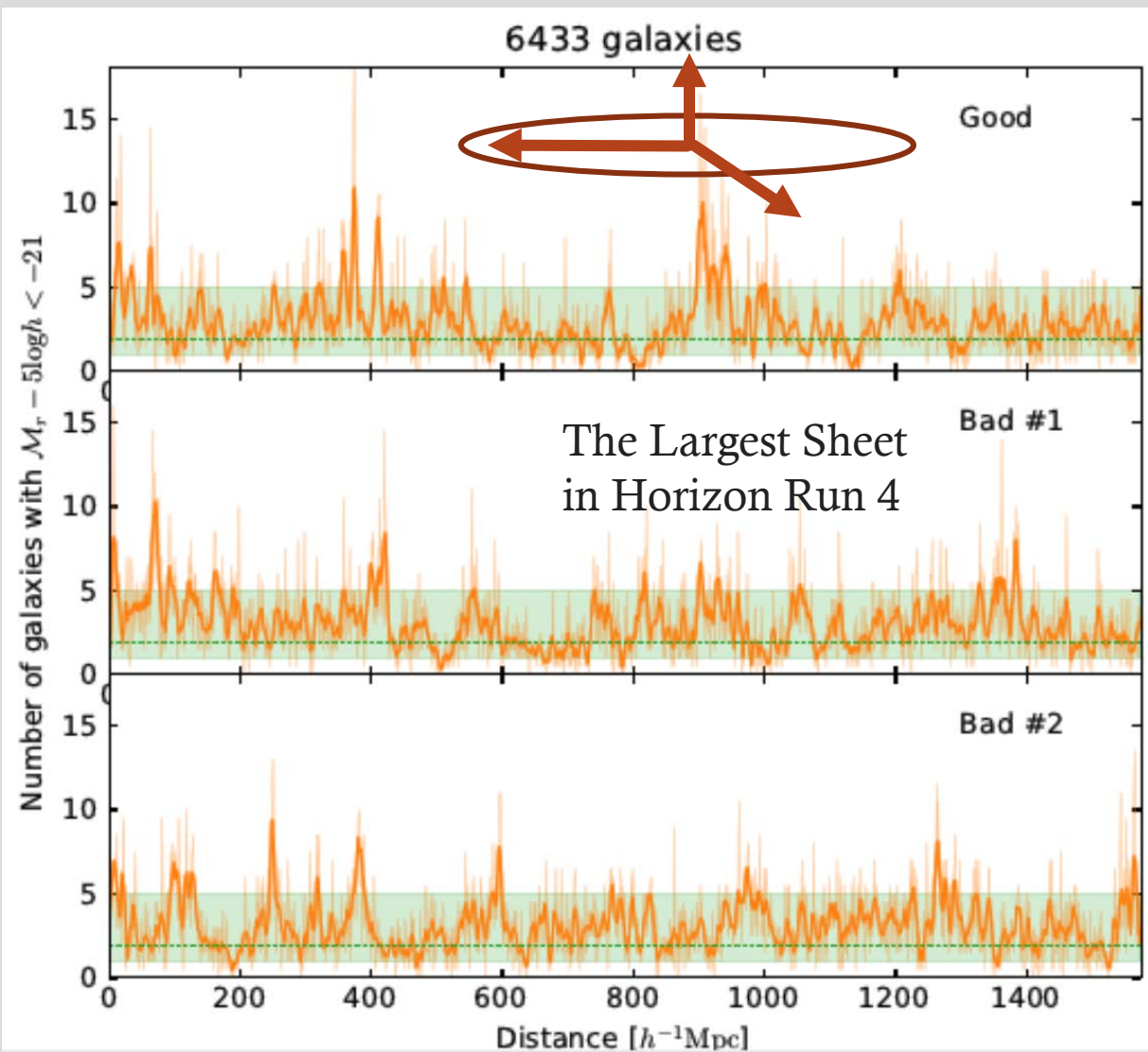- Or is it real, with physical background?

Test 1: Galaxy Number Density around Large Clusters

The Largest Cluster in Horizon Run 4

3rd Largest Cluster in Horizon Run 4
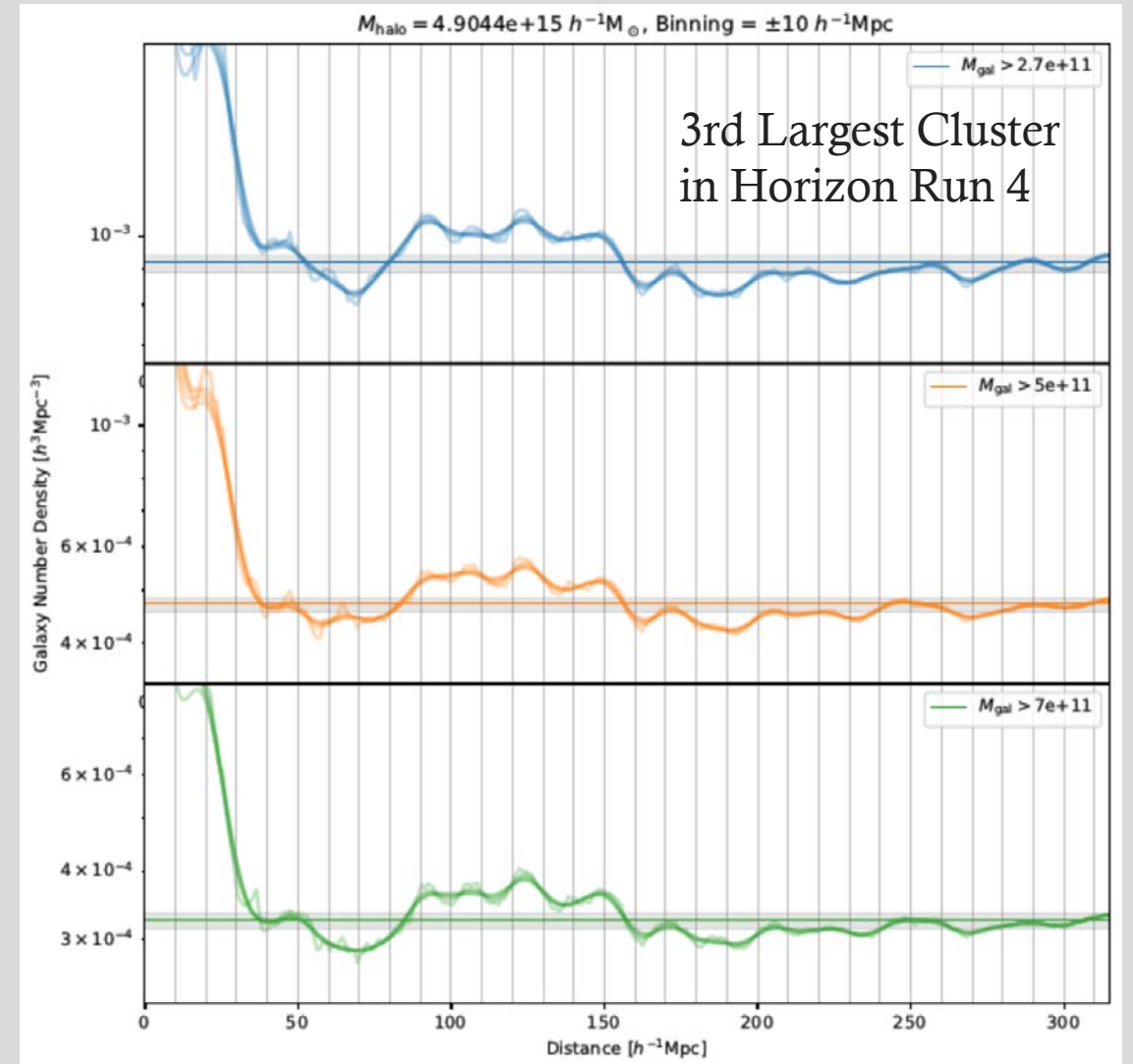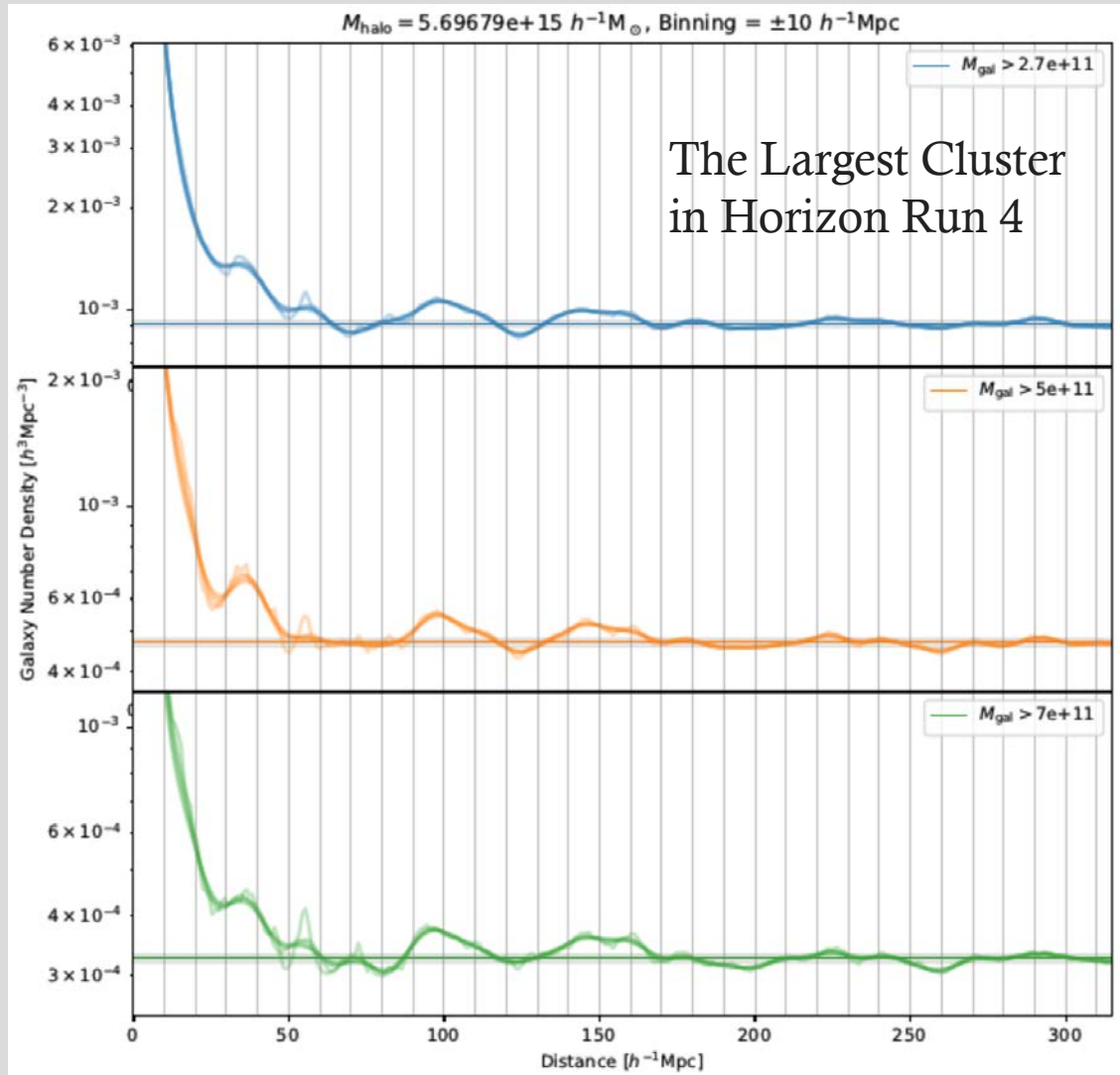
Test 1: Galaxy Number Density around Large Clusters
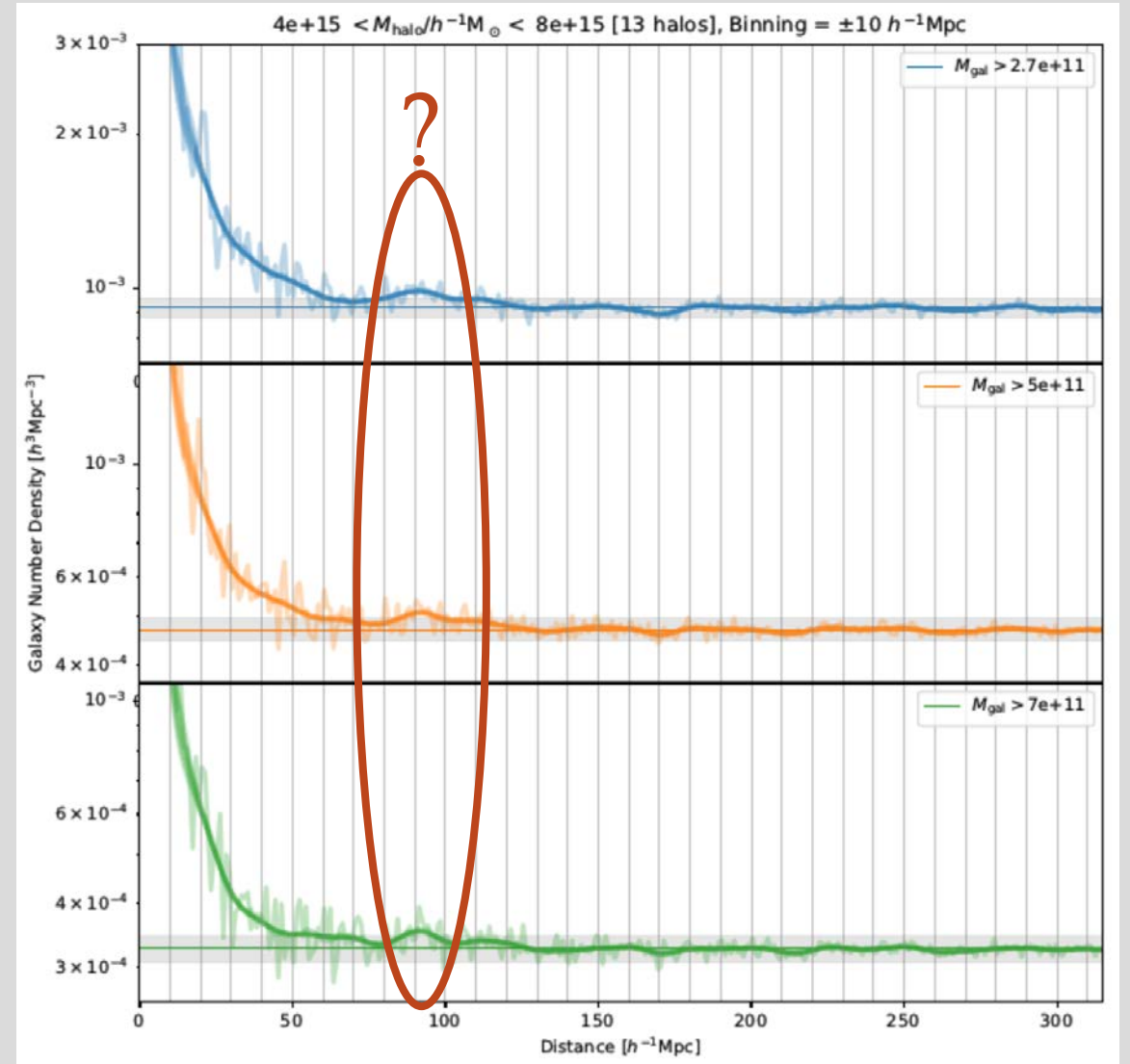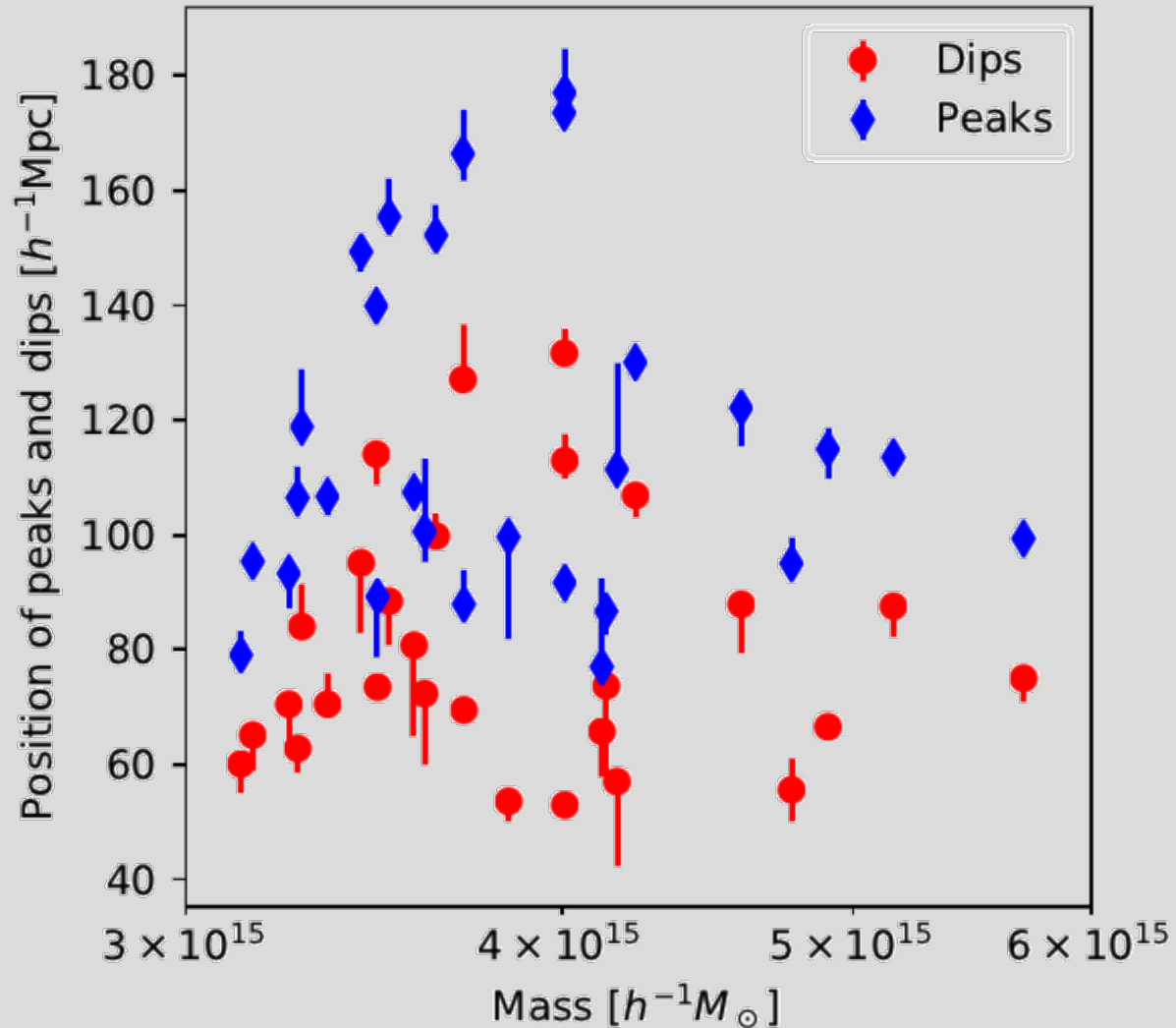
Test 2: Galaxy Number Density around Large Sheets

Summary

◈ Horizon Run 4 mock galaxy catalog is available,
both for snapshot data and lightcone data up to $z = 1.5$

◈ Horizon Run 4 mock galaxy catalog can be applied
to study various topics, including repeatability of large-scale
structures.