Cosmography of the Local Universe

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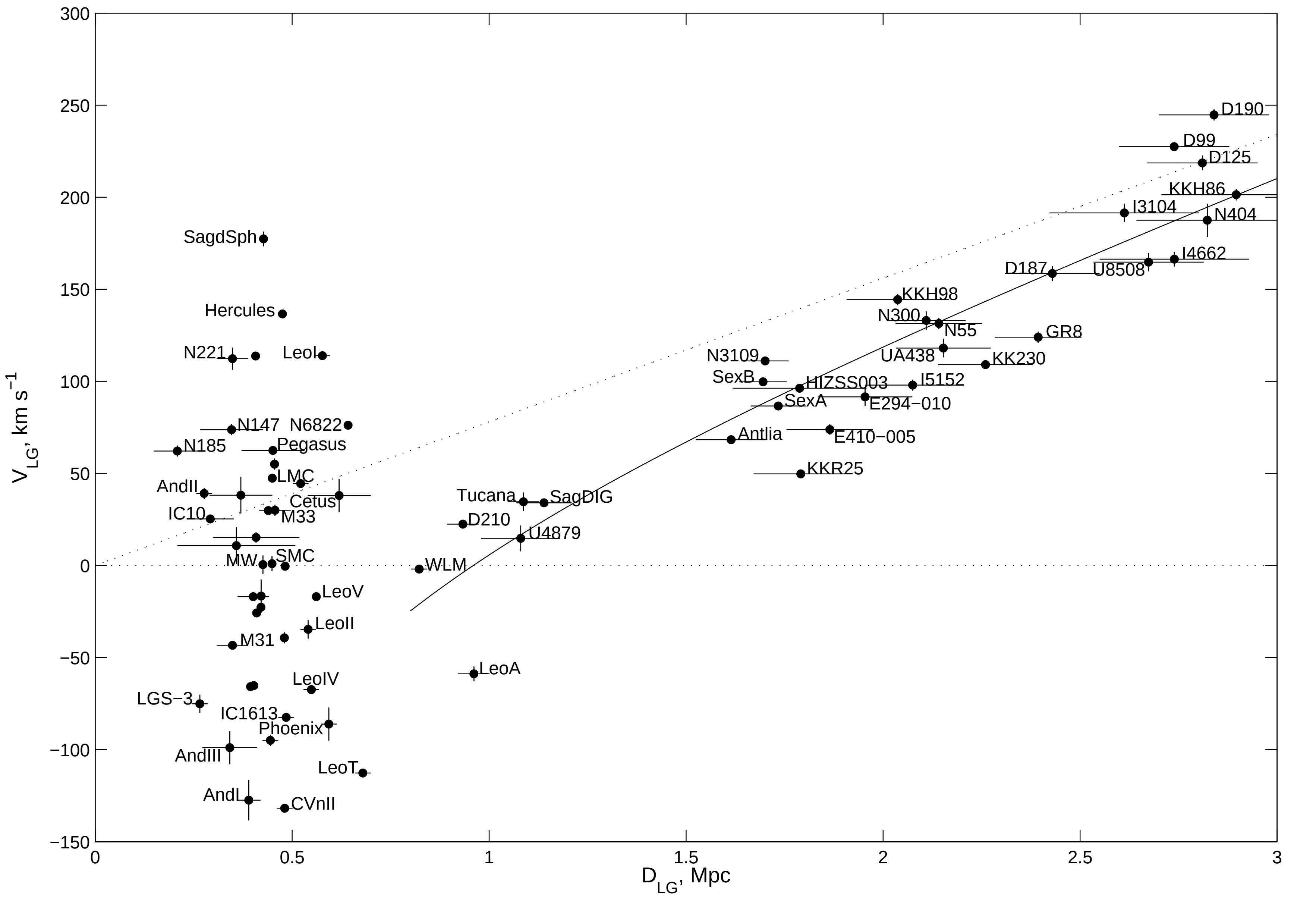
The Chalonge 16th Paris Cosmology Colloquium, 2012 June

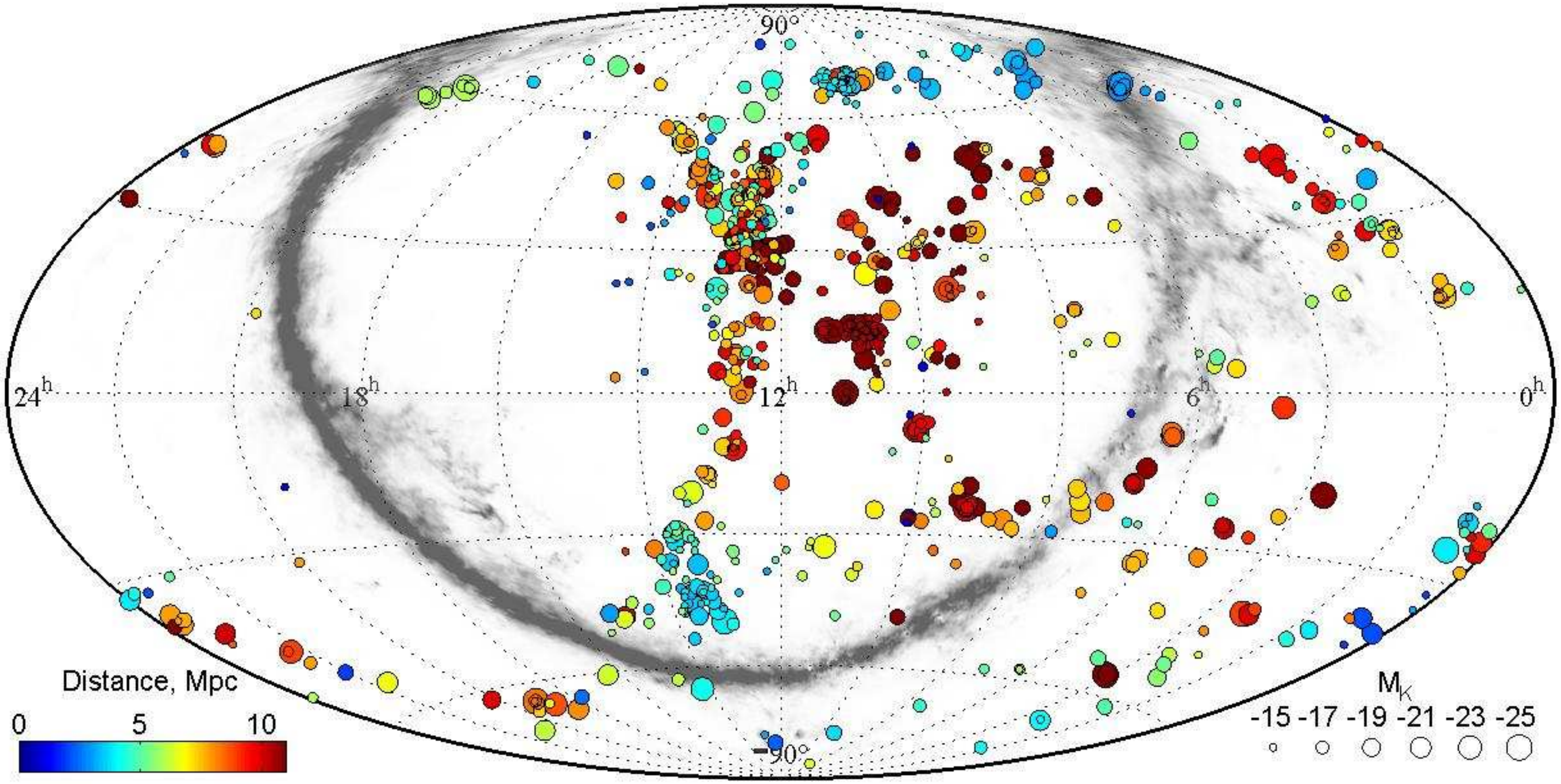
There are two asymmetric branches of observational cosmology:

1. Investigation of high redshift objects & cosmic backgrounds.
2. The near field cosmology at Z=0.

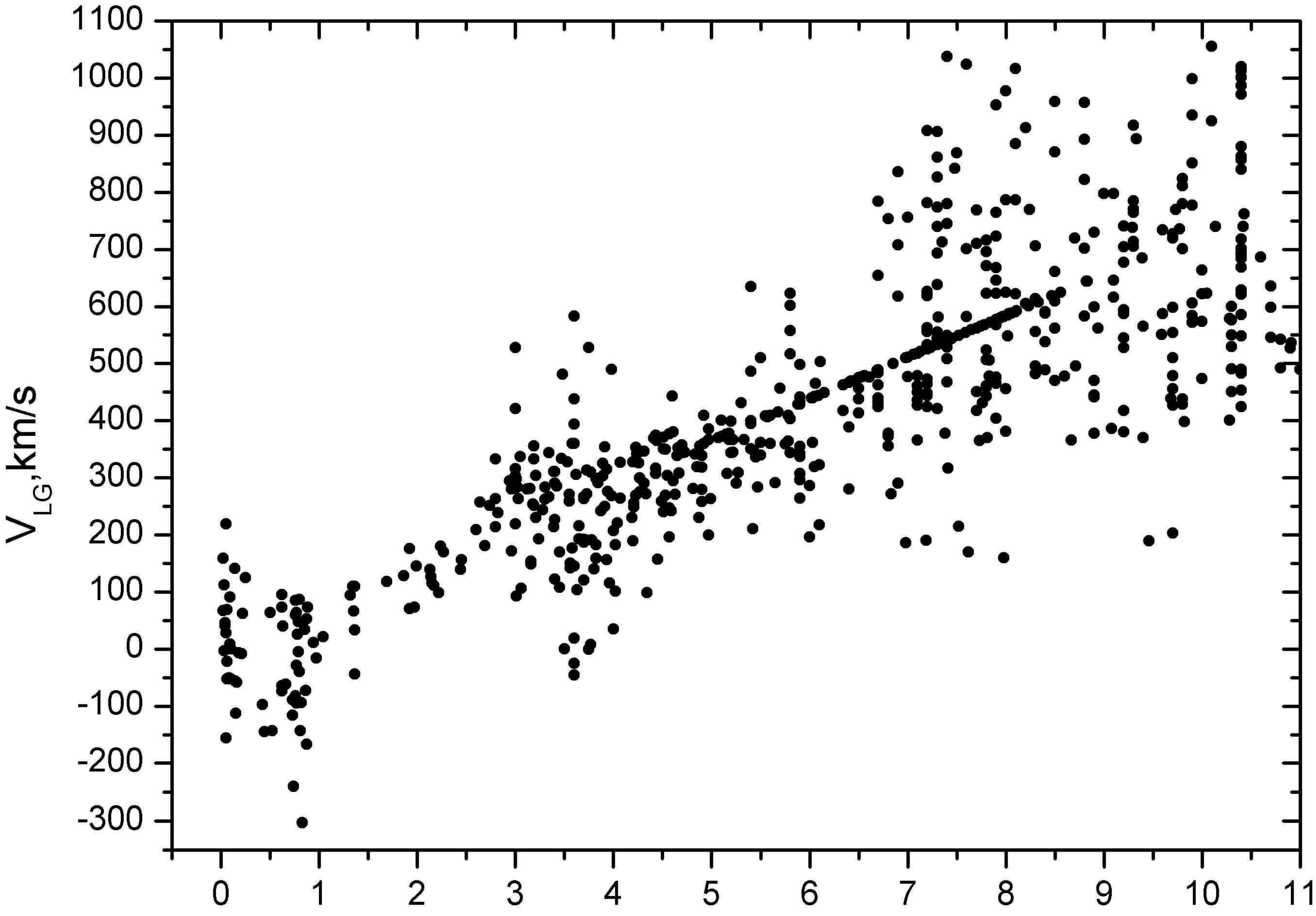
«A Catalog of 450 Neighboring Galaxies» with distances D < 10 Mpc (Karachentsev et al. 2004, AJ, 127, 2031) contains a lot of objects with accurate distance measurements derived from HST. This is the most suitable sample to study peculiar velocity motions and Dark Matter distribution on scales ~(1-3)Mpc. Its new updated version amounts to ~800 galaxies.



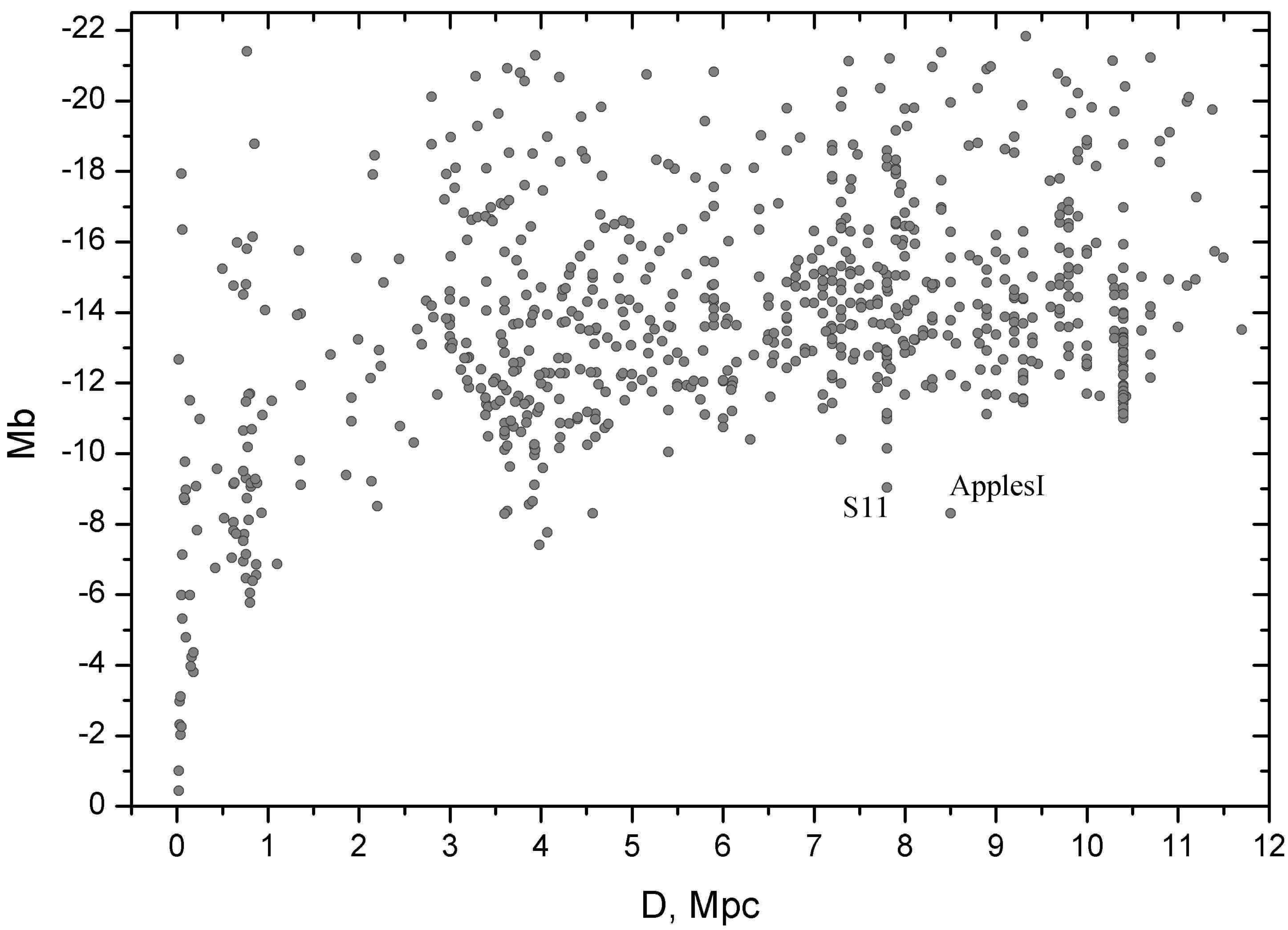
V_{LG}, km s^{-1}
D_{LG}, Mpc
SagdSph
Hercules
N221
LeoI
N147
N6822
N185
Pegasus
LMC
AndII
Cetus
IC10
M33
MW
SMC
LeoV
LeoII
M31
LeoIV
LGS−3
IC1613
Phoenix
AndIII
LeoT
AndI
CVnII
WLM
Tucana
SagDIG
D210
U4879
LeoA
N3109
SexB
HIZSS003
SexA
Antlia
KKR25
E294−010
E410−005
UA438
I5152
N300
N55
KKH98
GR8
KK230
D187
U8508
I4662
I3104
N404
KKH86
D125
D99
D190



90°
24h
18h
12h
6h
0h
-90°
Distance, Mpc
0
5
10
M_K
-15 -17 -19 -21 -23 -25



1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
V_LG, km/s
0
1
2
3
4
5
6
7
8
9
10
11



-22
-20
-18
-16
-14
-12
-10
-8
-6
-4
-2
0
Mb
0
1
2
3
4
5
6
7
8
9
10
11
12
D, Mpc
S11
ApplesI

As a next step, we passed from the Local volume (D<10 Mpc) to the Local universe (D < 50 Mpc), whose scale is comparable with the cosmological «cell of homogeneity».

Our basic effort were directed towards:

- to systematize data on radial velocities, apparent magnitudes, morphological types of galaxies;
- searches for new dwarf galaxies;
- optical identifications of HI-sources from HIPASS, ALFALFA and other surveys;
- cleaning numerous ASTRO-SPAM (!)

As a result we obtained a sample of 10 900 galaxies with $V_{LG} < 3500$ km/s over the whole sky, excepting $|b| < 15$ deg.

To identify groups and clusters of galaxies we used a new algorithm, more sophisticated in comparison to «FoF», taking into account individual properties of galaxies.

On a step of linking 2 galaxies as a virtual pair, we used two criteria:

a) negative total energy of the pair, $2T < |U|$, and

b) causial connection of the pair components, $R_{12} < R_o$.

Our approach leads to creation of the following catalogs: 509 pairs, 168 triplets, 395 groups (with $k > 3$) as well as 520 especially isolated galaxies.

(Makarov & Karachentsev, 2011, MNRAS, 412, 2498)

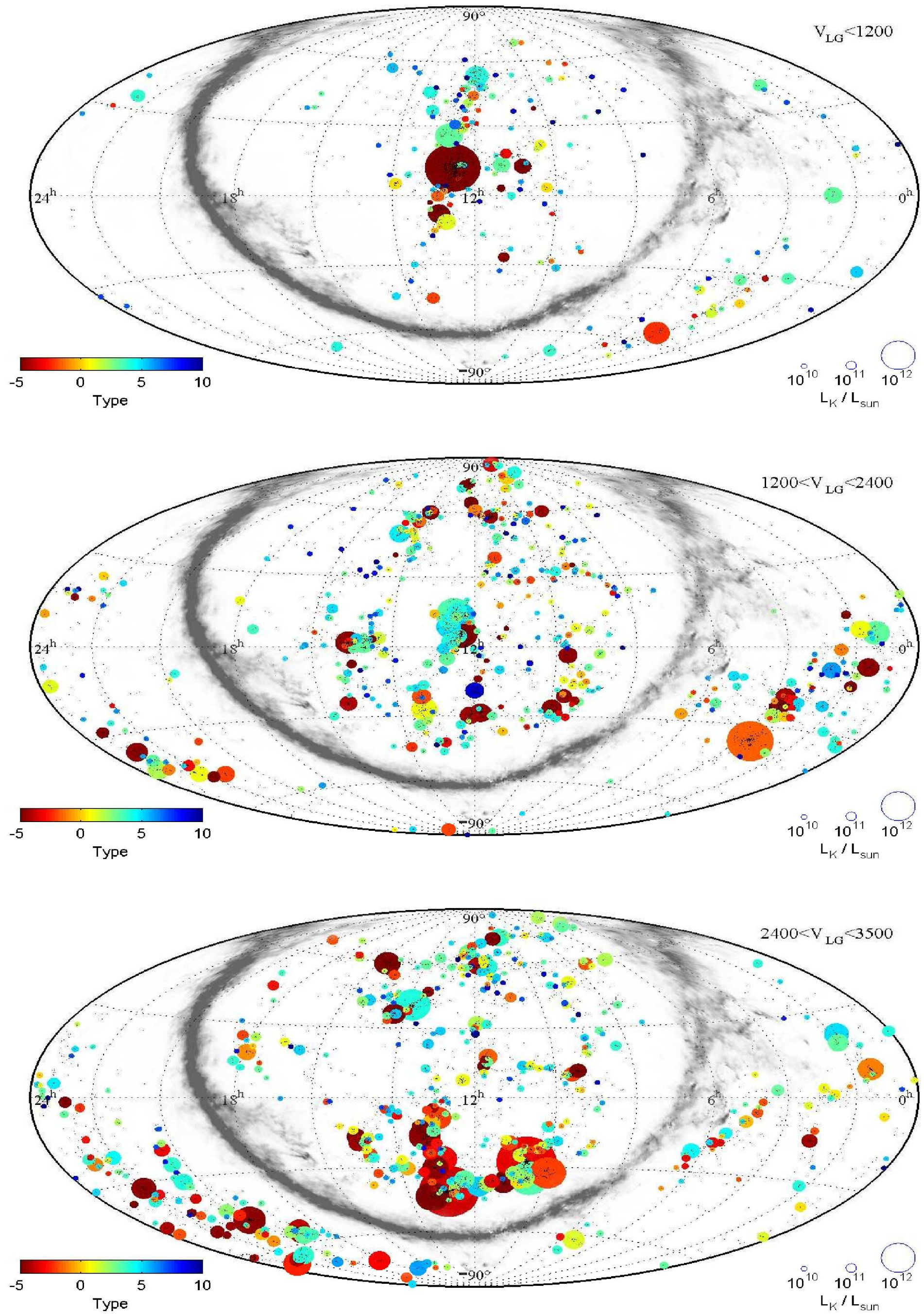
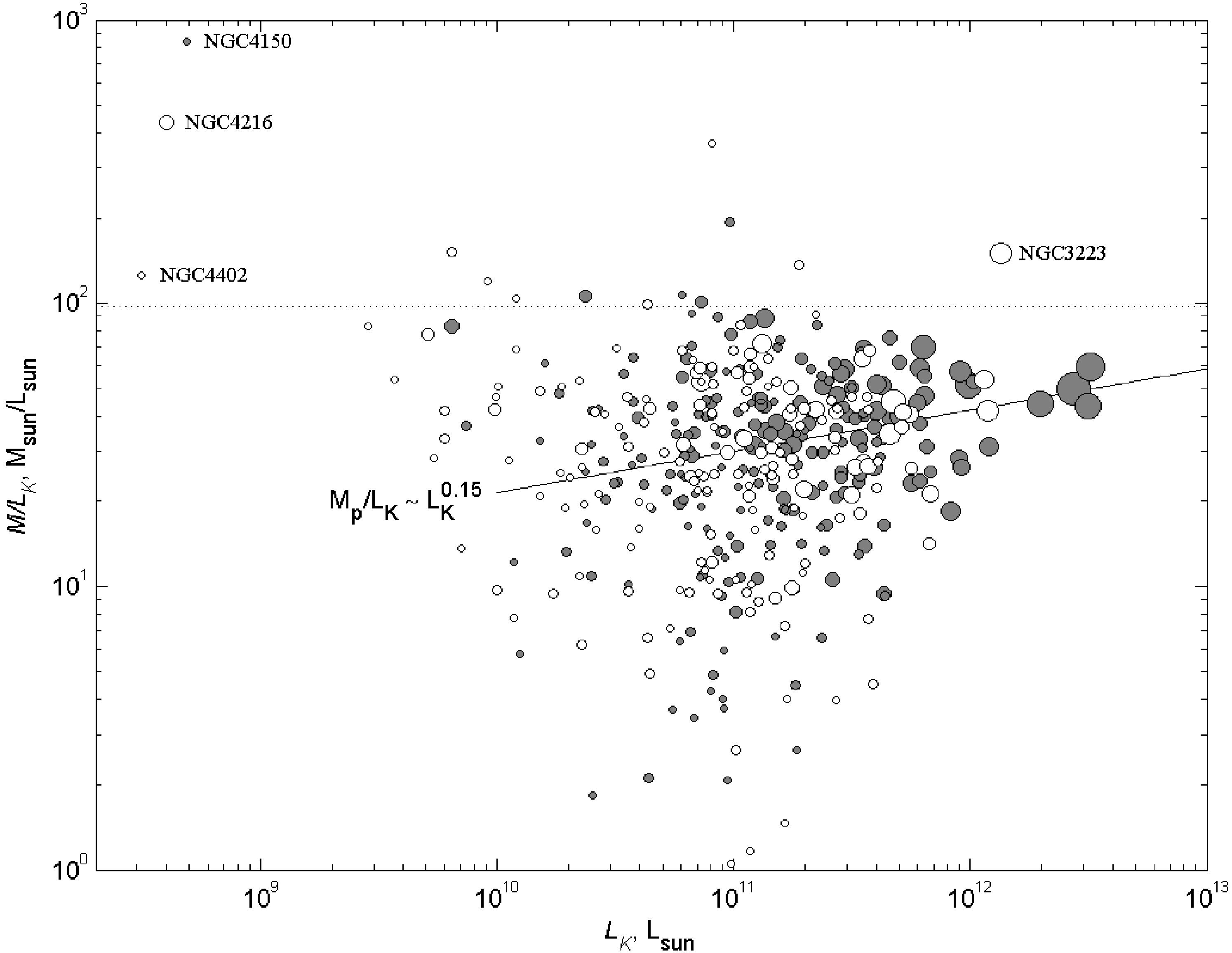
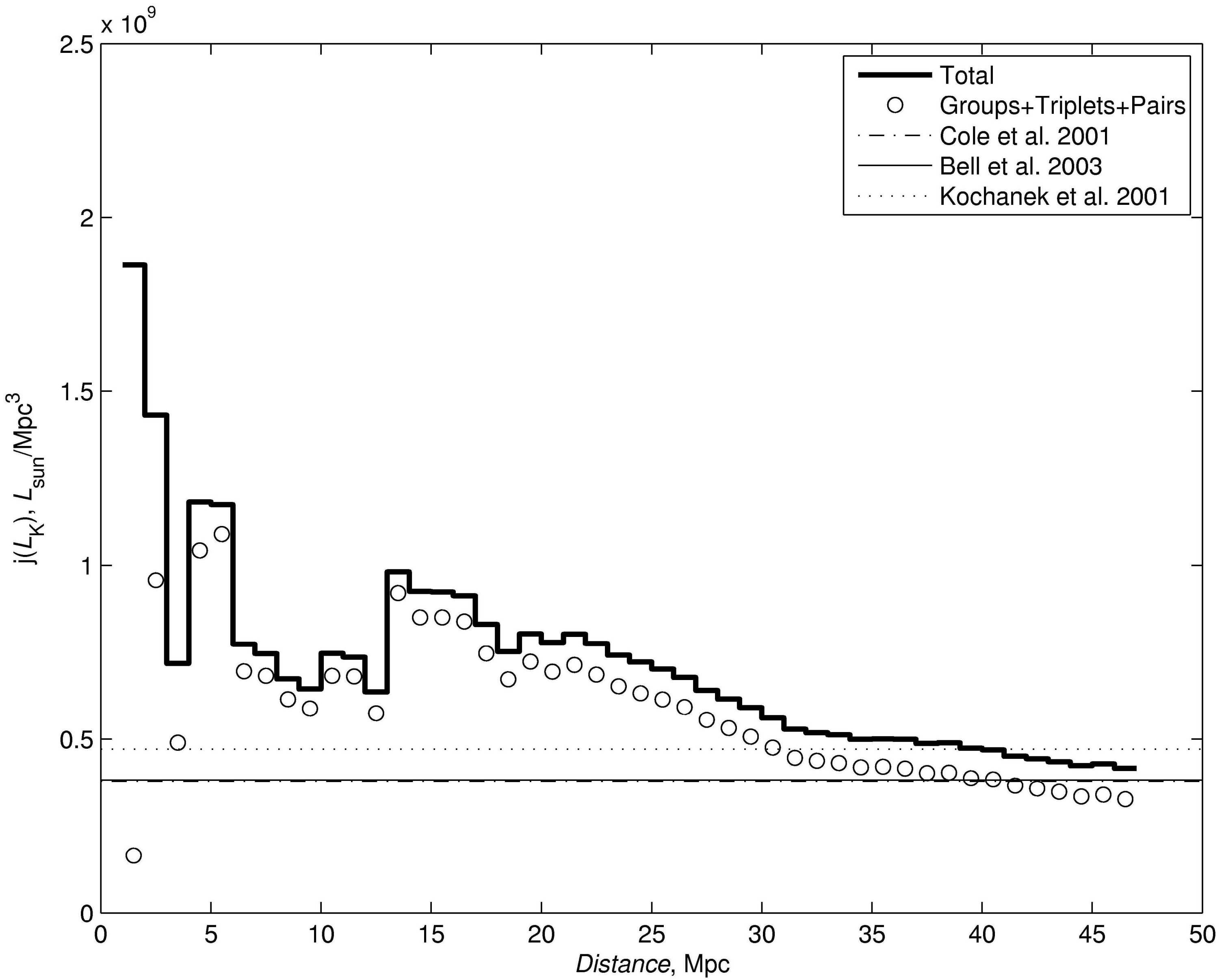
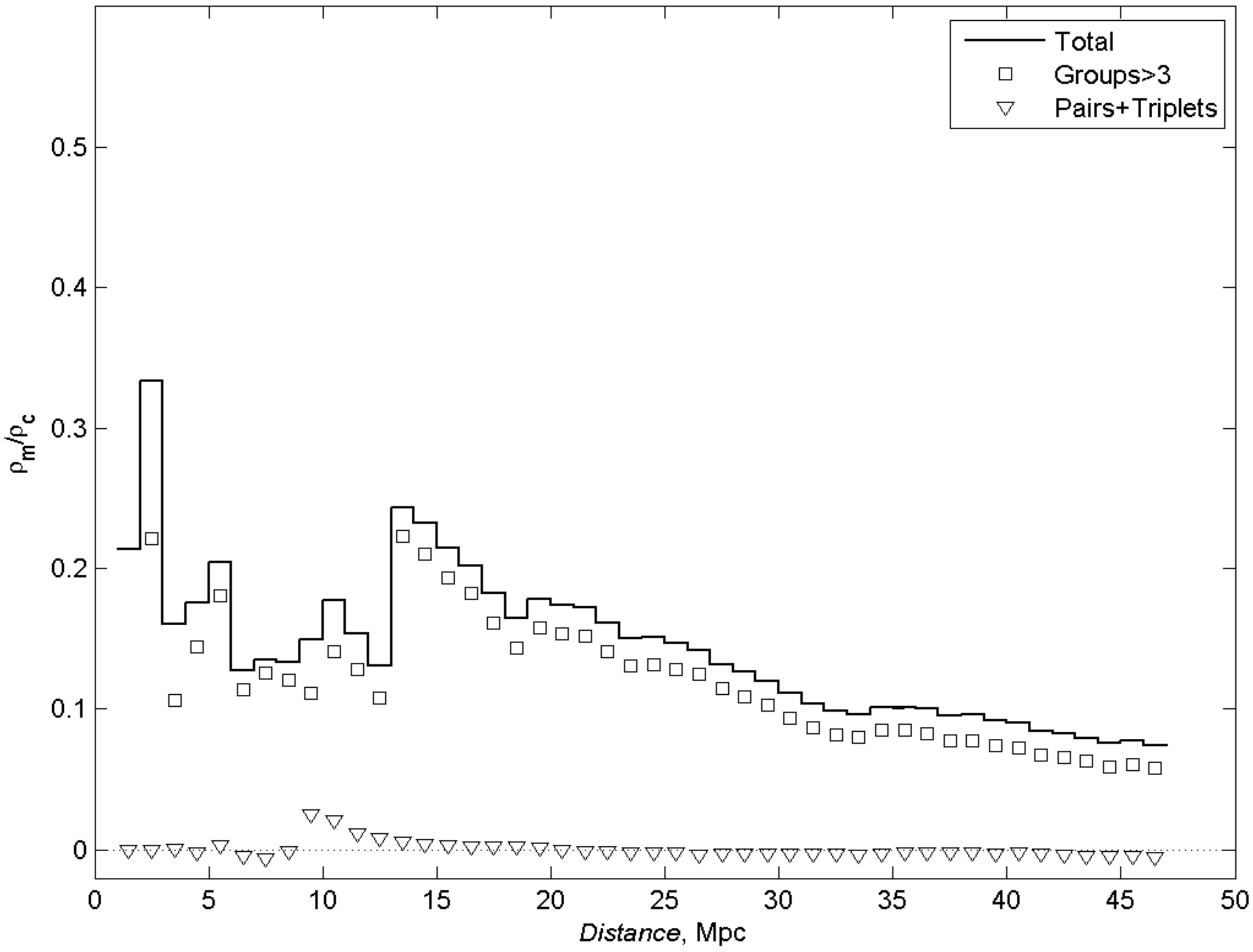


Figure 1. Sky distribution of the groups in equatorial coordinates. The groups are plotted as circles with a diameter proportional to the



NGC4150
NGC4216
NGC4402
NGC3223
$M_p/L_K \sim L_K^{0.15}$
M/L_K, M_{sun}/L_{sun}
L_K, L_{sun}
10^0
10^1
10^2
10^3
10^9
10^{10}
10^{11}
10^{12}
10^{13}


x 10^9
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
40
45
50
j(L_K), L_sun/Mpc^3
Distance, Mpc
Total
Groups+Triplets+Pairs
Cole et al. 2001
Bell et al. 2003
Kochanek et al. 2001



Total
Groups>3
Pairs+Triplets
0.5
0.4
0.3
0.2
0.1
0
ρ_m/ρ_c
0
5
10
15
20
25
30
35
40
45
50
Distance, Mpc

Problem of missing Dark Matter in the Local universe

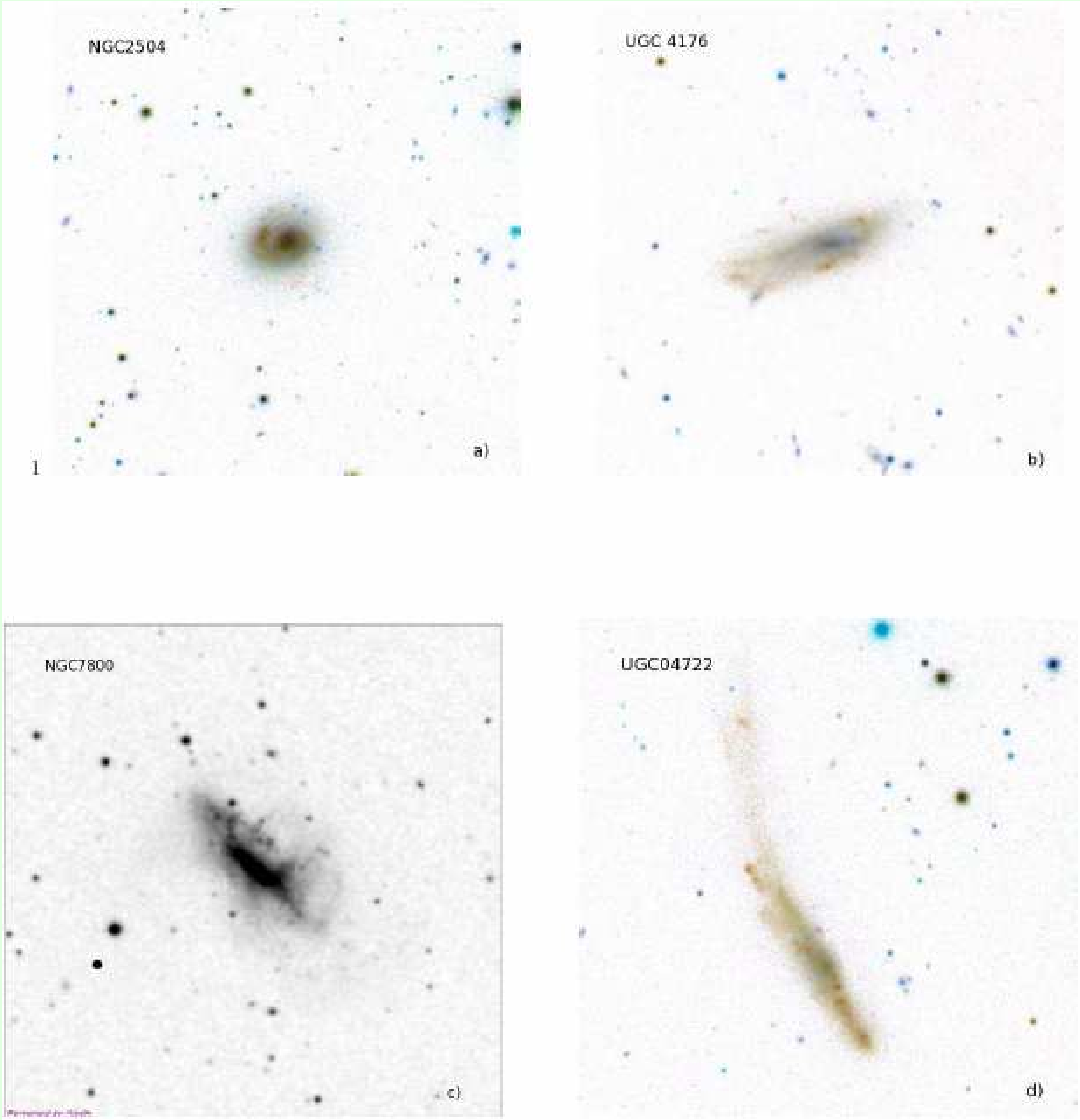
$\Omega_{m\ (local)}$ = 0.08+-.02 vs. $\Omega_{m\ (global)}$ = 0.28+-.03

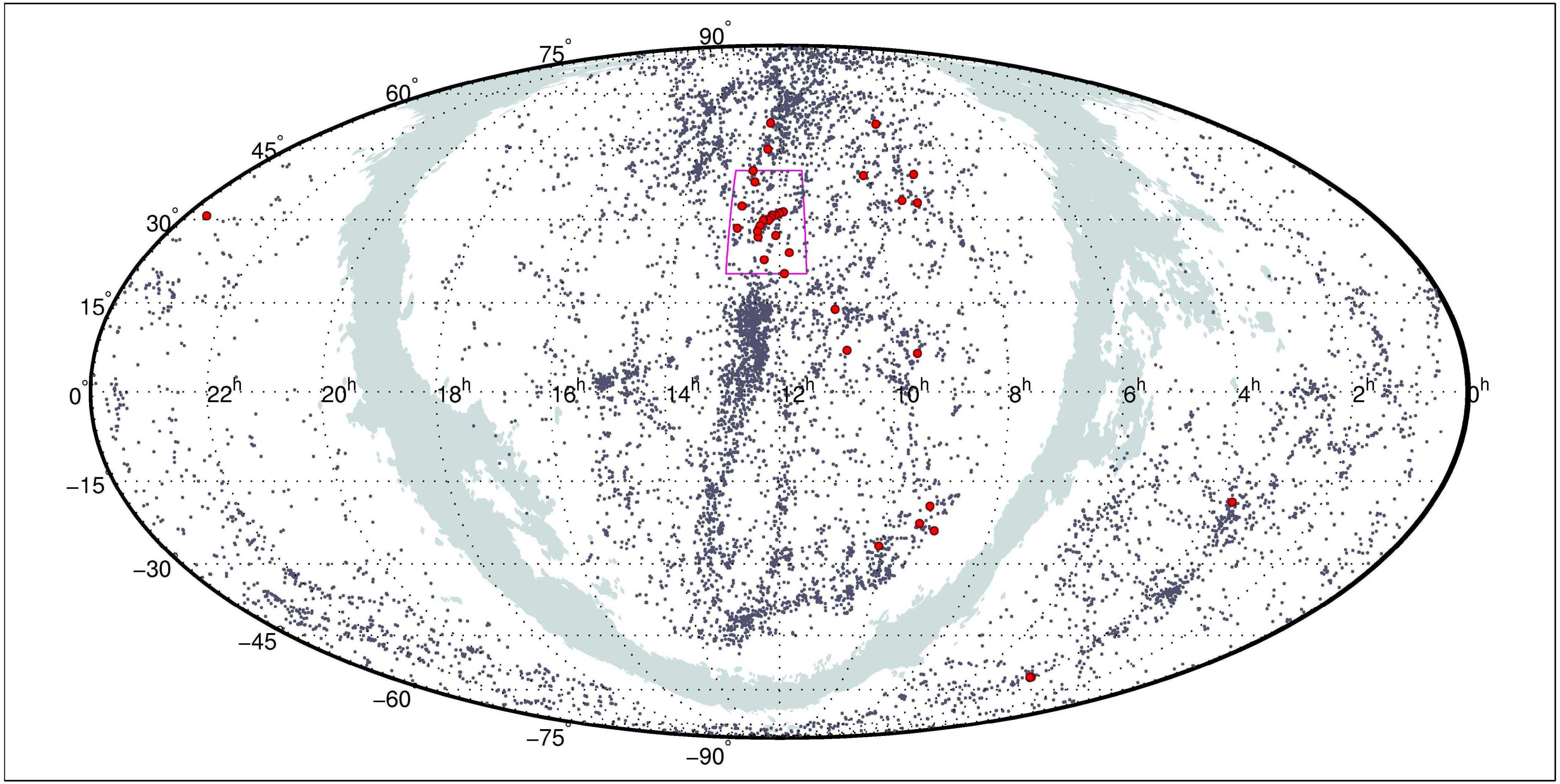
and its probable explanations:

1. All galaxy systems extend much far beyond their virial radii,having at average $M_{tot} = 3\ M_{vir}$.

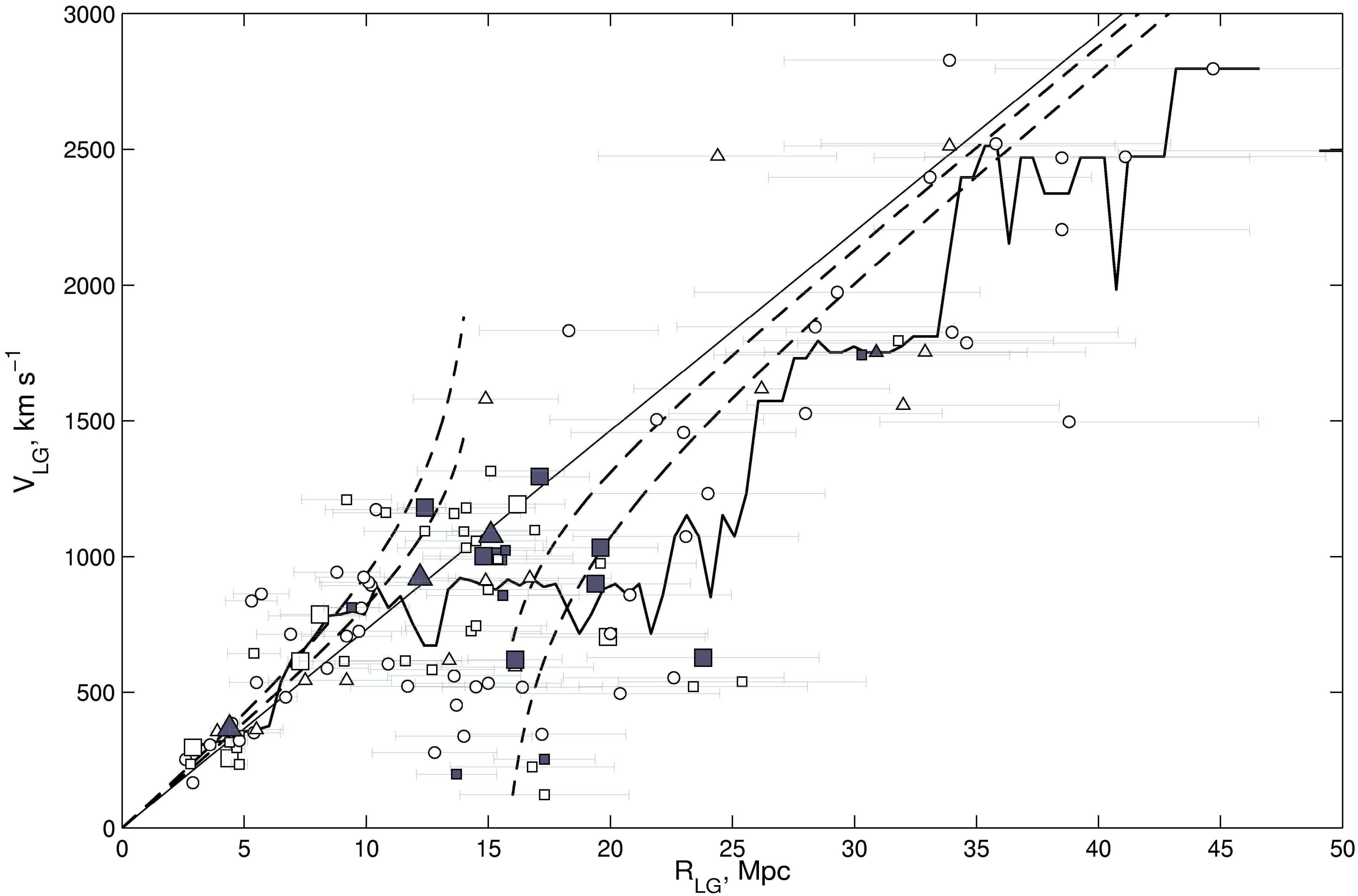
2. The true scale of homogeneity is not a 50 Mpc but ~300 Mpc, and we are living in a zone of extended low density (huge void).

3. The basic fraction of DM (about 2/3) is distributed outside R_{vir} (and even R_o), being concentrated in dark clumps (or smoothed «ocean»).


NGC2504
1
a)
UGC 4176
b)
NGC7800
c)
UGC04722
d)


90°
75°
60°
45°
30°
15°
0°
22h
20h
18h
16h
14h
12h
10h
8h
6h
4h
2h
0h
–15
–30
–45
–60
–75°
–90°

N = 8811 gg


3000
2500
2000
1500
1000
500
0
V_{LG}, km s^{-1}
0
5
10
15
20
25
30
35
40
45
50
R_{LG}, Mpc

WEAK LENSING MEASUREMENT OF GALAXY CLUSTERS IN THE CFHTLS WIDE SURVEY

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Draft version August 18, 2011

ABSTRACT

We present the first weak lensing analysis of the completed Canada-France-Hawaii Telescope Legacy Survey (CFHTLS). We study the 72 deg^2 W1 field, the largest of the CFHTLS wide survey fields, and present the largest contiguous weak lensing convergence "mass map" yet made.

Galaxy shapes are measured in sub-arcsecond i'-band imaging, with a KSB pipeline verified against high resolution Hubble Space Telescope imaging that covers part of the CFHTLS, and also consistent with measurements in the r'-band. The reconstructed lensing convergence map contains 301 peaks with signal-to-noise ratio $\nu > 3.5$, consistent with predictions of a ΛCDM model. Of these peaks, 126 lie within $3.0'$ of a BCG identified from multicolor optical imaging in an earlier red sequence survey. We also identify 7 counterparts for massive clusters previously seen in X-ray emission within 6 deg^2 XMM-LSS survey.

With photometric redshift estimates for the source galaxies, we use a tomographic lensing method to fit the redshift and mass of each convergence peak. Matching these to the optical observations, we confirm 85 groups/clusters with $\chi^2_{\mathrm{reduced}} < 3.0$, at a mean redshift $\langle z_c \rangle = 0.36$ and velocity dispersion $\langle \sigma_c \rangle = 658.8$ km/s. We derive an empirical relation between the cluster mass and the galaxy velocity dispersion, $M_{200} = 9.01^{+3.27}_{-2.71} \times 10^{14} \times (\sigma_v/1000\,km/s)^{3.48^{+0.59}_{-0.61}}/E(z)h^{-1}M_\odot$, which is in reasonable agreement with predictions from N-body ΛCDM simulations. The future survey, such as DES/LSST/Kdust/EUCLID, will allow to map clusters on much larger cosmological volume thus effectively probing cosmology.

Subject headings: gravitational lensing — weak lensing — clusters: general — cosmology: large-scale structure

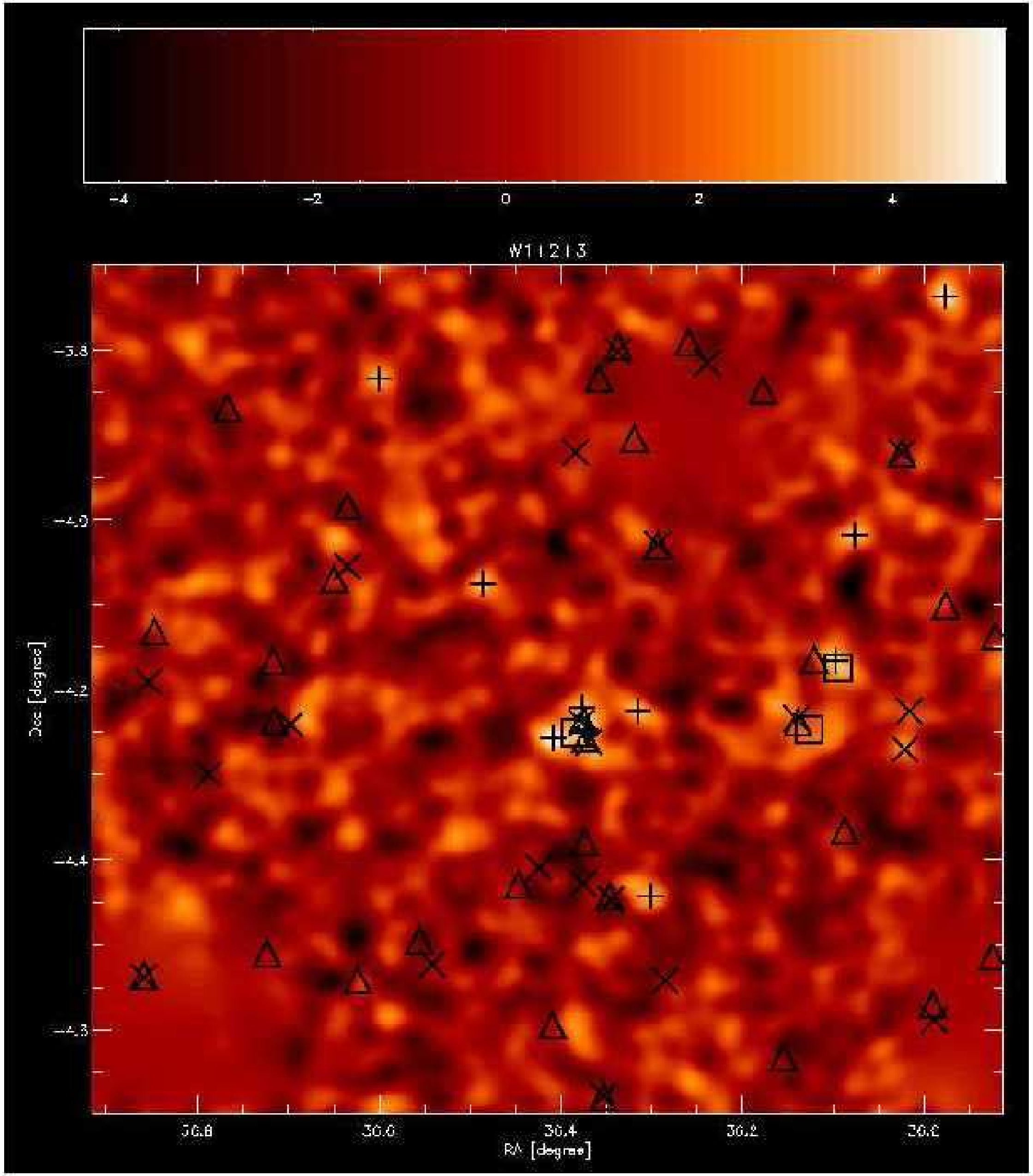


Figure 15. Reconstructed convergence signal-to noise map for the representative W1+2+3 pointing, including overlays showing optically and X-ray selected cluster counterparts. The smoothing scale of the background greyscale map is $\theta_G = 1'$. Positions of lensing peaks detected with $\nu > 3.5$ in the $\theta_G = 1'$ $(2')$ map are labeled with a + (Squares) symbol. Triangles represent optically-detected clusters in the *K2* catalog. $\times$ represent X-ray selected clusters found in the XMM-LSS survey by Adami et al. (2011).

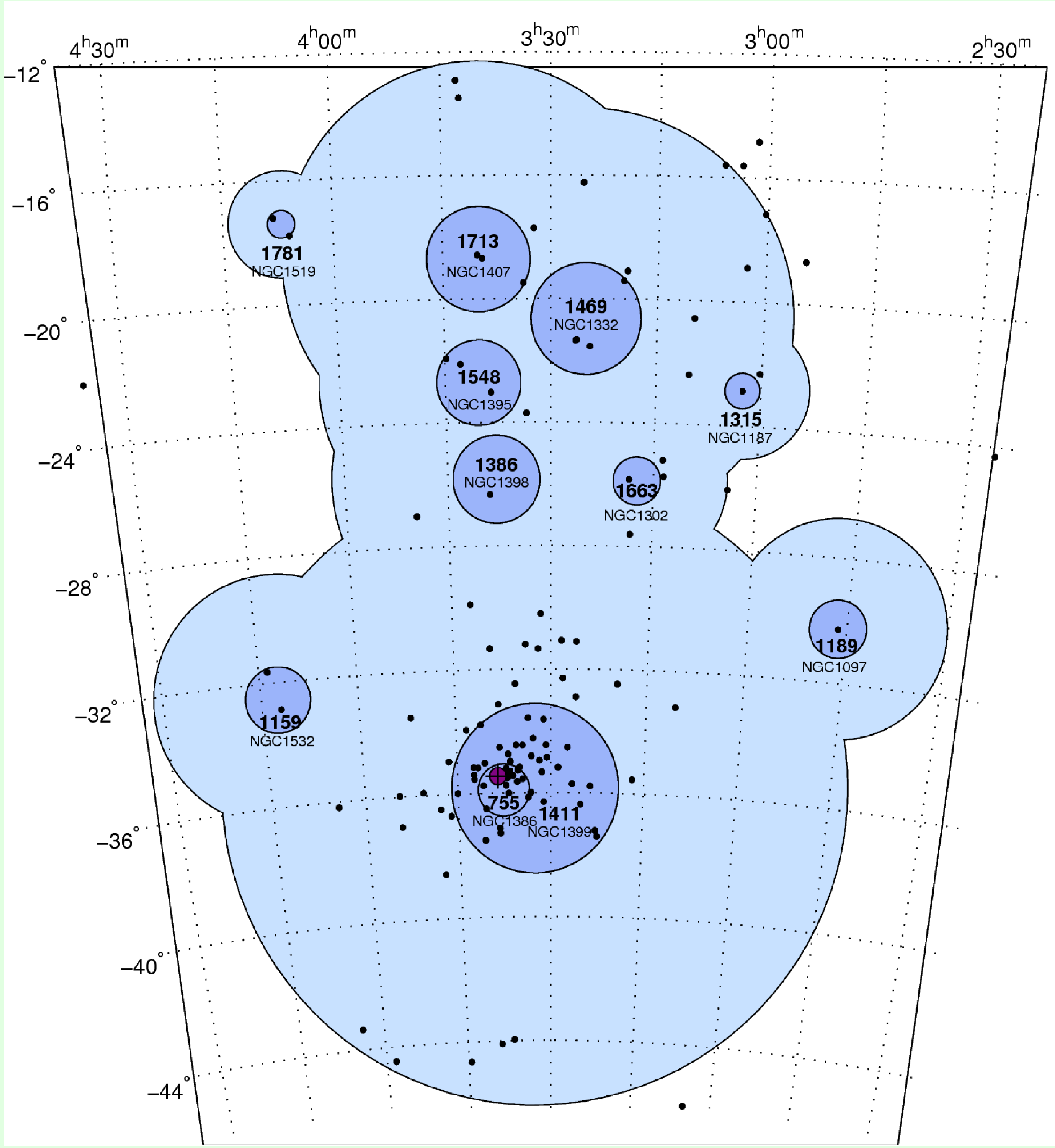
Three dynamically different components of the Large Scale Structure of the universe:

A) Virialized zones of groups and clusters, where $T = |U|/2$;

B) Collapsing regions around them in spheres of radius R_0;

C) remaining, infinitely expanding components:

filaments, population of the «field» and voids.



4h30m
4h00m
3h30m
3h00m
2h30m
−12°
−16°
−20°
−24°
−28°
−32°
−36°
−40°
−44°
1781
NGC1519
1713
NGC1407
1469
NGC1332
1548
NGC1395
1315
NGC1187
1386
NGC1398
1663
NGC1302
1189
NGC1097
1159
NGC1532
755
NGC1386
1411
NGC1399

Basic parameters of the zones	A	B	C
Fraction of galaxies	54%	~20%	~26%
Fraction of stellar mass, L_K	82%	~ 8%	~10%
Fraction of occupied volume	0.1%	5%	95%
Input to the Ω_m	0.06	0.02	0.20
Mean dark-to-luminous ratio, M_{tot}/L_K	~26	~87	~690

Some predictions of the standard ΛCDM model are not well consistent with the observational data available nowadays:

- The problem of missing satellites, (1:30)
- The problem of missing baryons, (1:10)
- The problem of missing dark matter, (1:3)

The "precision cosmology era" has came (?!)

The assumption of proportional distribution of dark and stellar matter is not quite justifiable paradigm.

Our Universe might happen to be more hidden and dark than we thought until recently

Thank you!

The group finding algorithm:

$$V^2_{12,r} R_{12,p} < 2GM_{12}$$

$$\pi H^2_0 R^3_{12,p} < 8GM_{12}$$

$$M/L_K = \mathrm{K}(M_{☼}/L_{☼})$$

Where K is taken equal to 6.