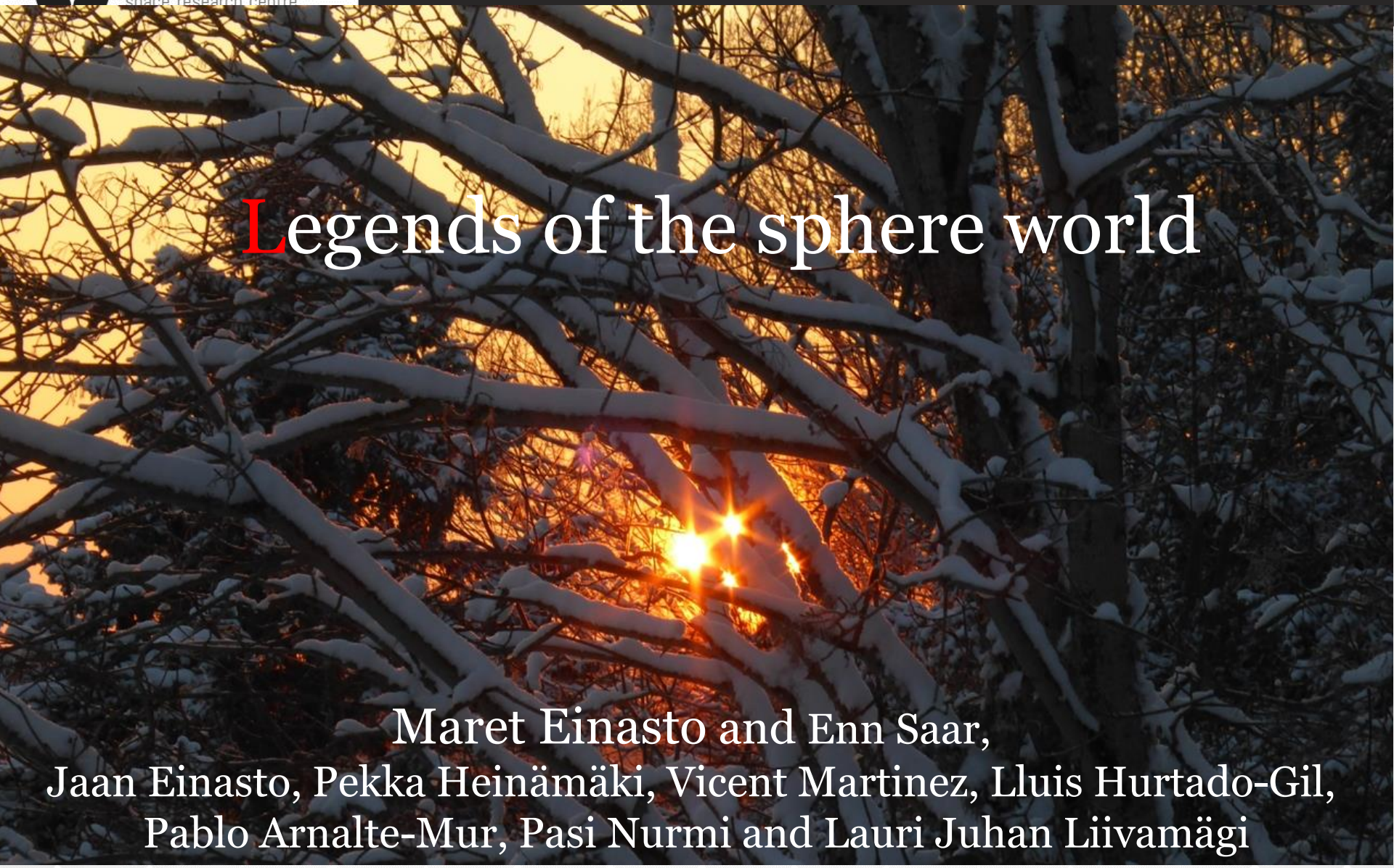
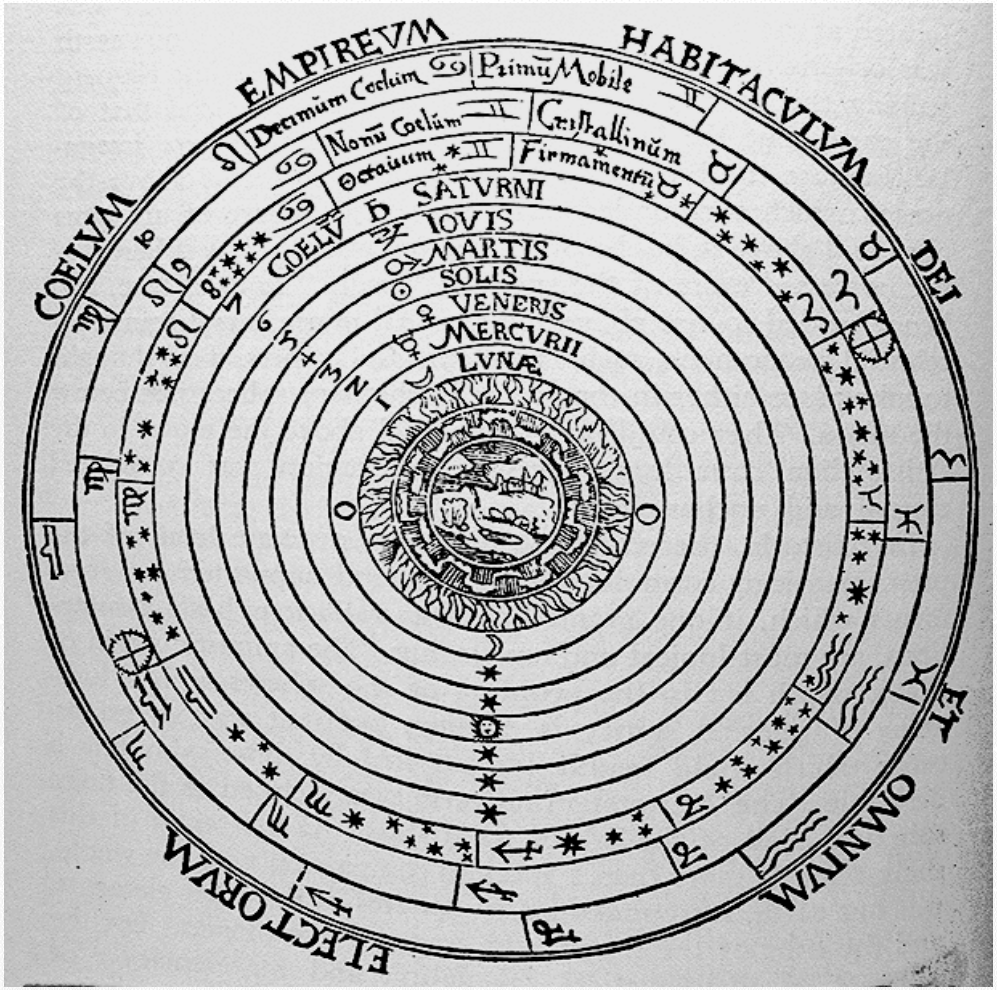
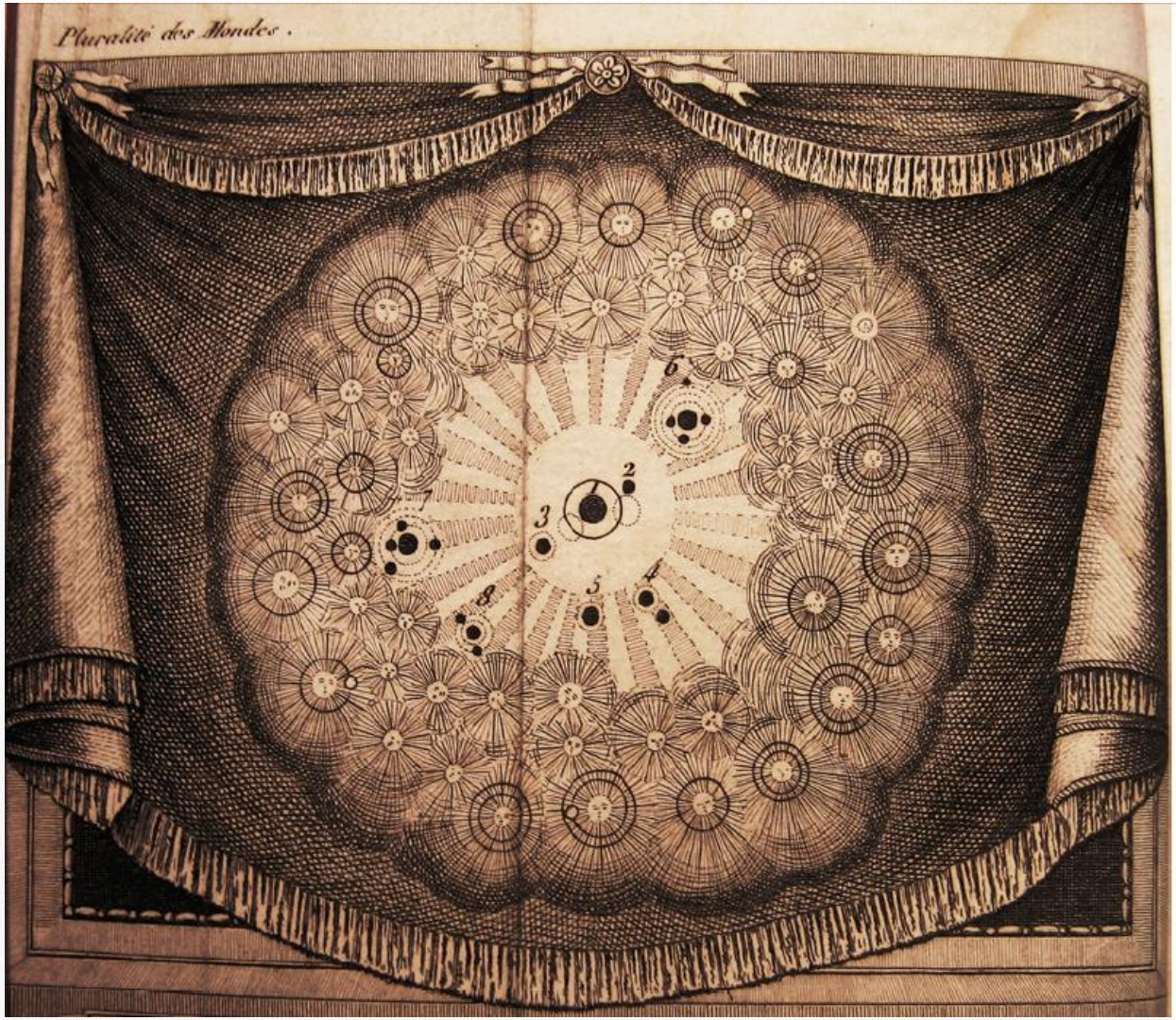


Legends of the sphere world

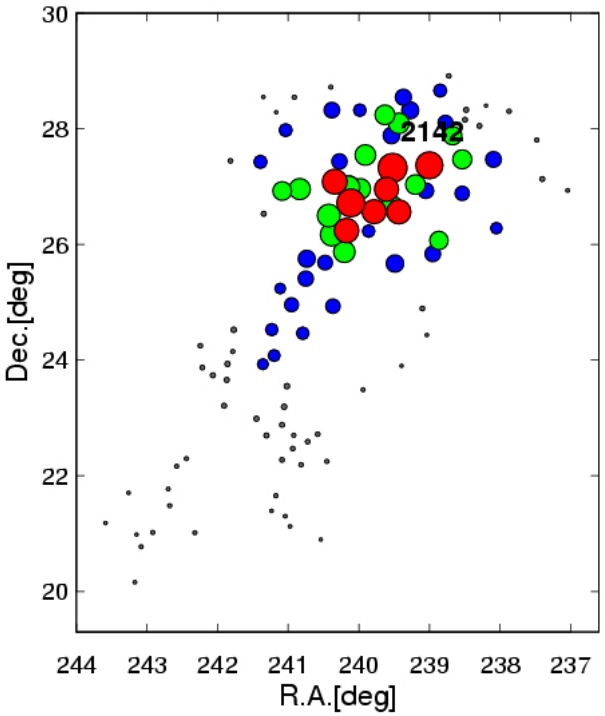
Maret Einasto and Enn Saar,
Jaan Einasto, Pekka Heinämäki, Vicent Martinez, Lluis Hurtado-Gil,
Pablo Arnalte-Mur, Pasi Nurmi and Lauri Juhan Liivamägi

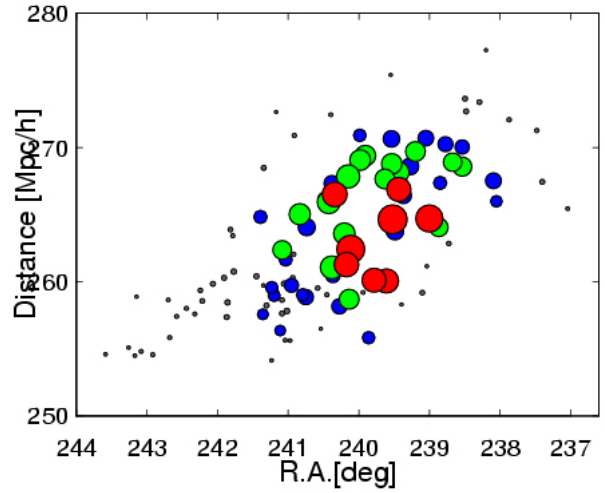
In the beginning, there was the Sphere (or egg, at least)
The birth of Sun, earth and sky from the egg of the world bird


EMPIREVM
HABITACVLVM
DEI
ET
OMNIVM
ELECTORVM
COELVM
Decimum Coelum
Primu Mobile
Nonu Coelum
Octauum
Firmamentu
Crystallinum
COELV
SATVRNI
IOVIS
MARTIS
SOLIS
VENERIS
MERCVRII
LVNÆ

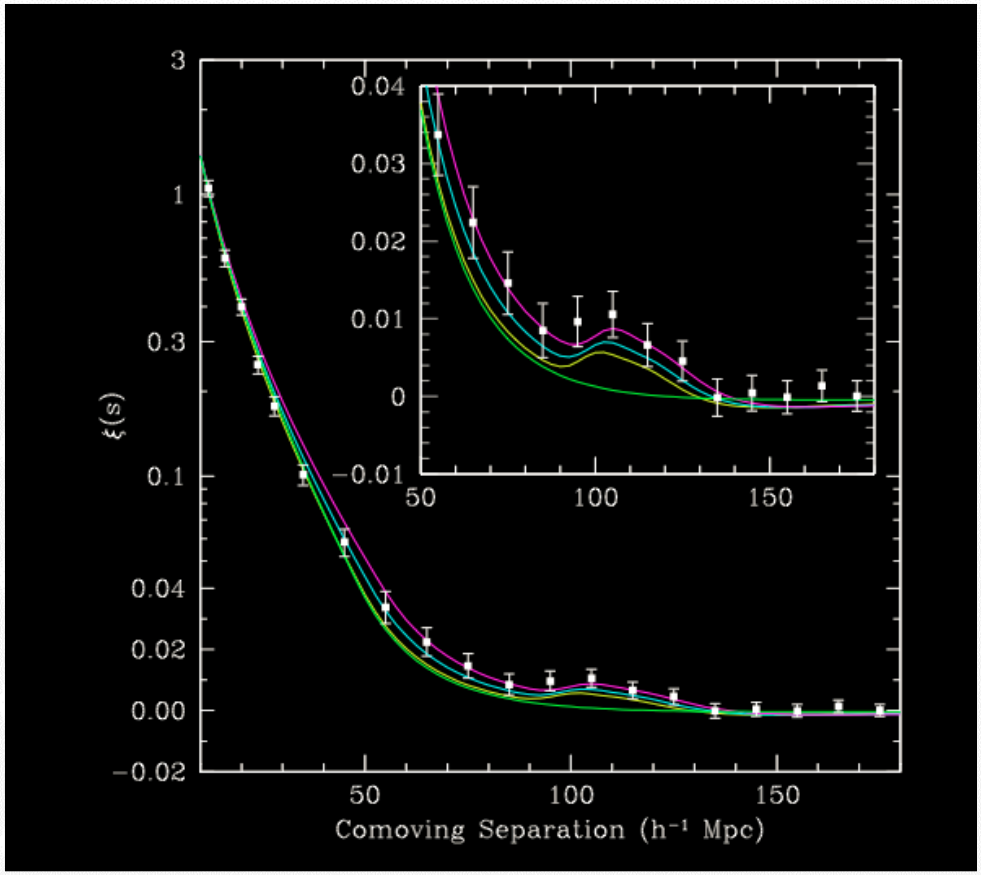


Pluralite des Mondes
D'Olivar (1682, 1800) and Lucia Ayala 2012





Supercluster A2142
with almost spherical main body



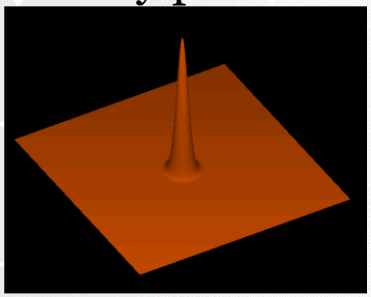
The correlation function of SDSS galaxies

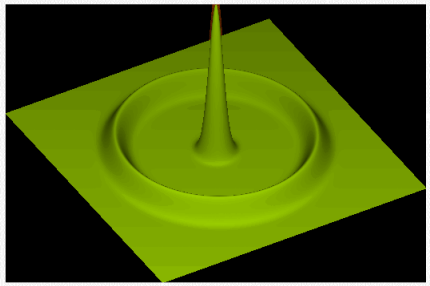
(Eisenstein et al 2005)

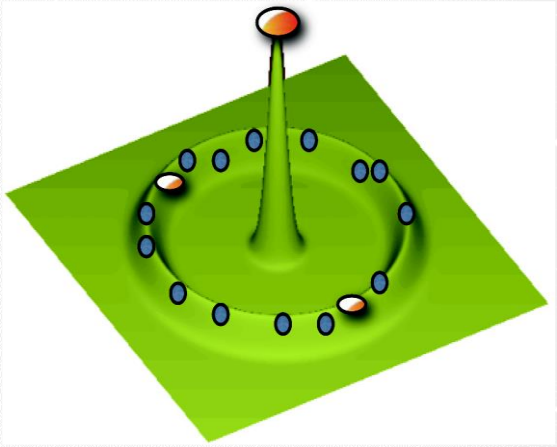
Baryonic acoustic oscillations (BAO)

In the early Universe density fluctuations produce sound waves in the hot plasma.
At recombination (t ≈ 380 000 years), baryons decouple from photons,
sound waves become `frozen'.

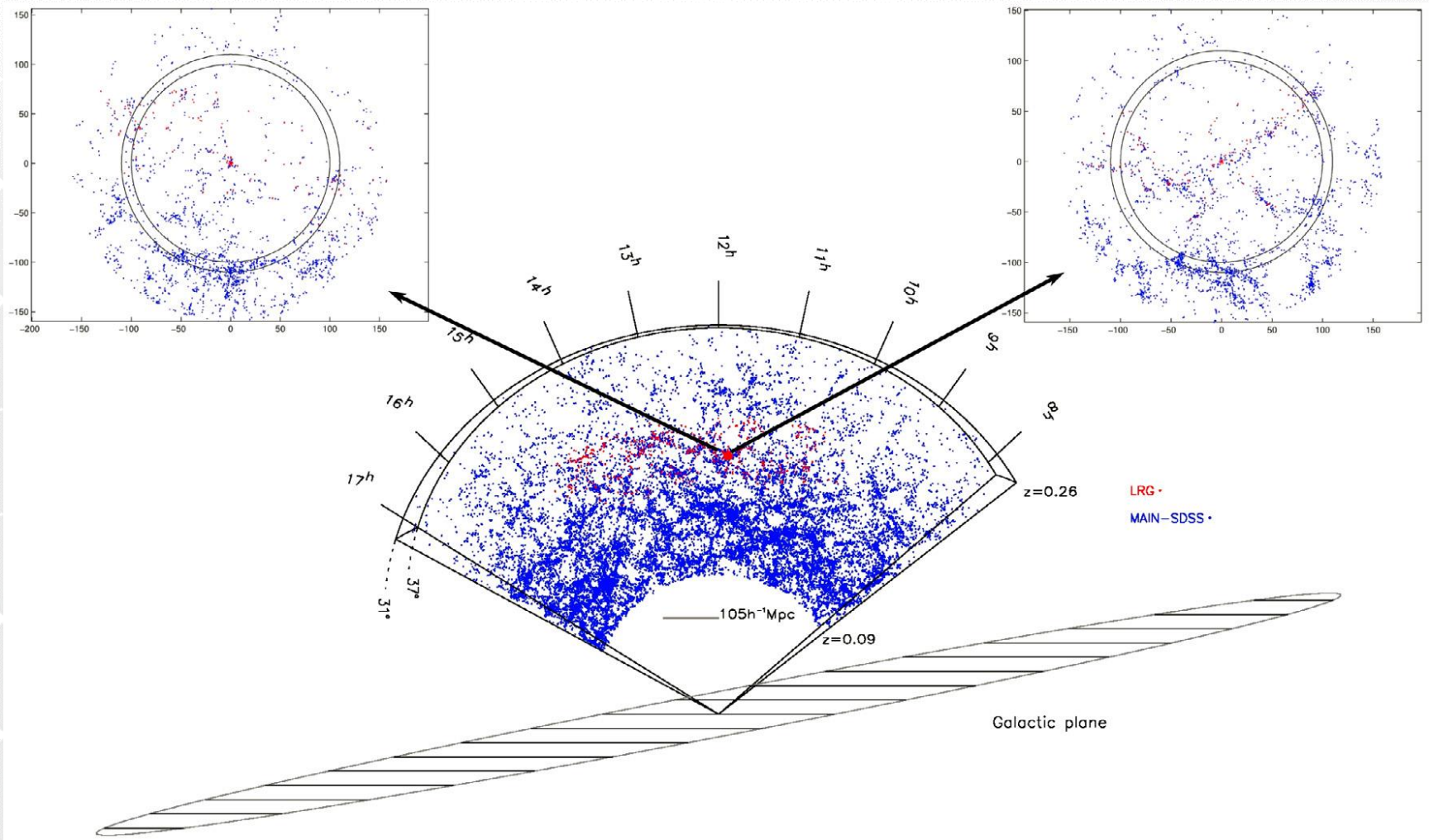
A shell of matter will form around initial density perturbations.



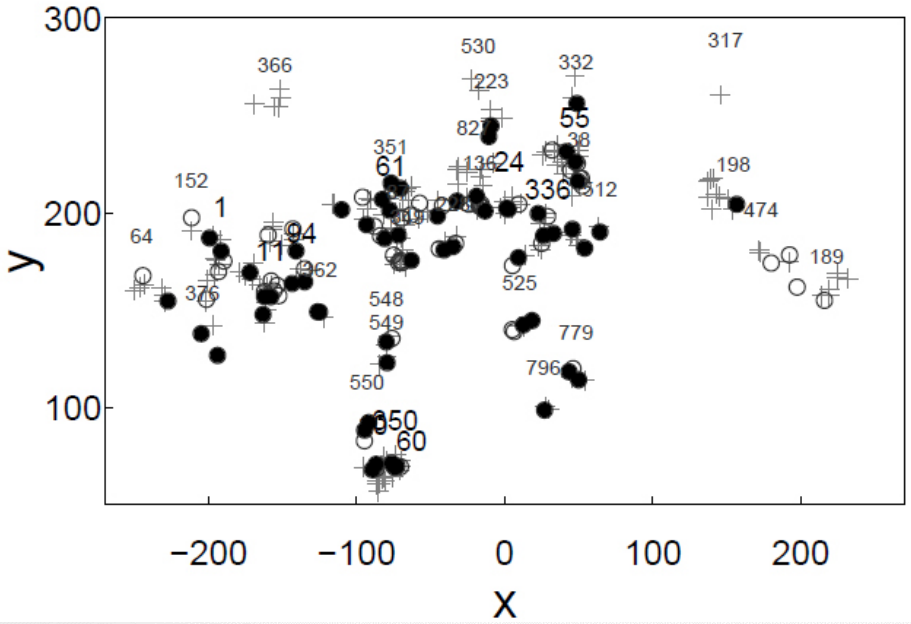


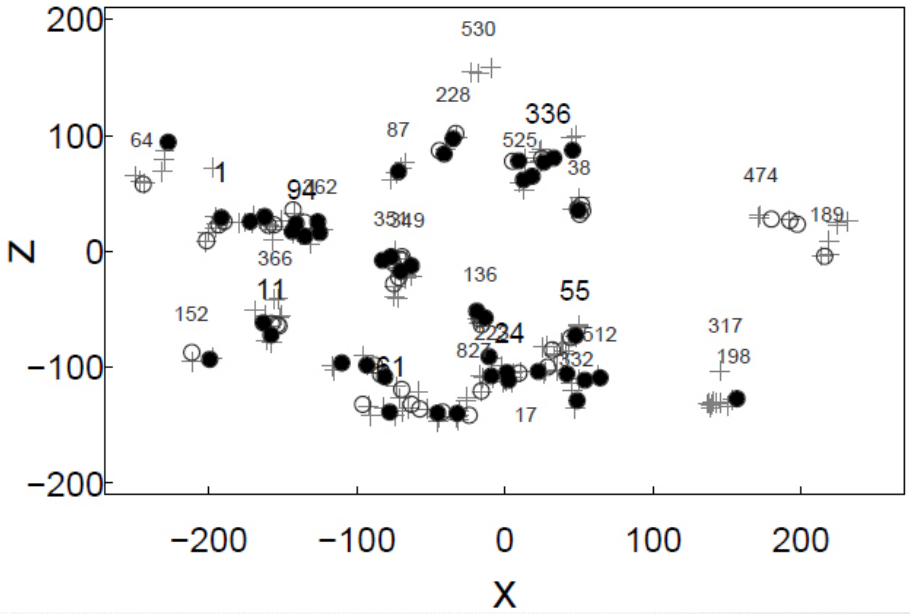


Central large density enhancement, surrounded by a shell – like structure
Arnalte–Mur et al. 2012



BAO shells: SDSS LRGs as centres, MAIN galaxies as shell walls
Shells with radius 109 Mpc/h at redshifts 0.15 < z < 0.30 (Arnalte–Mur et al. 2012)





Distribution of galaxy superclusters

Einasto et al. (2012)

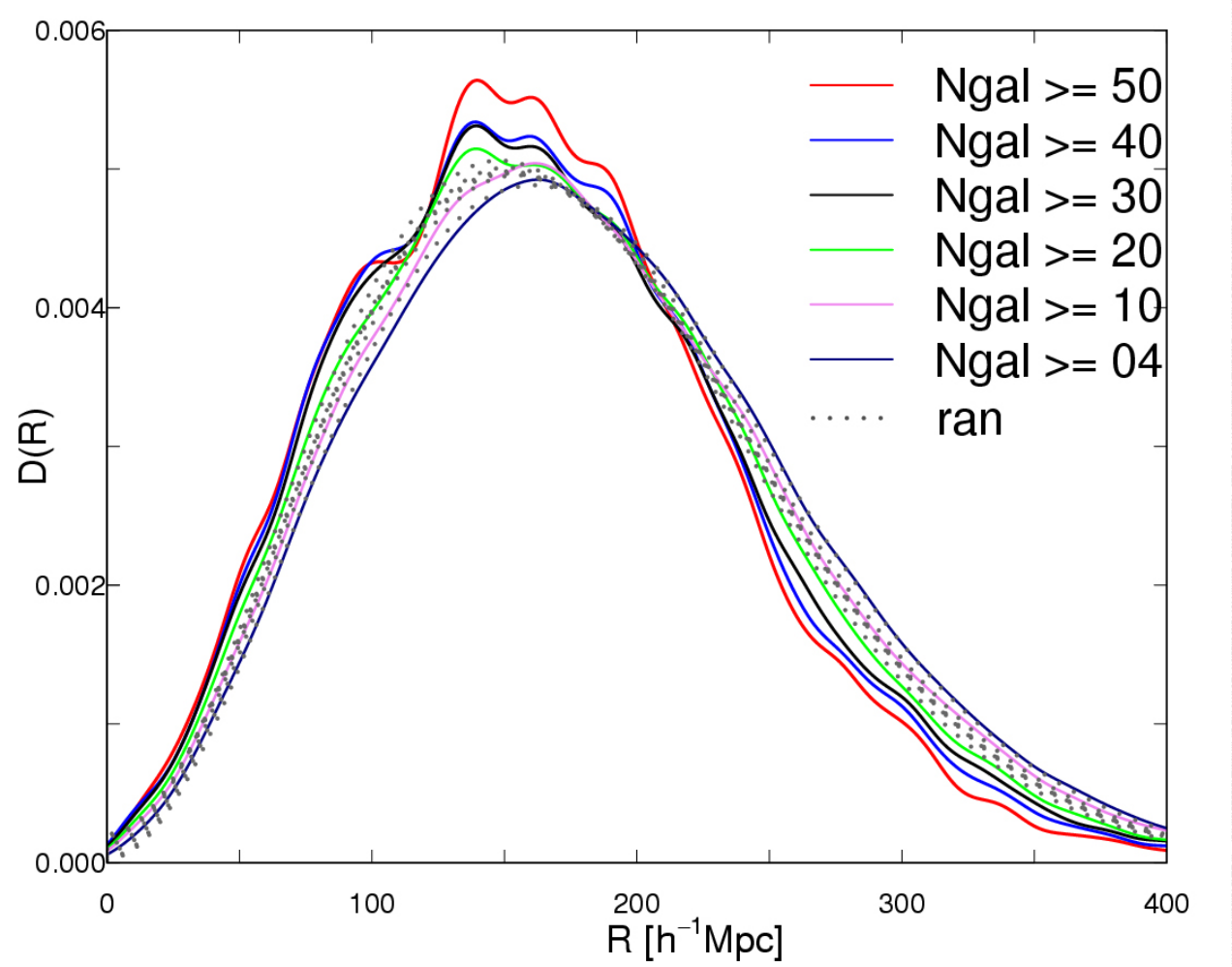
Shell-like structures in our cosmic neighbourhood:

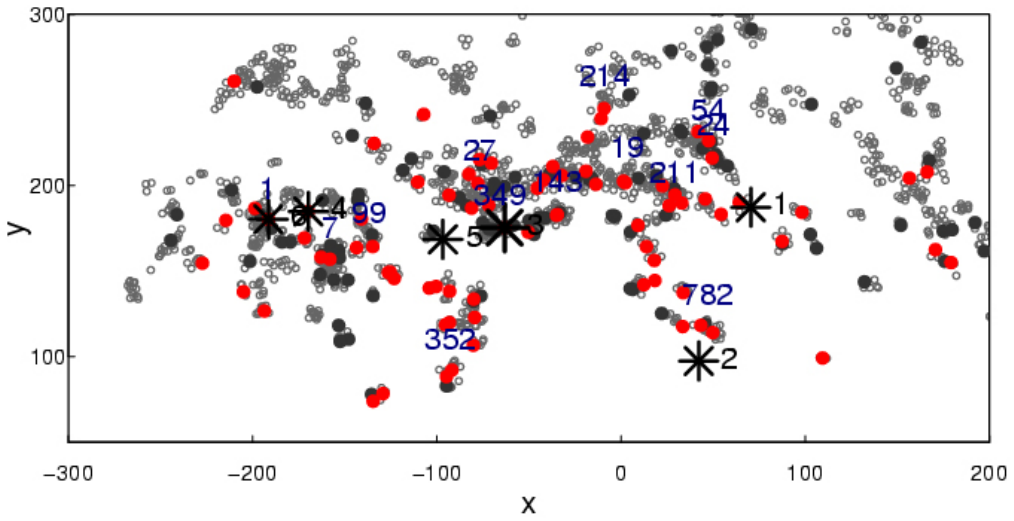
Rich clusters from Sloan Digital Sky Survey as shell centres, groups and clusters of galaxies as shell walls

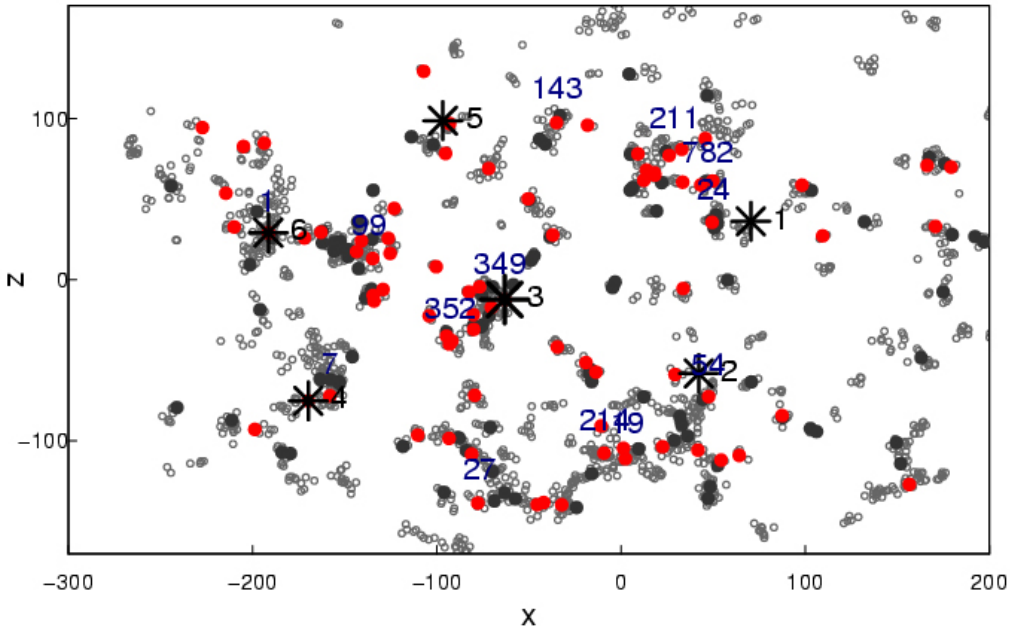
109 rich clusters with at least 50 member galaxies
in a distance interval 120 – 340 Mpc/h ($0.04 < z < 0.12$)

Distance and density distributions around them,
using groups and clusters of all richnesses from pairs to rich clusters

Bootstrap analysis for statistical reliability
Comparison with random distribution


0.006
0.004
0.002
0.000
D(R)
0
100
200
300
400
R [h^{-1}Mpc]
Ngal >= 50
Ngal >= 40
Ngal >= 30
Ngal >= 20
Ngal >= 10
Ngal >= 04
ran



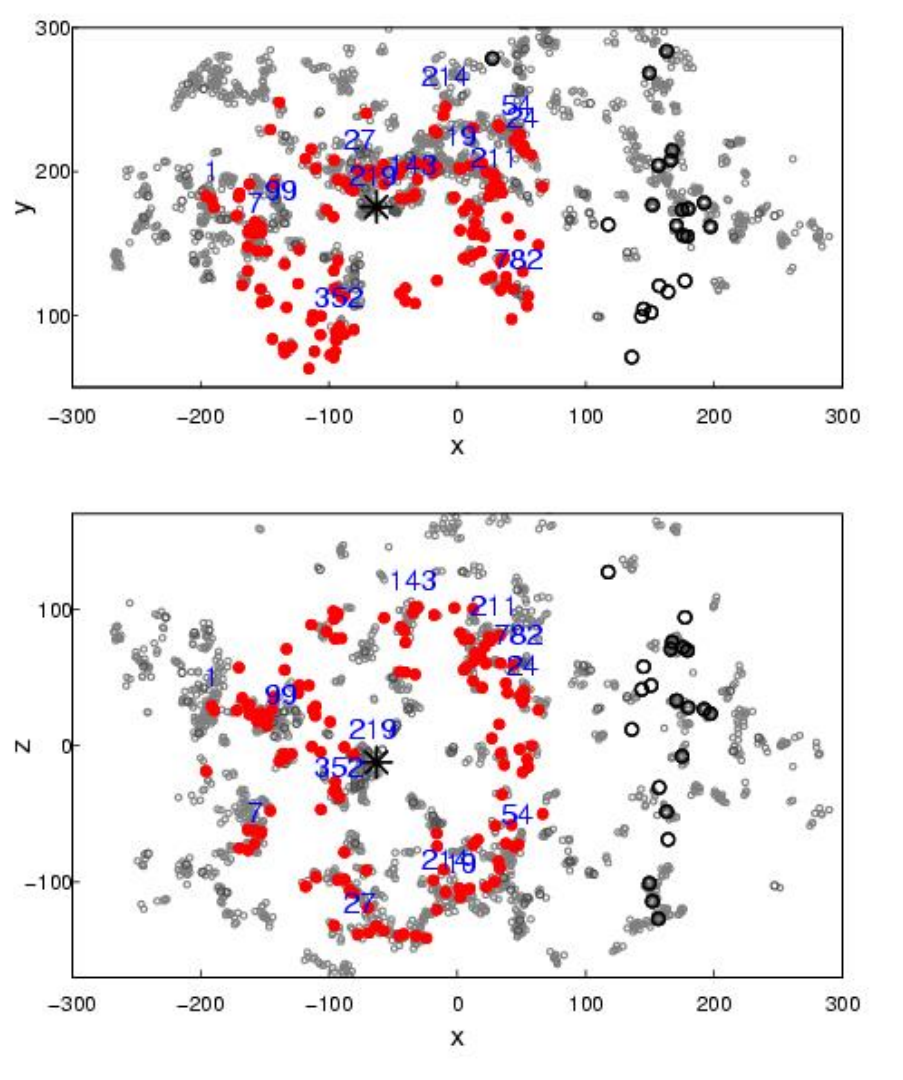


Distribution of galaxy groups and clusters with $N_{gal} \geq 4$.

Red circles:
groups with $N_{gal} \geq 50$

Stars – shell centre candidates

(1) No.	(2) ID	(3) N_{gal}	(4) R.A. [deg]	(5) Dec. [deg]	(6) Dist. [h^{-1} Mpc]	(7) L_{tot} [$10^{10}h^{-2}L_{\odot}$]	(8) $D8$	(9) Abell ID	(10) SCl ID
1	20159	52	158.02	40.16	203.31	59.80	3.9	A 1026, A 1035X	—
2	3714	82	164.58	1.56	121.07	54.71	5.6	A 1139X	—
3	23374	114	207.22	26.68	186.81	100.95	9.0	A 1795X, A 1818	349
4	34513	53	225.86	7.88	261.94	94.18	5.9	A 2020	1311
5	50647	52	232.32	52.88	217.84	62.30	4.4	—	—
6	29587	207	239.52	27.32	264.53	365.47	20.7	A 2142X	1

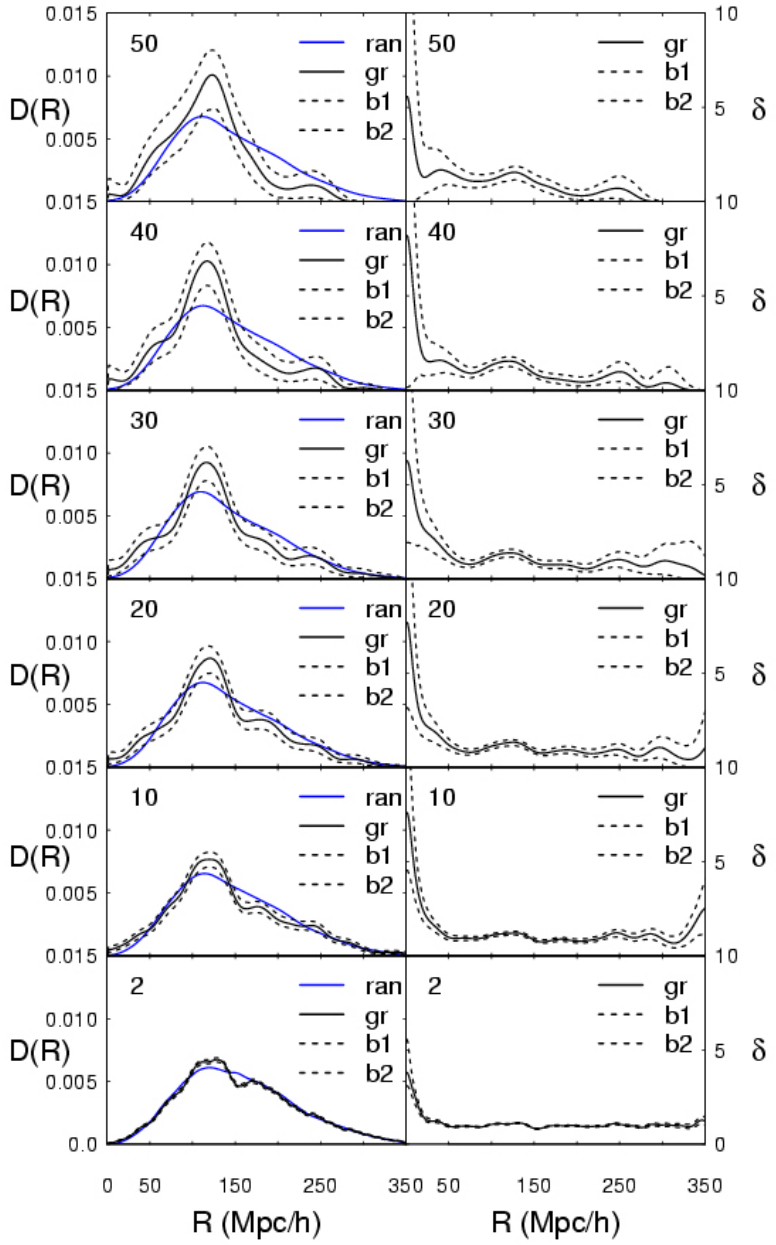


Structures around A1795

Distribution of galaxy groups and clusters with N_gal ≥ 4.

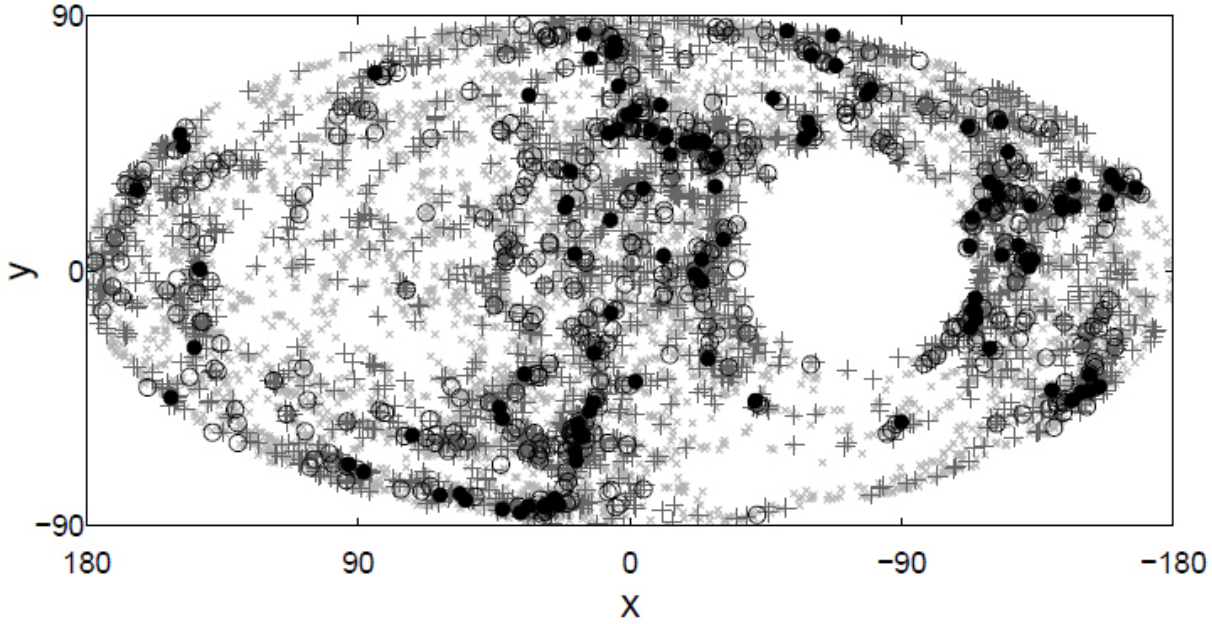
Red circles:
groups with N_gal ≥ 30
In a distance interval
90 – 140 Mpc/h from A1795.

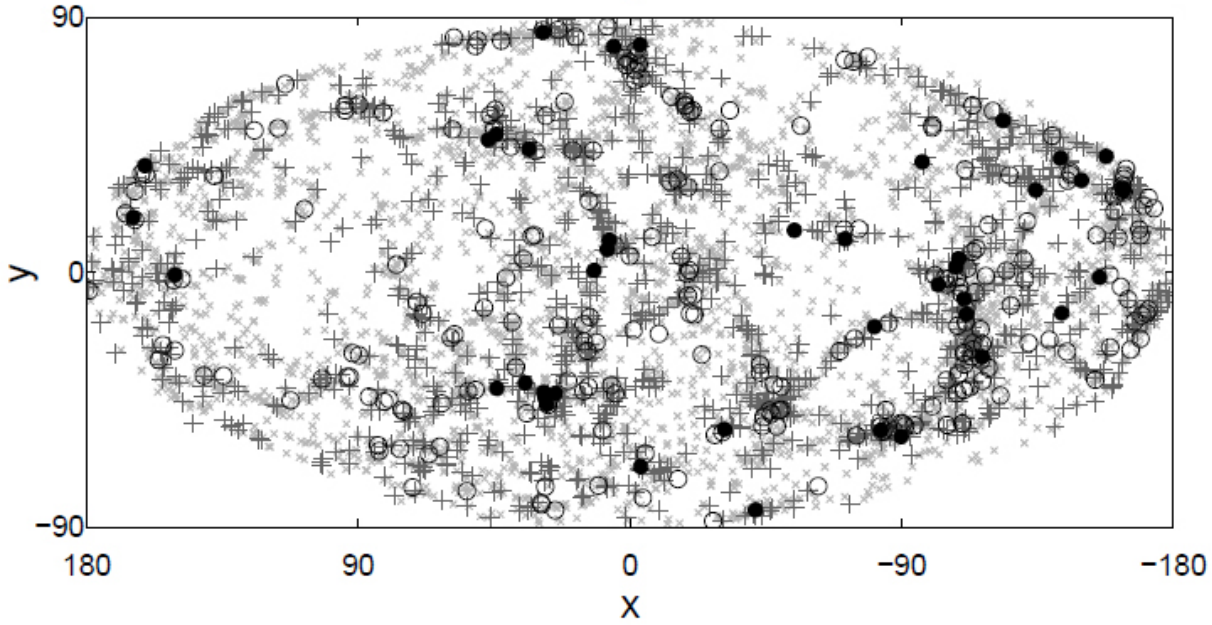
Grey circles:
groups with N_gal ≥ 30
In a distance interval
225 – 275 Mpc/h from A1795.



Distance and density distributions from the cluster A1795

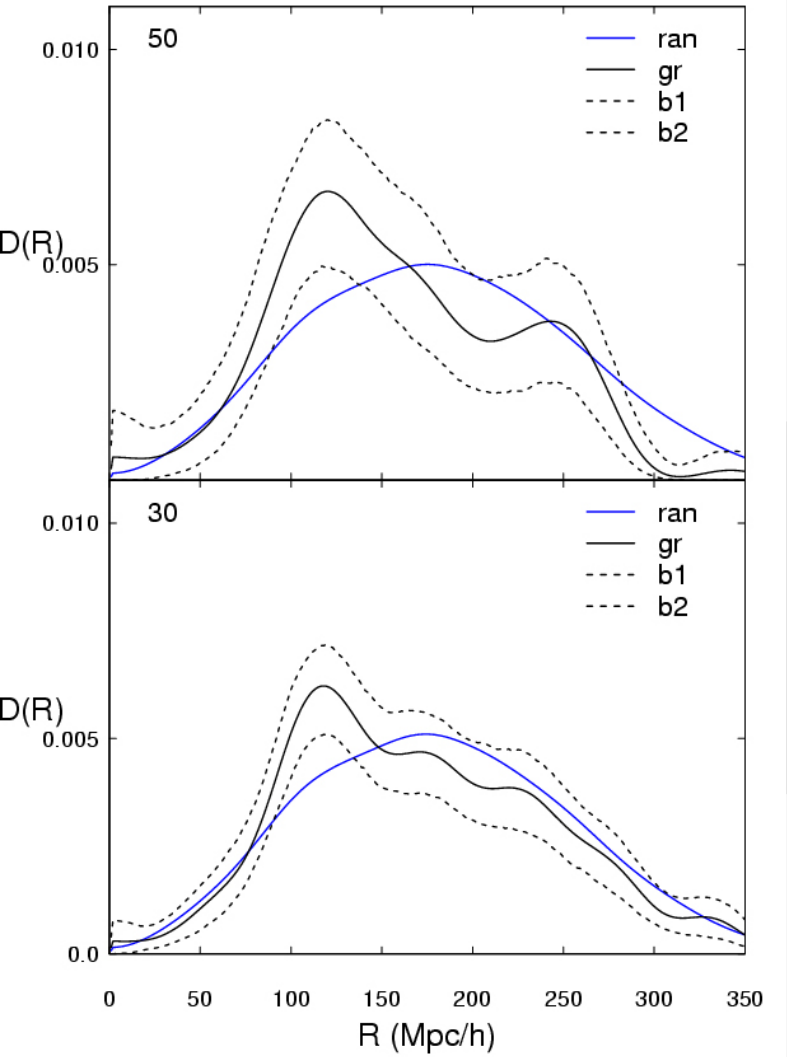
Maxima:
120 Mpc/h and 240 Mpc/h

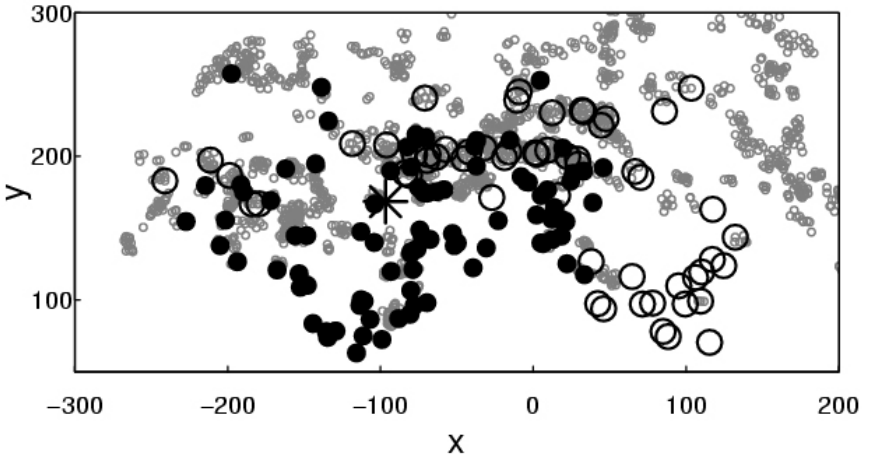


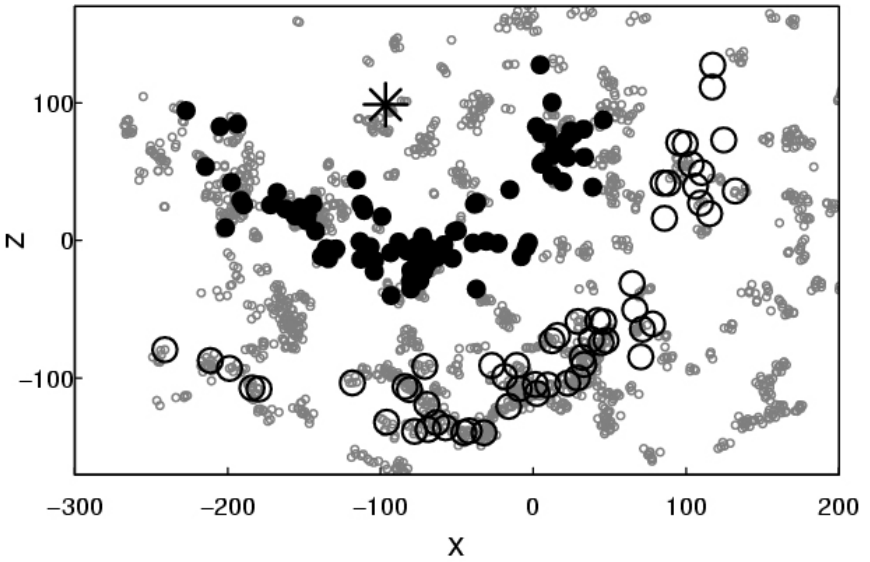


Sky distribution of groups around A1795.

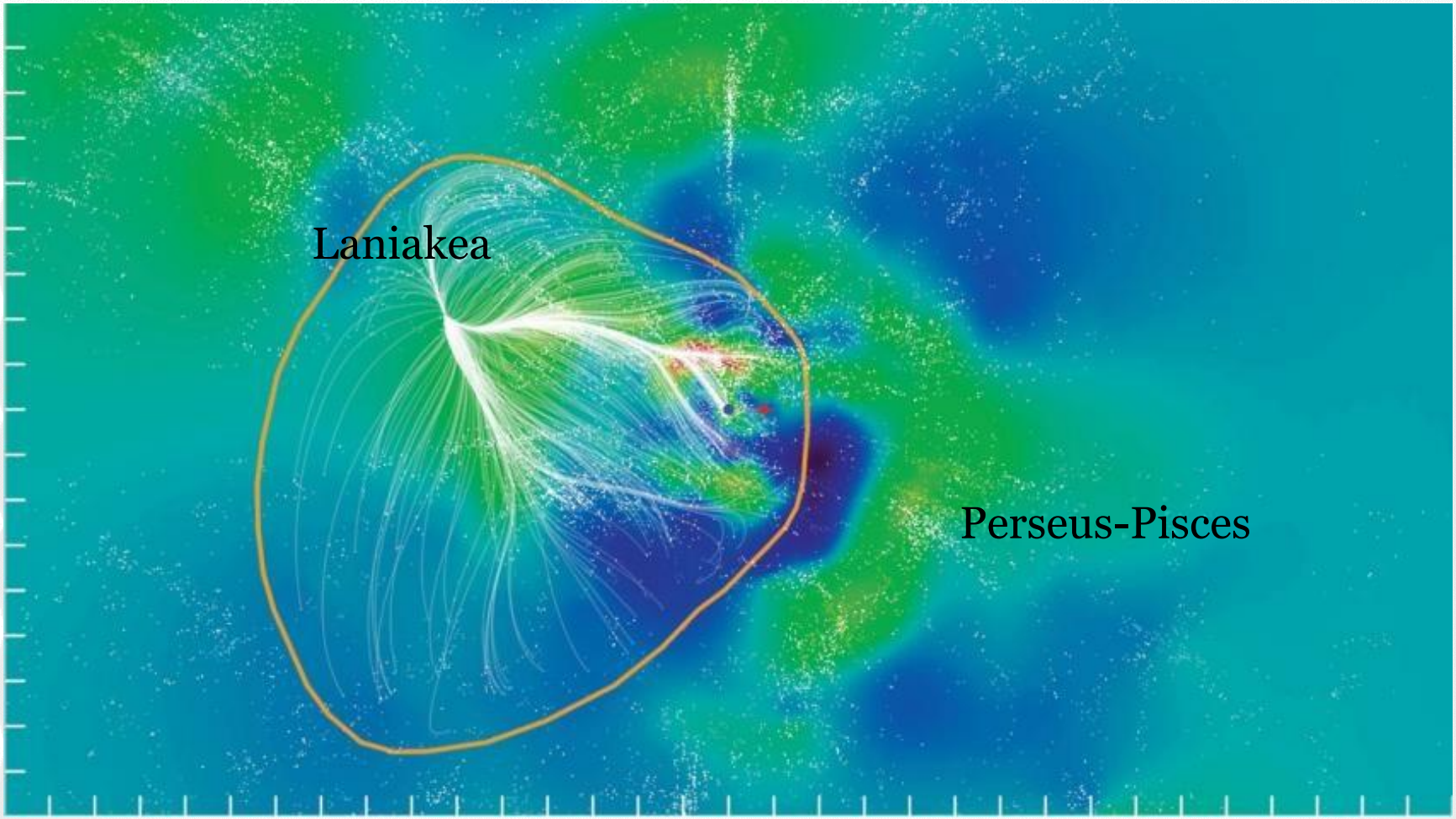
Upper: 90 – 130 Mpc/h
Lower: 50 – 90 Mpc/h



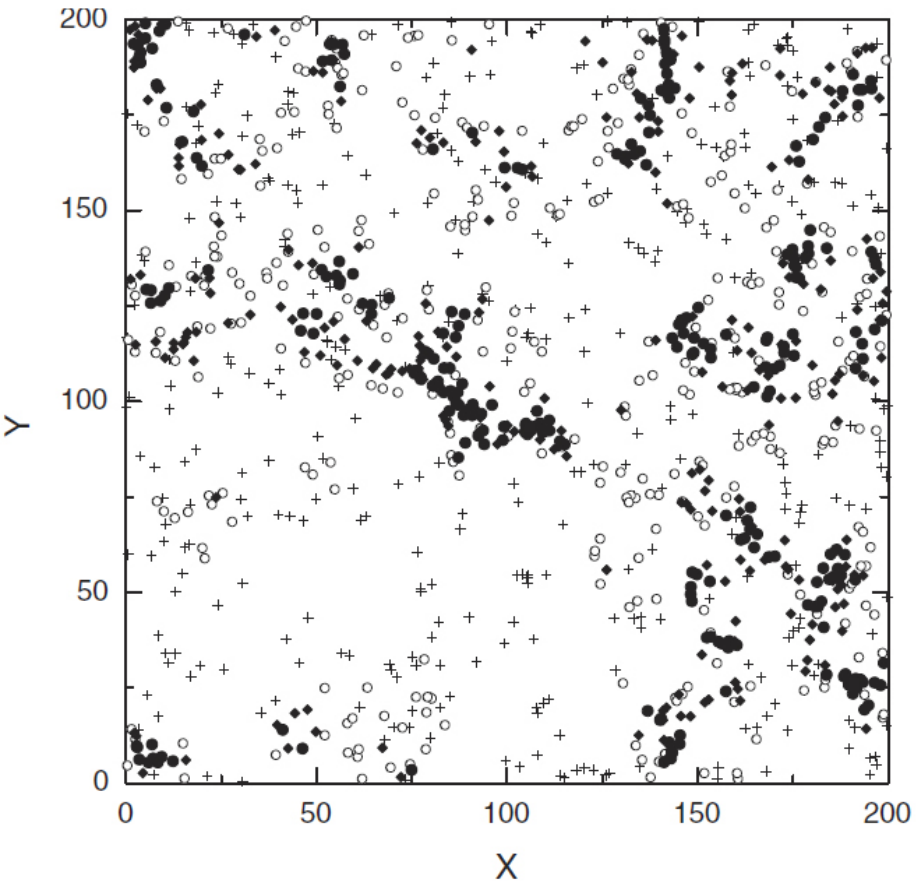


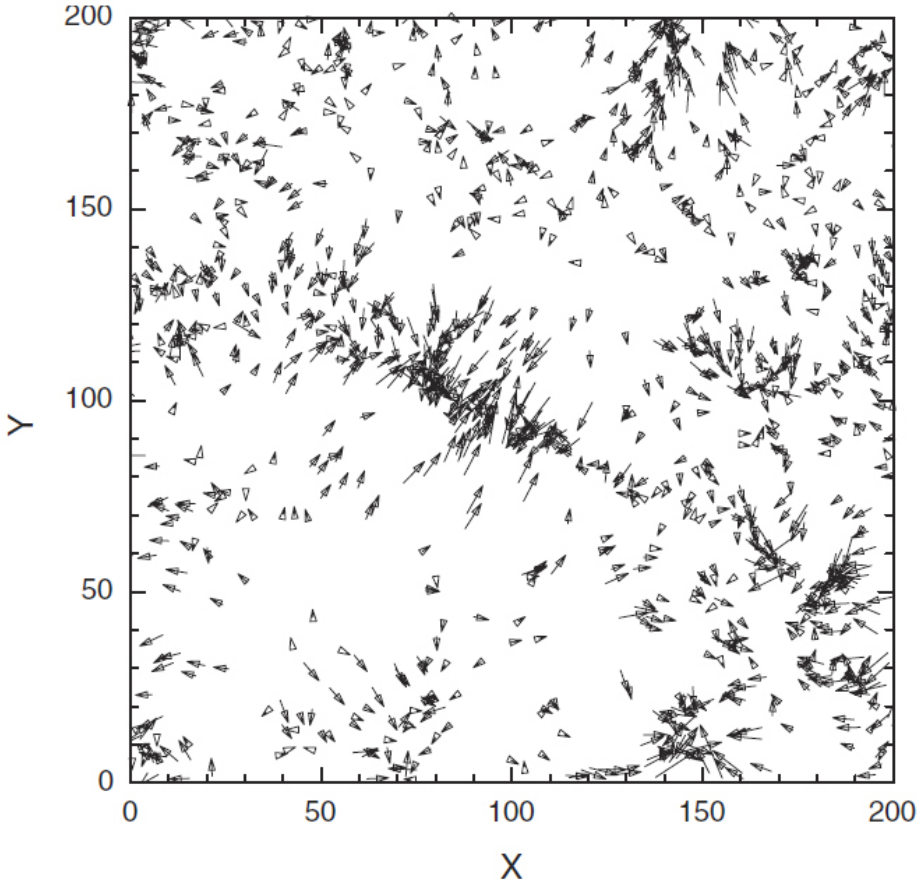


Distance distributions from the cluster Gr50647



Distance between centres of Laniakea and Perseus-Pisces superclusters ~ 120 Mpc/h.





Distribution of dark matter haloes in simulations

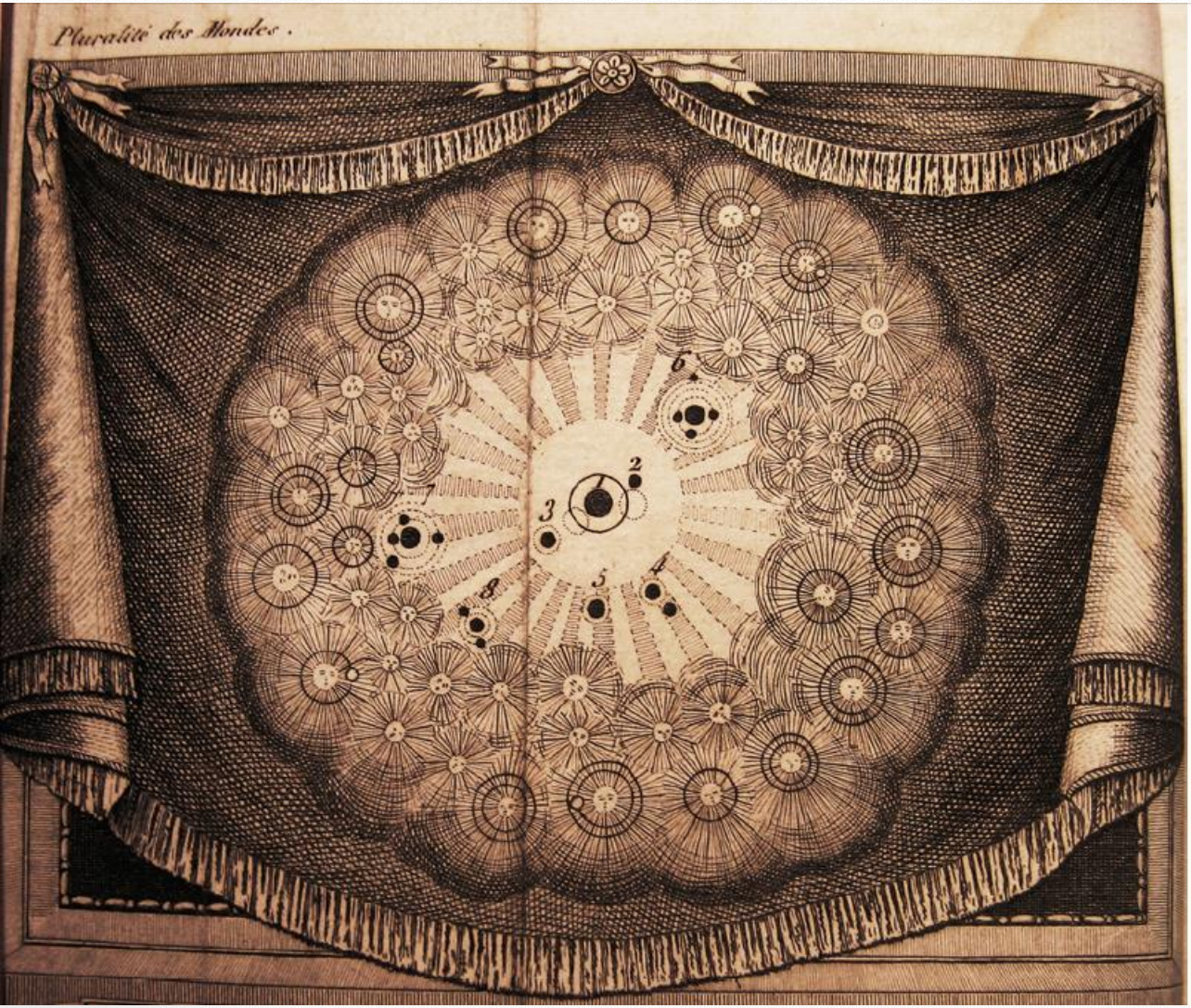
Conclusions:

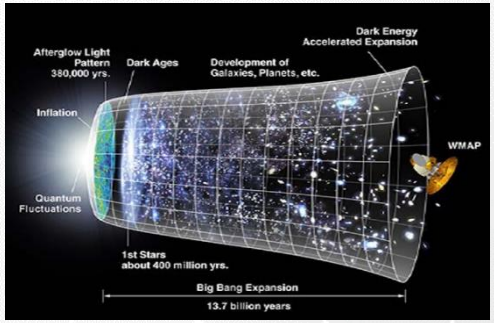
We detected shell-like structures in the distribution of nearby groups, clusters, and superclusters of galaxies,
centered at rich clusters in superclusters and in the field

The radius of the shell is larger than expected for BAO
(120 – 130 Mpc/h vs. 109 Mpc/h)

Shell walls are delineated by *very rich superclusters* – this is the most important difference between our shells and BAO shells

We plan to continue our study with a deeper sample of groups and clusters to understand better the structures in nearby and distant Universe, and the properties of the cosmic web formed by an interplay of many physical processes with their characteristic scales.


Pluralité des Mondes.
1
2
3
4
5
6
7
8


Afterglow Light Pattern 380,000 yrs.
Dark Ages
Development of Galaxies, Planets, etc.
Dark Energy Accelerated Expansion
Inflation
WMAP
Quantum Fluctuations
1st Stars about 400 million yrs.
Big Bang Expansion
13.7 billion years

Thank you!