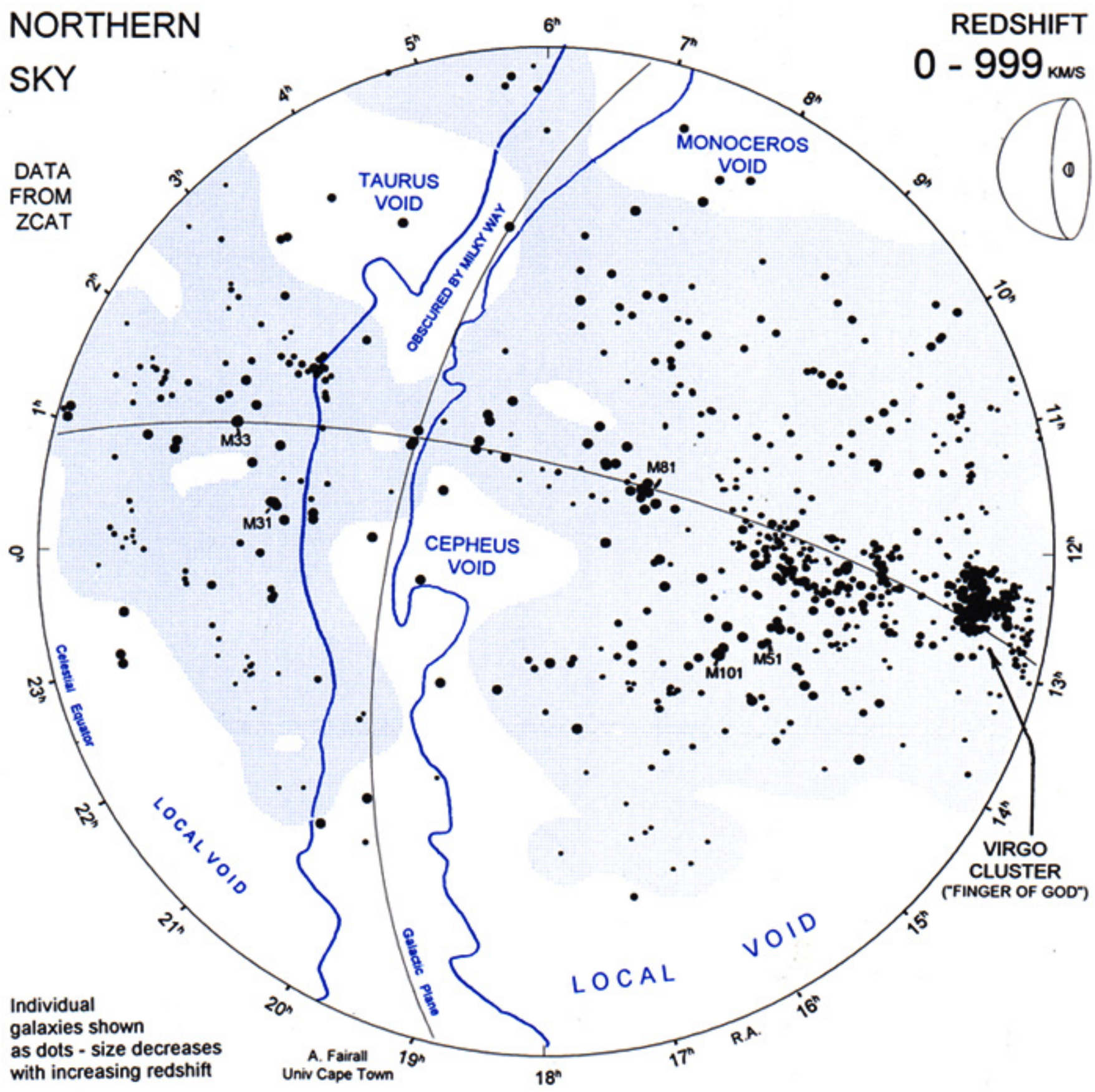
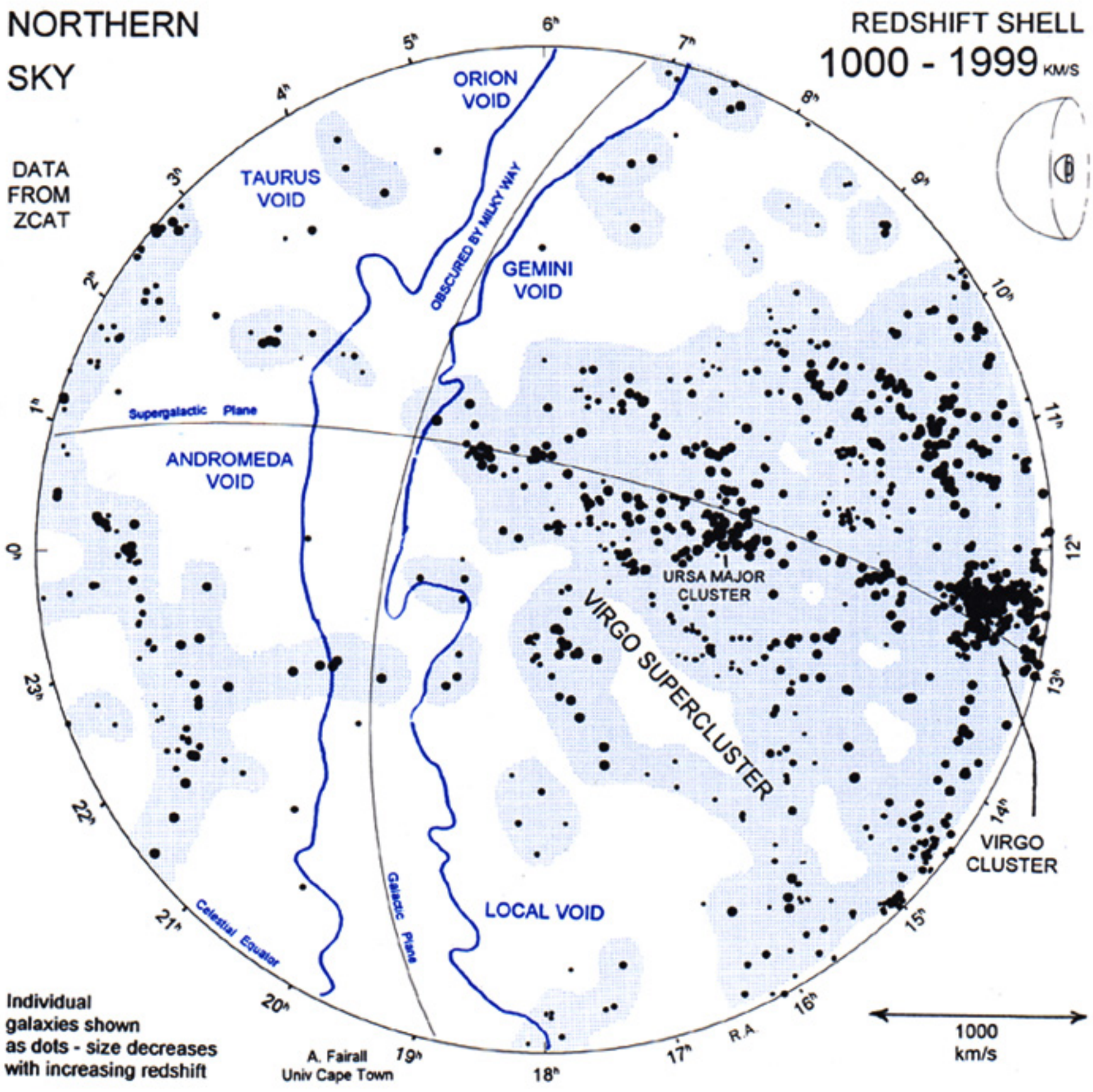
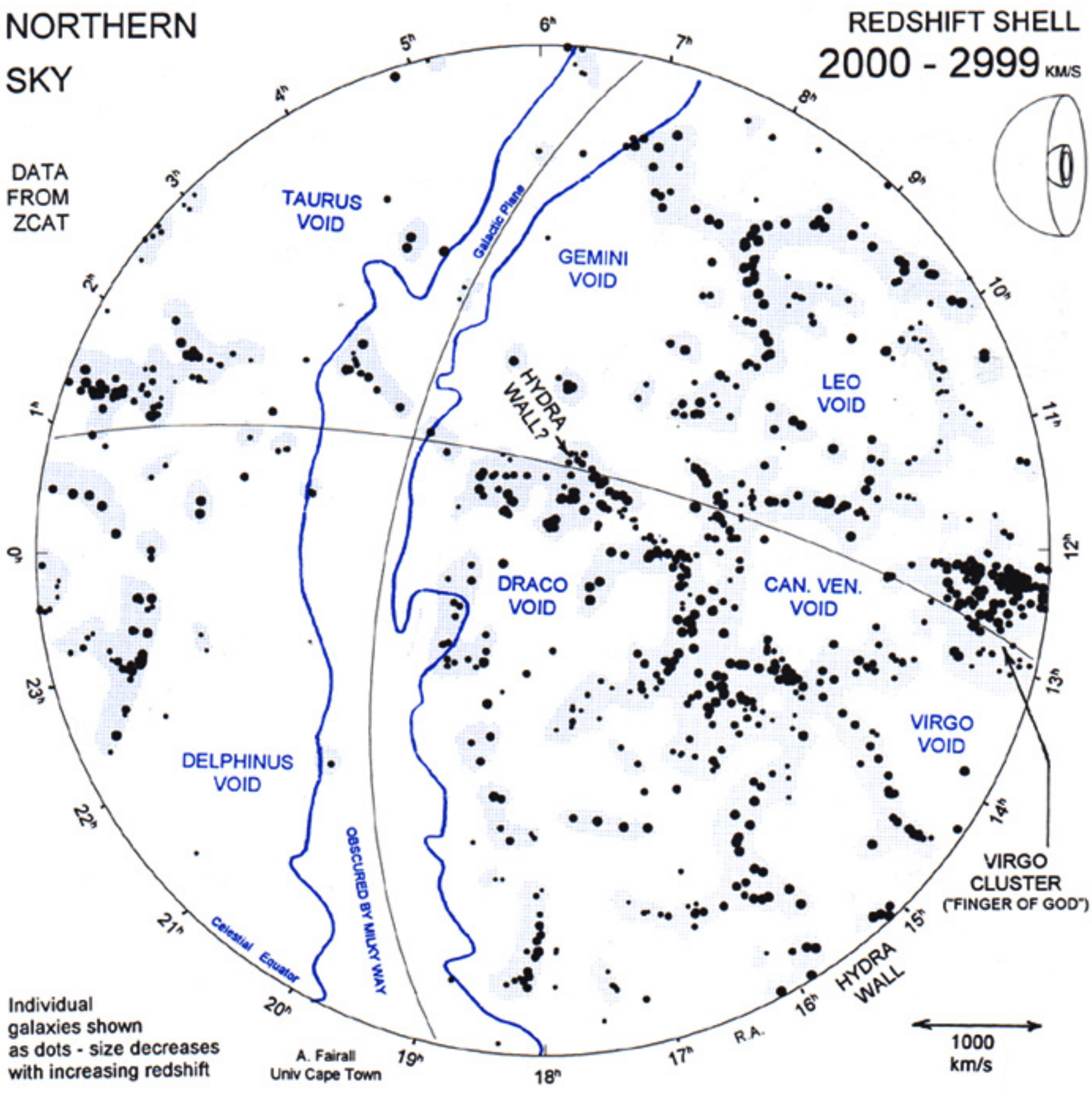
Large scale distribution of galaxies

Projections on the sky
Pie diagrams
Motion of galaxies
Constrained simulations
Voids
Galaxies: effects of environment

Projection


NORTHERN
SKY
REDSHIFT
0 - 999 KM/S
DATA
FROM
ZCAT
TAURUS
VOID
MONOCEROS
VOID
OBSCURED BY MILKY WAY
M33
M31
M81
M101
M51
CEPHEUS
VOID
LOCAL VOID
LOCAL VOID
VIRGO
CLUSTER
("FINGER OF GOD")
Celestial Equator
Galactic Plane
R.A.
Individual
galaxies shown
as dots - size decreases
with increasing redshift
A. Fairall
Univ Cape Town


NORTHERN SKY
REDSHIFT SHELL
1000 - 1999 KM/S
DATA FROM ZCAT
ORION VOID
TAURUS VOID
OBSCURED BY MILKY WAY
GEMINI VOID
Supergalactic Plane
ANDROMEDA VOID
URSA MAJOR CLUSTER
VIRGO SUPERCLUSTER
VIRGO CLUSTER
LOCAL VOID
Celestial Equator
Galactic Plane
R.A.
1000 km/s
Individual galaxies shown as dots - size decreases with increasing redshift
A. Fairall
Univ Cape Town


NORTHERN
SKY
REDSHIFT SHELL
2000 - 2999 KM/S
DATA
FROM
ZCAT
TAURUS
VOID
Galactic Plane
GEMINI
VOID
HYDRA
WALL?
LEO
VOID
DRACO
VOID
CAN. VEN.
VOID
VIRGO
VOID
DELPHINUS
VOID
OBSCURED BY MILKY WAY
Celestial Equator
VIRGO
CLUSTER
("FINGER OF GOD")
HYDRA
WALL
R.A.
1000
km/s
Individual
galaxies shown
as dots - size decreases
with increasing redshift
A. Fairall
Univ Cape Town

REDSHIFT

0 - 999 KMS

SOUTHERN SKY

DATA FROM SRC

MONOCEROS VOID

VOLANS VOID

CETUS VOID

CRATER VOID

LOCAL VOID

LOCAL VOID

CENTAURUS WALL

NGC 253

NGC 300

NGC 5128

M83

Galactic Plane

Supergalactic Plane

Celestial Equator

OBSCURED BY MILKY WAY

6h 7h 8h 9h 10h 11h 12h 13h 14h 15h 16h 17h 18h 19h 20h 21h 22h 23h 0h 1h 2h 3h 4h 5h R.A.

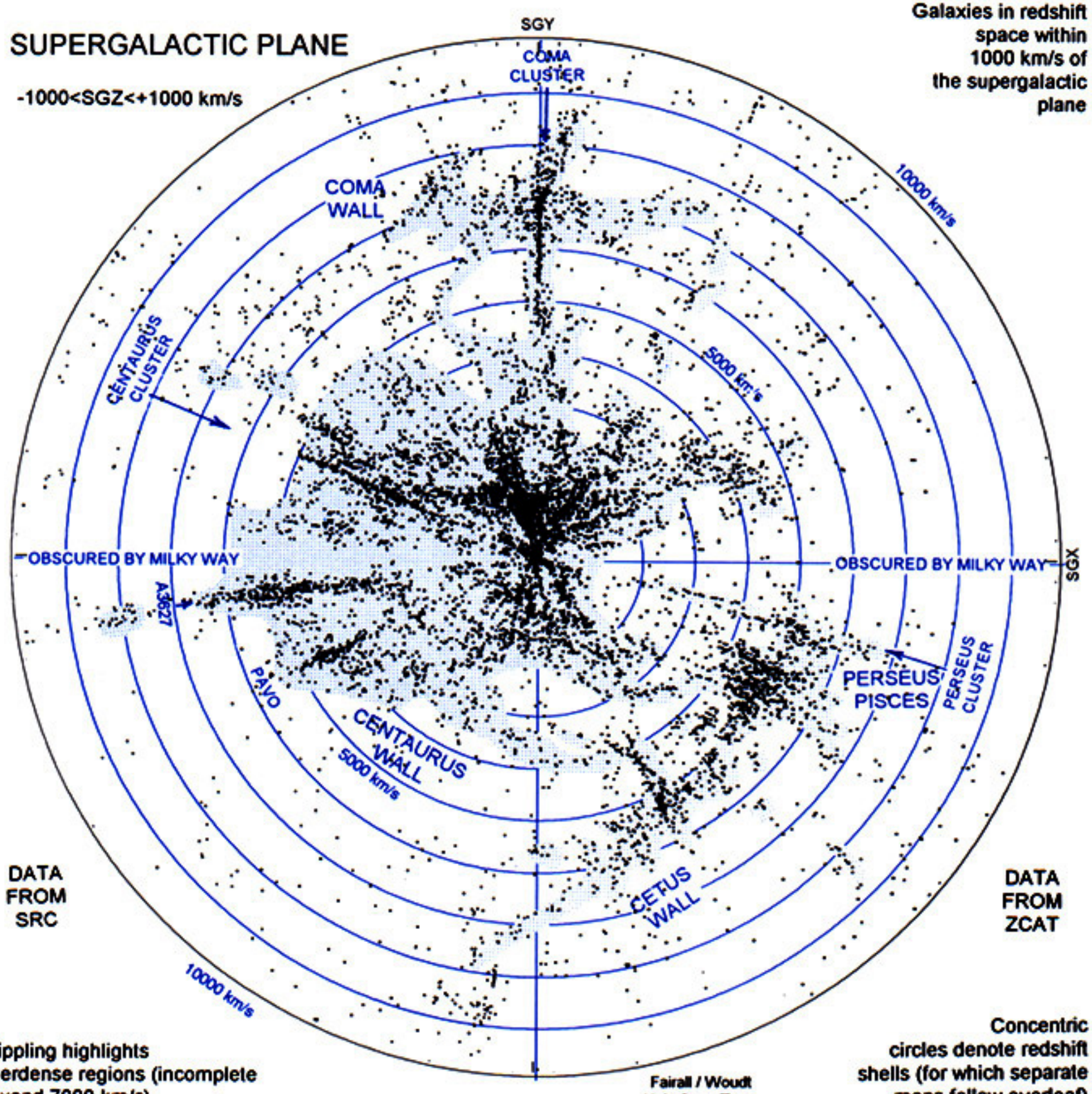
A. Fairall
Univ Cape Town

Large - scale Structures (galaxies closer than 200 km/s to each other) shown by stippling.

SUPERGALACTIC PLANE

-1000<SGZ<+1000 km/s

Galaxies in redshift space within 1000 km/s of the supergalactic plane



DATA FROM SRC

DATA FROM ZCAT

Stippling highlights overdense regions (incomplete beyond 7000 km/s)

Concentric circles denote redshift shells (for which separate maps follow overleaf)

Fairall / Woudt
Univ Cape Town

A SLICE OF THE UNIVERSE

VALÉRIE DE LAPPARENT,[2,3] MARGARET J. GELLER,[2] AND JOHN P. HUCHRA[2]

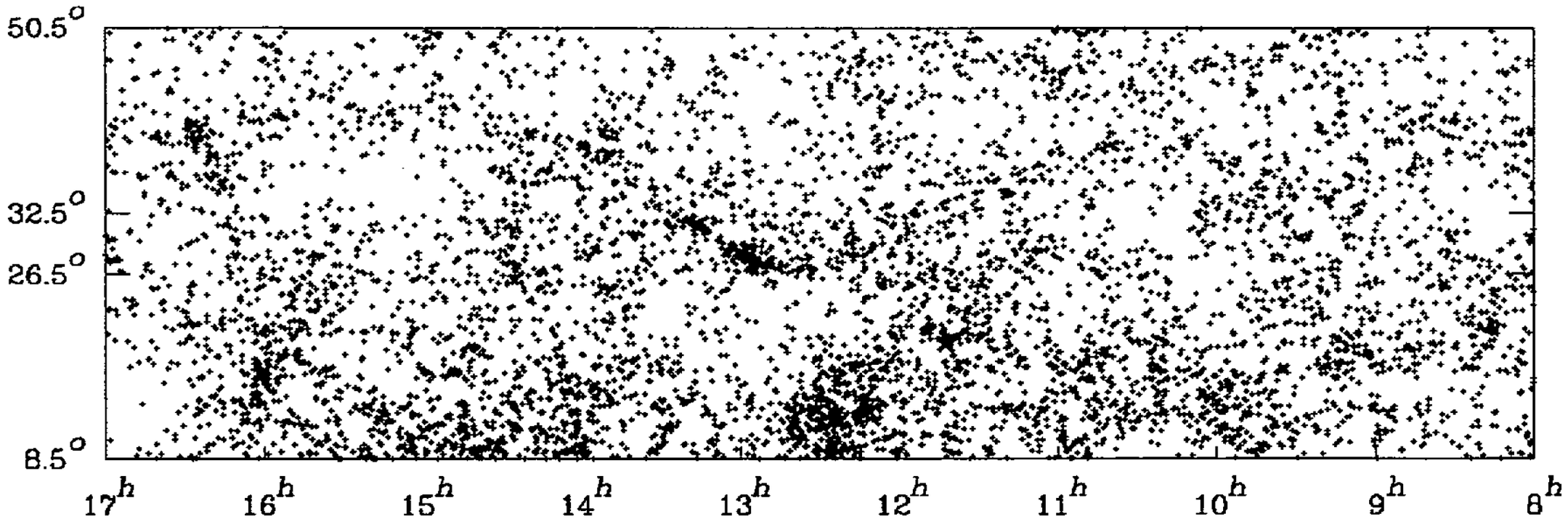
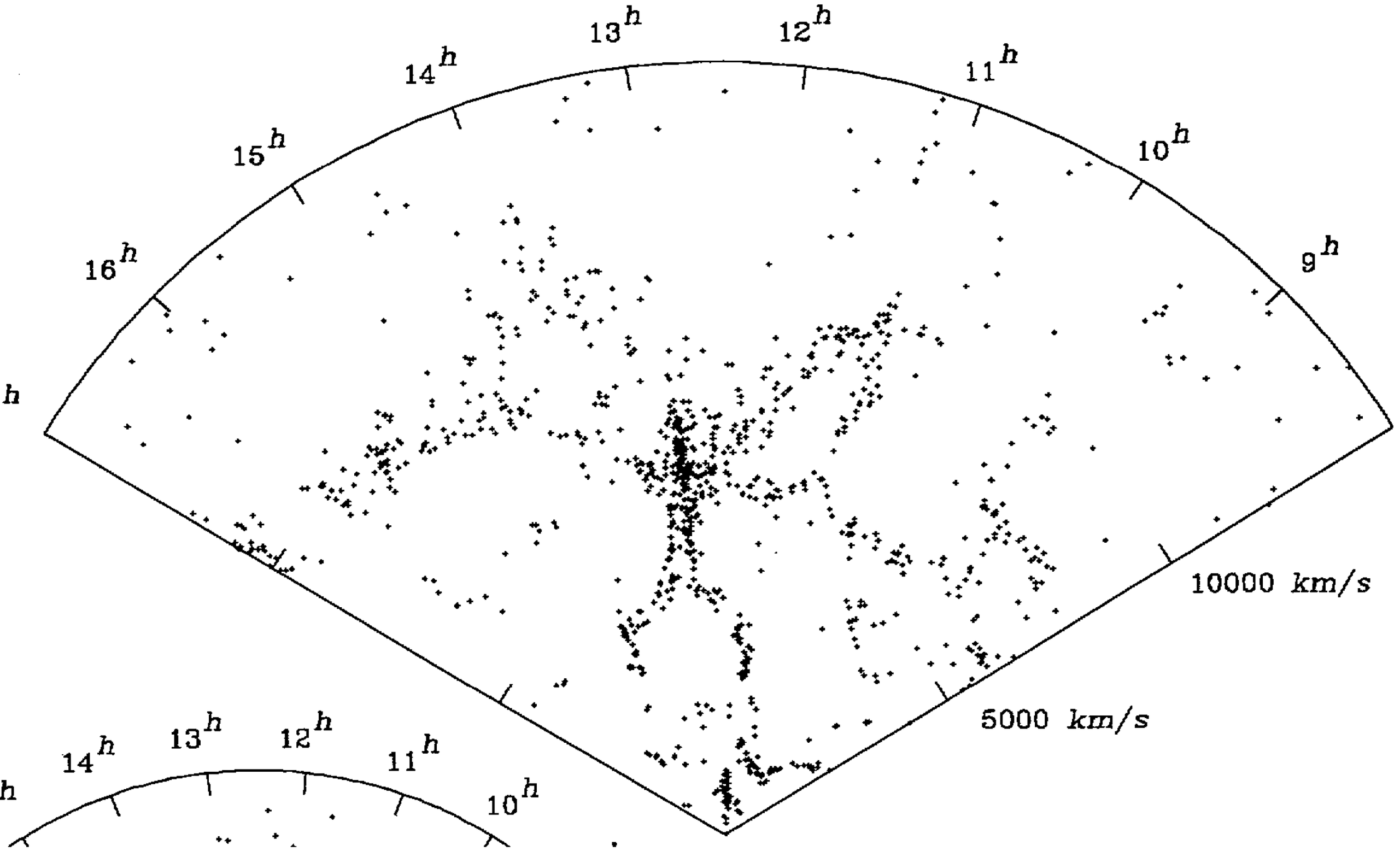


FIG. 1.—(*a*) Map of the observed velocity plotted vs. right ascension in the declination wedge $26°.5 \leq \delta \leq 32°.5$. The 1061 objects plotted have $m_B \leq 15.5$ and $V \leq 15{,}000$ km s^{-1}. (*b*) Same as Fig. 1*a* for $m_B \leq 14.5$ and $V \leq 10{,}000$ km s^{-1}. The plot contains 182 galaxies. (*c*) Projected map of the 7031 objects with $m_B \leq 15.5$, listed by Zwicky *et al.* in the region bounded by $8^h \leq \alpha \leq 17^h$ and $8°.5 \leq \delta \leq 50°.5$.


13^h
12^h
14^h
11^h
15^h
10^h
16^h
9^h
10000 km/s
5000 km/s
14^h
13^h
12^h
11^h
10^h

Pie diagrams: structure of superclusters

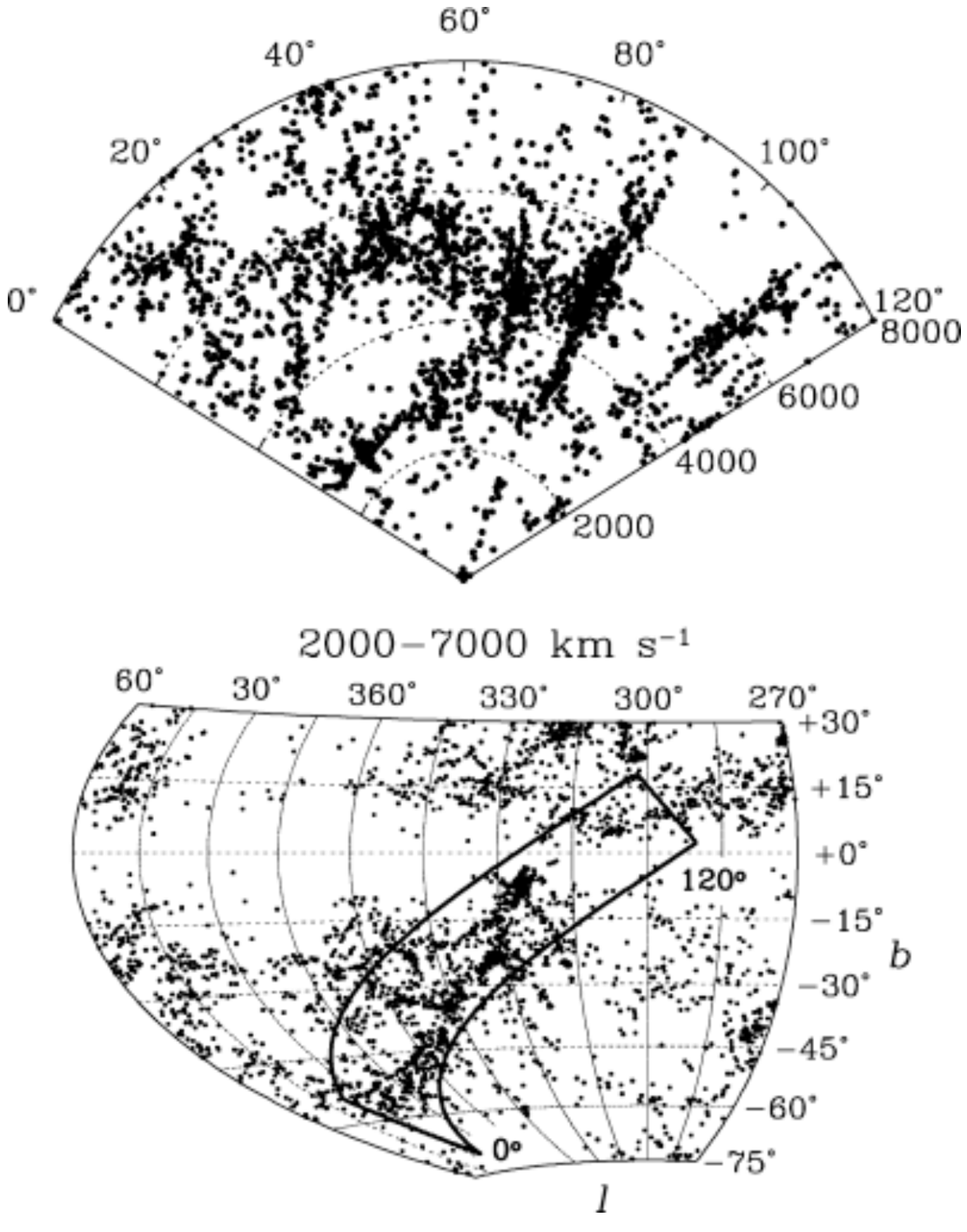
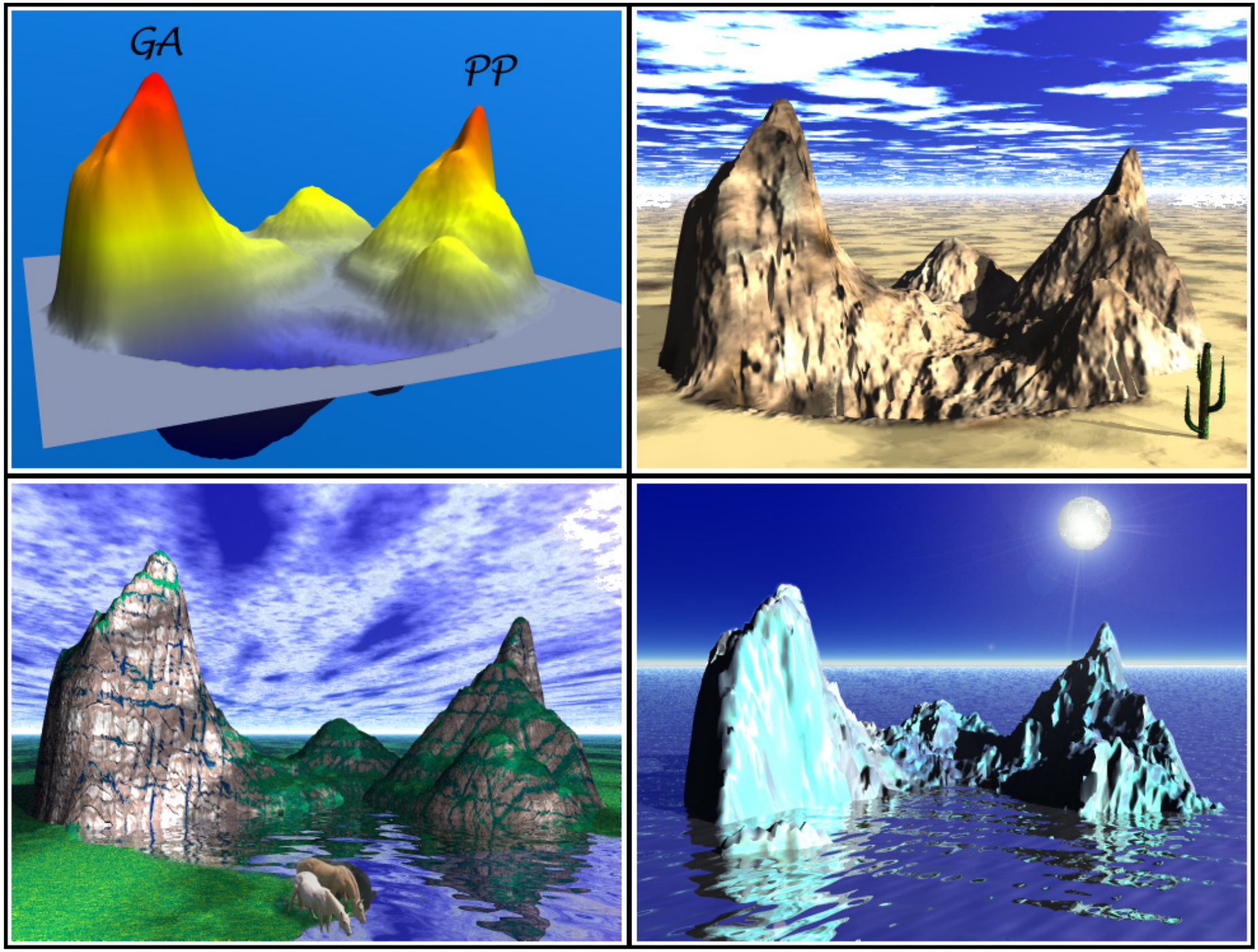


Figure 7. The pieplot represents the radial distribution of galaxies along the projected rectangular strip shown in the lower panel. The strip covers a region 120°× 10°, orientated to lie along the filament. From the Norma cluster, lying 86° along the strip, the Norma supercluster is clearly seen as a wall of galaxies extending through the Pavo II cluster (at 71°) towards a point 20° along the strip. The Centaurus Wall appears as a smaller connection of galaxies, running almost parallel to the Norma supercluster at 2600 km s^{1}. The void lying between the Norma supercluster and the Centaurus Wall is an extension of the massive Microscopium Void.

Landscape of the MW neighborhood: 80Mpc



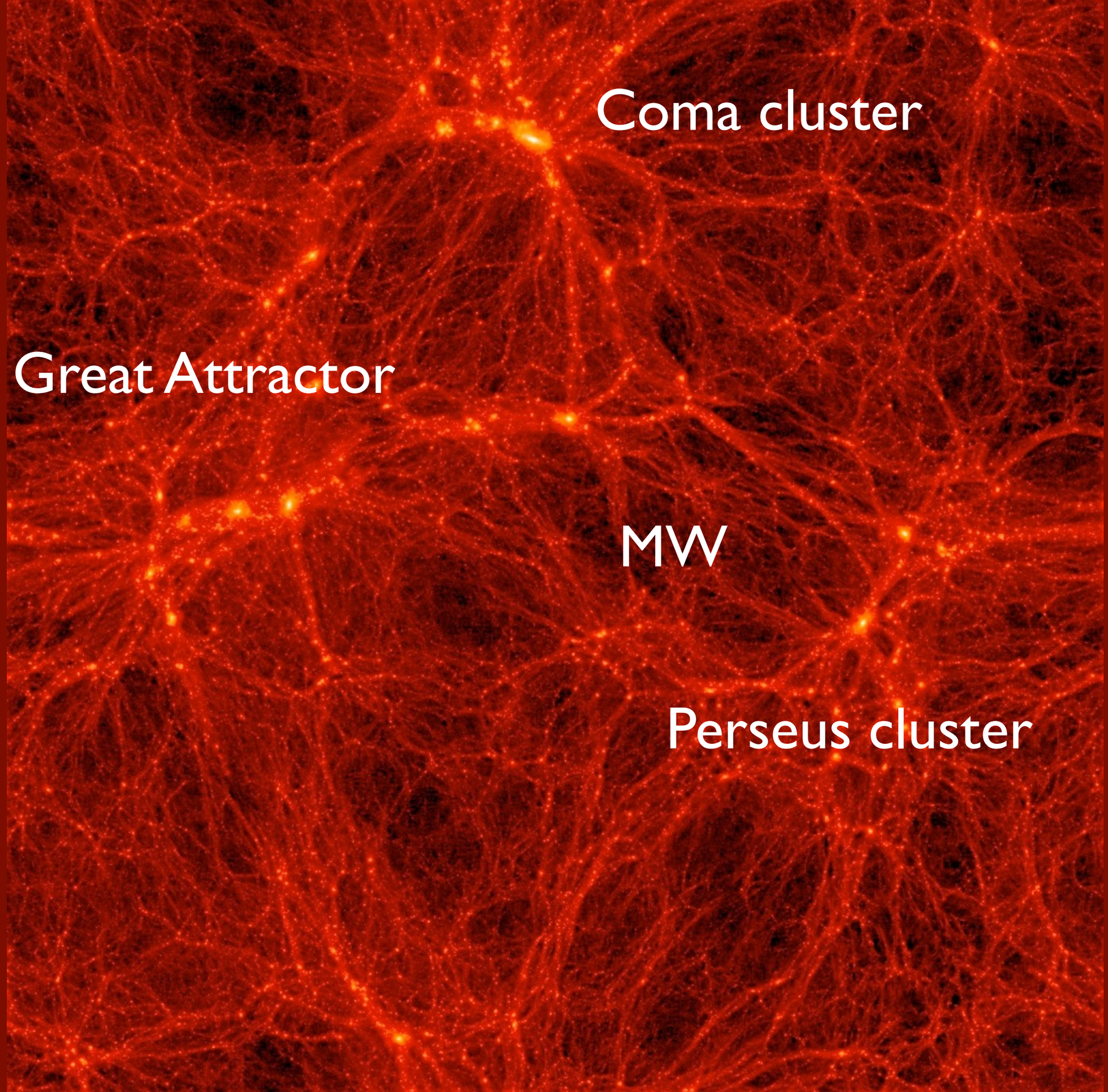
1G particles

Dynamical range 1e5

Constrained simulations

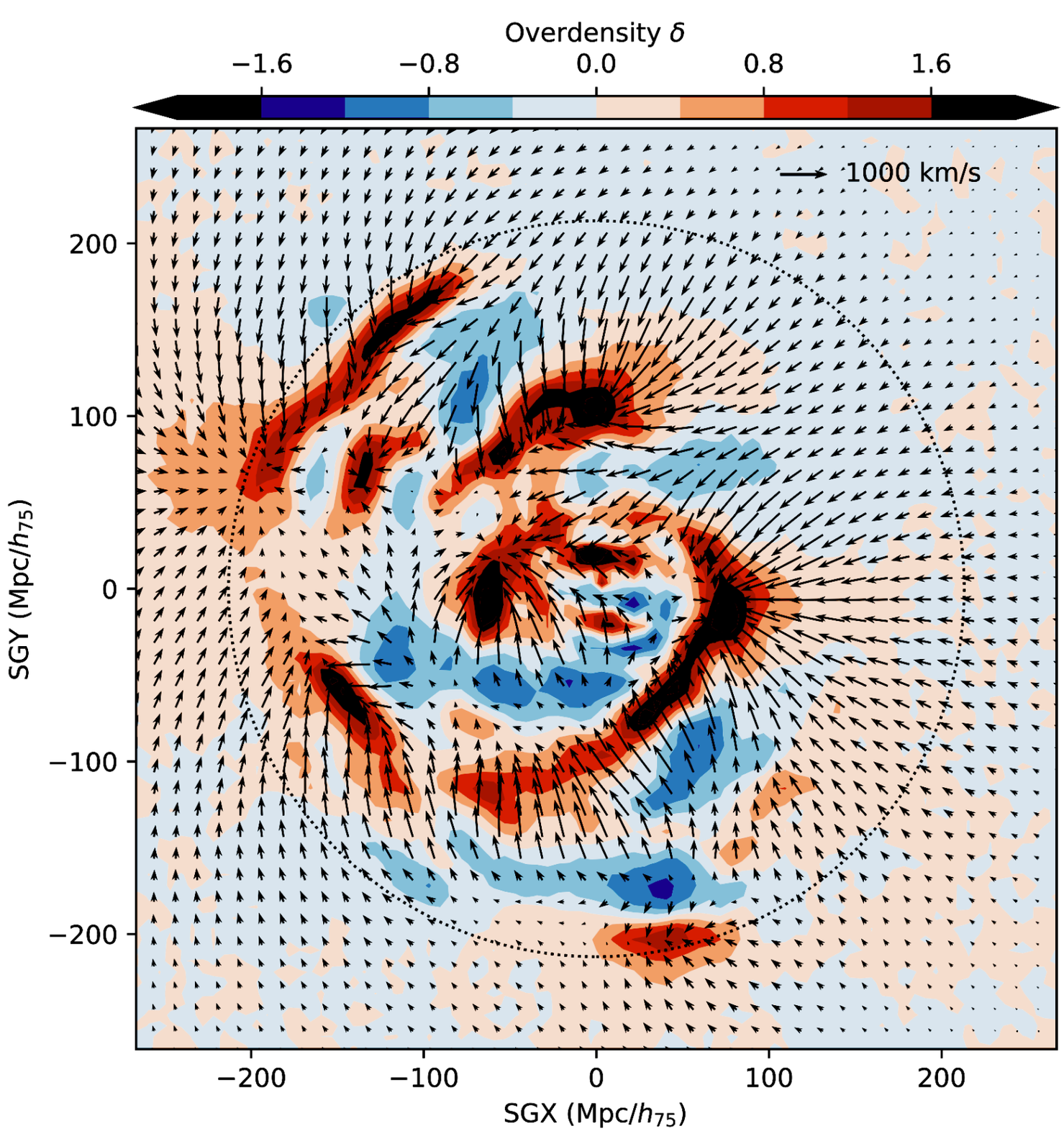
160 Mpc

Klypin, Hoffman, Gottlober



Density and velocity Field within 200 Mpc radius from Milky Way. This is a slice through the Volume.

Milky Way is at the center (0,0)
Coma supercluster is at (0,100)

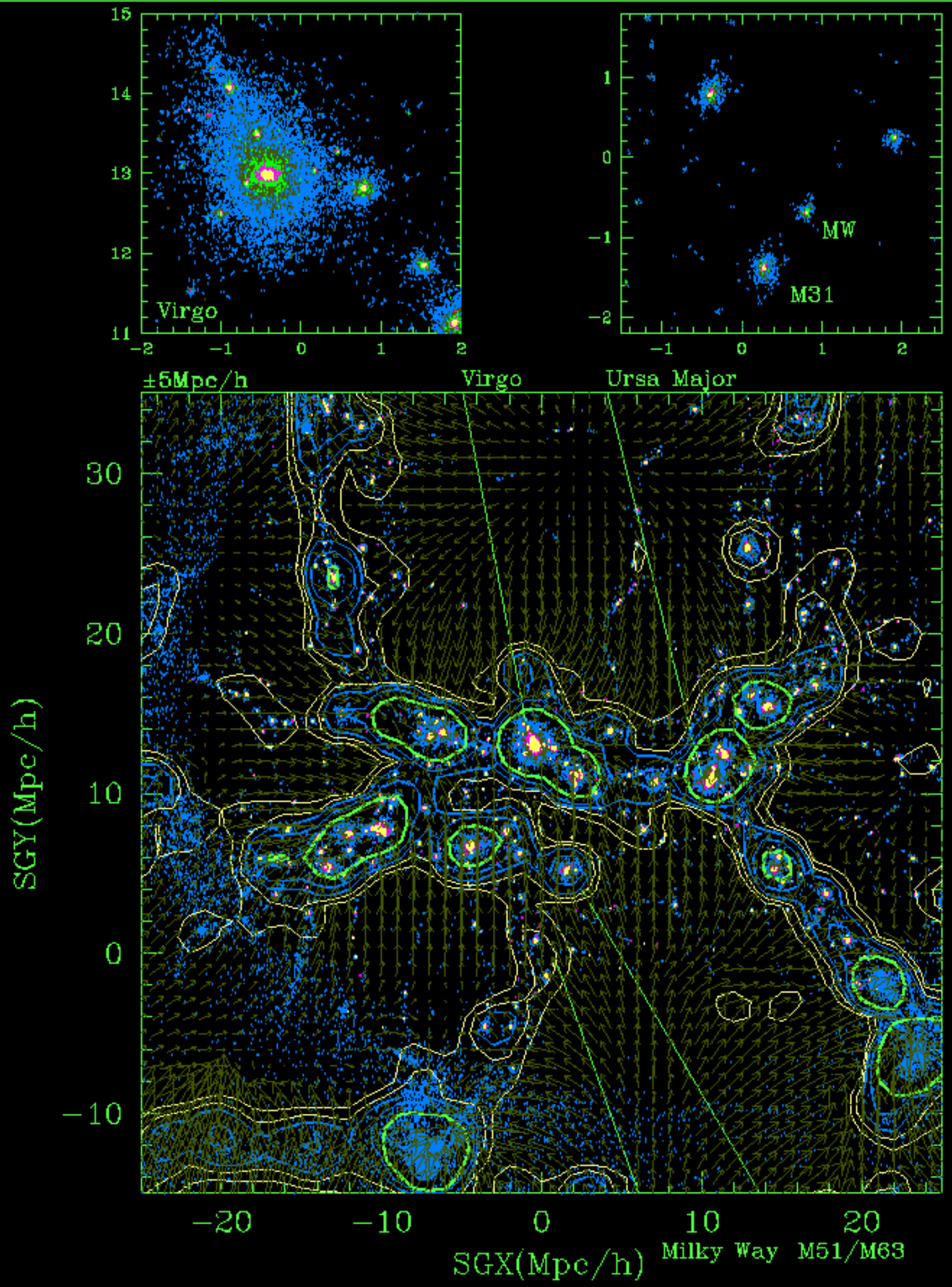


Central part of the CF3 velocity field reconstruction in the SGZ = 0 Mpc/h75 slice. The color corresponds to the value of the overdensity field while the black arrows represent the tridimensional reconstructed linear peculiar velocity field. The dotted black circle illustrates the edge of the data at z = 0.054.

Graziani 2018

Local Supercluster:

- Distribution of light and mass
- Peculiar velocities (deviations from the Hubble flow)
- Voids


Virgo
MW
M31
±5Mpc/h
Virgo
Ursa Major
SGY(Mpc/h)
SGX(Mpc/h)
Milky Way
M51/M63

30
20
10
0
−10
SGY(Mpc/h)
−20
−10
0
10
20

Virgocentric frame. OverDensity: 1 2 3 5 10 15 20 25

30
20
10
0
−10
SGY(Mpc/h)

−20
−10
0
10
20
SGZ(Mpc/h)

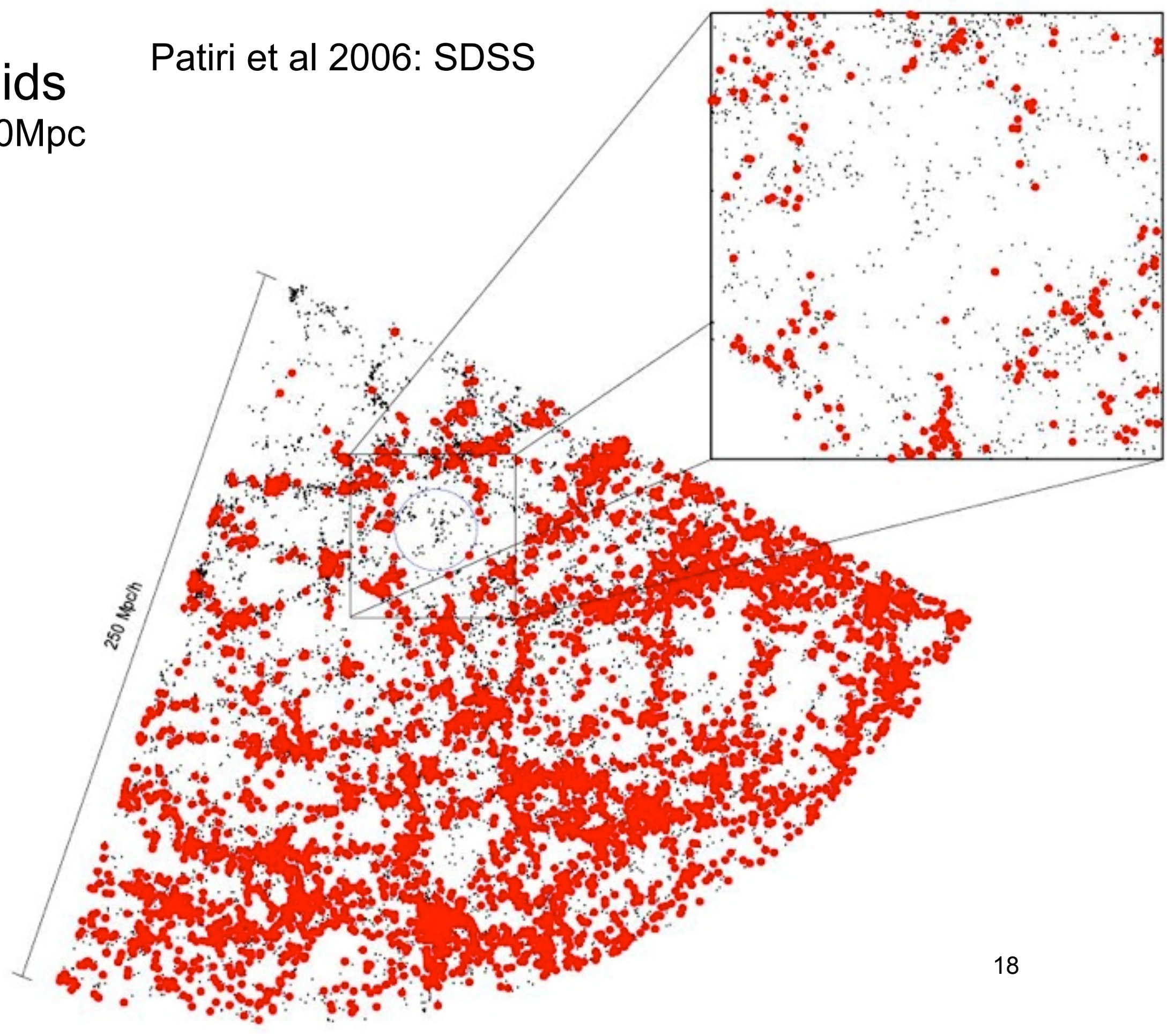
Voids:

- Distribution of light and mass in giant voids

Voids

R>10Mpc

Patiri et al 2006: SDSS



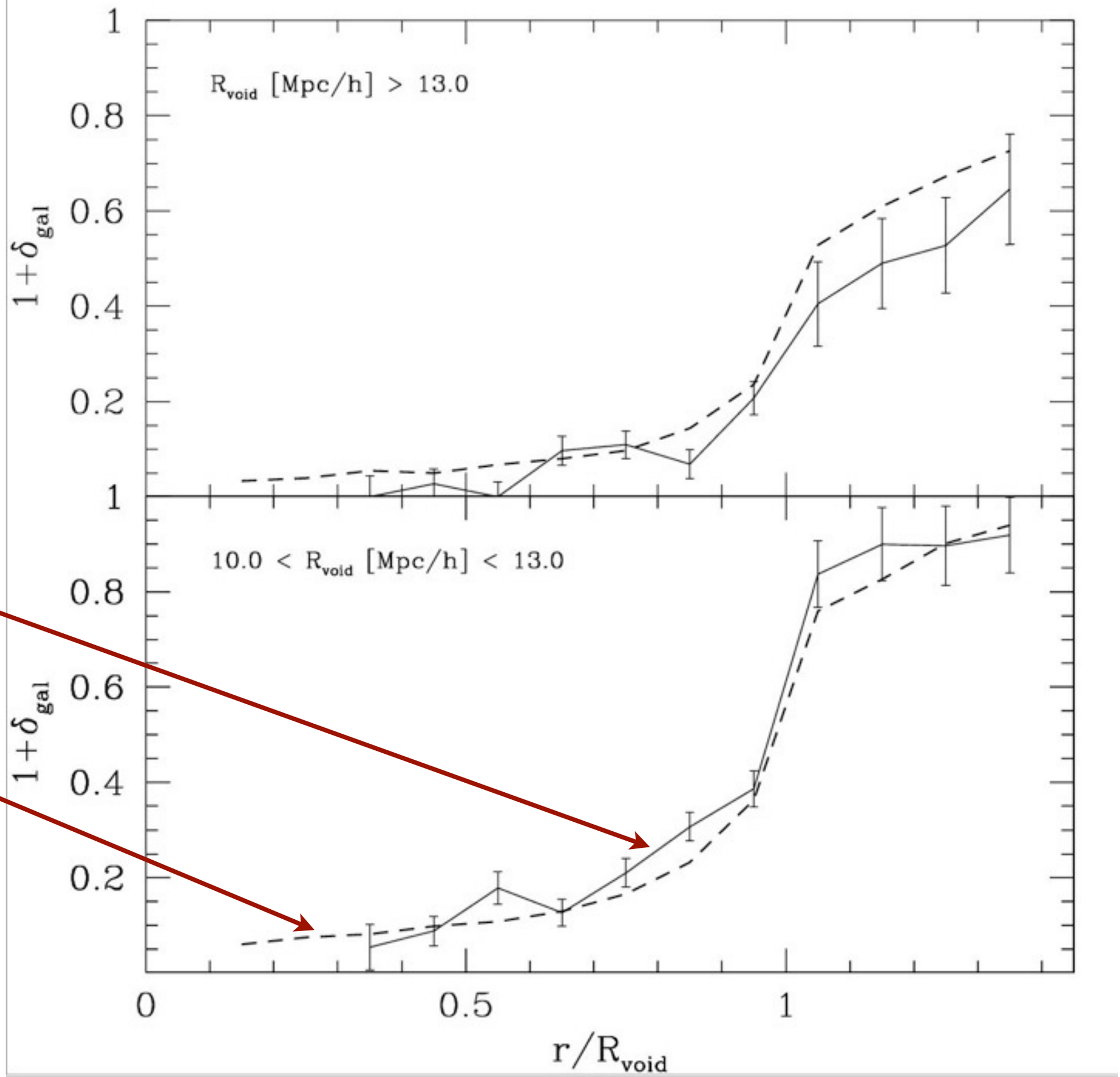
Number-density Profiles of Voids:

n(R)/<n>

Patiri et al 2006

SDSS

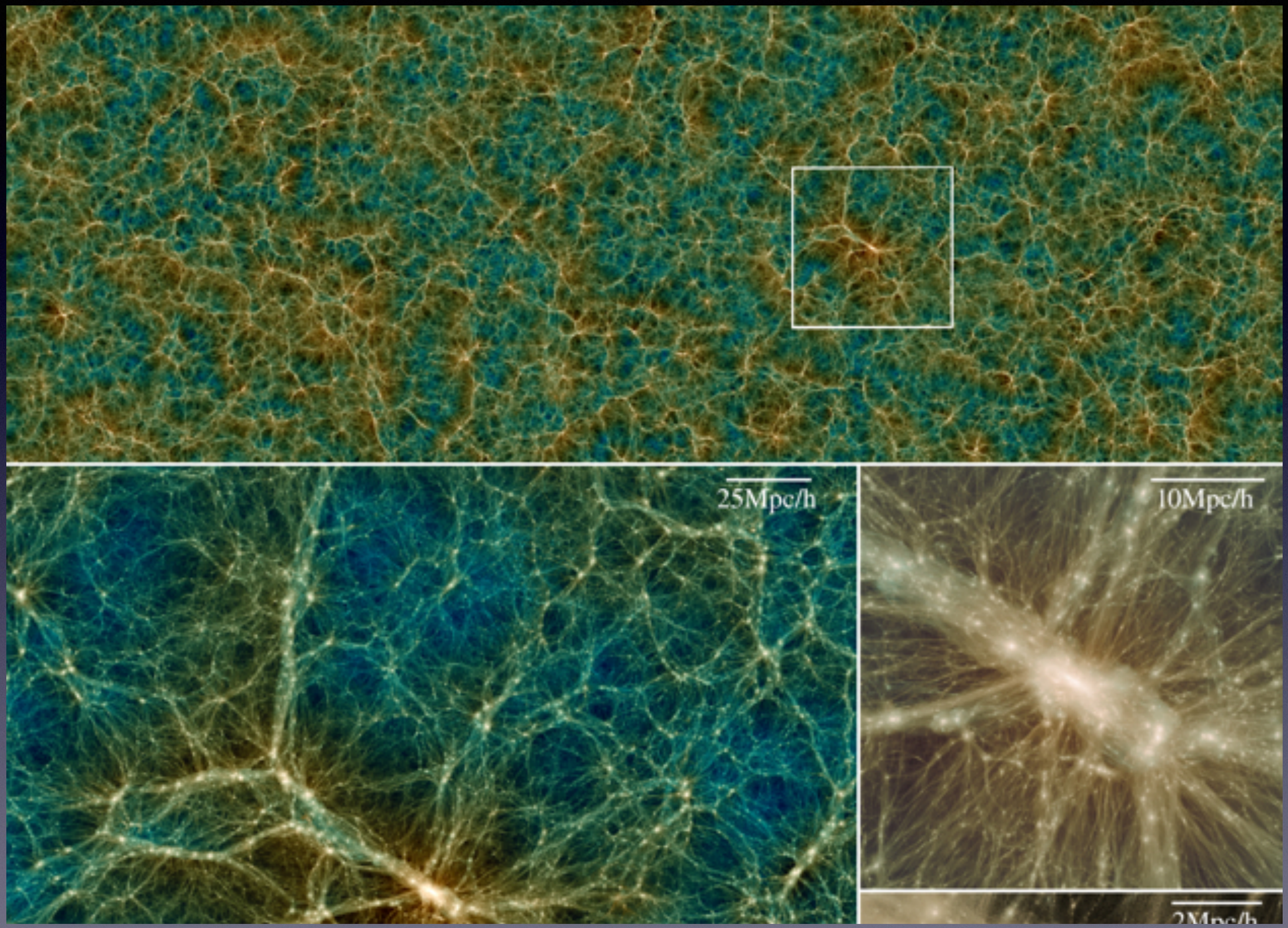
LCDM



Large Scale Structure and Galaxies:

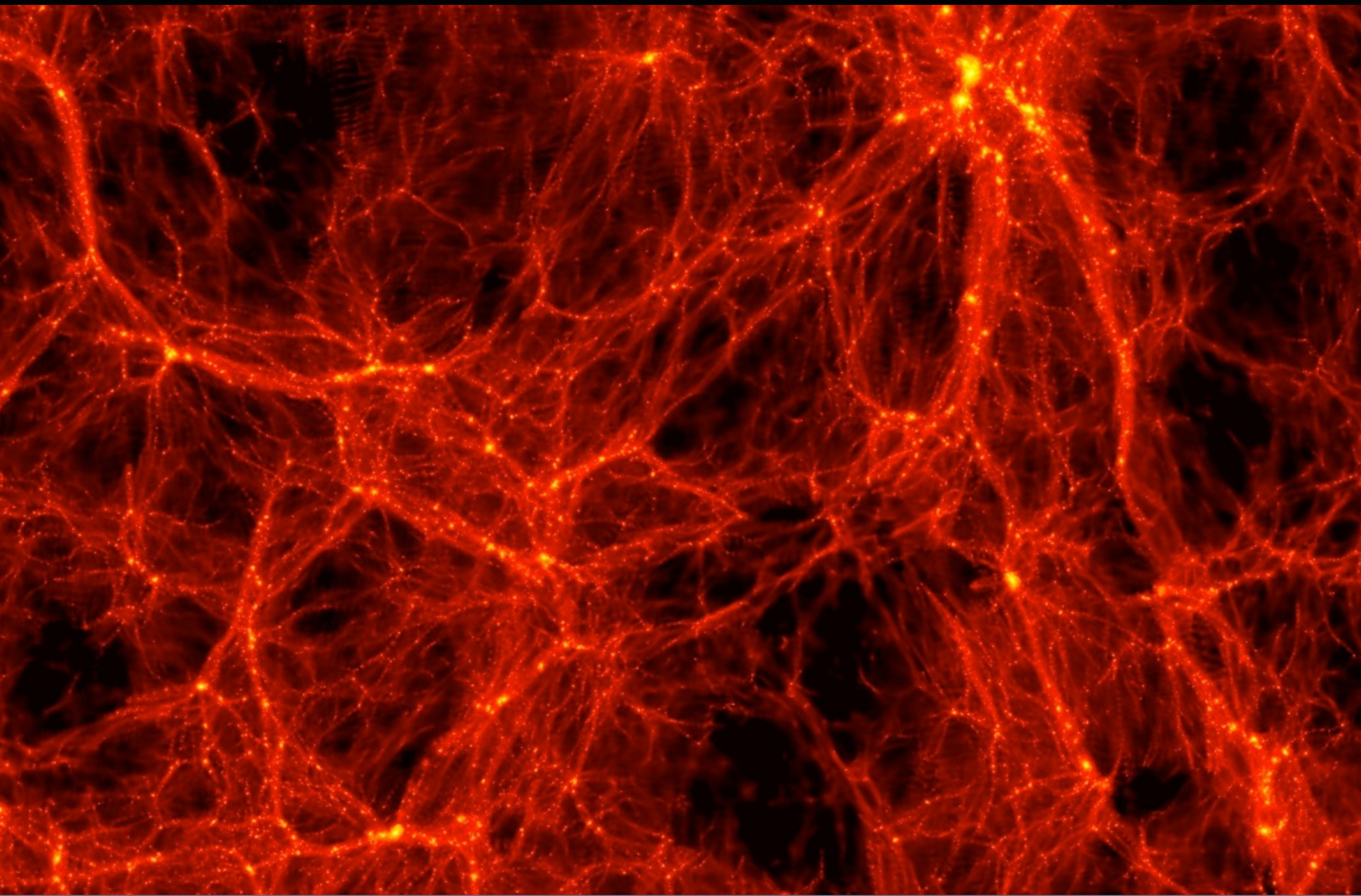
- Morphology - density relation
- Effects of environment

Dark matter distribution at z=0. The image shows a 2000 Mpc/h × 2000 Mpc/h projected volume with a thickness of 25 Mpc/h. The white box in the top panel is the same region visualized in the left-bottom panel



LSS: 300Mpc

Ben Moore: PKDGRAV

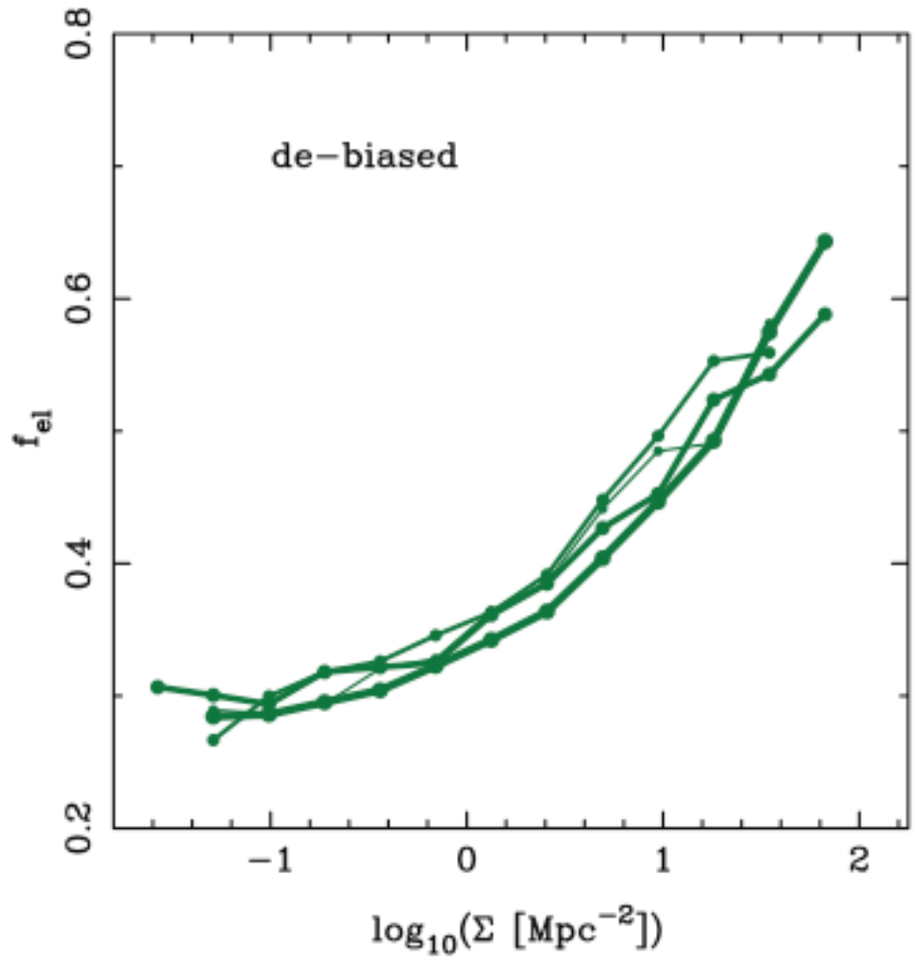


8 Mpc/h

Morphology -Density relation:

The local density for a galaxy is given by $\Sigma_N = N/(\pi d_N^2)$ where d_N is the projected distance to the Nth nearest neighbour that is more luminous than $M_r = -20$ (with a small evolution correction, see below). In our analysis we use an estimate of local galaxy density, Σ, determined by averaging $\log \Sigma_N$ for $N = 4$ and 5. In addition,

$$|c\,\Delta z| < 1000\,\mathrm{km\,s^{-1}}$$



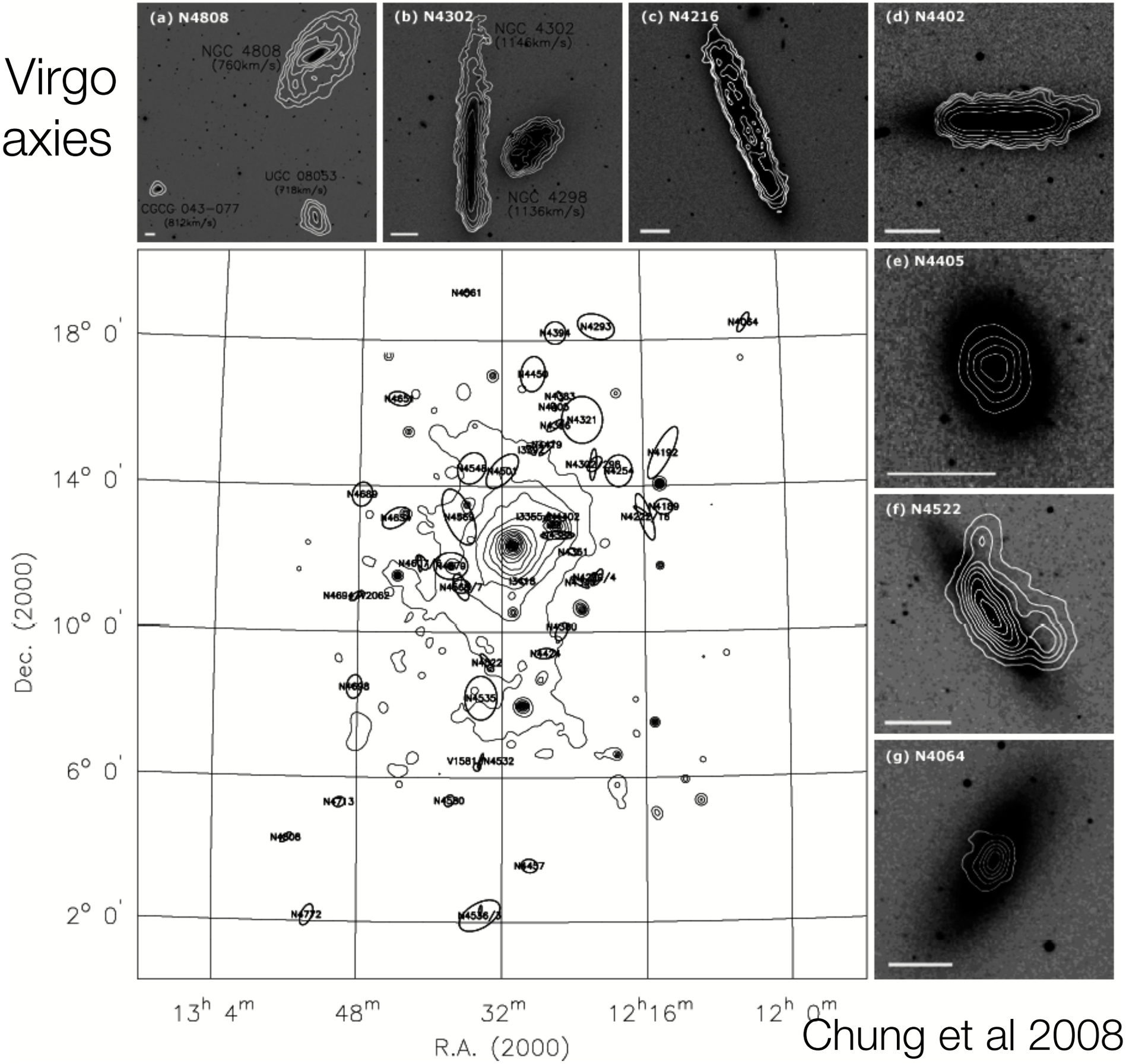
Fraction of early-type galaxies as the function of density

Bamford et al.

Mon. Not. R. Astron. Soc. **393,** 1324–1352 (2009)

Gas stripping in Virgo cluster spiral galaxies

Spiral galaxies lose their gas and gradually get transformed into S0's



Chung et al 2008

The main effect in morphology-density relation is that galaxies in denser environments are more massive and more massive galaxies tend to be ellipticals and red regardless of their environment.

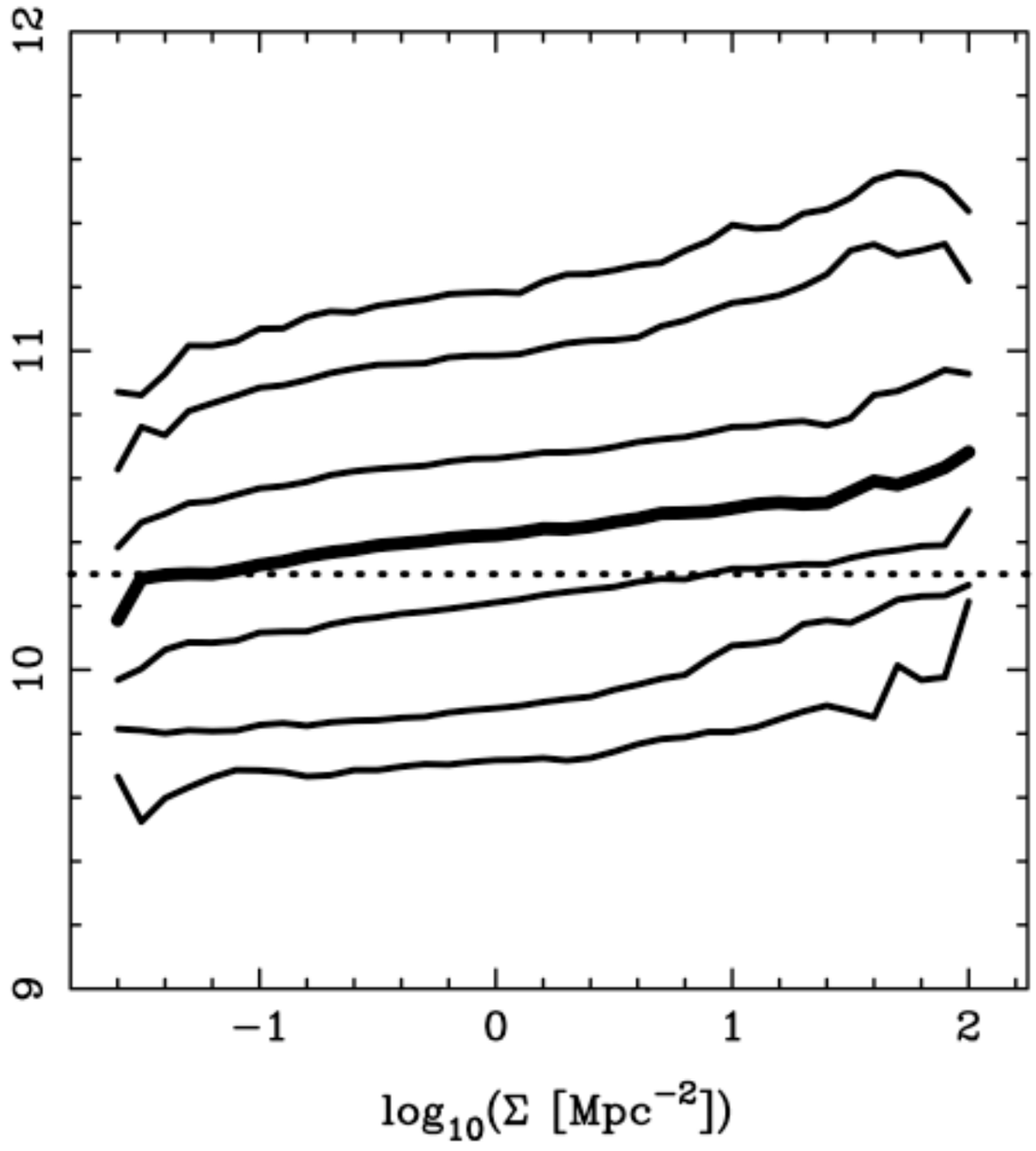
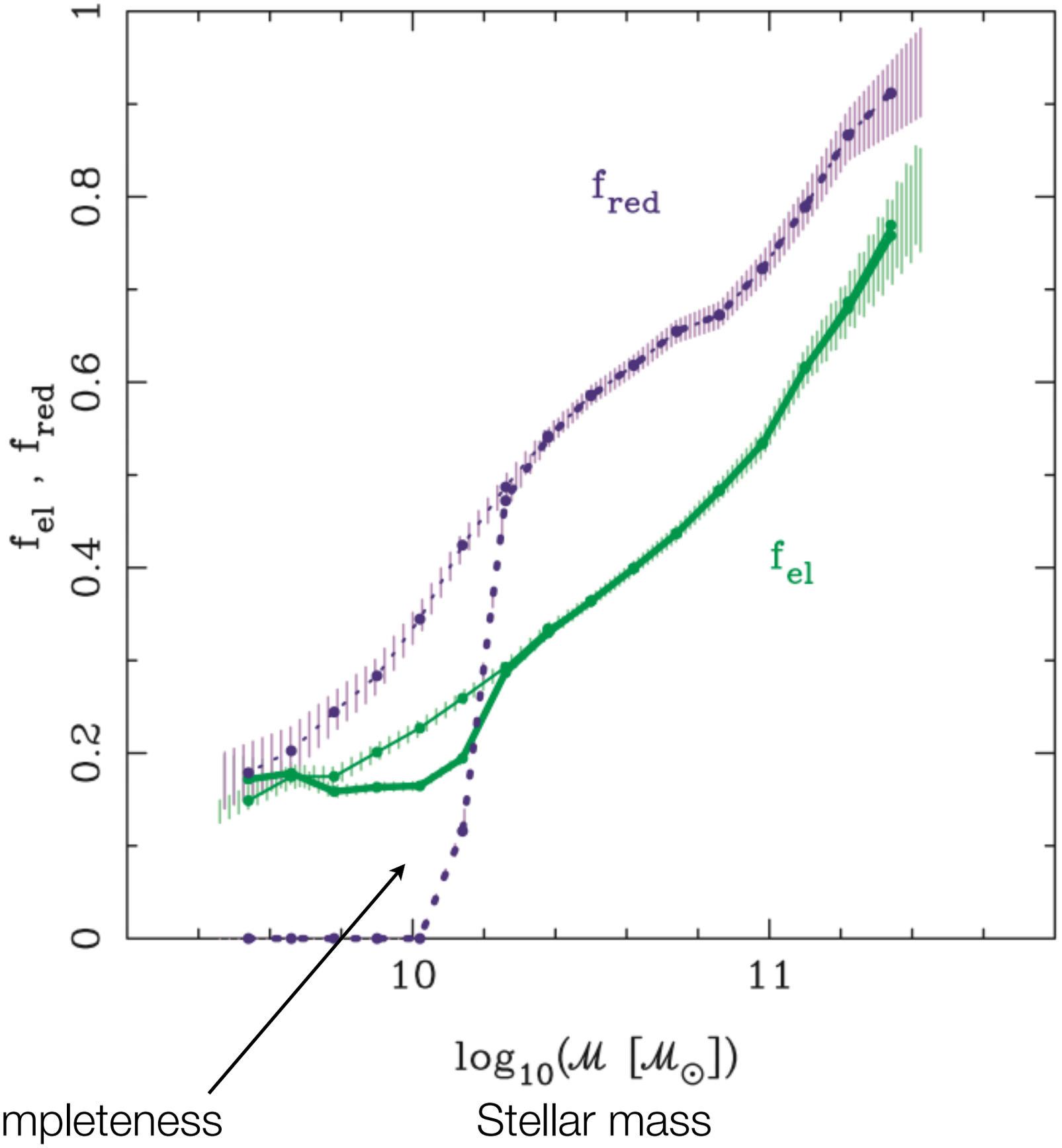


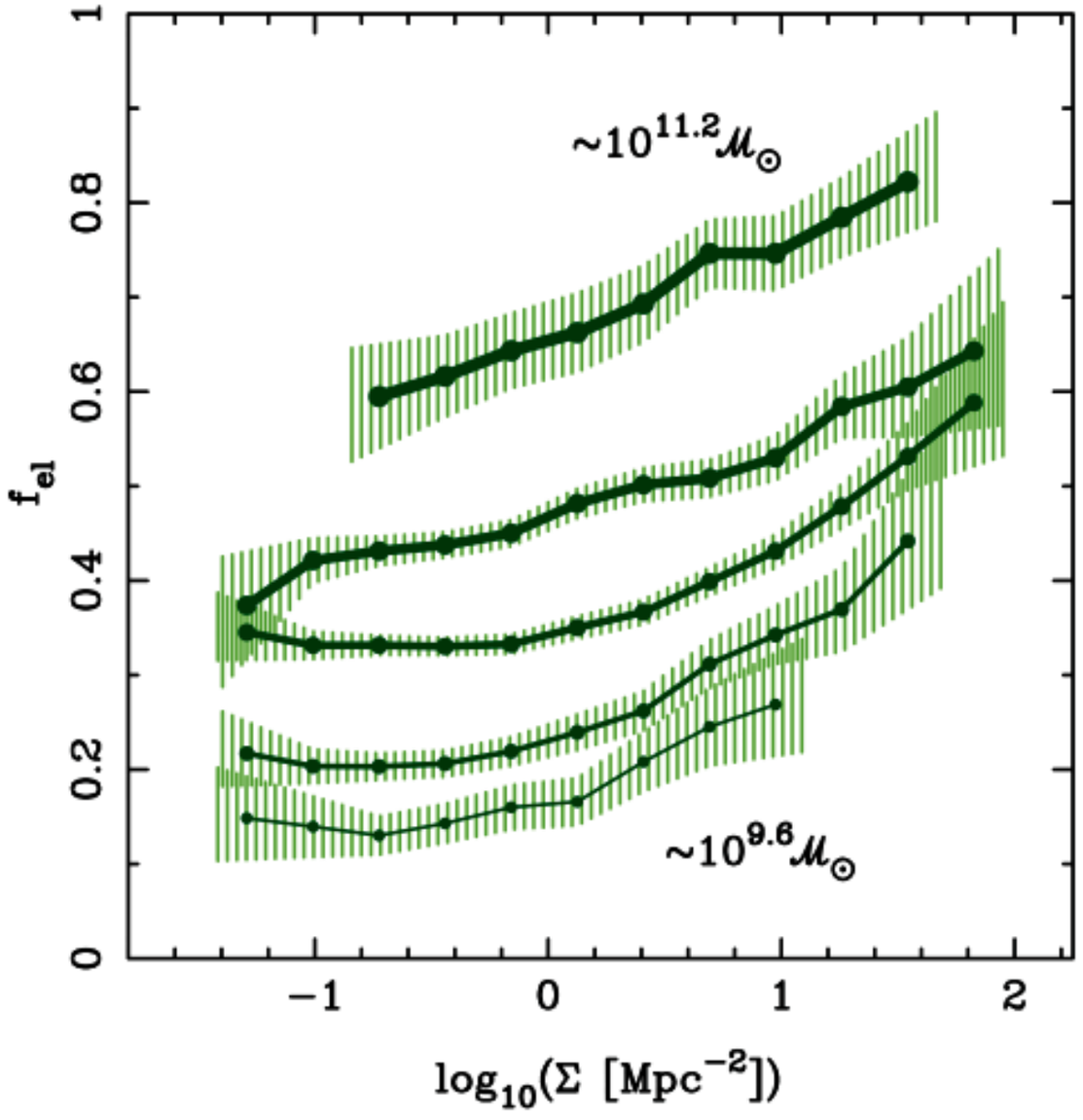
Figure 10. The distribution of stellar mass in our *luminosity-limited sample* as a function of (left) local galaxy density and (right) groupocentric distance. The lines trace the 1, 5, 25, 50 (thick), 75, 95 and 99 percentiles of the stellar-mass distribution in bins of environment. The stellar-mass distribution shifts steadily versus local density, while versus groupocentric distance most of the change in the stellar-mass distribution occurs within $\sim$0.2 $R_{\rm vir}$. The dotted horizontal lines indicate a stellar mass of $10^{10.3}\,\mathcal{M}_\odot$, below which our *luminosity-limited sample* becomes incomplete for red galaxies.

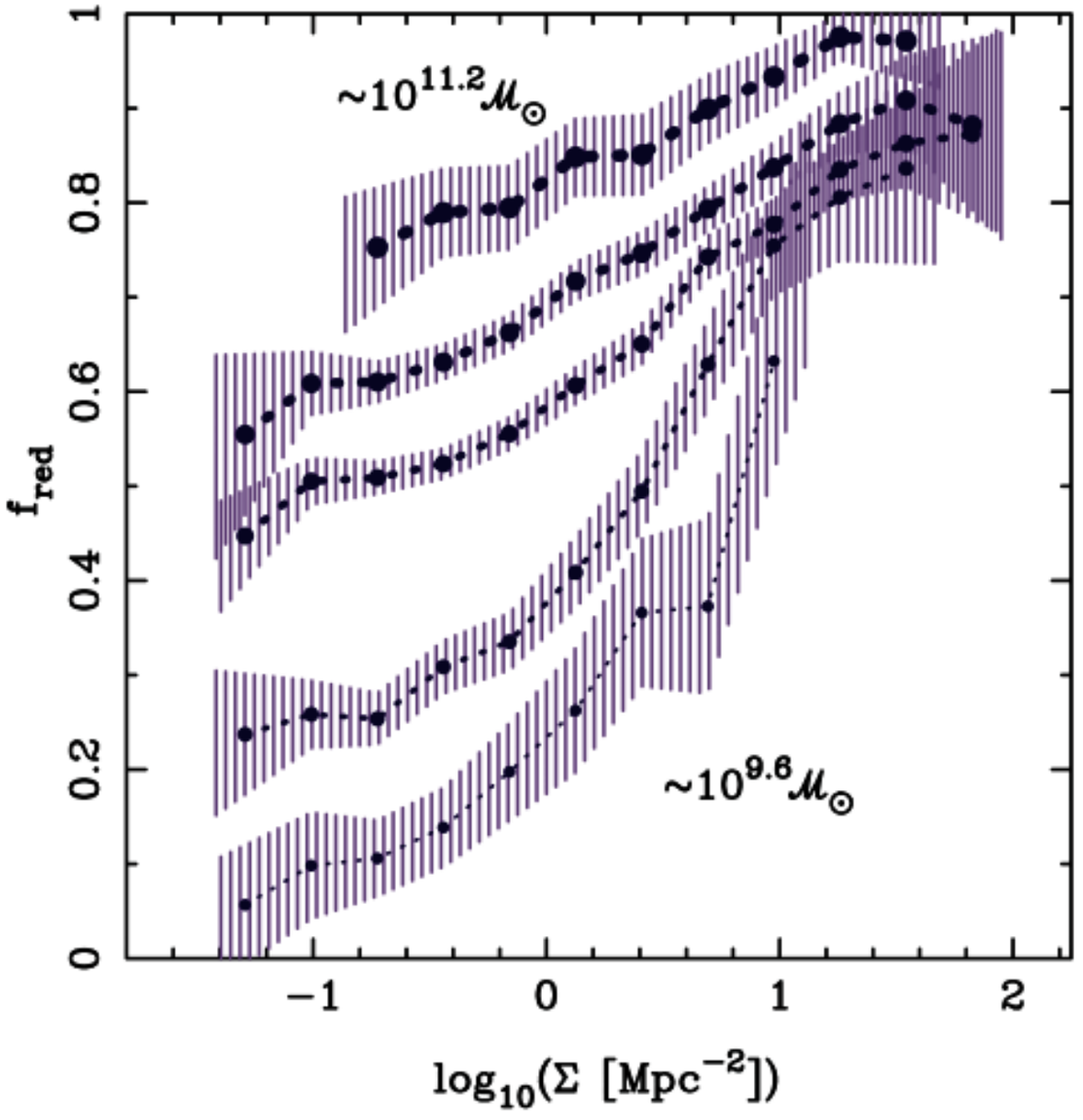
Fraction of red and early-type galaxies in low-density environment

There are many ellipticals in the field where environment does not play a role



Fraction of ellipticals for different colors and stellar masses





Small galaxies:

- in low density environments are preferentially blue spirals
- in high density they are red ellipticals

Large galaxies:

- preferentially red regardless of environment
- in high density they are red ellipticals