

PROGRESS REPORT: REPEATABILITY OF VERY-LARGE-SCALE STRUCTURES IN THE HORIZON RUN 4 SIMULATION

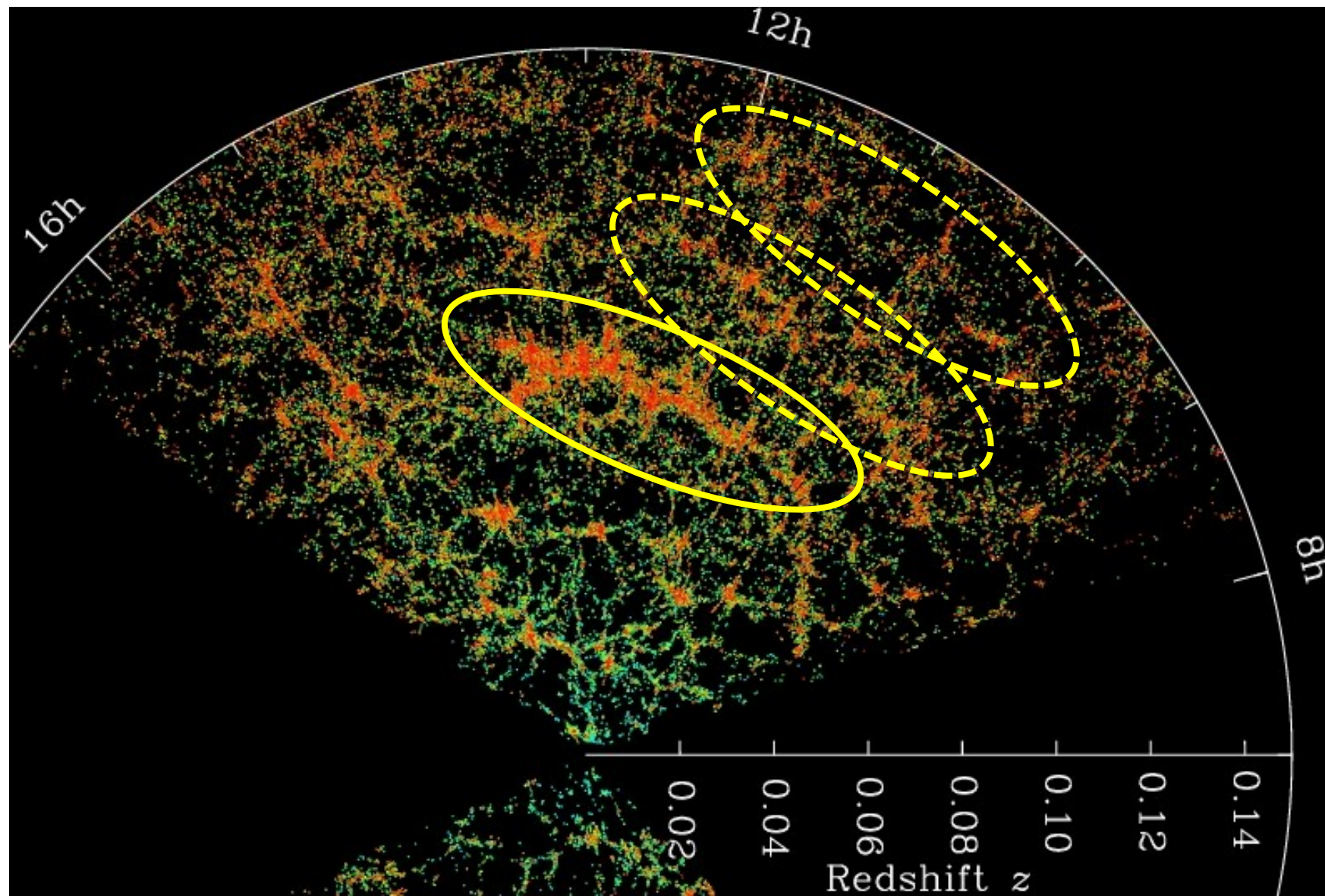
Sungwook E. Hong (U. Seoul)

with Changbom Park (KIAS)

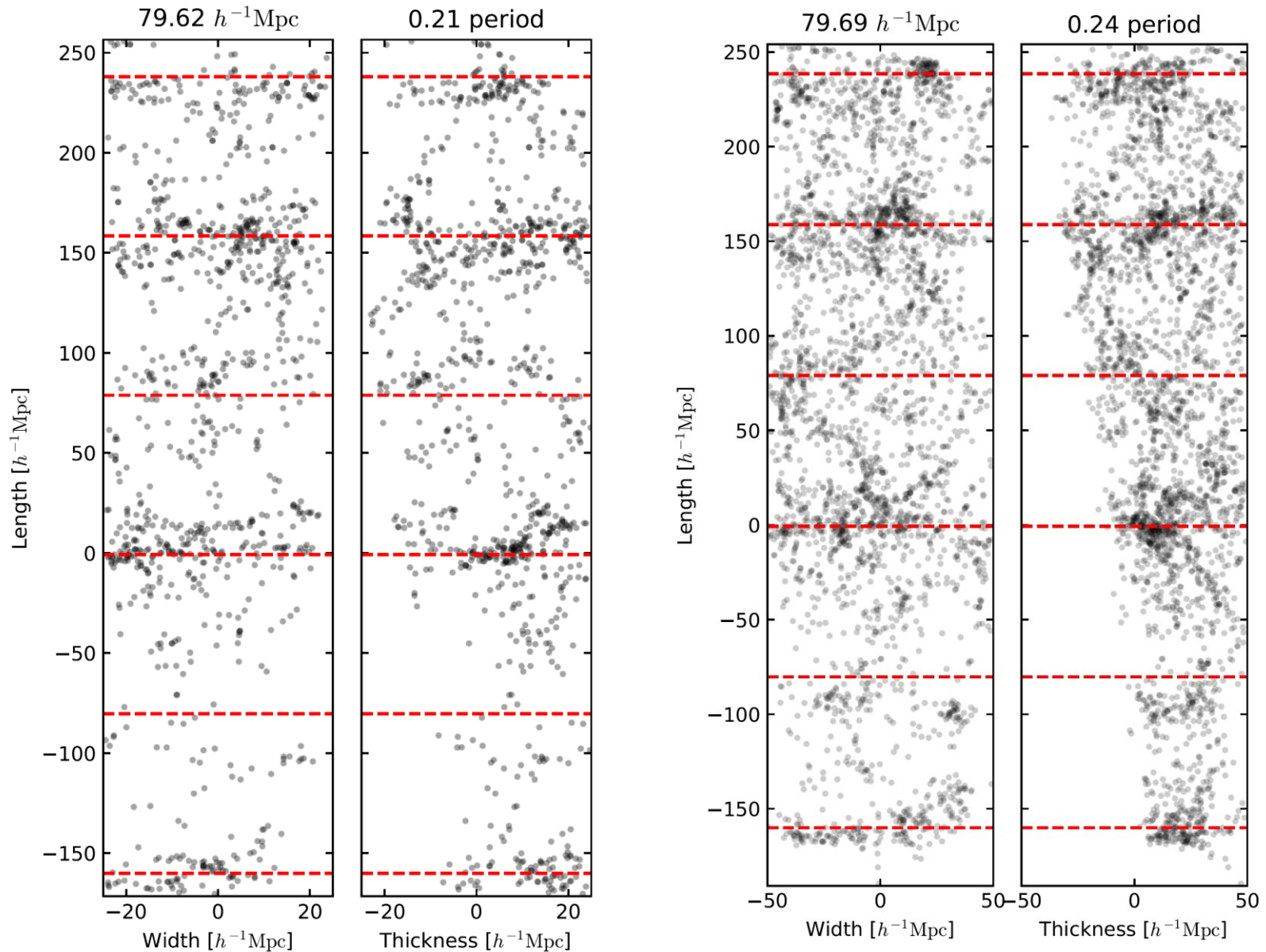
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Apr. 23rd, 2019

REPEATABILITY OF VERY-LARGE-SCALE STRUCTURES (VLSSs)?

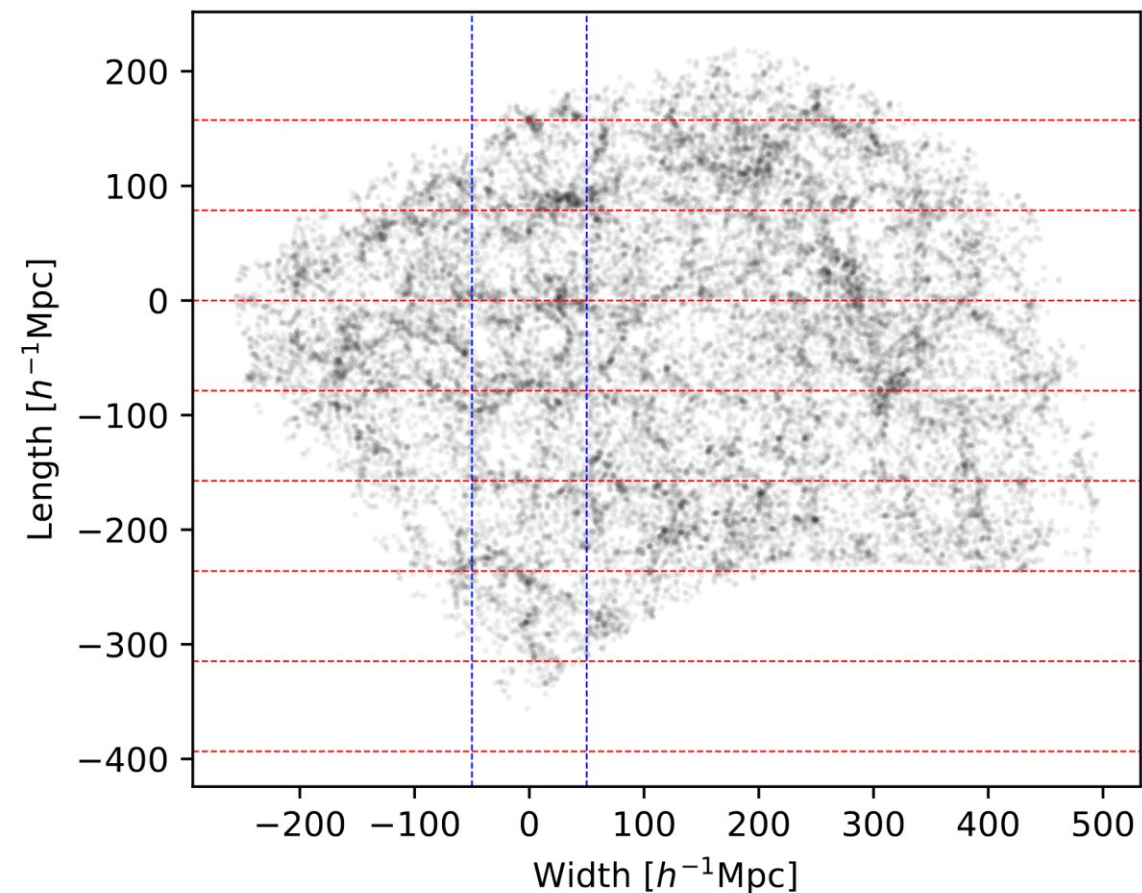


REPEATABILITY OF VERY-LARGE-SCALE STRUCTURES (VLSSs)?

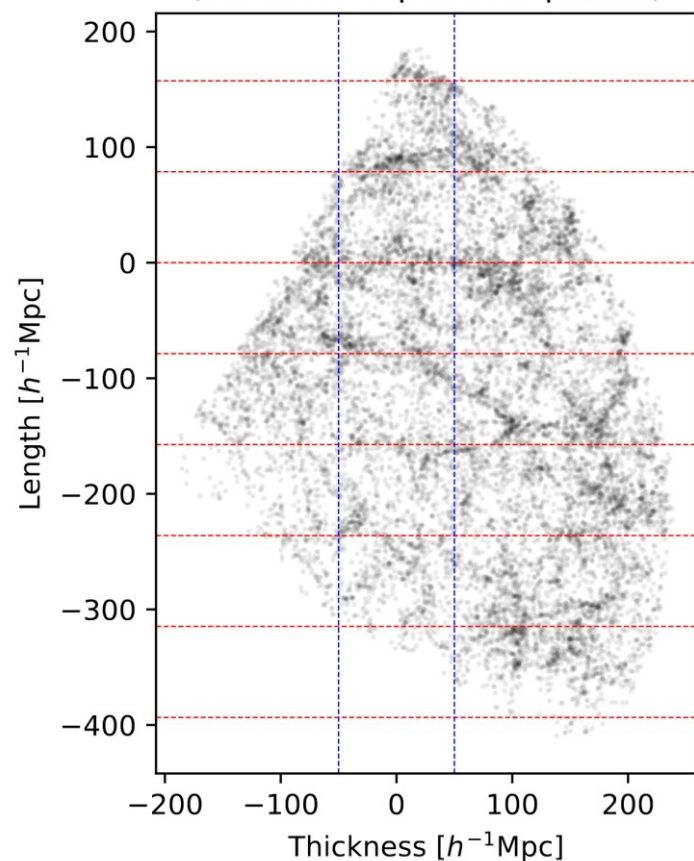


REPEATABILITY OF VERY-LARGE-SCALE STRUCTURES (VLSSs)?

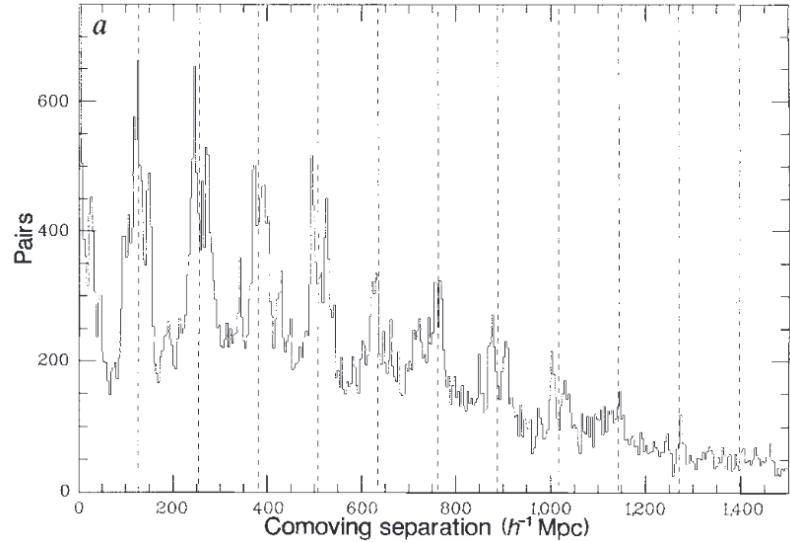
(78.69 h^{-1} Mpc, 0.23 period)



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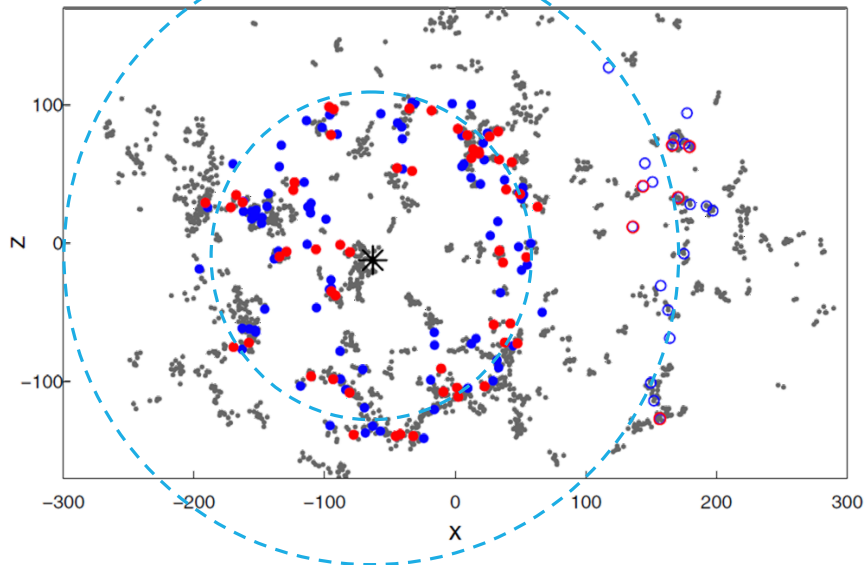


REPEATABILITY OF VERY-LARGE-SCALE STRUCTURES (VLSSs)?



Broadhurst+ (1990) :
 $\sim 127 h^{-1}$ Mpc periodicity
in pencil beam survey?

Einasto+ (1997) :
 $\sim 120 h^{-1}$ Mpc separation
between superclusters?



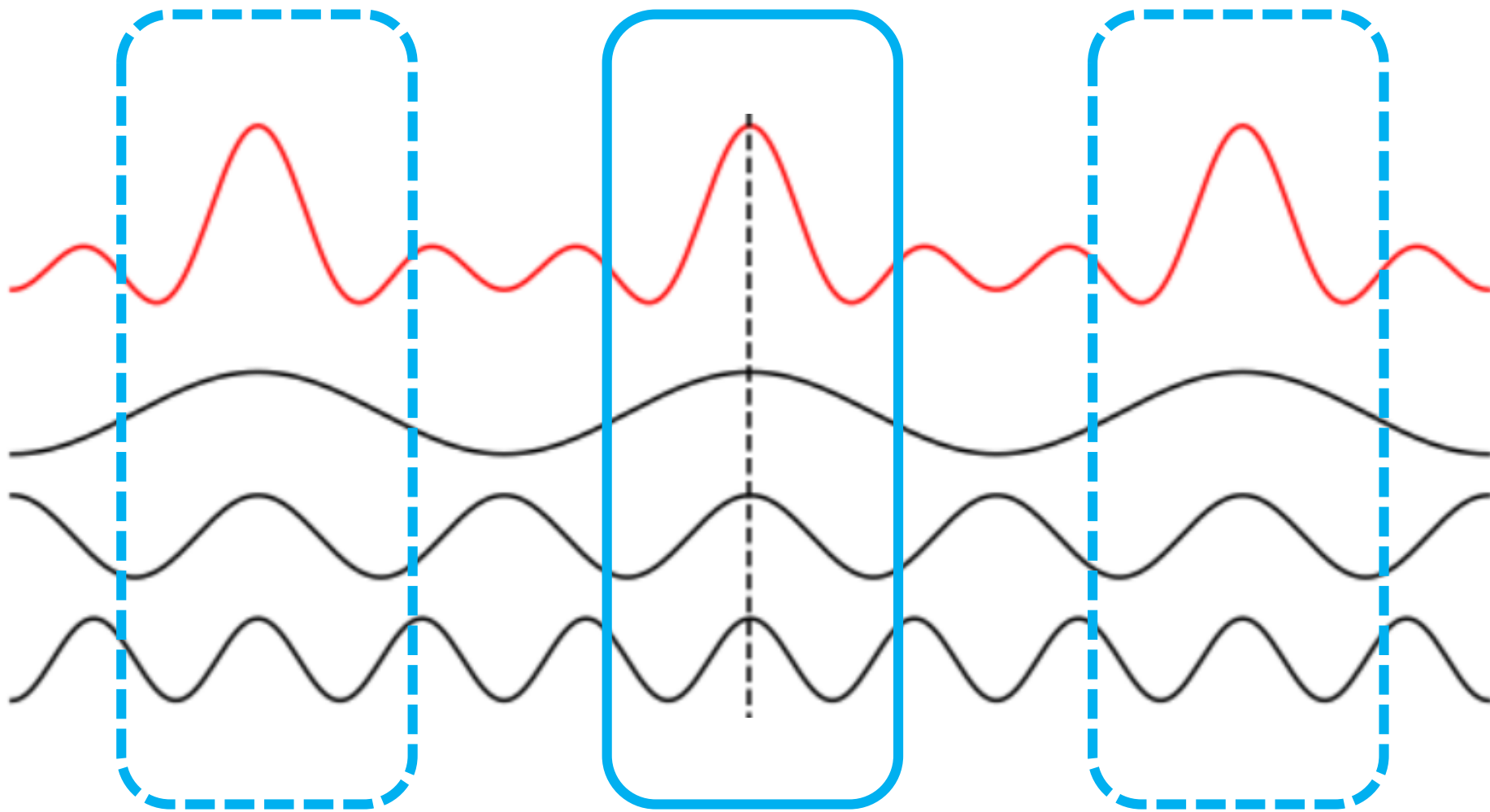
Einasto+ (2016):
 $119 - 135 h^{-1}$ Mpc radius
shell structures
around superclusters?

Real one with physical meaning?

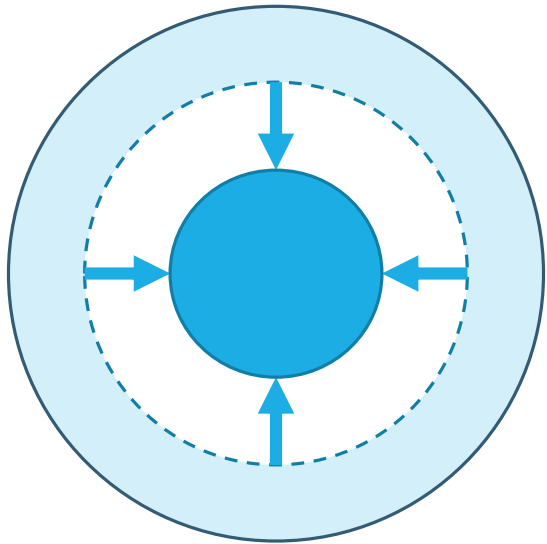
WHAT IS EXPECTED AROUND VLSS?

Very high density peak ← Many k -modes are phase-coupled

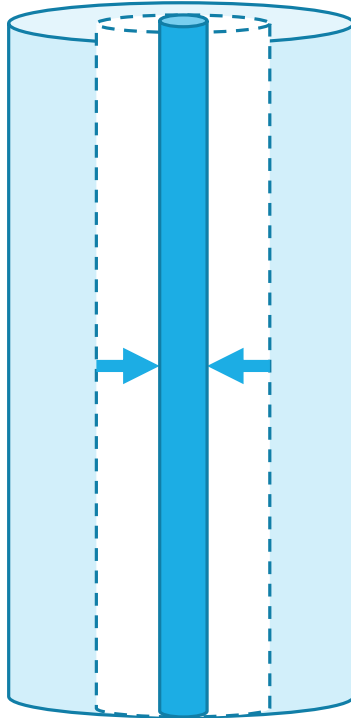
→ Similar peak pattern may appear at a certain scale



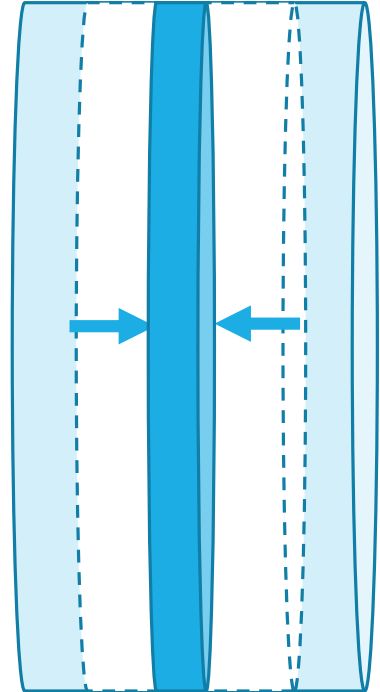
WHAT IS EXPECTED AROUND VLSS?



SPHEROIDS



PROLATES

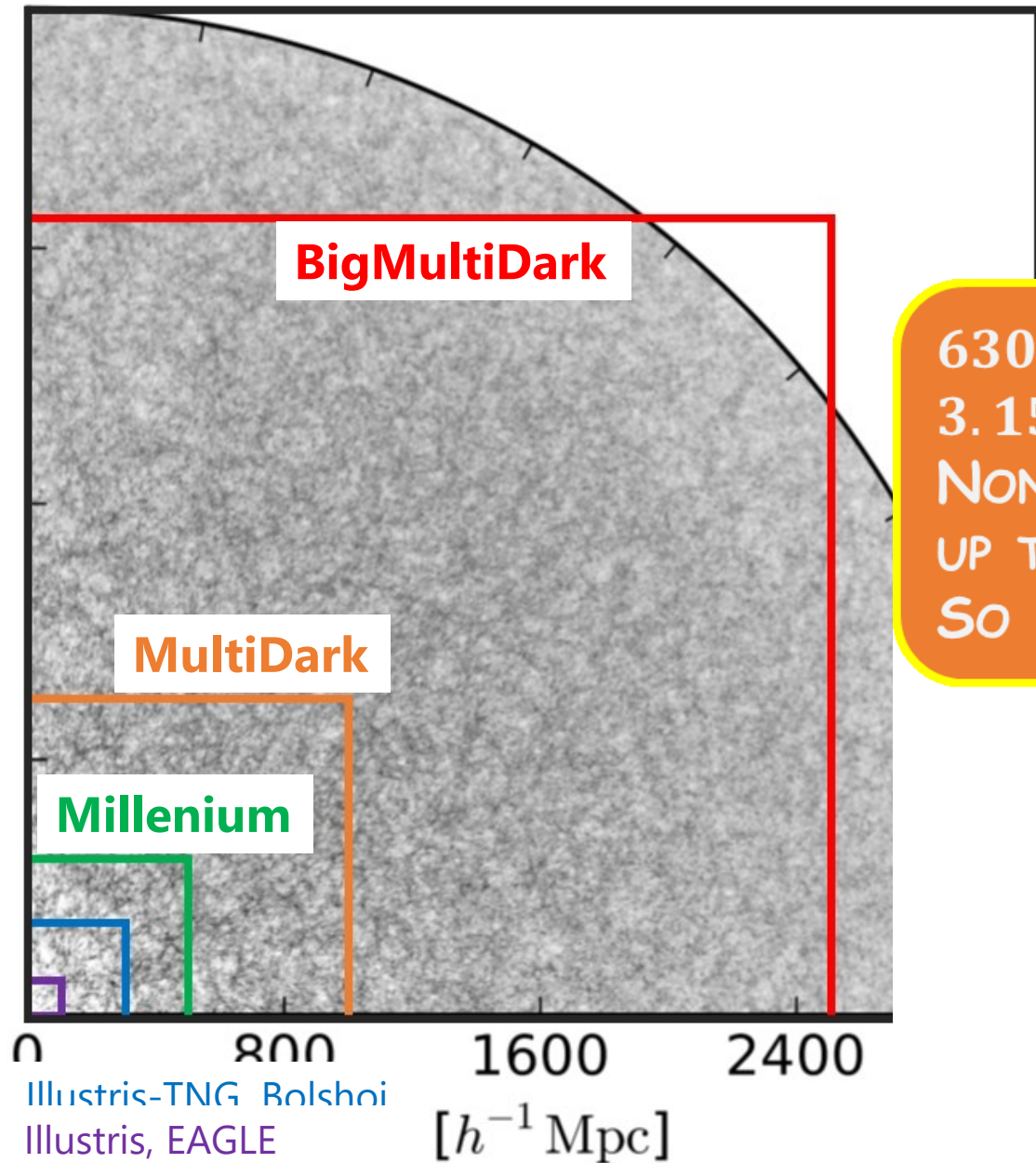


OBLATES

→ Spherical/Cylindrical/1D Galaxy Number Density Profile

HORIZON RUN 4 (HR4)

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

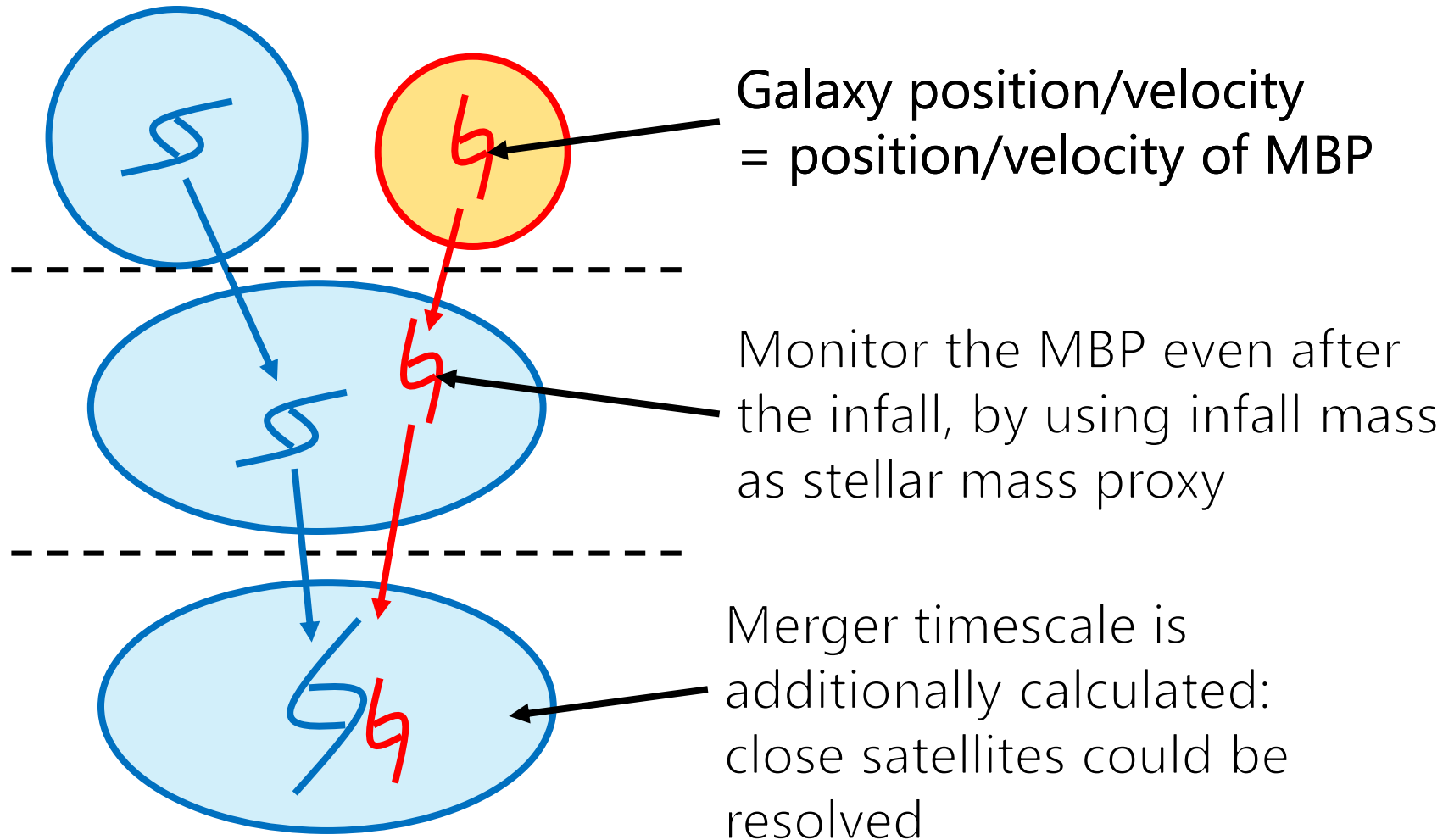


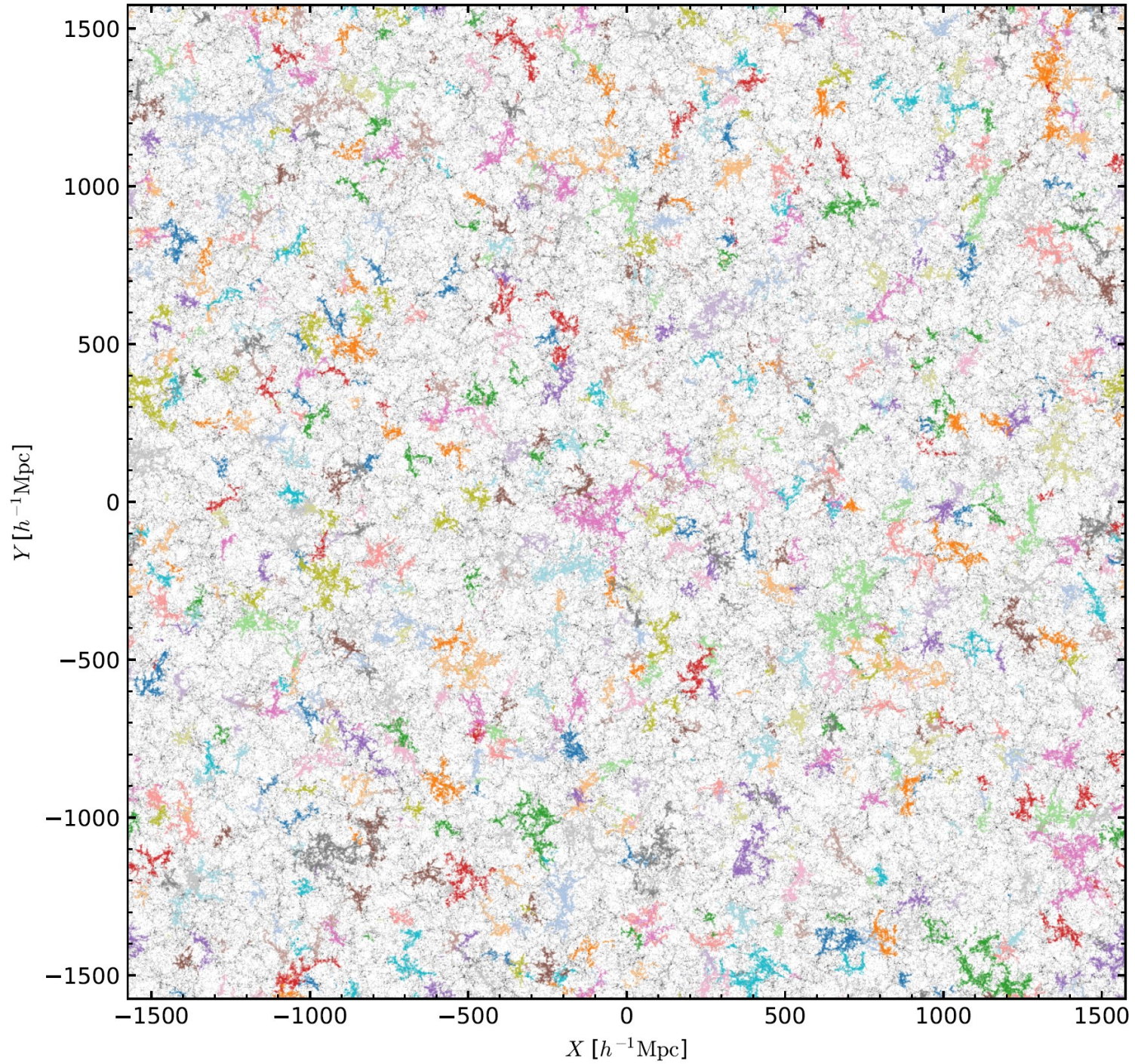
6300³ DM PARTICLES IN
3.15 Gpc/h BOXSIZE?
NON-OVERLAPPING LIGHTCONE
UP TO $z = 1.5$?
So BIG!!!!



MOST BOUND PARTICLE-GALAXY ABUNDANCE MATCHING

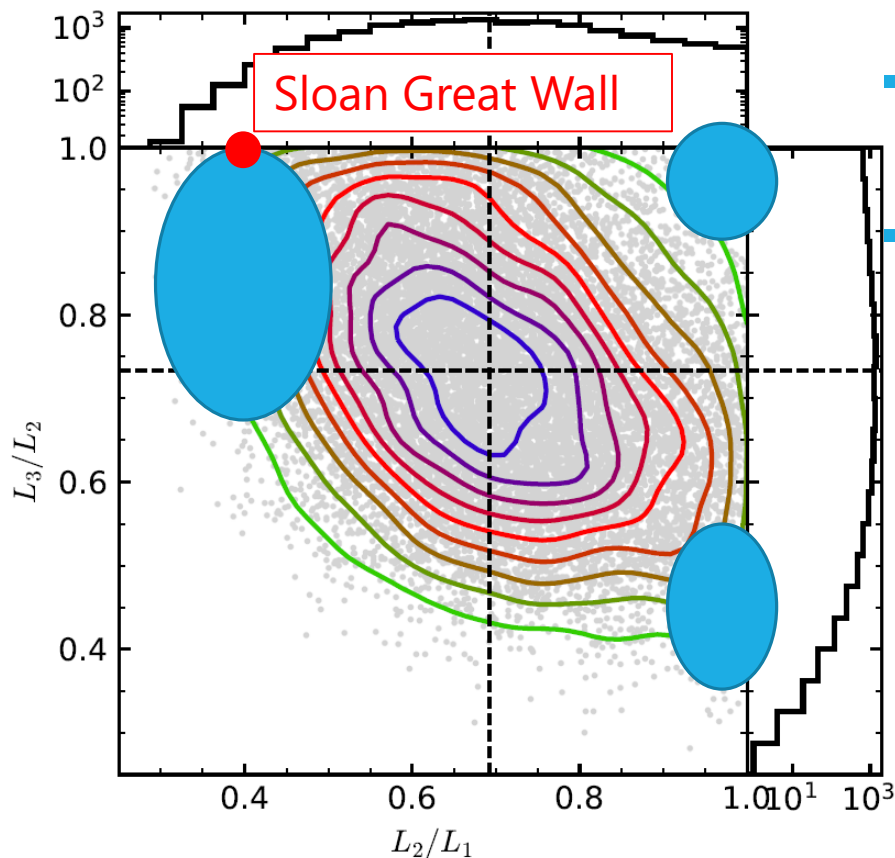
Hong, Park & Kim (2016)





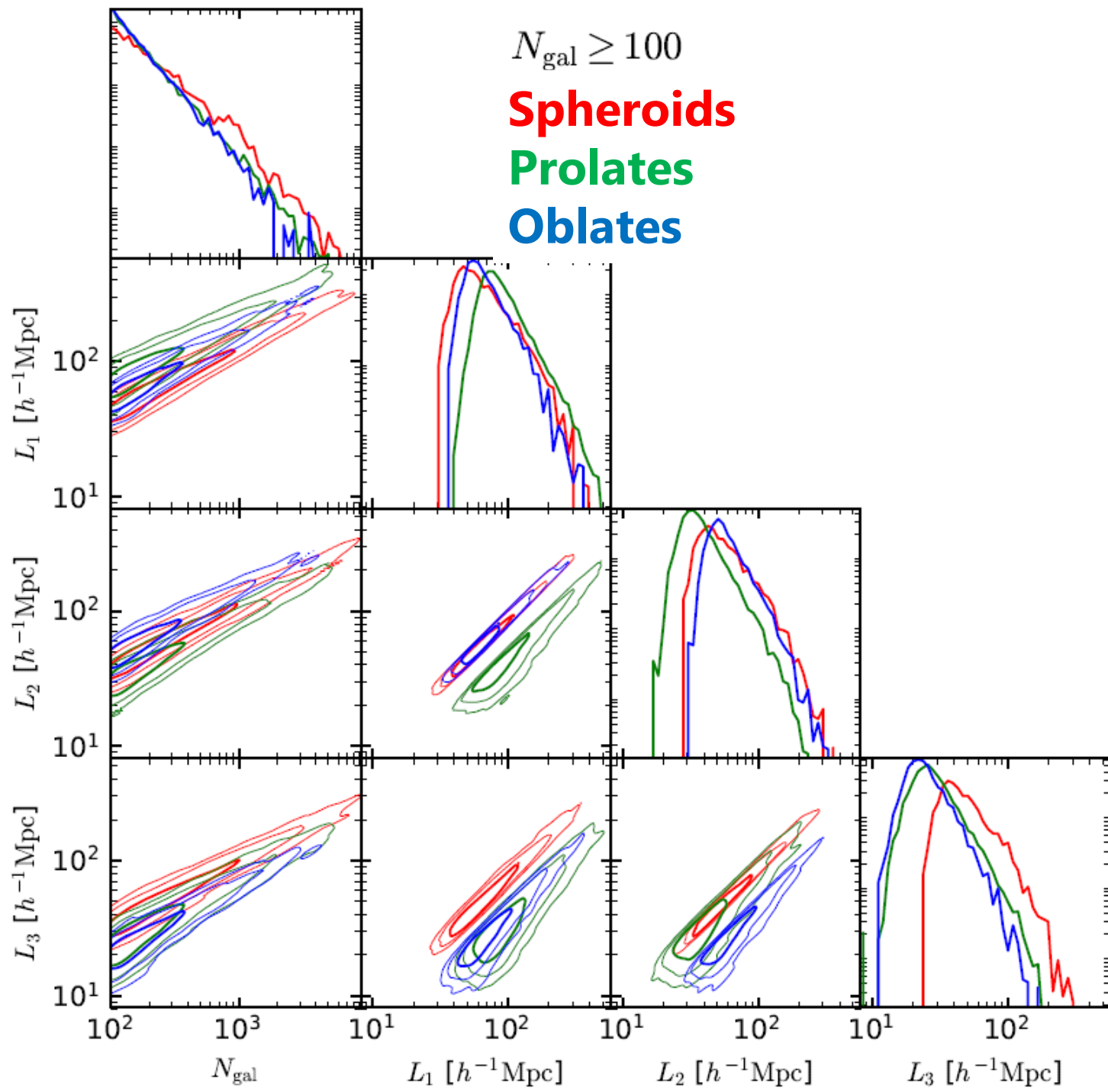
SHAPE CLASSIFICATION

- Shape is defined by linear extents ($L_1 \geq L_2 \geq L_3$) along with the eigenvectors (\hat{e}_i) of inertia tensor



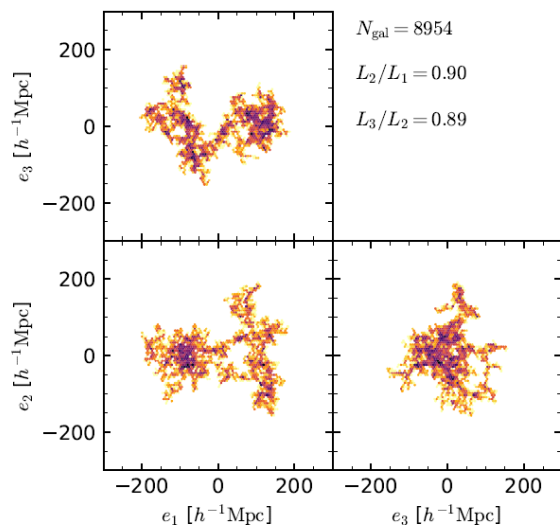
- Spheroids ($L_1 \sim L_2 \sim L_3$)
: $\min L_2/L_1 = \min L_3/L_2 = 0.8$
- Prolates ($L_1 \gg L_2, L_3$)
: $\max L_2/L_1 \simeq 0.5$
- Oblates ($L_1 \sim L_2 \gg L_3$)
: $\min L_2/L_1 = 0.8, \max L_3/L_2 = 0.5$

Type	Number
Spheroids	1770
Prolates	6588
Oblates	2013

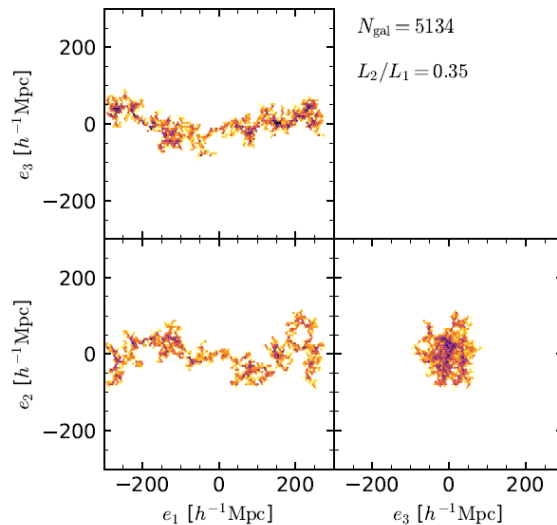


RICHEST "CLASSIFIED" VLSSs

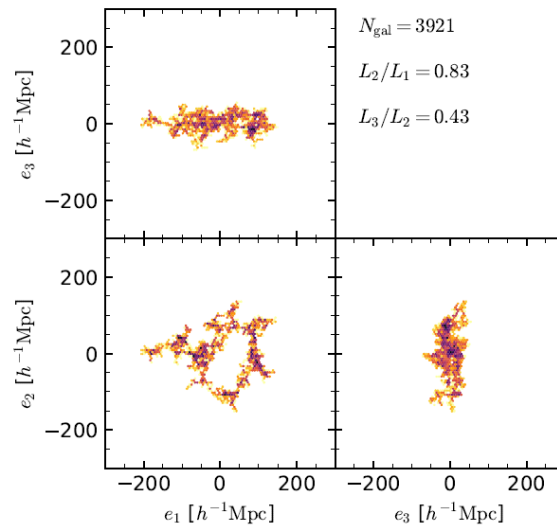
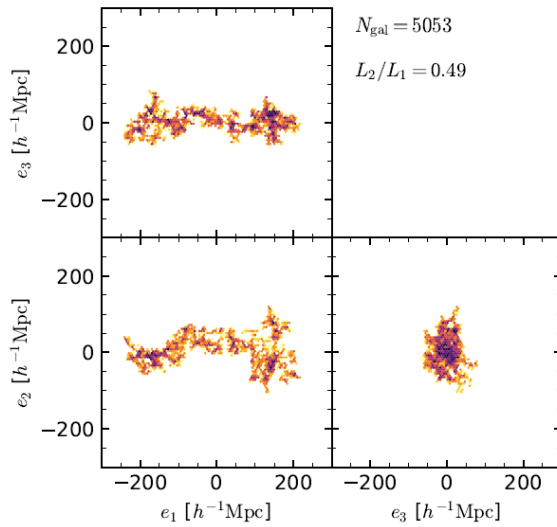
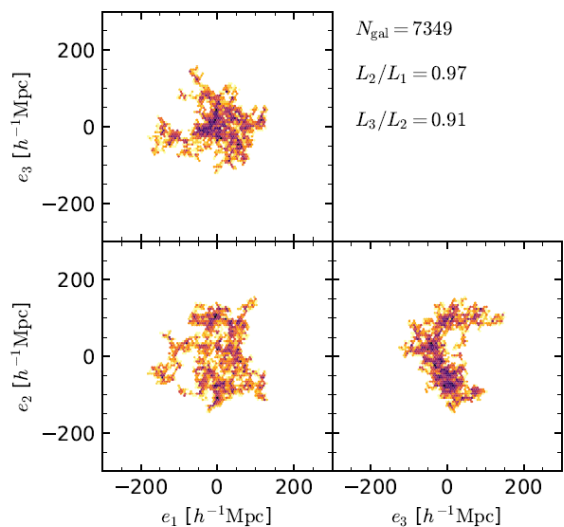
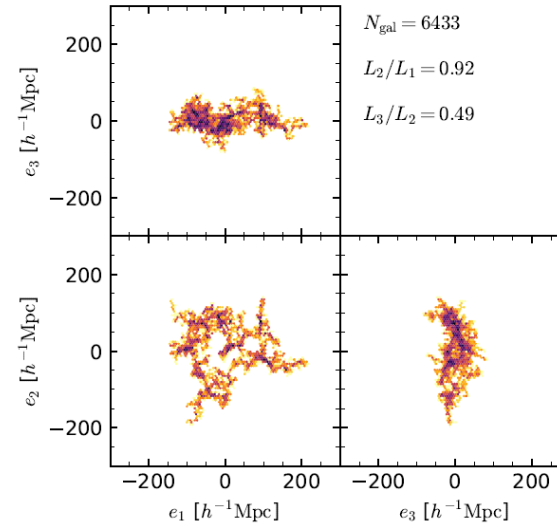
SPHEROIDS



PROLATES

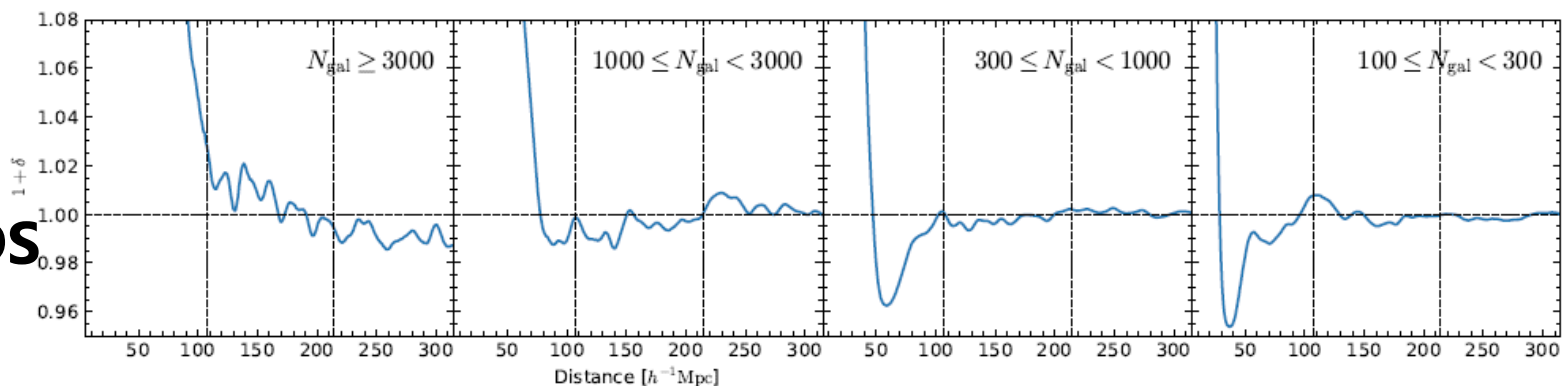


OBLATES

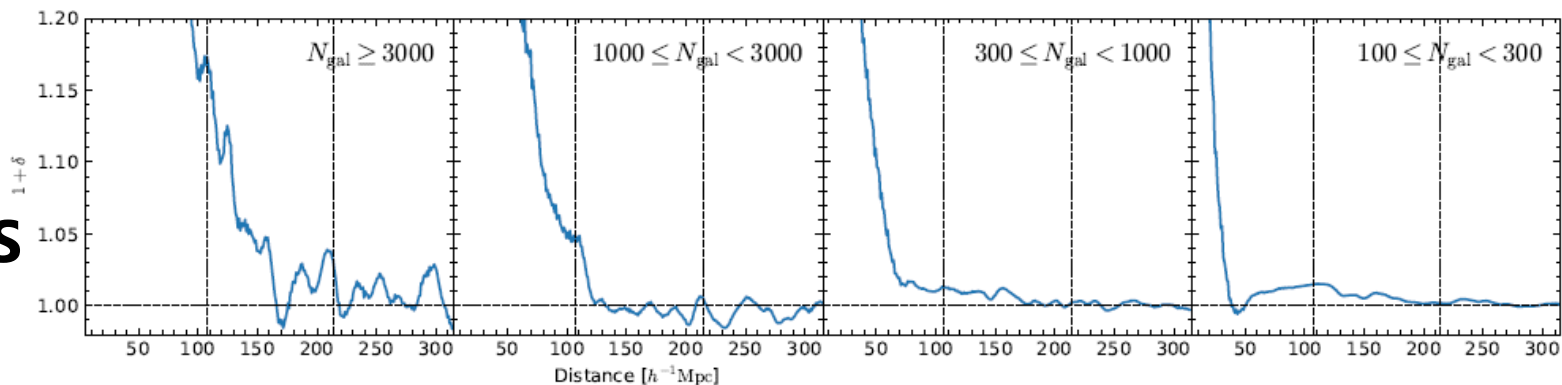


AVERAGED GALAXY DENSITY PROFILES

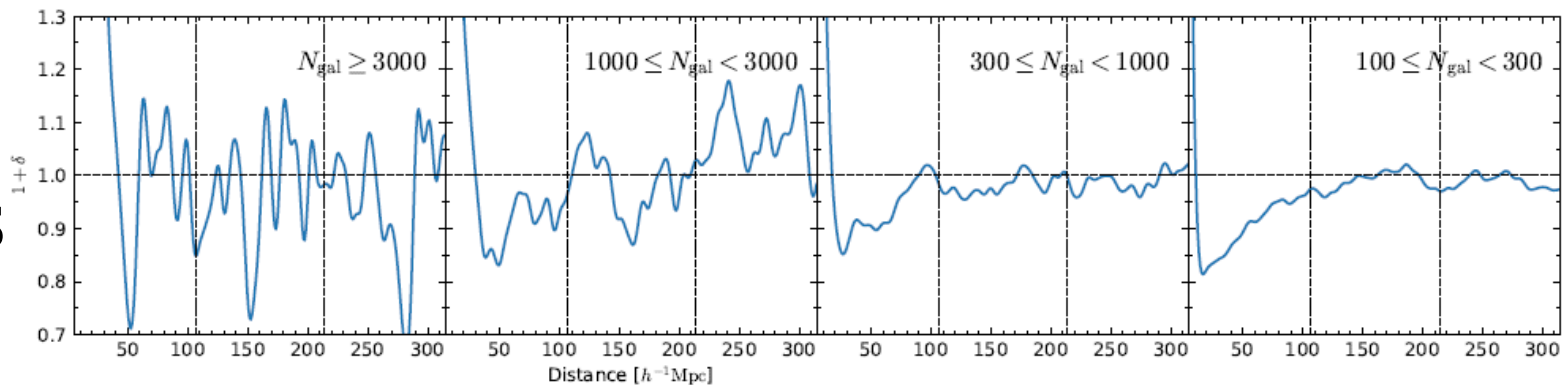
SPHEROIDS



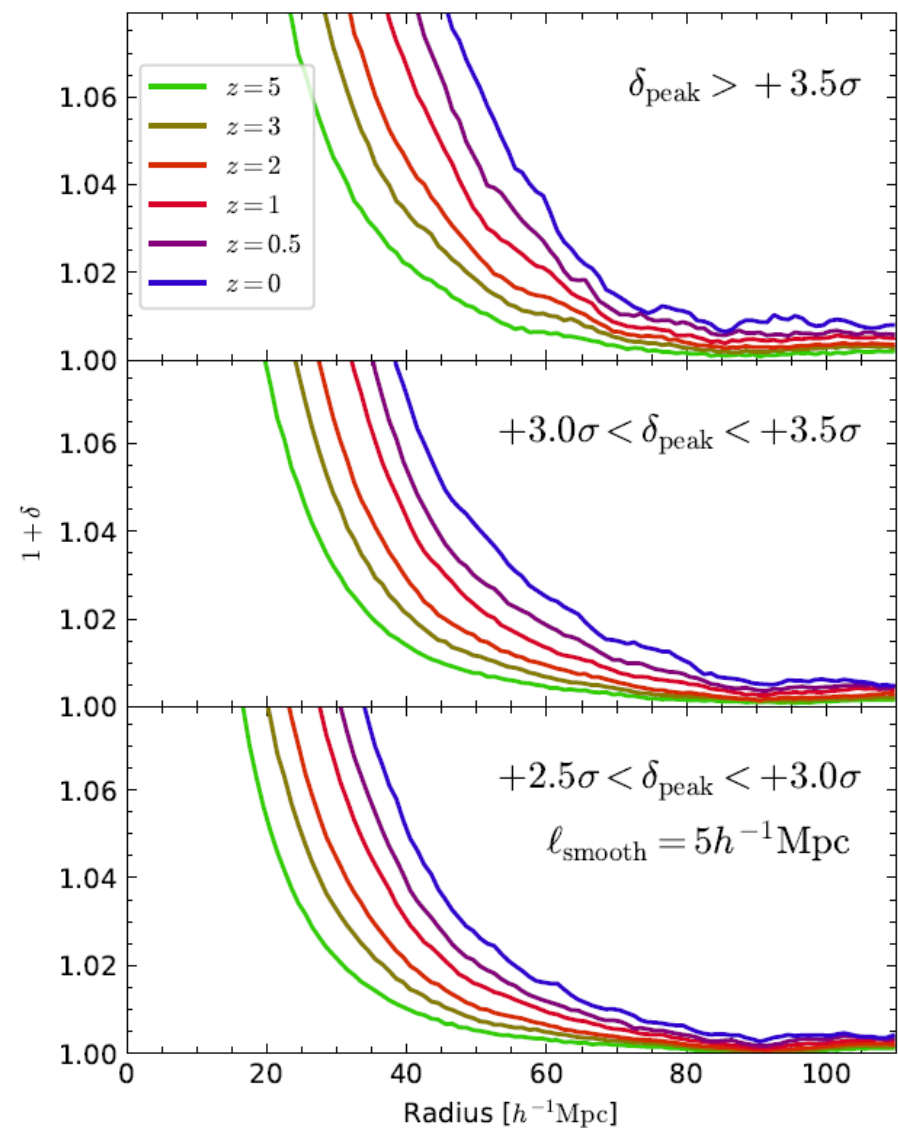
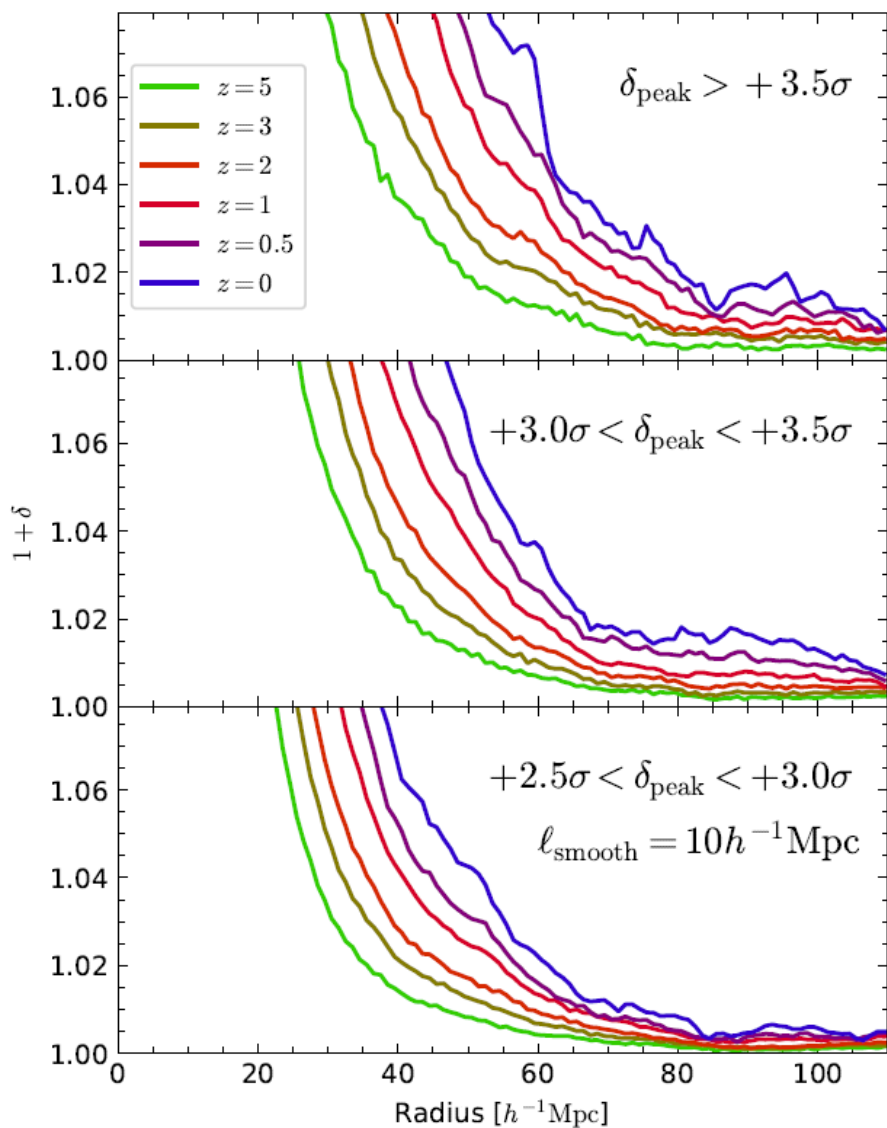
PROLATES



OBLATES



MATTER DENSITY PROFILE EVOLUTION AROUND EXTREME DENSITY PEAKS

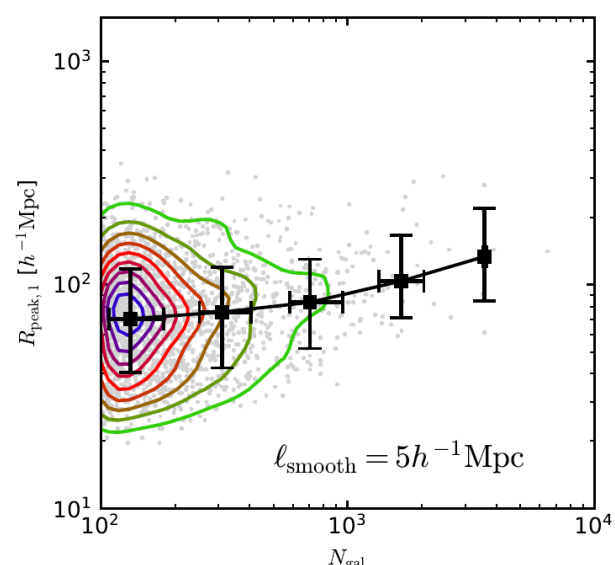
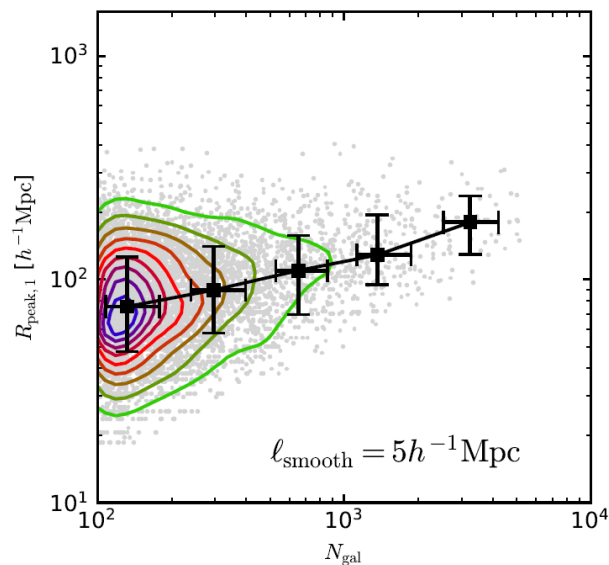
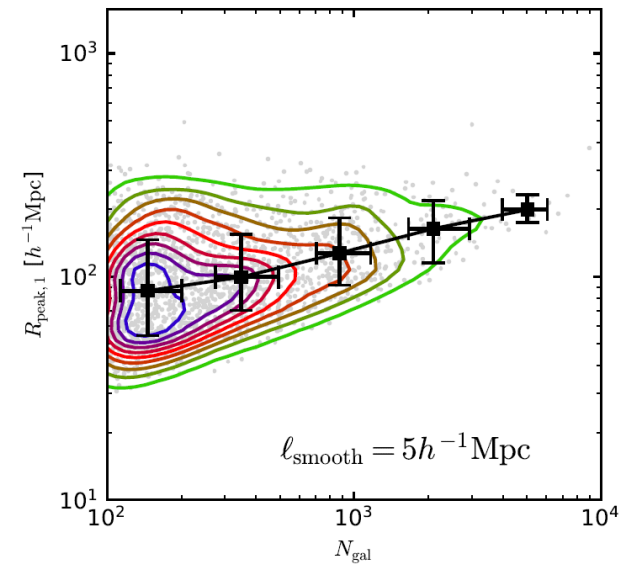
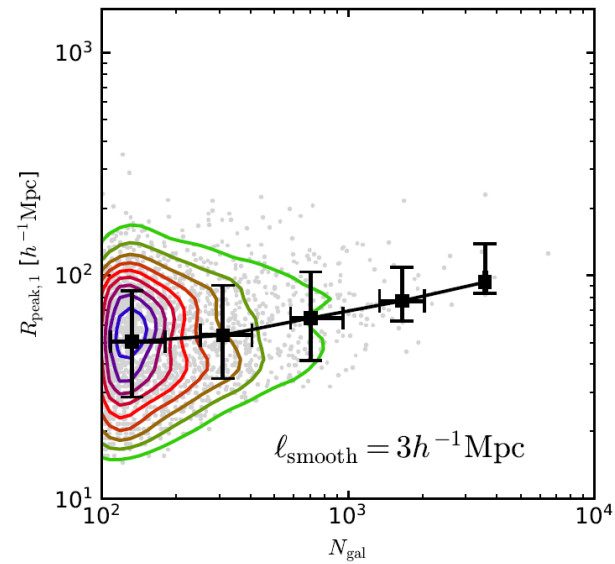
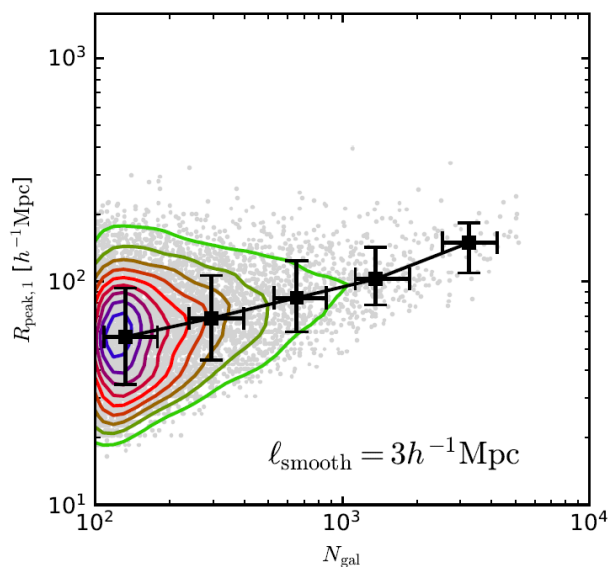
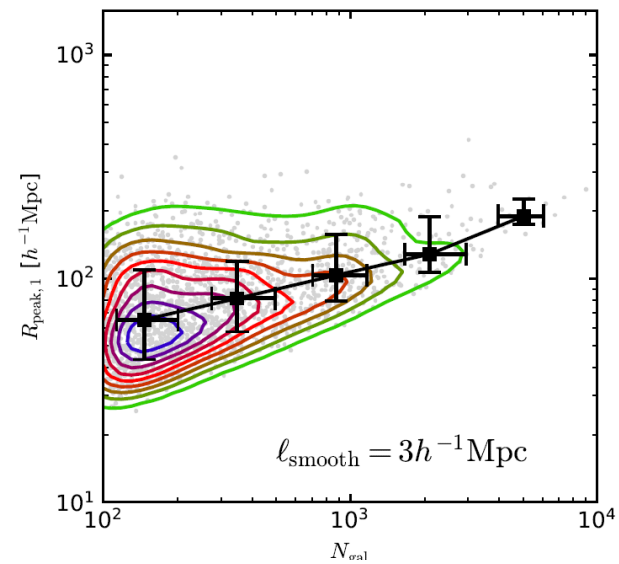


RICHNESS-NEXT DENSITY PEAK

SPHEROIDS

PROLATES

OBLATES



SUMMARY... UP TO NOW

VLSSs produced by phase coupling of multiple k -modes could make repeatability pattern in the surrounding galaxy distribution.

Positive relation found in the HR4 simulation between VLSS richness and the next density peak position.

- $50 \sim 200 h^{-1} \text{Mpc}$, depending on smoothing scale
- Large scatter in low-rich VLSSs, due to the environmental effects