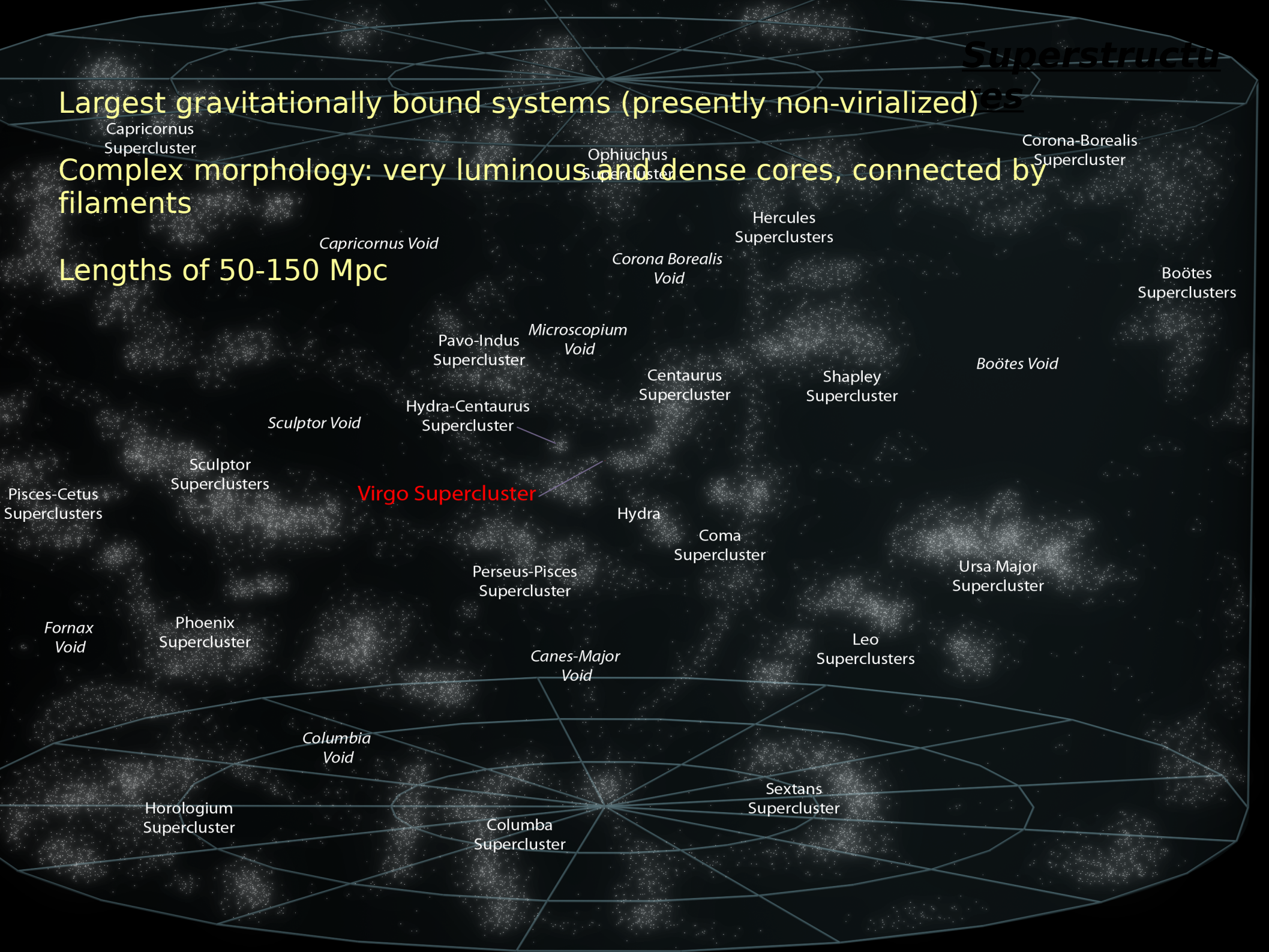
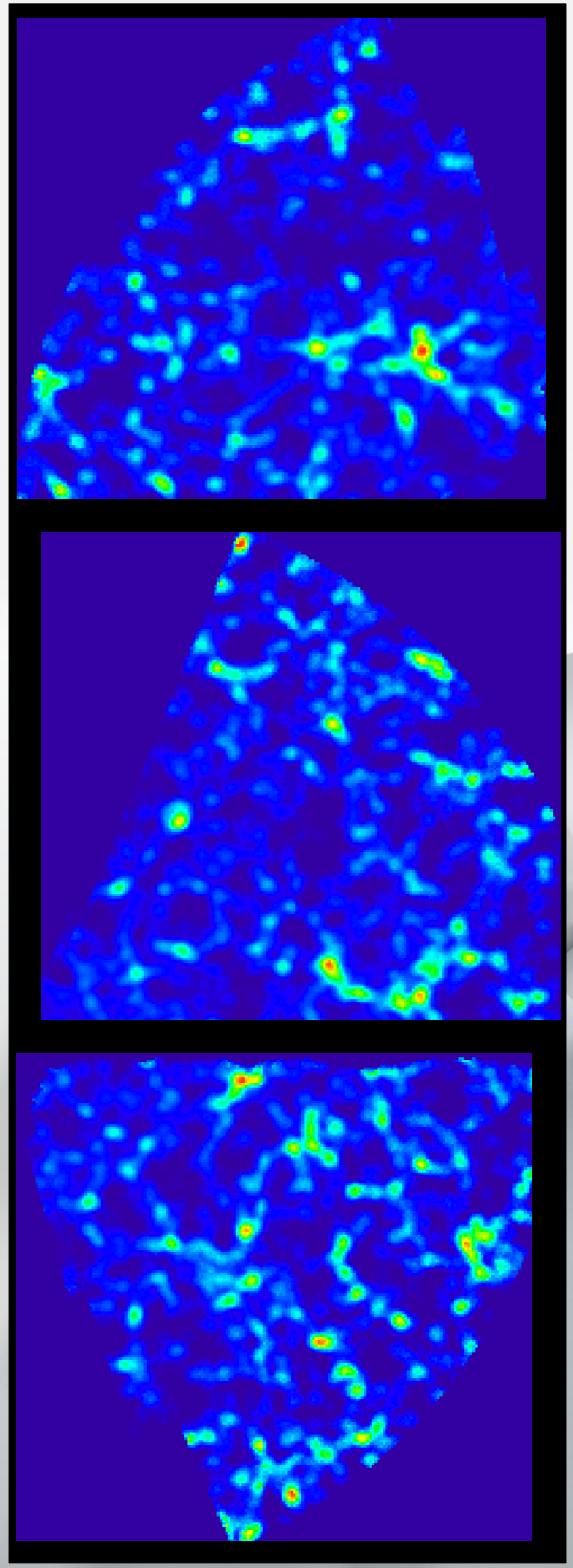
# Future Virialized Structures

*An analysis of superstructures in SDSS-DR7*

Heliana Luparello
Marcelo Lares
Diego García Lambas
Nelson Padilla


Superstructures
Largest gravitationally bound systems (presently non-virialized)
Capricornus Supercluster
Ophiuchus Supercluster
Corona-Borealis Supercluster
Complex morphology: very luminous and dense cores, connected by filaments
Hercules Superclusters
Capricornus Void
Corona Borealis Void
Lengths of 50-150 Mpc
Boötes Superclusters
Microscopium Void
Pavo-Indus Supercluster
Boötes Void
Centaurus Supercluster
Shapley Supercluster
Hydra-Centaurus Supercluster
Sculptor Void
Sculptor Superclusters
Virgo Supercluster
Pisces-Cetus Superclusters
Hydra
Coma Supercluster
Perseus-Pisces Supercluster
Ursa Major Supercluster
Fornax Void
Phoenix Supercluster
Leo Superclusters
Canes-Major Void
Columbia Void
Sextans Supercluster
Horologium Supercluster
Columba Supercluster



# *Identification Process*

FoF algorithm on galaxy clusters *(Einasto et al., 1997)*
*Percolation parameter?*

Luminosity-Density Maps *(Einasto et al., 2007)*

1. *smooth luminosity of galaxies --> Kernel*
2. *estimate luminosity density --> grid*
3. *connect overdense cells*

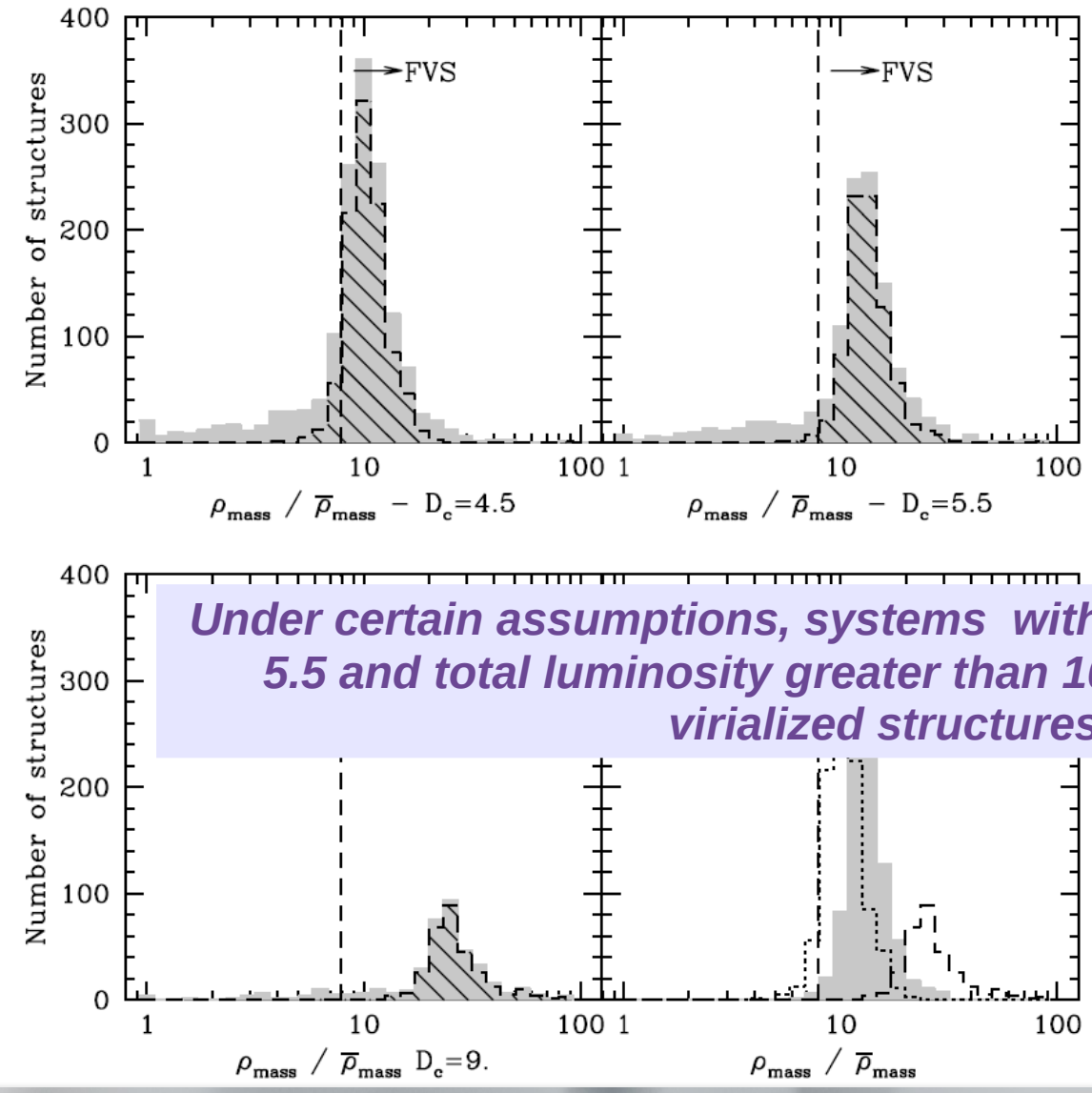
*Luminosity overdensity threshold?*

# *Threshold selection*

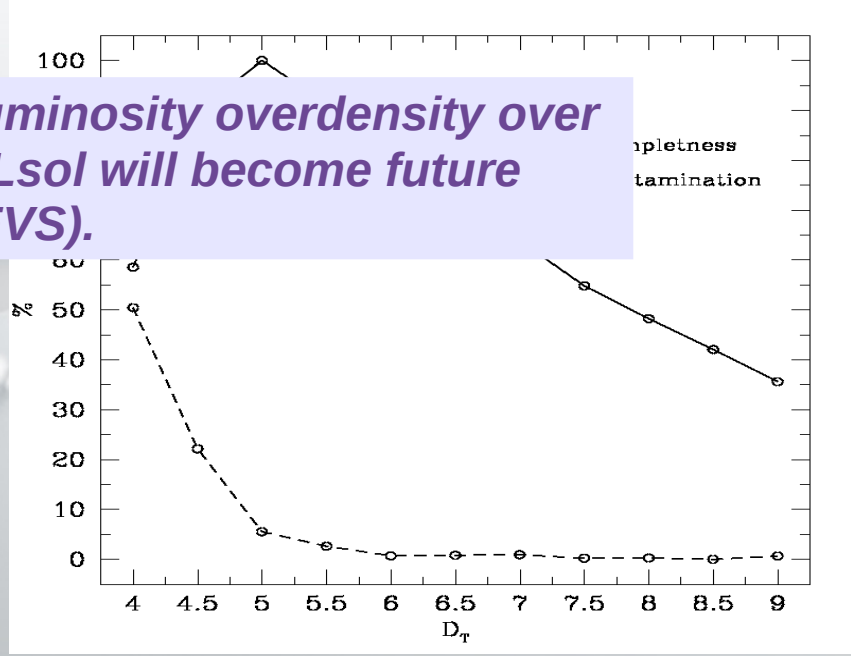
*007)*

emains gravitationally bound:

ock >=7.88




***Under certain assumptions, systems with luminosity overdensity over 5.5 and total luminosity greater than $10^{12}$Lsol will become future virialized structures (FVS).***



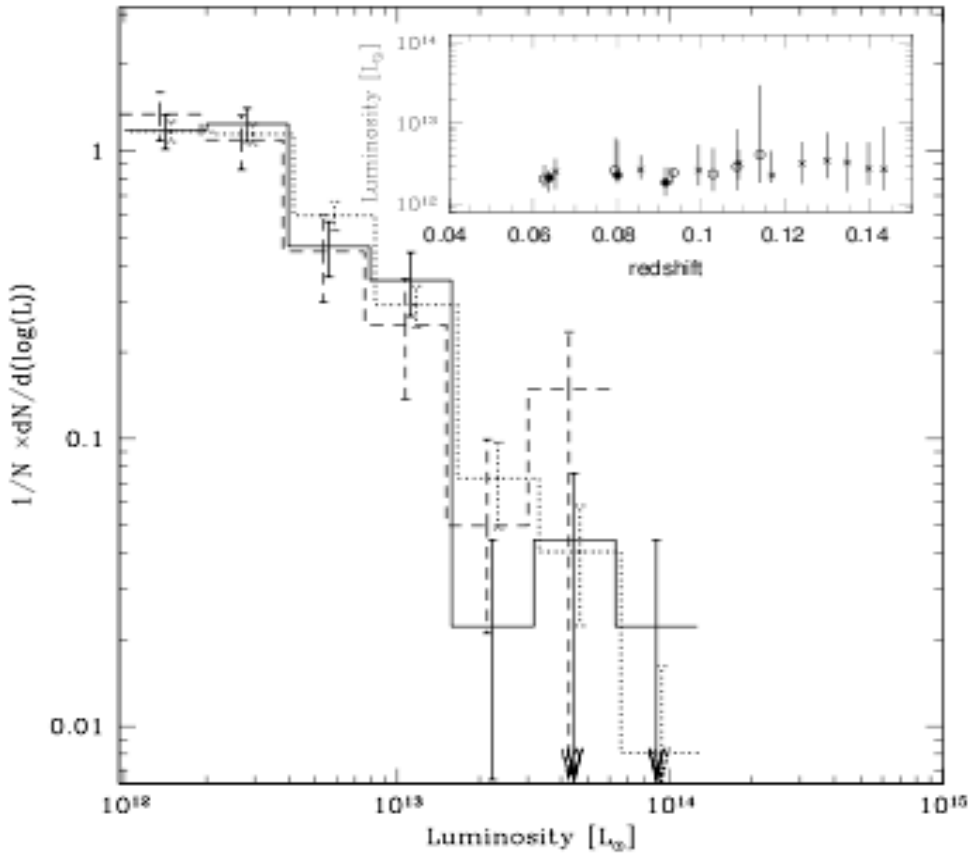
| Sample | $z_{max}$ | $D_{max}[h^{-1}\,Mpc]$ | $M_r^{lim}$ | Volume $[10^7(h^{-1}\,Mpc)^3]$ | $N_{gal}$ | $\bar{\rho}_{lum}[10^8 L_\odot/Mpc^3]$ | $F$ | Corrected $\bar{\rho}_{lum}[10^8 L_\odot/Mpc^3]$ |
|---|---|---|---|---|---|---|---|---|
| S1 | 0.10 | 293.92 | -20.05 | 1.85 | 94271 | 0.80 | 2.11 | 1.68 |
| S2 | 0.12 | 351.34 | -20.47 | 3.17 | 89513 | 0.58 | 2.98 | 1.73 |
| S3 | 0.15 | 436.55 | -21.00 | 6.01 | 62344 | 0.29 | 5.66 | 1.64 |
| S2c | 0.10 | 293.92 | -20.47 | 1.85 | 51188 | 0.56 | 2.98 | 1.73 |
| S3c | 0.10 | 293.92 | -21.00 | 1.85 | 17507 | 0.27 | 5.66 | 1.64 |
| $M_{Rsp}$ | 0.12 | 351.34 | -20.47 | 3.17 | 106604 | 0.75 | 2.98 | 2.23 |
| | | | | | | 0.75 | 2.98 | 2.23 |

| Sample | $N_{FVS}$ | $F_{vol}$ | $F_{lum}$ | $gl.xs_{inFVS}$ |
|---|---|---|---|---|
| S1 | 67 | 1.08% | 10.85% | 9707 |
| S2 | 150 | 1.26% | 13.54% | 11394 |
| S3 | 412 | 1.66% | 20.61% | 11682 |
| $M_{Rsp}$ | 227 | 1.62% | 18.87% | 19265 |
| $M_{Zsp}$ | 181 | 1.35% | 15.14% | 15368 |

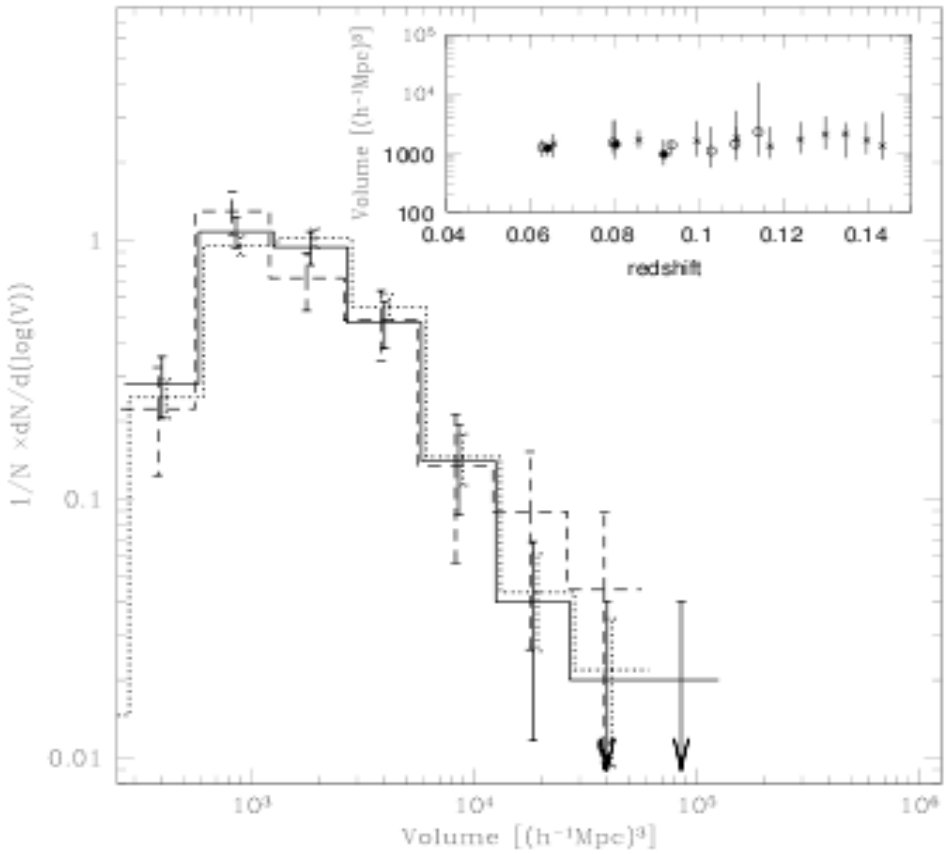
de in the r–band is in the range $14.5 \leqslant r \leqslant 17.5$. The mean
xies. The correction factor $F$ (Eq. 6) and the resulting mean

**Table 2.** Main results obtained for the samples of identified FVS. For each sample, we show the number of future virialized structures $N_{FVS}$, the percentage of volume occupied by FVS $F_{vol}$, the percentage of luminosity of galaxies within FVS $F_{lum}$ and the total number of galaxies within FVS $gl.xs_{inFVS}$.

# *Future Virialized Structures on SDSS-DR7*




(a) Luminosity distribution of FVS




(b) Volume distribution of FVS

**Figure 5.** Luminosity and volume distributions of structures for samples S1 (dashed line), S2 (solid line) and S3 (dotted line). The insets show the average volume and luminosity as a function of the redshift, in redshift bins with equal numbers of superstructures, with filled circles, empty circles and cruxes, respectively for samples S1, S2 and S3. Error bars on the histograms indicate Poisson uncertainty. In the inset box, the uncertainty bars correspond to the 25 per cent and 75 per cent percentiles.

# *Future Virialized Structures on SDSS-DR7*

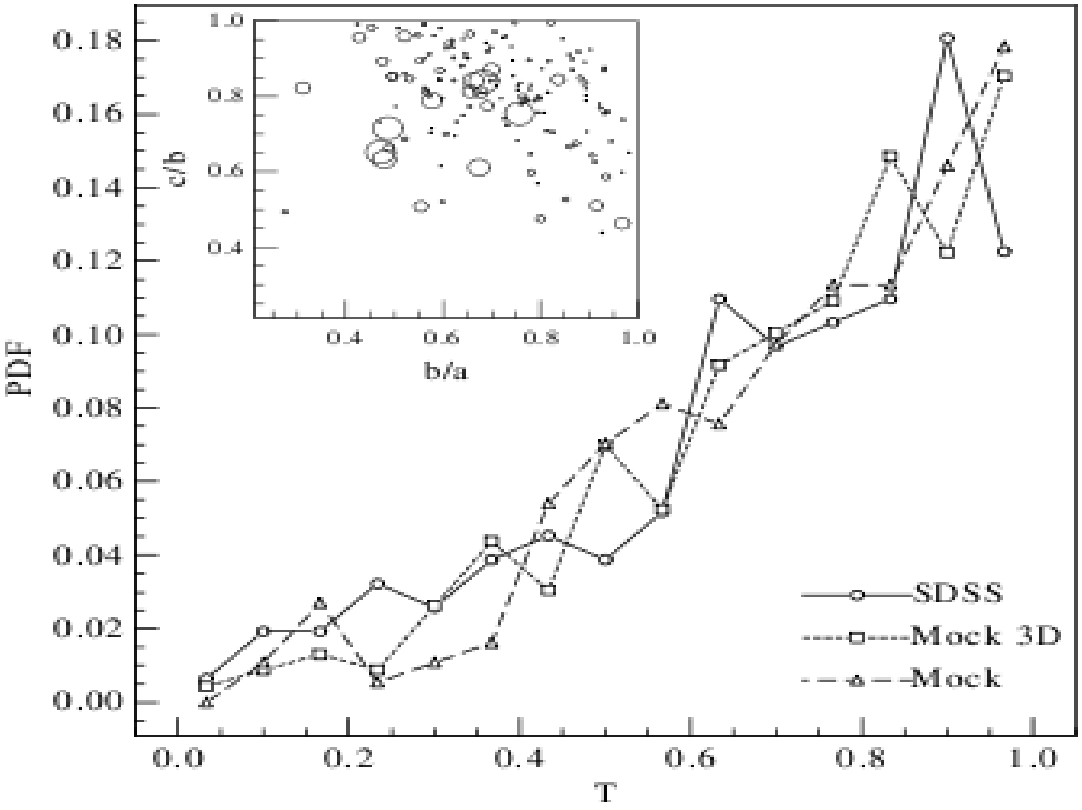



**Figure 6.** Probability density distribution estimates of the shape indicator parameter $T$ (defined in section Section 4.1). The distributions correspond to FVS from the SDSS galaxy catalogue (solid line), the real–space mock catalogue (short dashed line) and the redshift–space mock catalogue (long dashed line). The inset shows a scatter-plot of the semi–axis ratios $c/b$ and $b/a$ that characterize the shapes of the FVS. The sizes of circles are proportional to the number of galaxies contained in each FVS.

*$T=(1-(b/a)^2)/(1-(c/a)^2)$*

*T --> 1 indicates prolate structures*

*T --> 0 indicates oblate structures*

# *Redshift space vs. Real Space FVS*

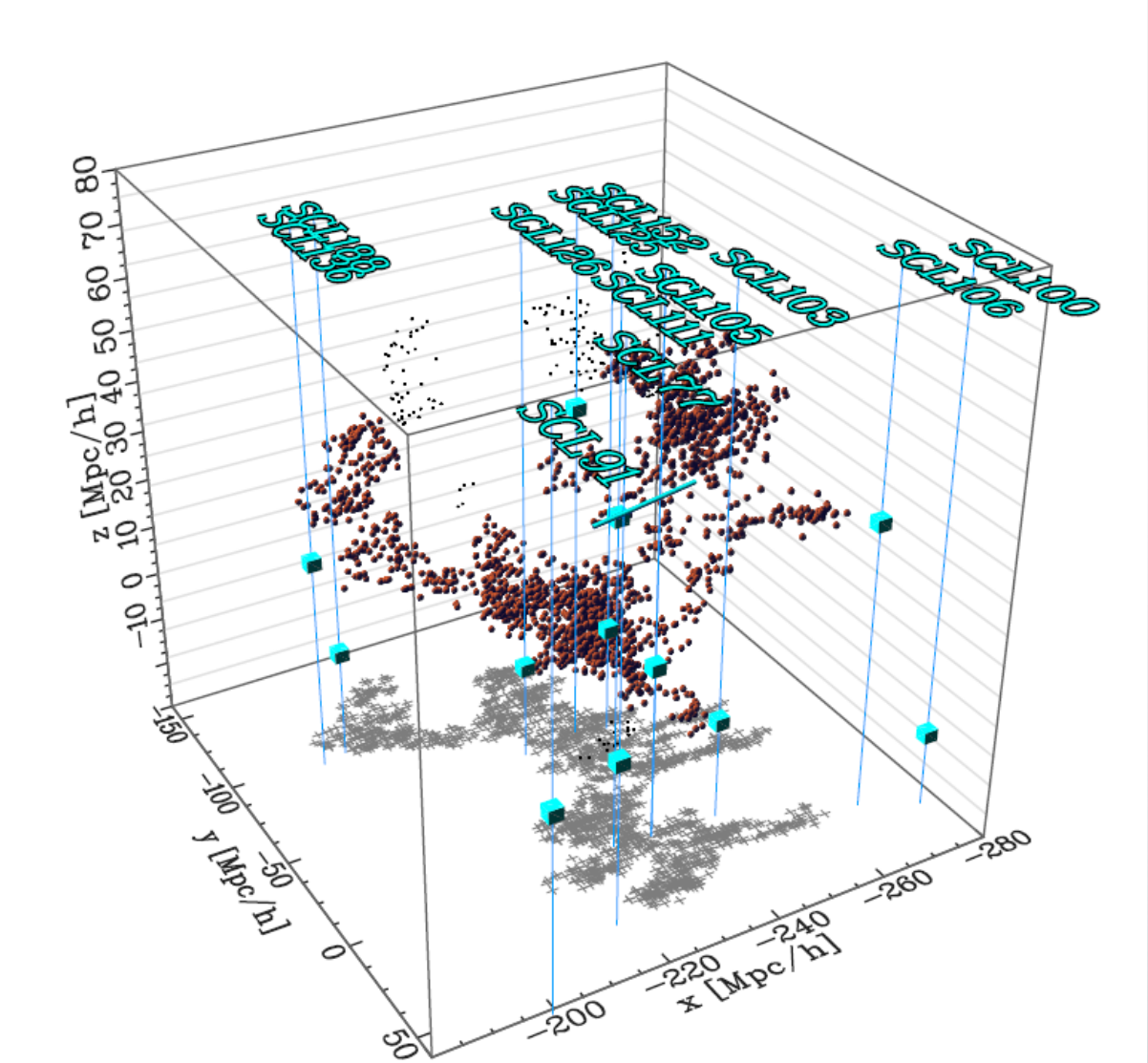
*Lower number of FVS in redshift-space in comparison to real-space FVS.*

*20% of real-space structures are lost when analyzing redshift-space data.*

*Only 2% of FVS identified in redshift–space are not real–space FVS.*

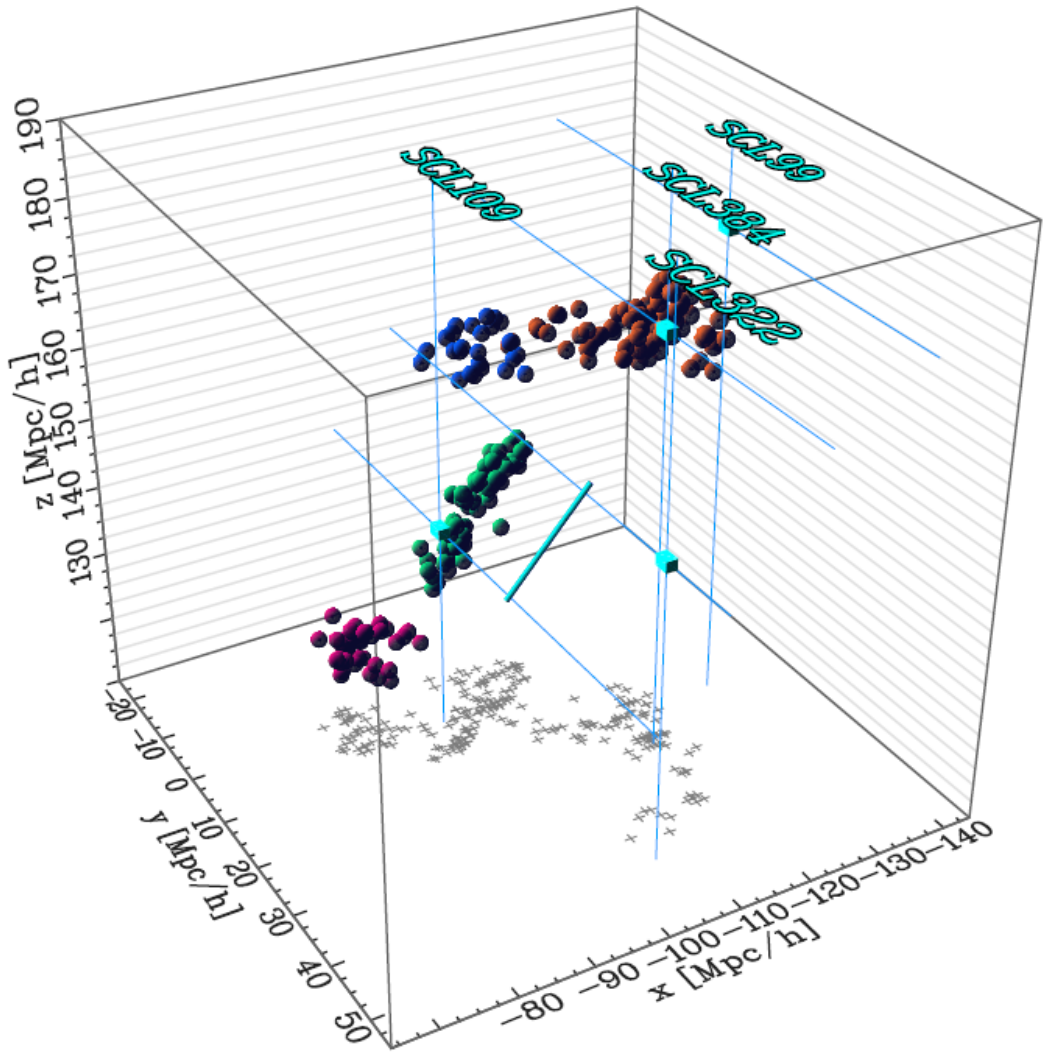
*3% of redshift-space FVS are associated with more than one FVS in real-space.*

# *... And Nostradamus*



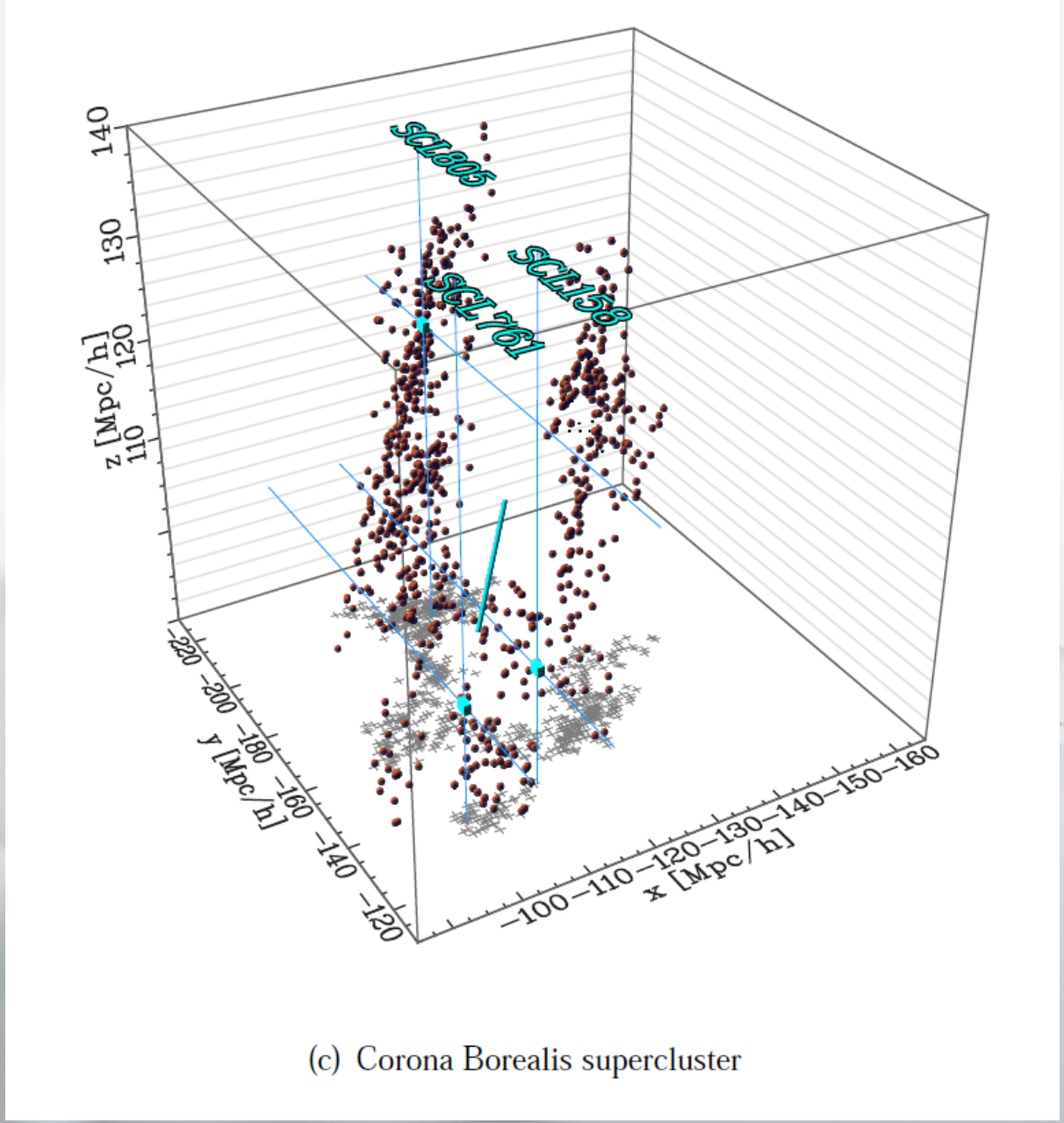

(a) Sloan Great Wall

# ... And Nostradamus



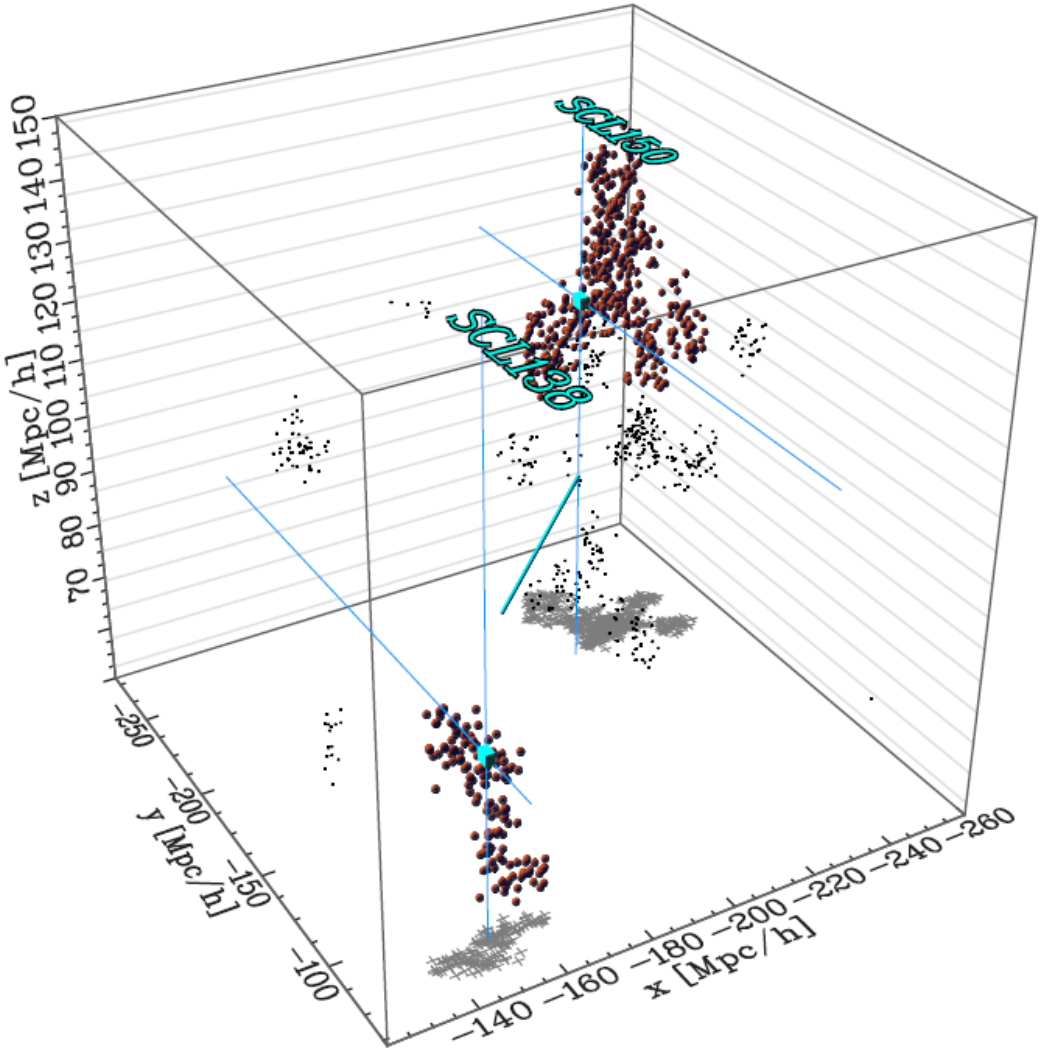

(b) Ursa Major supercluster

# ... And Nostradamus




(c) Corona Borealis supercluster

# ... And Nostradamus




(d) Bootes supercluster