

Galaxies, Cosmology and Dark Matter



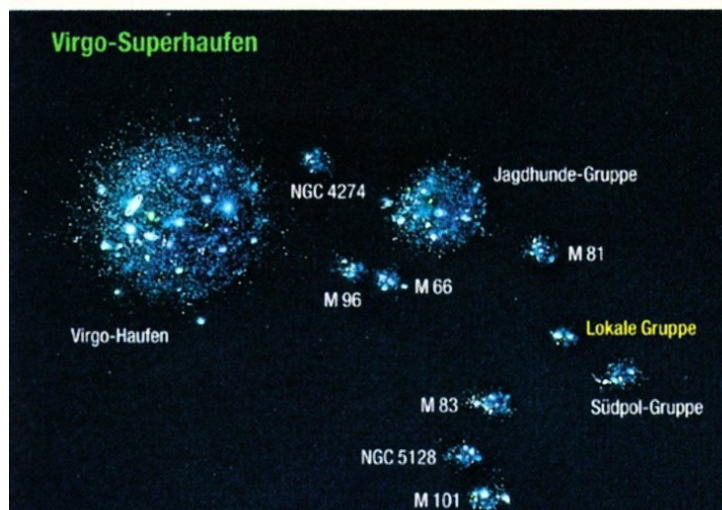
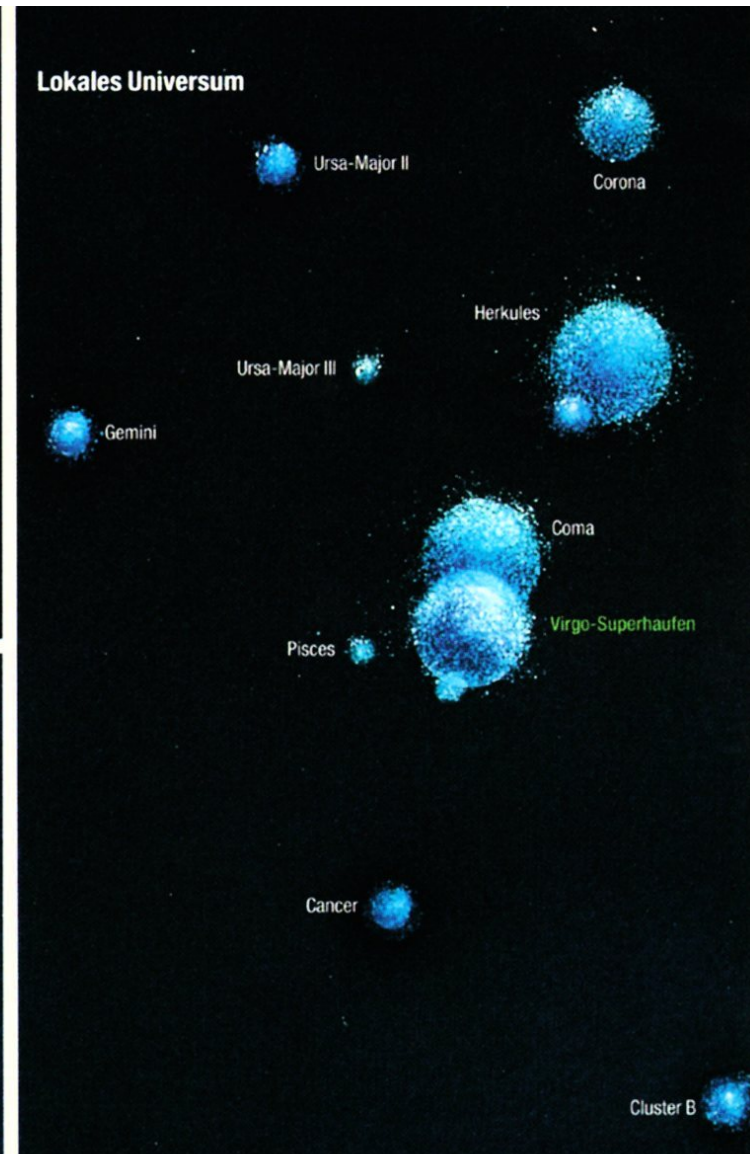
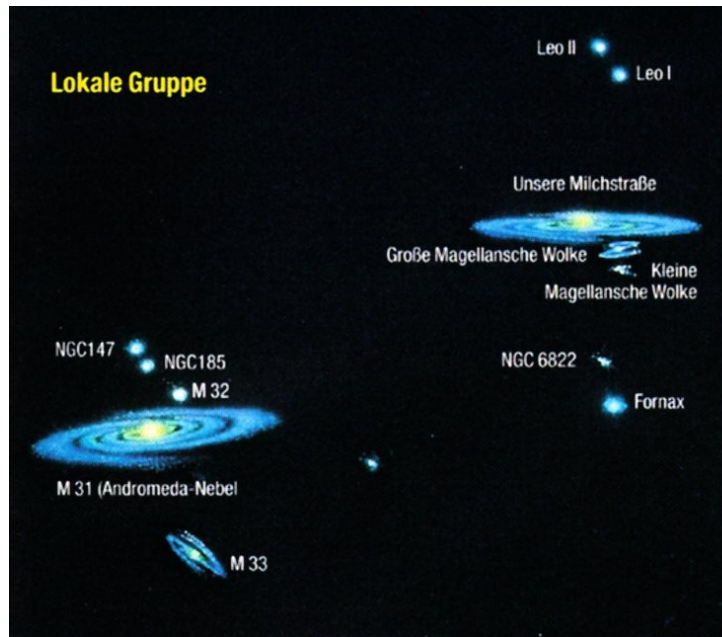
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Georg Feulner, Jan Snigula

Summer semester 2000

Chapter 10

The Local Universe

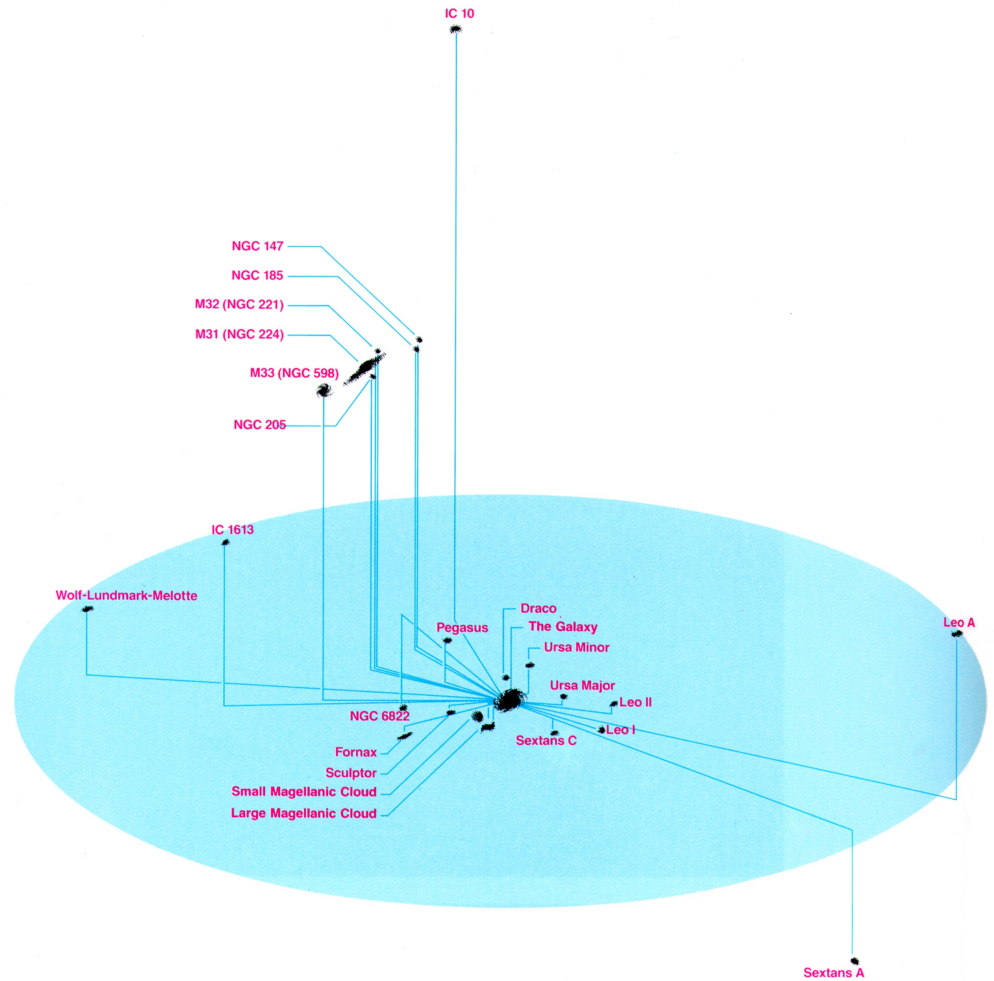


10.1 The Local Group

- The Milky Way belongs to a loose collection of galaxies called the **Local Group**.
- The brightest members of the Local Group are the Andromeda Galaxy (M31), the Milky Way, and M33, three spiral galaxies. Apart from M32 (which is not very typical) there are no elliptical galaxies found in the Local Group. The most frequent galaxy types in the Local Group members are the irregulars (like the Large and the Small Magellanic Cloud) and dwarf ellipticals.
- The total number of galaxies known to belong to the Local Group is about 40, but there probably exists a number of dwarf galaxies which may have remained undetected (especially behind the Milky Way plane).
- All Local Group galaxies are gravitationally bound (M31 approaches the Milky Way with 120 km/s).

The distribution of Local Group members in space

(*Cambridge Atlas of Astronomy*
Third Edition, Cambridge 1994)



List of Local Group Members:

The following table gives the names, the celestial coordinates α and δ (for the equinox 2000), the Hubble type, the distance D (in kpc), the absolute V magnitude M_V , and the radial velocity V_0 (in km/s) of Local Group galaxies.

The data were taken from M. Irvin's page on the local group (http://www.ast.cam.ac.uk/~mike/local_members.html).

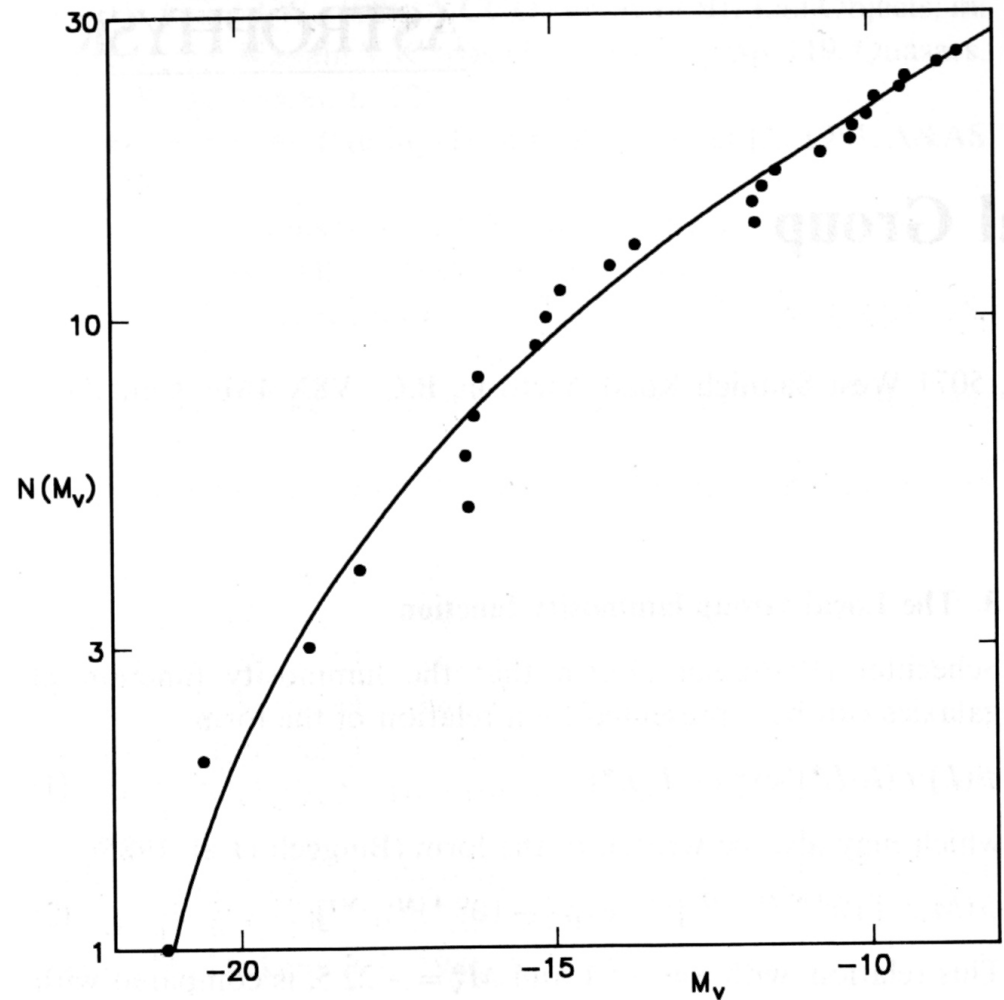
Name		Coordinates	Type	D(kpc)	Mv	Vo(km/s)
M31	NGC 224	00 40.0 +40 59	Sb	725	-21.1	-299
Galaxy		17 42.4 -28 55	Sbc		-20.6	
M33	NGC 598	01 31.1 +30 24	Sc	795	-18.9	-180
LMC		05 24.0 -69 48	Irr	49	-18.1	270
IC 10		00 17.7 +59 01	Irr	820	-17.6	-343
NGC 6822	DDO 209	19 42.1 -14 56	Irr	540	-16.4	-49
M32	NGC 221	00 40.0 +40 36	E2	725	-16.4	-190
NGC 205		00 37.6 +41 25	E5	725	-16.3	-239
SMC		00 51.0 -73 06	Irr	58	-16.2	163
NGC 3109	DDO 236	10 00.8 -25 55	Irr	1260	-15.8	403
NGC 185		00 36.2 +48 04	E3	620	-15.3	-208
IC 1613	DDO 8	01 02.2 +01 51	Irr	765	-14.9	-236
NGC 147	DDO 3	00 30.5 +48 14	E4	589	-14.8	-157
Sextans A	DDO 75	10 08.6 -04 28	Irr	1450	-14.4	325
Sextans B	DDO 70	09 57.4 +05 34	Irr	1300	-14.3	301
WLM	DDO 221	23 59.4 -15 45	Irr	940	-14.0	-116

Sagittarius		18 51.9	-30 30	dE7	24	-14.0	140
Fornax		02 37.8	-34 44	dE3	131	-13.0	53
Pegasus	DDO 216	23 26.1	+14 28	Irr	759	-12.7	-181
And VII	Cas Dw	23 24.1	+50 25	dE3	760	-12.0	
Leo I	DDO 74	10 05.8	+12 33	dE3	270	-12.0	285
Leo A	DDO 69	09 56.5	+30 59	Irr	692	-11.7	+26
And II		01 13.5	+33 09	dE3	587	-11.7	
And I		00 43.0	+37 44	dE0	790	-11.7	
And VI	Peg Dw	23 49.2	+24 18	dE3	775	-11.3	
SagDIG		19 27.9	-17 47	Irr	1150	-11.0	-79
Antlia		10 01.8	-27 05	dE3	1150	-10.7	361
Sculptor		00 57.6	-33 58	dE	78	-10.7	107
And III		00 32.6	+36 12	dE6	790	-10.2	
Leo II	DDO 93	11 10.8	+22 26	dE0	230	-10.2	76
Cetus		00 23.6	-11 19	dE4	775	-10.1	
Sextans		10 10.6	-01 24	dE4	90	-10.0	224
Phoenix		01 49.0	-44 42	Irr	390	-9.9	56
LGS 3		01 01.2	+21 37	Irr/dE	760	-9.7	-277
Tucana		22 38.5	-64 41	dE5	900	-9.6	
Carina		06 40.4	-50 55	dE4	87	-9.2	223
And V		01 07.3	+47 22	dE	810	-9.1	
Ursa Minor	DDO 199	15 08.2	+67 23	dE5	69	-8.9	-250
Draco	DDO 228	17 19.2	+57 58	dE3	76	-8.6	-289

The cumulative luminosity function of Local Group galaxies

is consistent with a Schechter function.

(van den Bergh (1992), *A&A*, **264**, 75)

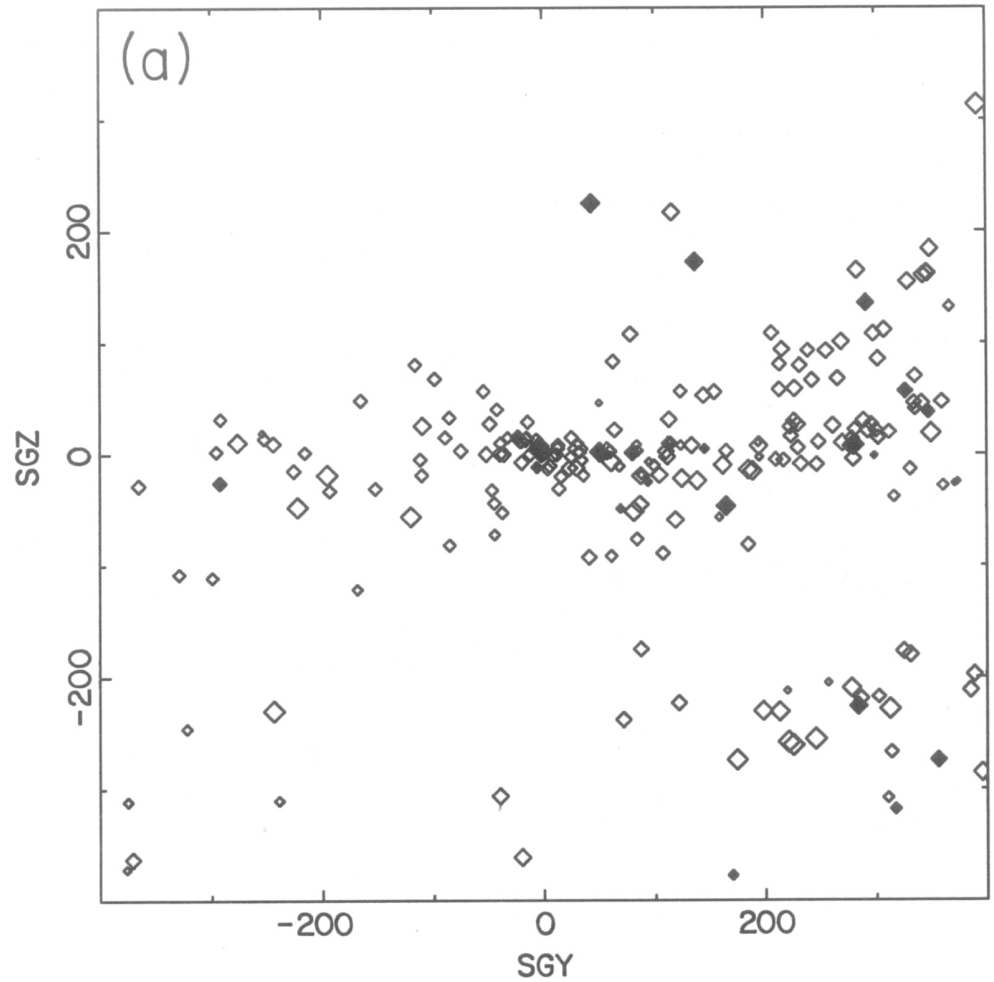


10.2 The Supergalactic Plane

The **Supergalactic Coordinate System** is a coordinate system with the Milky Way at its centre. The (X, Y) plane is orientated to include the local concentration of galaxies called the **Supergalactic Plane**, the Y axis roughly points in the direction of the Virgo cluster.

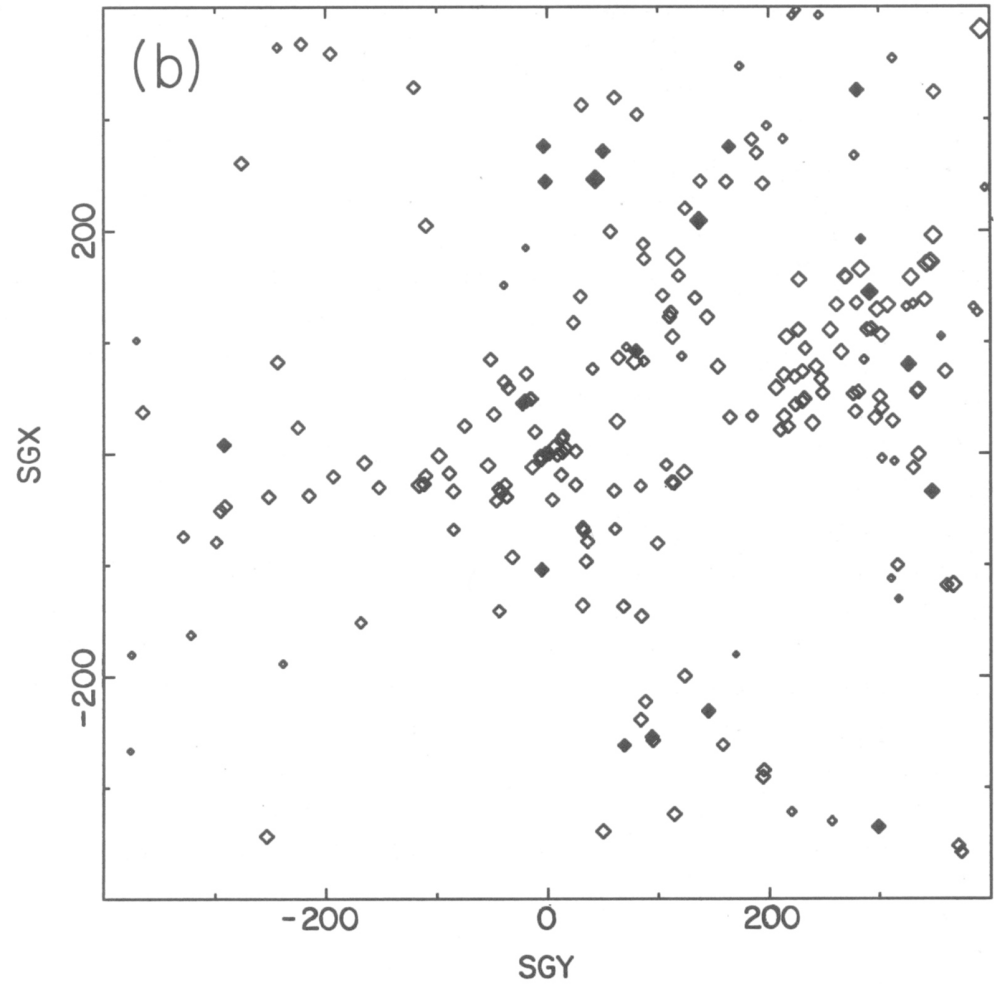
In the following plots (taken from Peebles 1993, *Principles of Physical Cosmology*) we show the Supergalactic Plane edge-on and face-on. The Milky Way is at the centre of the figures. The scale of the axes is given in cz (in units of km/s), making the width of each box $8 h^{-1}$ Mpc.

Supergalactic Plane
(edge-on)



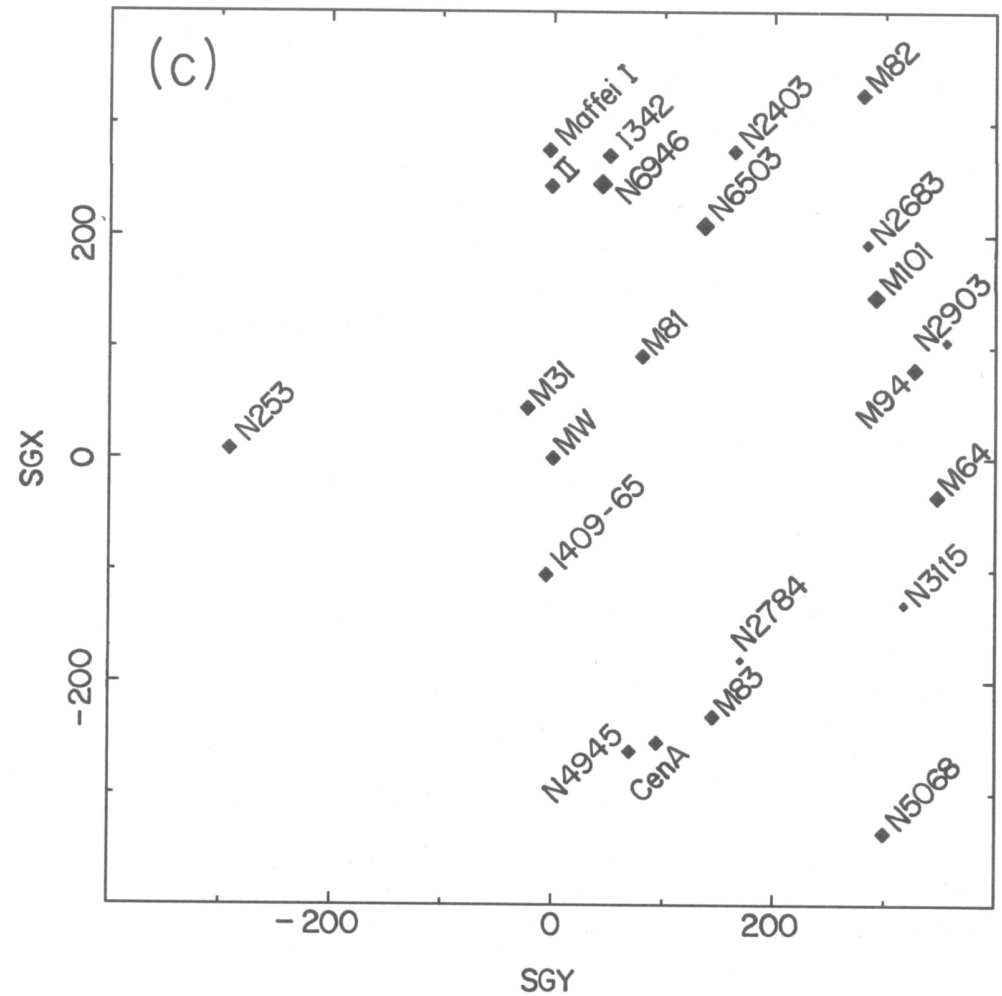
Supergalactic Plane

(face-on)



Supergalactic Plane

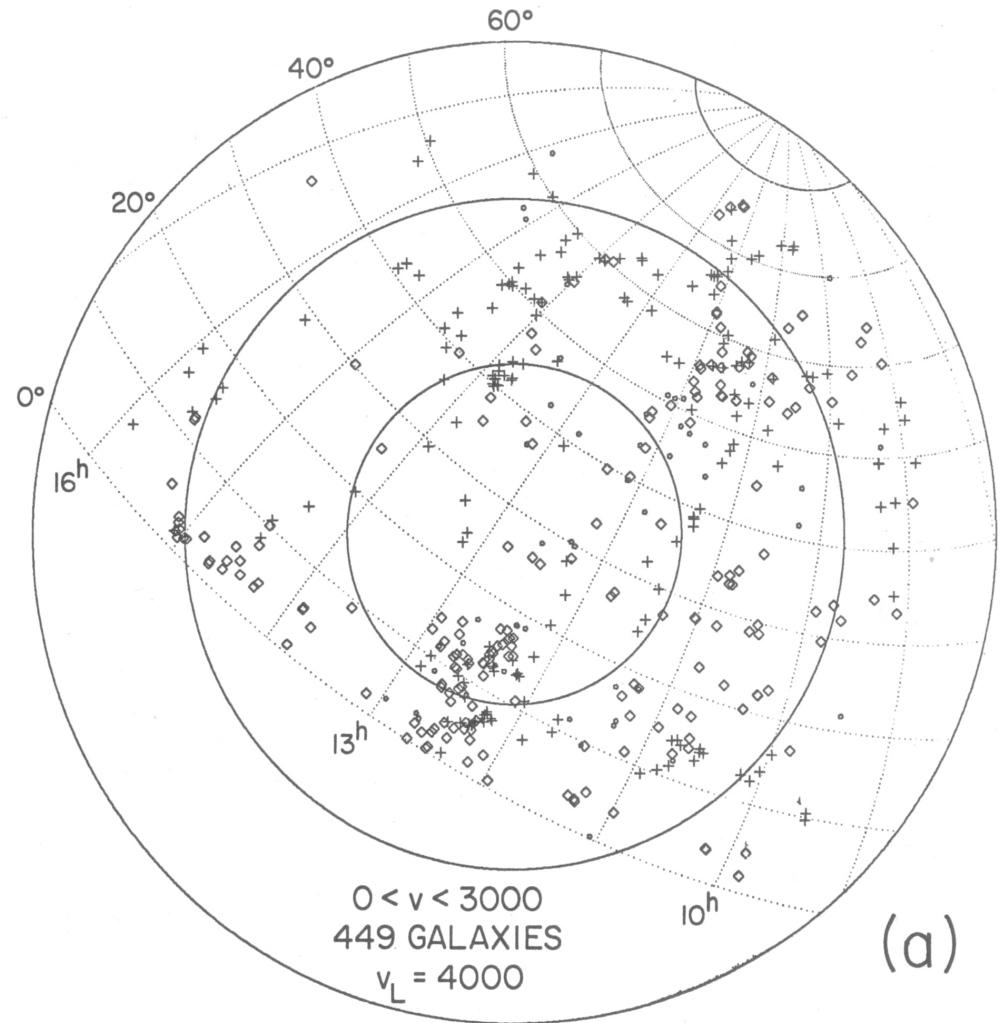
(face-on, only bright galaxies)



Angular distribution of galaxies

(redshifts $cz < 3000$ km/s,
abs. magnitude < -18.5)

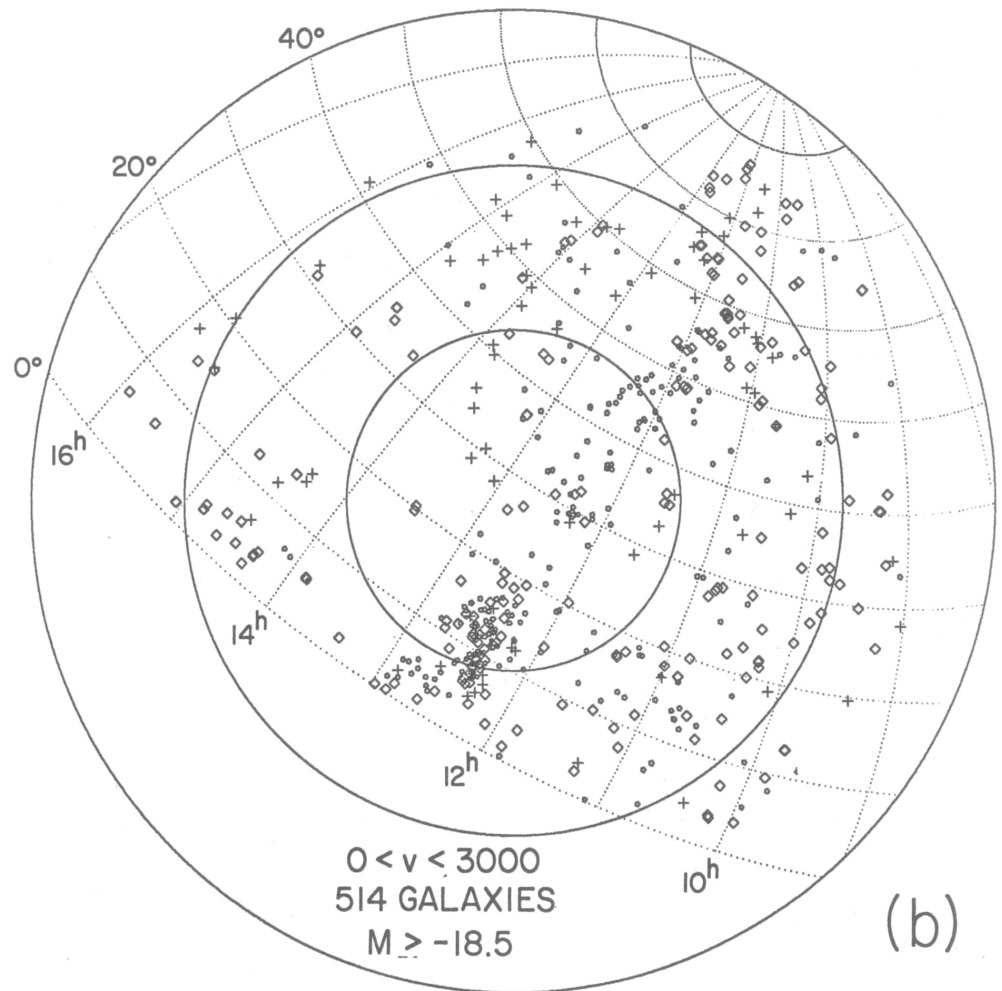
(Peebles 1993)



Angular distribution of galaxies

(redshifts $cz < 3000$ km/s,
abs. magnitude > -18.5)

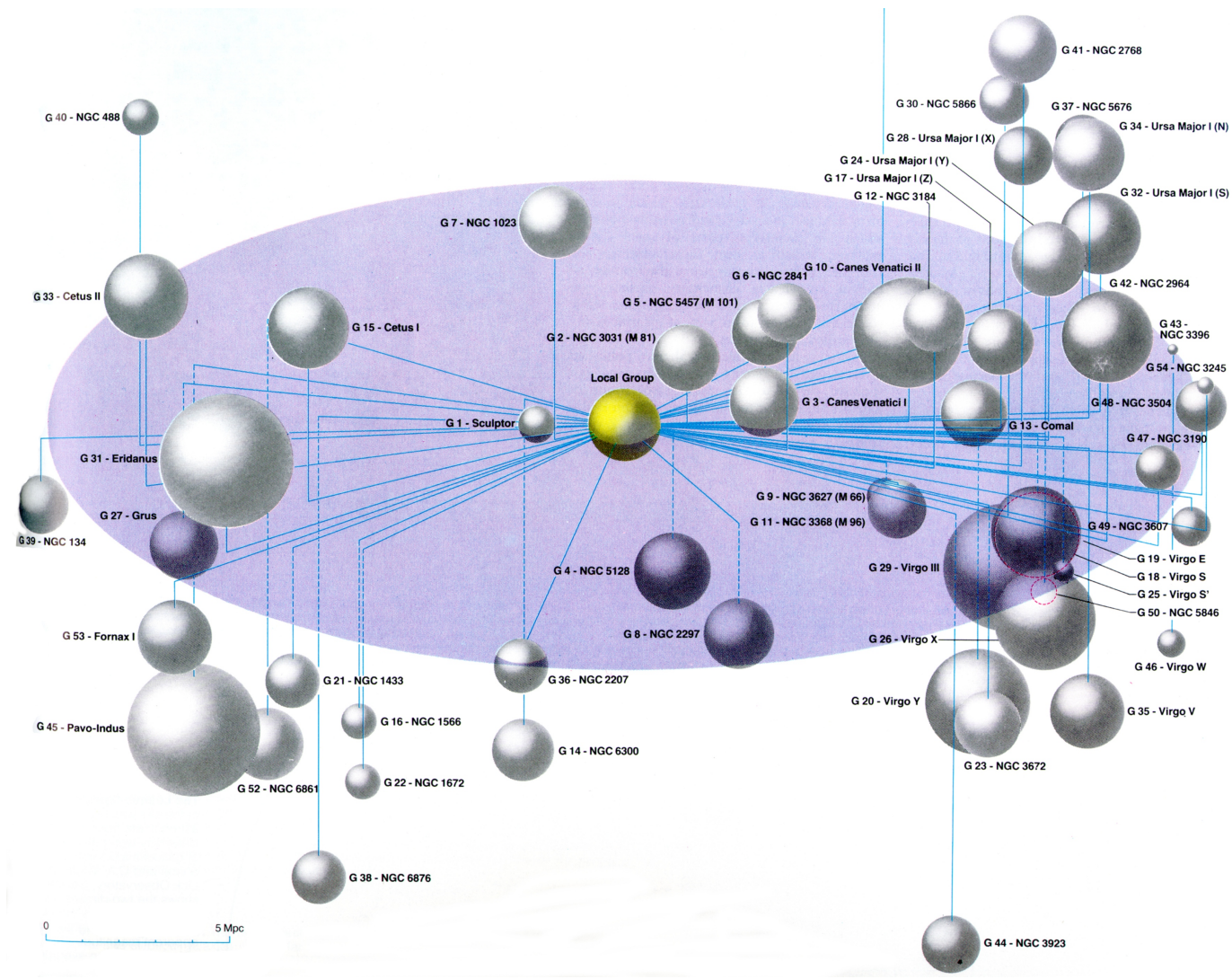
(Peebles 1993)



10.3 The Distribution of Nearby Groups

The distribution of nearby groups of galaxies around the Local Group is visible in the following figure, taken from the *Cambridge Atlas of Astronomy*, Third Edition, Cambridge University Press 1994.

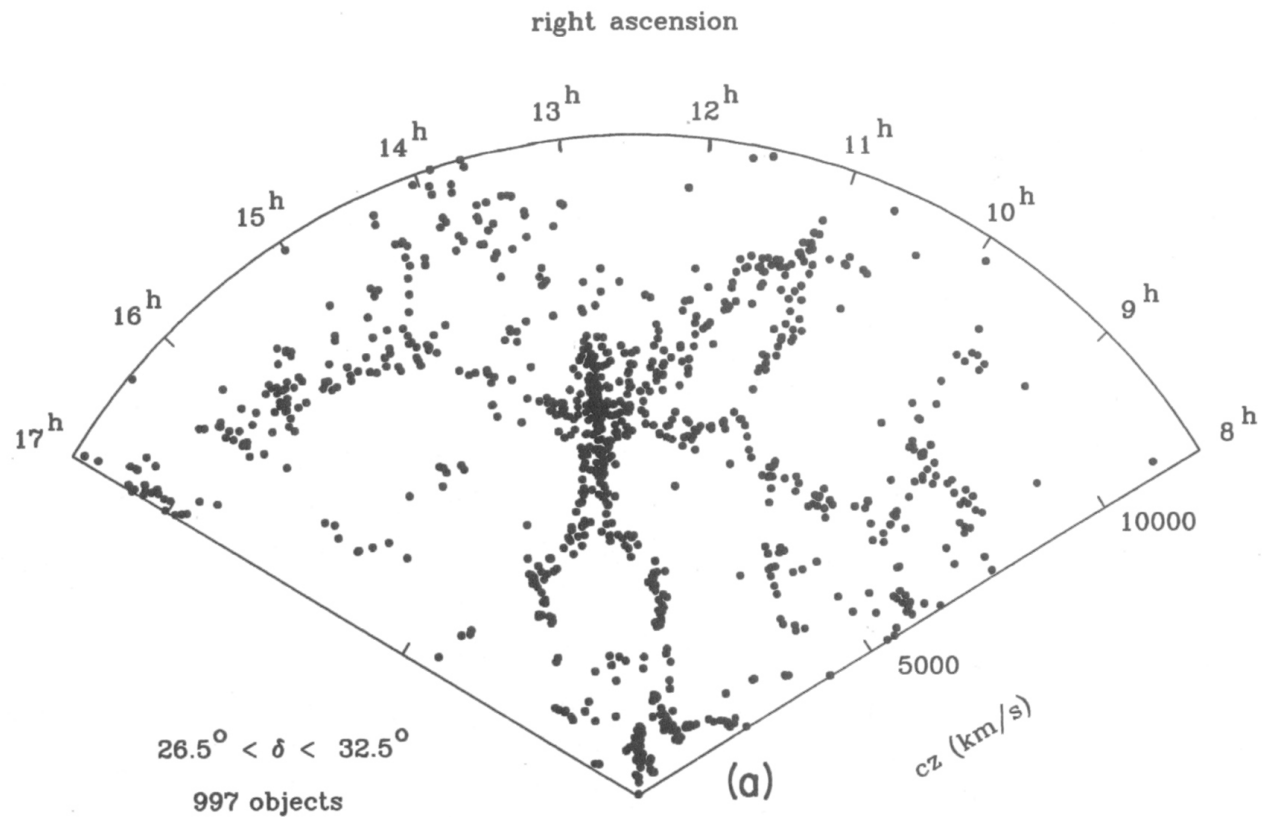
Note that the spherical symbol used for each group is **not** a good representation of the distribution of galaxies within the group and between the groups (see the Local Group, for example).



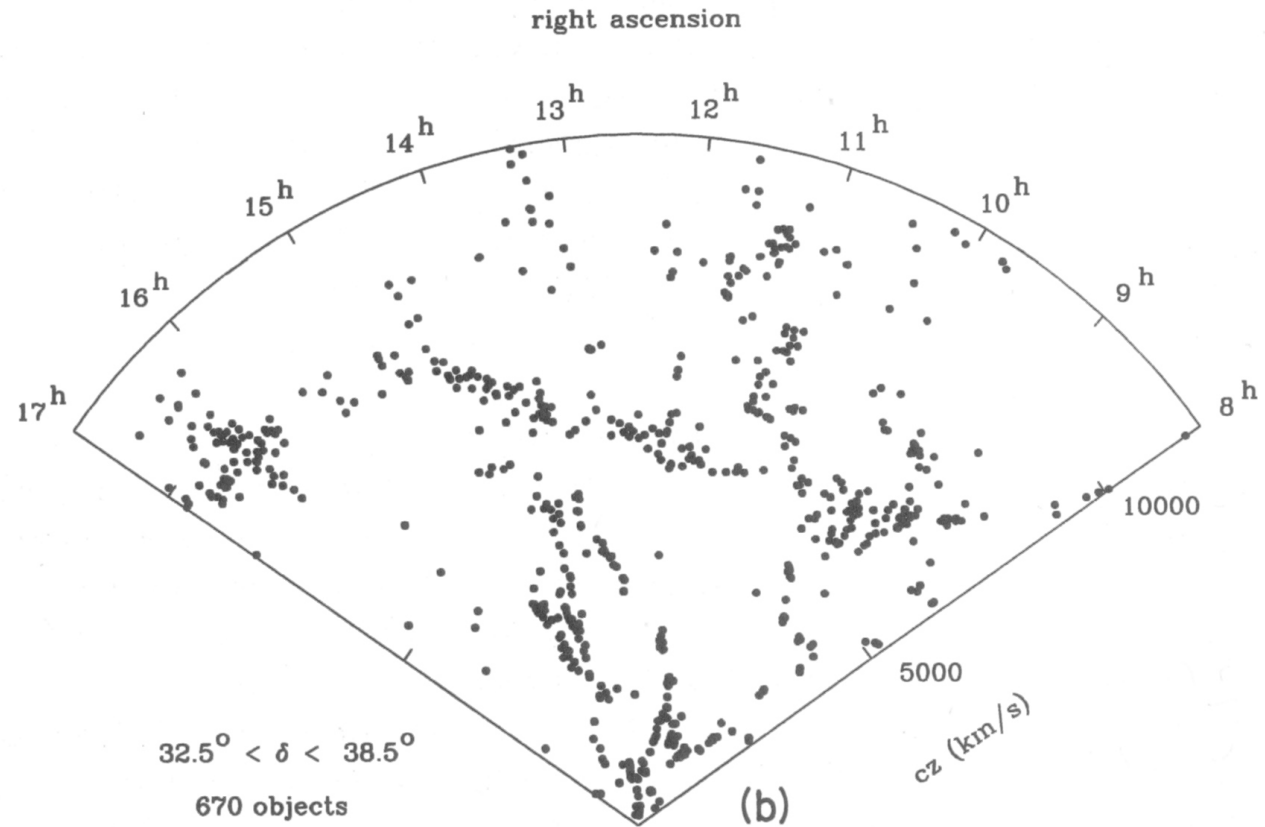
10.4 The Large–Scale Distribution of Galaxies

Galaxies are not uniformly distributed in space. They rather form large **superclusters** of galaxies, which surround regions with very low galaxy density (**voids**).

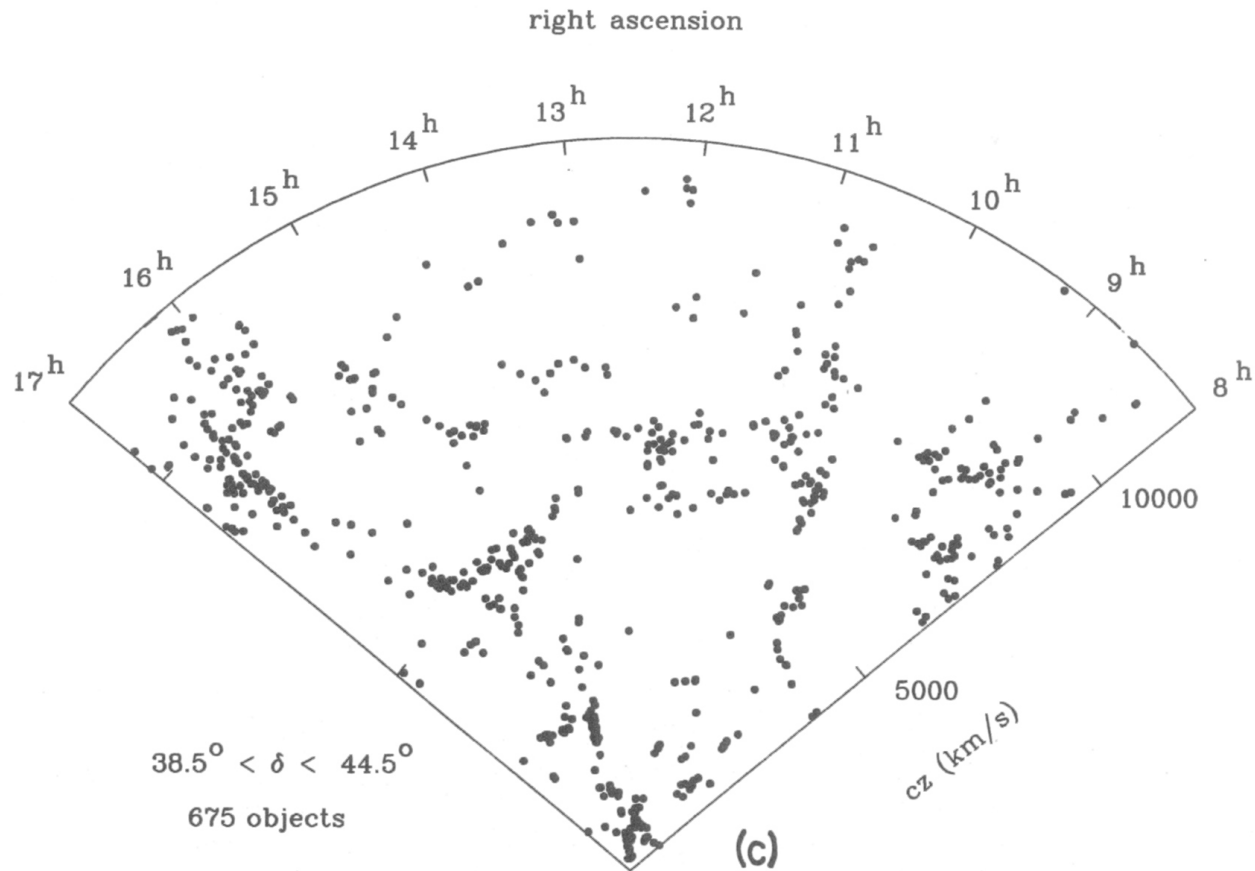
The following diagrams, taken from various redshift surveys, show this inhomogeneity of the large–scale distribution of galaxies in right-ascension—redshift space (“wedge diagram”).



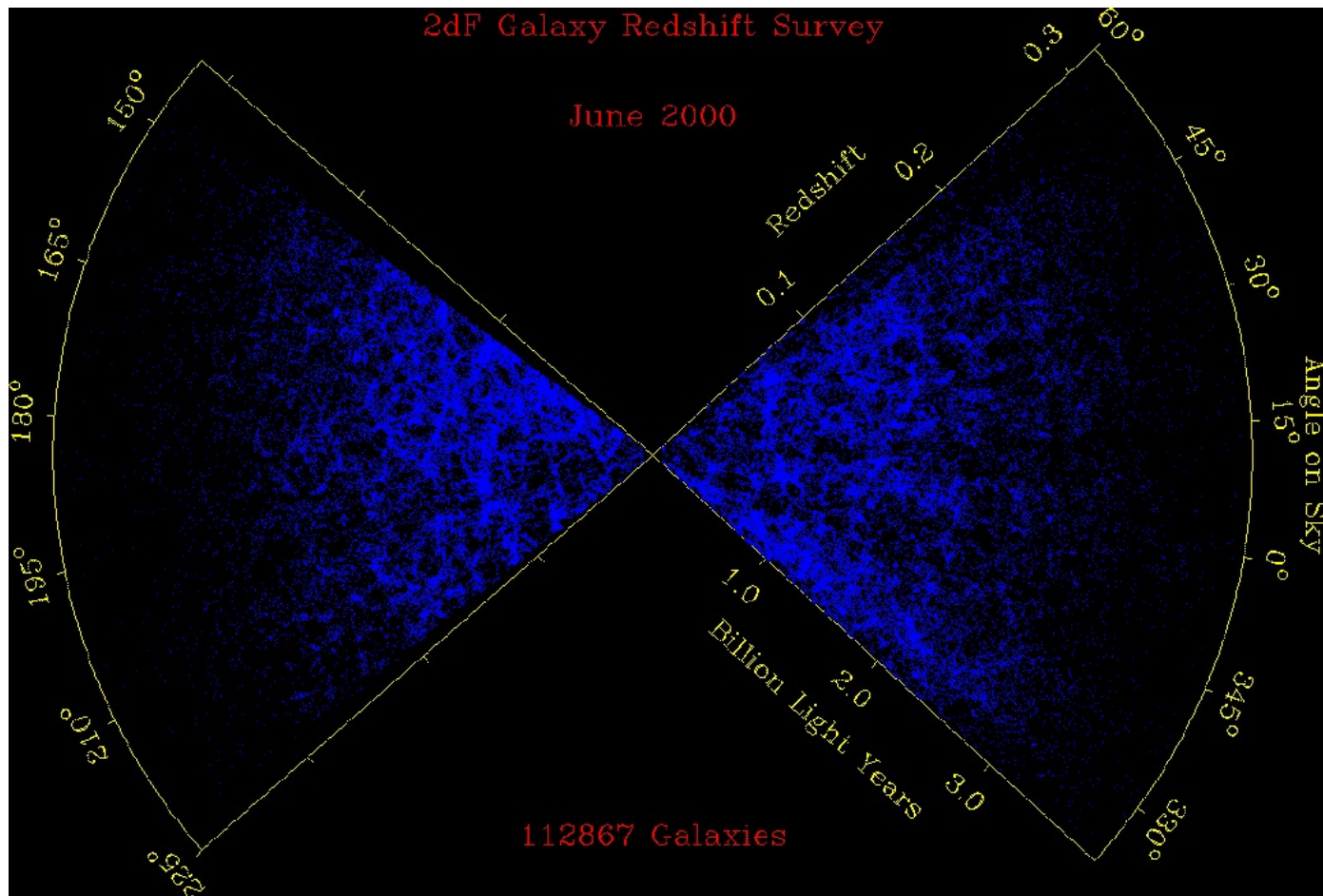
Center for Astrophysics (CFA, Harvard) Survey (from Peebles 1993)



Center for Astrophysics (CFA, Harvard) Survey (from Peebles 1993)



Center for Astrophysics (CFA, Harvard) Survey (from Peebles 1993)



2dF Galaxy Redshift Survey

Typical Scales of Large–Scale Structure

Galaxies	~ 10 kpc
Groups & Clusters	$\sim (1 \dots 10)$ Mpc
Superclusters	~ 100 Mpc

- Superclusters of galaxies are the largest known structures in the universe.
- The Local Group is a member of the **Local Supercluster**, a huge flattened distribution of galaxies centred on the Virgo cluster.