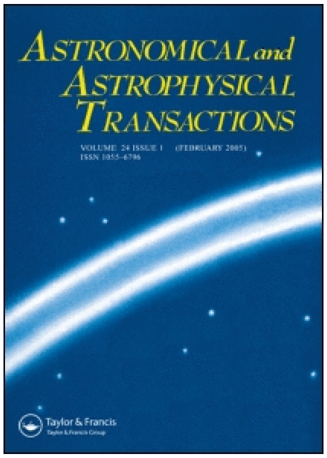

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CRITERION FOR BOUND GROUPS OF GALAXIES. APPLICATION TO THE LOCAL VOLUME

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To reveal multiple galaxies, a new approach is suggested which allows for individual properties of galaxies. The criterion is based on the assumption of closed Keplerian motions of companions around the dominating component of a system within their radius of gravitational influence.

The criterion is applied to a sample of 215 nearby galaxies with radial velocities less than 500 km/s, among which 1/3 have direct photometrical distance estimates. About 50% of this sample are grouped into systems with a membership of 2 to 8 and hierarchy levels from 1 to 3. The groups selected by the new algorithm have a typical radius of 123 kpc and a radial velocity difference of 42 km/s. The excess of dark matter in the groups and pairs is close to zero if the trajectories of the galaxies are modelled by orbits with small eccentricity.

The small-scale structure of the Universe in the local volume shows the same properties: voids and caustics which are characteristic of the large scales. Peculiar velocities of nearby galaxies tend to be oriented in the direction to the plane of the Local "pancake".

KEY WORDS Nearby galaxies, group of galaxies, local streaming

1 HISTORICAL REMARKS

Virial mass estimates for groups of galaxies is a principal, if not unique, source of data on the content and distribution of dark matter on scales of 0.1–1.0 Mpc. However, the mean excess values of the virial mass for a typical group from the data of different authors have a scatter by a whole order of magnitude. So, Gott and Turner (1976), and Huchra and Geller (1982) obtained the mean excess of $\mathfrak{M}_{\rm vir}/\mathfrak{M}_{\rm lum}$ to be ~50–100, whereas Tully (1987) and Magtesian (1988) give for the groups of the same population a virial mass excess of only 7–10. With time it has become more and more obvious that the main reason of the disagreement is caused by the difference in the algorithms for the selection of the systems of galaxies. However, the differences in the observational material used or in the manner of virial mass calculation are of minor importance.

The first more or less systematic attempts of compiling a list of multiple galaxies were made by Holmberg (1937), Karachentsev (1966, 1970) and de Vaucouleurs (1975). In each case, groups were selected by their apparent density contrast with respect to the neighbouring sky areas. However, the procedure of selection was subjective to a considerable extent, "by hand". Later on the efforts were directed towards creating "objective" algorithms which allowed to reveal groups in the existing catalogues of galaxies.

Gott and Turner (1976) united into a group those galaxies whose mutual angular separations did not exceed the radius of clustering r_c. The value of r_c was chosen to provide an apparent density contrast of the system $\Delta n/\bar{n} >$ *dex* 2/3. As one might expect, the groups selected by Gott and Turner contained a large number of spurious members projected on the line of sight by chance. Contamination of the Gott and Turner's groups with foreground and background objects led to a strong overestimation of the virial mass. As data on radial velocities of galaxies were accumulated, an opportunity arose to apply the principle of clustering to the spatial distribution of galaxies. Huchra and Geller (1982) used the CFA redshift survey for finding multiple galaxies. In order to secure a high enough spatial density contrast, $\Delta\rho/\bar{\rho}$, they united galaxies into groups at the mutual distance in projection $R_{\rm ik} < R_{\rm c} = 0.52$ Mpc and the radial velocity difference $V_{\rm ik} < V_{\rm c} = 600$ km/s. Such a procedure subjected to clustering 74% of the galaxies from the CFA catalogue, including 14% of galaxies in binary systems. According to Huchra and Geller, a typical group has the harmonic radius $R_{\rm H} = 1.1$ Mpc, the radial velocity dispersion $\sigma_{\rm V} = 208$ km/s and the virial mass $\lg(\mathfrak{M}_{\rm vir}/\mathfrak{M}_\odot) = 13.5$.

A similar approach was applied by Maia *et al.* (1988) to the radial velocity survey of 2028 galaxies in the southern hemisphere. The clustering parameters $R_{\rm c} = 0.39$ Mpc and $V_{\rm c} = 600$ km/s were chosen to ensure the spatial density contrast $\Delta\rho/\bar{\rho} >$ *dex* (1.3). As a result, only 49% of the galaxies were involved in clustering, but the mean parameters of the groups ($R_{\rm H} = 1.0$ Mpc, $\sigma_{\rm V} = 183$ km/s and $\lg(\mathfrak{M}_{\rm vir}/\mathfrak{M}_\odot) = 13.2$) turned out to be close to the parameters of a group of Huchra and Geller.

An essential improvement of the cluster selection procedure was proposed by Magtesian (1988). Along with the limitation in mutual velocities, $V_{\rm ik} < V_{\rm c} = 400$ km/s, he used the clustering parameter $E_{\rm c} \propto L_{\rm ik}/R_{\rm ik}$. So the projected distance between galaxies at which they associated became dependent on the luminosity (mass) of the galaxies. Applying his criterion to the CFA survey, Magtesian obtained a list of groups with the following median characteristics: $R_{\rm H} = 0.34$ Mpc, $\sigma_{\rm V} = 140$ km/s and the virial mass-to-luminosity ratio $\mathfrak{M}_{\rm vir}/L_{\rm B} = 50\ f_\odot$. The relative number of galaxies united into systems was 52%, including binaries (12%).

Despite the presence of a precise algorithm, the clustering method in all its versions has two essential shortcomings: it leaves the possibility of a subjective choice of the clustering parameters ($R_{\rm c}$ and $V_{\rm c}$) and provides a simplified picture of the one-level clustering. The latter is originally absent in another approach, which unites galaxies into a hierarchical "tree" by the principle of minimum distance. Modifications of this technique called sometimes "taxonometry" were described by Materne (1978, 1979).

Most efficiently this approach was realized by Tully (1987, 1988) who proposed a list of groups and associations of galaxies in the Local Supercluster volume. Treating all the galaxies with the radial velocities $V_0 < 3500$ km/s, Tully united the galaxies in succession by the principle of maximum density contrast. Among the entire population of "particles", those two were selected whose luminosities L_i and L_k and mutual separation R_{ik} corresponded to $\max(L_{ik}/R_{ik}^3)$. Then the pair was replaced by a "particle" with the total luminosity and mean coordinates of the initial particles, the next particle being added according to the same criterion. The process was accomplished by unifying all the galaxies into a single supersystem, the hierarchical tree. Tully chose the threshold density value, $\rho_g = 2.5 \times 10^9\ L_\odot/\mathrm{Mpc}^3$, at which the branches, i.e. groups, were cut off the tree. Cutting at another level, $\rho_a = \rho_g/10$, would give more friable systems - associations comprising the groups. Tully's groups cover 64% of 2367 galaxies considered. Passing to the level of associations increases this number up to 85%. For his group, Tully estimated the following median parameters: $R_H = 0.32$ Mpc, $\sigma_V = 100$ km/s and $\mathfrak{M}_{vir}/L_B = 94\ f_\odot$, which is essentially lower than for the groups of Huchra and Geller (1982).

Almost at the same time Vennik (1984, 1987) applied a similar algorithm for the detection of nearby groups of galaxies in the same volume. As the ordinate of the hierarchical tree he used the number density of galaxies, $\rho_n = 3n/4\pi R_{ik}^3$, and realized the transition from the difference of radial velocities V_{ik} to the spatial separation of galaxies R_{ik} through a somewhat different scheme. As a result, Vennik obtained the relative number of galaxies in the group as 43% (except for binary systems), and the median characteristics of the groups as $R_H = 0.15$ Mpc, $\sigma_V = 100$ km/s and $\mathfrak{M}_{vir}/L_B = 97\ f_\odot$.

Recently Gourgoulhon *et al.* (1992) extended the application of the hierarchical algorithm to galaxies in a volume up to 80 Mpc from the PGC catalogue (Paturel *et al.*, 1989), having somewhat improved the initial method of Tully. Their list of 264 groups covers 57% of the galaxies under study (including 16% of binaries) and gives for the groups the median values $R_H = 0.77$ Mpc, $\sigma_V = 73$ km/s and $\mathfrak{M}_{vir}/L_B = 62\ f_\odot$.

Similarly to clustering, the hierarchical technique contains two parameters (the level of cutting the dendrogram and the scale factor of the transition $V_{ik} \rightarrow R_{ik}$), the quantities that are specified "by hand". In this sense the two branches of the algorithms may be regarded objective only marginally. There are other reasons as well which force to seek for a new way of the selection of groups of galaxies.

All the approaches mentioned above utilize, explicitly or implicitly, the principle of density contrast, $\delta\rho/\bar{\rho} \gg 1$, for the detection of virialized systems. This principle has clear physical grounding in the picture of a universe where individual systems are immersed in the Poisson field of galaxies. As was emphasized by Nolthenius and White (1987) in the real Universe with a complex pattern of the large-scale structure, the principle of density contrast loses its obvious meaning. The employment of the universal density threshold leads to missing isolated groups in low density volumes and to the selection of false systems (projective "chimeras", caustics) in the regions of "pancakes" and "filaments".

Another reason for the inefficiency of the criteria mentioned above is due to their "totalitarian" approach to the "collectivization" of galaxies. Considering the conditions of physical relation of neighbouring galaxies, one should take into account their individual parameters. In this sense the application of one and the same radius of clustering to both giant and dwarf galaxies is an unwarranted simplification. An attempt to allow for this was made recently by Morgan and Hartwick (1988).

Hereafter we describe a new approach to revealing bound groups of galaxies and its application to the most studied region, the Milky Way vicinity.

2 THE CRITERION FOR GROUPING THE GALAXIES

For the last years, the observational basis for the application of galaxy clustering algorithms has changed greatly. The number of galaxies with known radial velocities has grown, the accuracy of their measurements has increased (the contribution of HI-surveys at 21 cm), an opportunity has arisen to determine in mass the luminosities of spiral galaxies from the width of the HI-line profile.

We assume that, from a reference catalogue, say RC3 (Vaucouleurs *et al.*, 1991) or PGC (Paturel *et al.*, 1989), we know the following parameters of galaxies:

$$\{\alpha,\ \delta,\ a,\ b,\ m,\ A_{\rm B},\ T,\ V,\ (W),(D)\}, \tag{1}$$

where α and δ are the equatorial coordinates, a and b are major and minor angular diameters measured on a standard isophote 25 mag/square arcsec, m is the integral apparent magnitude in the B-band, $A_{\rm B}$ is the value of interstellar light absorption, T is the morphological type, V is the radial velocity and (if they are accessible) W is the profile width of 21 cm line at a level 50% of the maximum and D is a direct estimate of the galaxy distance. Introducing standard corrections to the apparent magnitude and angular diameter of a galaxy for its inclination and light absorption,

$$\Delta m = -A_{\rm B} + 1.2\ \lg(b/a),$$

$$\Delta \lg a = 0.09 A_{\rm B} + 0.2\ \lg(b/a),$$

and also correcting the width of the HI line for the inclination,

$$W_0 = W(1-(b/a)^2)^{-1/2},$$

and reducing the measured radial velocity to the center of the Galaxy,

$$V_0 = V + 300 \sin l \cos b,$$

we derive the global parameters of a galaxy:

standard linear diameter

$$A = a\,D, \tag{2}$$

integral luminosity in the B-band

$$L = dex\,[0.4(5.4 - M)], \quad M = m - 5\lg D - 25, \tag{3}$$

and mass inside the standard isophote,

$$\mathfrak{M}_{25} = G^{-1}(W_0/2)^2\,(A/2). \tag{4}$$

Here $D = V_0/H$, if there is no direct distance estimate, H is the Hubble constant, and G is the gravity constant. For H we have used the value 75 km/s Mpc. In the cases when the line width of HI is unknown or the galaxy has a small inclination of the rotational axis to the line of sight, namely $b/a > 0.80$, we find the mass of the galaxy from its luminosity:

$$\mathfrak{M}_{25} = f_{25}(T)\,L, \quad F_{25}(T) = (8 - 0.4T)\,f_{\odot}, \tag{5}$$

were the galaxy type, as classified by de Vaucouleurs, assumes discrete values between -5 (elliptical) and $+10$ (irregular). Thus we suppose that the mass-luminosity ratio inside the standard isophote varies from 10 for elliptical to 4 for irregular galaxies in terms of the solar mass and luminosity.

As it is well established, in most spiral galaxies rotation curves $V(R)$ are flat and extend beyond the limits of the standard optical diameter A_{25}. One usually associates this phenomenon with the presence of an additional subsystem, the halo at the periphery of the galaxies. To take into account this invisible subsystem, let us introduce the notion of the "global" mass,

$$\mathfrak{M} = \kappa\,\mathfrak{M}_{25}, \tag{6}$$

where the dimensionless parameter κ may be expressed as the ratio of the maximum observable portion of the flat rotation curve to the standard diameter

$$\kappa = A_{\mathrm{V}}/A_{25}.$$

The most reliable data on κ are obtainable from HI rotation curves. The distribution in κ for 72 spirals, according to Wevers (1988), Begeman (1987) and Broeils (1992), is shown in Figure 1. The data of the first two authors are shown shaded. As can be seen, for all the galaxies $\lg\kappa$ is positive with the mean value $+0.29$ and the standard deviation $\sigma(\lg\kappa) = 0.14$. Although κ is slightly dependent on the peculiarities of HI observations and morphological type, we assume a fixed mean ratio for all the galaxies:

$$\kappa = 2. \tag{7}$$

Further, for each arbitrary pair of galaxies we calculate their projected spatial separation

$$R_{\mathrm{ik}} = \sin(\Theta_{\mathrm{ik}}/2)(D_{\mathrm{i}} + D_{\mathrm{k}}), \tag{8}$$

where

$$\cos\Theta_{\mathrm{ik}} = \sin\delta_{\mathrm{i}}\,\sin\delta_{\mathrm{k}} + \cos\delta_{\mathrm{i}}\,\cos\delta_{\mathrm{k}}\,\cos(\alpha_{\mathrm{i}} - \alpha_{\mathrm{k}}),$$

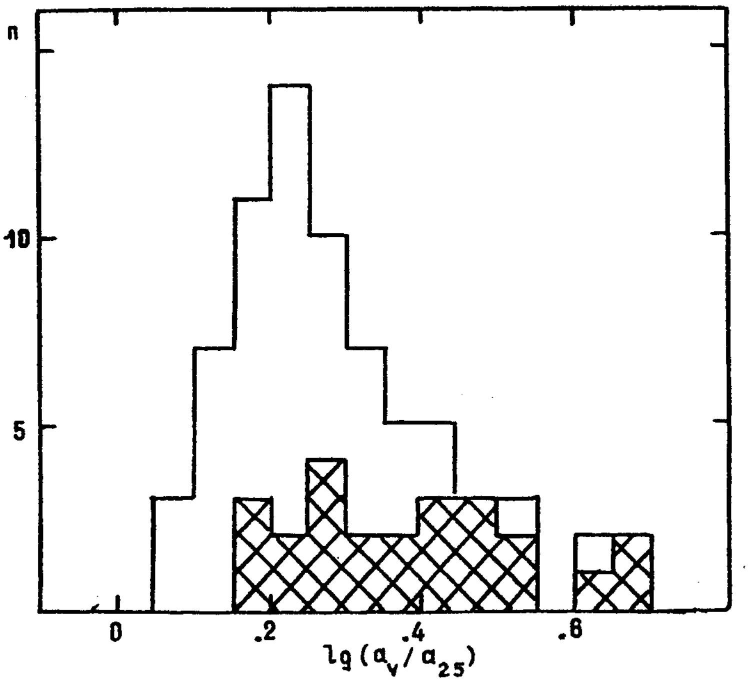

Figure 1 Distribution of the number of spiral galaxies versus the maximal extent of the rotation curve a_V expressed in terms of the standard galaxy diameter a_{25}. The data of more detailed HI-observation by Wevers and Begeman are shaded.

and the radial velocity difference

$$Y_{\text{ik}} = |V_{\text{oi}} - V_{\text{ok}}|. \tag{9}$$

If two galaxies travel along closed Keplerian orbits, then the condition

$$g_{\text{ik}} \equiv Y_{\text{ik}}^2 R_{\text{ik}}/2G(\mathfrak{M}_{\text{i}} + \mathfrak{M}_{\text{k}}) < 1 \tag{10}$$

is valid. Applying the third Kepler's law we can determine the cyclic orbiting period of the pair, $T_{\text{ik}}/2\pi$. For causely related galaxies it must not exceed the age of the Universe, H^{-1}. In other words,

$$t_{\text{ik}} \equiv (H\,T_{\text{ik}}/2\pi) = H R_{\text{ik}}^{3/2}/[G(\mathfrak{M}_{\text{i}} + \mathfrak{M}_{\text{k}})]^{1/2} < 1. \tag{11}$$

Thus, we leave for further consideration only the pairs which satisfy conditions (10) and (11).

It should be noted that conditions (10), (11) are conservative with respect to the projection factors. At any angle of view, a true pair with closed motions will not be rejected basing on these conditions. On the other hand, the criterion

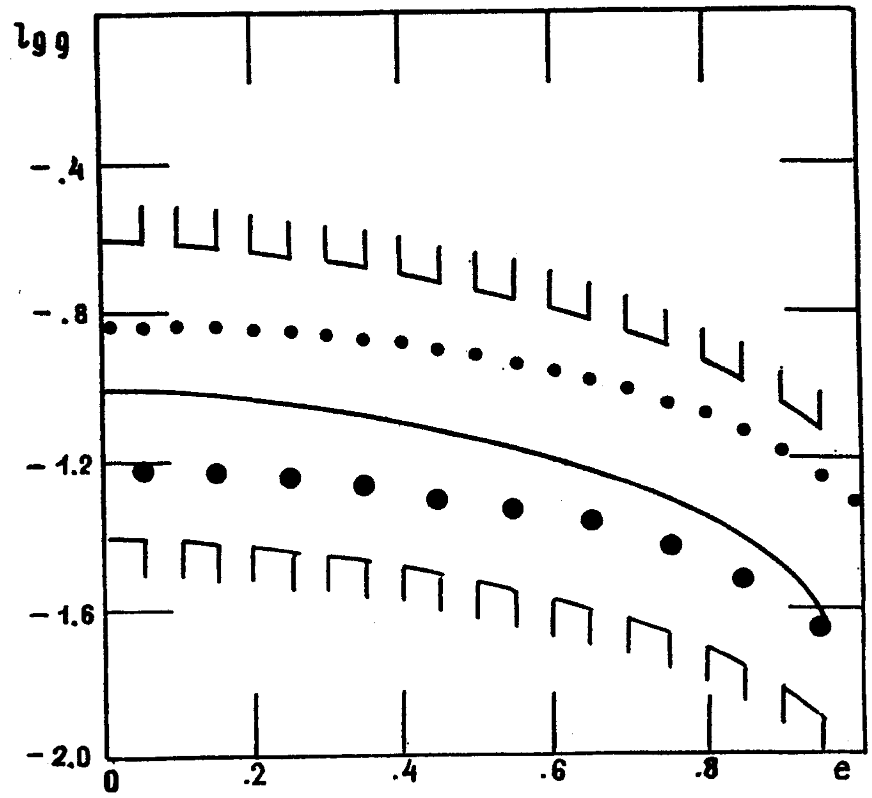

Figure 2 Statistics of the potential factor g defined in (10) for orbits with different eccentricity e and random orientation with respect to the line of sight. The solid and two dashed lines correspond to the median and quartiles. Dots and filled circles show the mean and geometrical mean.

$\{g_{\mathrm{ik}} < 1,\ t_{\mathrm{ik}} < 1\}$ may be satisfied at a favourable angle of view by some spurious pairs.

Among the cases that obey conditions (10) and (11) we will come across the pairs with a recurrent component. As a rule, these are massive galaxies surrounded by companions. Ranking the sample of pairs by the masses $\mathfrak{M}_{\mathrm{i}}$ and $\mathfrak{M}_{\mathrm{k}}$ of both components,

$$\mathit{rank}\ \left\{\,\|g_{\mathrm{ik}} < 1,\ t_{\mathrm{ik}} < 1\,\|\,{}^{\downarrow}\mathfrak{M}_{\mathrm{i}}\,{}^{\downarrow}\mathfrak{M}_{\mathrm{k}}\right\}, \tag{12}$$

we reveal all the companions of each galaxy dominating in the group. Finally if some galaxy turns out to be a companion of several more massive galaxies, then we choose from these combinations the "closest" case by the principle

$$\min\{t_{\mathrm{ik}}\}. \tag{13}$$

By our experience, this condition seems more attractive than the principle of minimum geometrical distance, $\min\{R_{\mathrm{ik}}\}$. The output of this four-stage procedure is a list of galaxies with one or many companions. Each of the galaxies may have a subsystem of companions of its own, i.e. the algorithm adopted admits the existence of multilayer structures. This will be illustrated by examples below.

Thus, in order to reveal groups of galaxies, we employ the algorithm in which the clustering parameters are not constant (as in Huchra and Geller, 1982), but depend on the individual properties of galaxies. The conditions for aggregation of galaxies (closed motions, $g_{\mathrm{ik}} < 1$, and the horizon of events, $t_{\mathrm{ik}} < 1$) do not contain parameters specified subjectively. We treat each group in a liner (planetary) approximation as a set of trial bodies orbiting round the primary most massive component. This allows us to estimate the mass of a group using a simple statistics of the projection factors for Keplerian orbits (Karachentsev, 1987). So, for the motion with the orbit eccentricity e we have the mean values

$$\langle g_{\mathrm{ik}}|e\rangle = (1 - 2e^2/3)\,3\pi/64, \tag{14}$$

$$\langle g_{\mathrm{ik}}^2|e\rangle = (1 - 5e^2/6)\,3/70.$$

In particular, at a strictly circular motion of the companions and in the absence of hidden mass in the system we obtain the following mean and median values:

$$\lg\langle g_{\mathrm{ik}}\rangle = -0.83, \quad \langle \lg g_{\mathrm{ik}}\rangle = -1.21, \quad \lg \hat{g}_{\mathrm{ik}} = -1.00. \tag{15}$$

The dependence of these quantities on the orbit eccentricity turns out to be not very steep (Figure 2). The comparison of the empirical means of g_{ik} for different groups of galaxies with the expected value from (15) allows to estimate the amount of dark matter in the group, if present at all.

3 APPLICATION OF THE CRITERION TO THE LOCAL VOLUME

In order to see the merits and disadvantages of the new approach, we have used our criterion to select groups of galaxies in the neighbourhood of the Milky Way. Following Kraan-Korteweg and Tammann (1979), we have restricted ourselves to a study of galaxies with radial velocities $V_0 < 500$ km/s. This decision is a reasonable compromise between the desire to have a sample of well studied objects and its sufficient representativeness. A summary of the data on the 215 nearby galaxies with $V_0 < 500$ km/s is presented in Table 1:

(1) – Name or number in the catalogues NGC, UGC (Nilson, 1973), PGC (Paturel *et al.*, 1989).

(2) – Equatorial coordinates for epoch 1950.0.

(3) – Equatorial coordinates for epoch 1950.0.

(4) – Angular diameter in minutes of arc measured along the major axis of a galaxy. The basic source is PGC.

(5) – Apparent axial ratio from PGC.

Table 1. Global parameters for the sample galaxies.

Name	R.A. (1950.0)	DEC	a arcmin	b/a	$m(B)$ mag	$A(B)$ mag	T	V km/s	W km/s	D Mpc
1	2	3	4	5	6	7	8	9	10	11
P 621	00 05 40.9	−34 51 24	1.1	0.82	15.5	.05	10	206	20	1.55
N 55	00 12 38.0	−39 29 54	30.1	0.20	8.4	.05	9	125	172	1.34
IC 10	00 17 41.4	59 00 52	6.4	0.83	11.8	3.65	10	−344	63	1.04
U 288	00 26 22.6	43 09 39	1.3	0.61	15.5	.34	10	187	45	–
N 147	00 30 27.4	48 13 56	13.0	0.61	10.6	.66	−5	−163	–	0.76
N 185	00 36 12.0	48 03 42	11.5	0.84	10.3	.71	−5	−211	–	0.76
N 205	00 37 38.7	41 24 44	19.5	0.59	8.9	.22	−5	−233	–	0.85
N 221	00 39 58.0	40 35 33	8.5	0.76	9.1	.26	−5	−203	–	0.76
M 31	00 40 00.3	40 59 43	189.1	0.33	4.3	.32	3	−300	510	0.77
P 2578	00 40 35.0	−22 31 27	2.1	0.38	14.4	.05	10	357	48	–
N 247	00 44 39.8	−21 01 58	21.0	0.27	9.6	.06	7	159	210	–
N 253	00 45 06.9	−25 33 54	26.4	0.23	8.0	.04	5	250	410	2.2
P 2902	00 47 21.0	−21 17 18	1.7	0.24	15.3	.04	10	300	23	–
SMC	00 51 00.0	−73 06 00	282.2	0.58	2.6	.17	10	151	90	.060
N 300	00 52 32.0	−37 57 12	21.7	0.72	8.8	.05	7	141	149	1.65
Sculptor	00 57 47.0	−33 58 42	40.0	0.76	9.2	.05	−5	109	–	.084
LGS–3	01 01 15.6	21 37 36	1.2	0.85	16.3	.14	10	−281	33	0.9
IC 1613	01 02 19.7	01 51 56	16.6	0.90	9.9	.03	10	−231	25	0.77
U 685	01 04 42.9	16 25 01	1.2	0.75	14.3	.11	10	155	72:	–
N 404	01 06 39.2	35 27 06	3.9	0.95	11.2	.21	−2	−49	–	–
M 33	01 31 01.6	30 24 15	68.7	0.61	6.2	.16	6	−180	184	0.84
N 625	01 32 54.9	−41 41 30	6.4	0.28	11.7	.05	9	386	–	–
P 6430	01 42 57.9	−43 50 54	3.6	0.86	12.7	.05	10	394	61	–
U 1281	01 46 39.2	32 20 40	4.5	0.18	12.9	.15	8	157	116	–
Phoenix	01 49 00.0	−44 42 00	4.7	0.83	13.1	.02	10	56	21	0.42
N 784	01 58 24.8	28 36 09	6.6	0.24	12.1	.20	8	198	96	–
Maffei–1	02 32 36.0	59 26 00	2.6	0.84	14.4	6.60	−5	15	–	2.1
P 9962	02 36 29.0	−61 33 24	7.2	0.14	13.3	.02	10	513	114	–
Fornax	02 37 50.4	−34 44 24	57.8	0.75	8.8	.05	−5	53	–	0.16
Maffei–2	02 38 07.9	59 23 24	3.8	0.49	16.0	8.20	4	−2	305	2.4
P 11139	02 55 23.9	−54 46 24	8.8	0.22	12.6	.00	7	578	124:	–
N 1156	02 56 46.7	25 02 21	3.3	0.85	12.3	.63	10	381	67	–
U 2684	03 17 34.2	17 06 54	1.8	0.50	15.2	.41	10	350	79	–
N 1313	03 17 39.0	−66 40 42	9.2	0.78	9.8	.05	7	456	156	–
N 1311	03 18 36.0	−52 22 00	3.0	0.27	13.4	.00	9	570	–	–
U 2716	03 21 17.0	17 34 40	1.6	0.56	15.0	.42	9	381	47	–
P 13163	03 31 42.0	−50 35 00	2.9	0.24	13.2	.00	5	639	–	–
N 1400	03 37 15.4	−18 50 56	2.5	0.84	11.9	.14	−2	558	–	–
IC 342	03 41 58.6	67 56 26	20.9	0.95	9.1	2.56	6	33	151	2.09
U 2905	03 54 10.0	16 22 50	0.9	0.67	15.5	.99	10	292	48	–
UGCA 86	03 55 00.0	66 59 00	4.5	0.68	14.2	3.78	9	67	99	1.86
N 1569	04 26 05.7	64 44 18	3.7	0.49	11.8	1.99	10	−89	74	1.84
N 1560	04 27 08.2	71 46 29	9.8	0.15	12.1	.58	7	−36	125	3.84
UGCA 92	04 27 24.0	63 30 24	2.0	0.48	15.0	3.99	10	−99	77	2.21
N 1705	04 53 06.0	−53 27 00	1.9	0.74	12.8	.16	−2	627	94	–
UGCA 105	05 09 35.9	62 31 00	5.5	0.62	12.4	1.36	10	111	118	3.31
U 3303	05 22 19.2	04 27 24	4.0	0.58	13.3	.64	10	521	163	–
LMC	05 24 00.0	−69 48 00	646.0	0.86	0.6	.28	9	260	65	.050
Orion	05 42 21.9	05 02 30	2.0	0.45	14.8	2.00	10	365	159	–

Table 1. Continued.

1	2	3	4	5	6	7	8	9	10	11
A0554+07	05 54 51.0	07 28 40	0.5	0.80	17.5	3.00	10	411	34	–
U 3476	06 27 10.0	33 20 26	1.0	0.30	15.6	1.91	10	469	70	–
P 19337	06 35 55.0	–25 57 18	1.7	0.82	13.7	.62	10	498	47	–
Carina	06 40 24.0	–50 55 00	23.3	0.66	7.8	.60	–5	240	–	.085
U 3600	06 52 11.9	39 09 18	1.4	0.32	15.1	.58	10	398	84	–
FG 202	07 04 30.0	–58 27 00	2.8	0.68	14.2	.37	10	554	78	–
U 3698	07 05 41.4	44 27 42	1.0	0.70	16.3	.41	10	426	50	–
N 2337	07 06 37.1	44 32 20	2.3	0.74	13.0	.38	10	434	144	–
U 3755	07 11 06.2	10 36 18	1.7	0.59	14.5	.67	10	317	37	–
U 3817	07 19 05.9	45 12 00	1.8	0.50	15.2	.34	10	437	43	–
N 2366	07 23 34.2	69 18 27	7.8	0.33	11.5	.16	10	99	96	3.45
U 3860	07 24 49.8	40 52 23	1.3	0.69	15.1	.22	10	353	38	–
P 21199	07 31 19.0	–68 04 41	2.0	0.95	13.7	.64	9	528	–	–
N 2403	07 32 05.4	65 42 40	23.4	0.51	8.9	.14	6	130	231	3.18
U 3966	07 38 00.9	40 13 47	1.8	0.94	14.4	.23	10	360	71	–
U 3974	07 39 02.9	16 55 07	3.1	0.94	14.0	.10	10	270	56	–
U 4115	07 54 13.6	14 31 17	1.8	0.55	14.1	.08	10	338	83	–
N 2537	08 09 43.0	46 08 33	1.8	0.83	12.3	.16	9	447	96	–
Ho–2	08 13 53.4	70 52 13	7.7	0.78	11.1	.09	10	157	66	3.60
K 52	08 18 43.0	71 11 25	1.3	0.95	16.5	.08	10	113	26	2.95
U 4426	08 25 06.9	42 01 13	2.0	0.50	15.1	.13	10	393	83	–
DDO 53	08 29 33.0	66 21 01	1.6	0.88	14.6	.11	10	19	–	3.5
U 4483	08 32 07.0	69 57 16	1.2	0.60	15.0	.09	10	156	49	3.63
N 2683	08 49 34.7	33 36 23	8.8	0.28	10.5	.07	3	409	425	–
F464–v3	09 00 03.0	20 16 24	0.87	0.77	15.9	.10	10	481	48	–
P 25827	09 07 32.0	–22 48 18	1.2	0.75	15.5	.75	10	724	76	–
N 2784	09 10 05.7	–23 57 56	5.7	0.44	11.3	.71	–2	691	–	–
F465–v1	09 16 38.4	21 48 54	0.67	0.87	16.2	.08	10	491	27	–
N 2915	09 26 30.9	–76 24 30	1.9	0.47	13.2	.55	10	460	135:	5.0
N 2903	09 29 19.8	21 43 19	12.0	0.47	9.6	.07	4	555	371	–
U 5086	09 29 58.8	21 41 01	1.0	0.82	15.4	.07	10	543	129	–
Ho–1	09 36 00.0	71 24 47	3.6	0.80	13.4	.08	10	136	26	6.66
N 2976	09 43 10.0	68 38 43	6.2	0.50	10.8	.14	5	3	97	4.57
U 5272	09 47 25.2	31 43 17	2.1	0.38	14.4	.03	10	519	82	–
KP 217	09 48 38.4	08 03 43	1.3	0.62	14.3	.03	10	556	93	–
BK3N	09 49 42.0	69 12 18	0.5	0.95	18.6	.17	10	–40	30	2.79
M 81	09 51 27.6	69 18 13	24.9	0.46	7.8	.17	2	–35	422	3.30
M 82	09 51 45.2	69 55 11	10.5	0.48	9.2	.15	10	202	147	–
Ho–9	09 53 27.9	69 16 53	3.5	0.82	14.1	.17	10	46	69	3.41
U 5340	09 53 52.0	29 03 47	2.7	0.33	14.7	.04	10	502	78	–
Leo A	09 56 29.0	30 59 07	5.1	0.61	13.0	.06	10	20	33	1.47
Sex B	09 57 22.8	05 34 22	5.1	0.68	11.9	.04	10	301	41	1.44
N 3077	09 59 21.8	68 58 33	5.2	0.90	10.6	.14	10	13	65	3.49
P 29086	10 00 05.9	–05 46 12	2.9	0.10	15.7	.07	7	661	130	–
N 3109	10 00 49.5	–25 55 04	19.7	0.17	10.4	.13	10	403	116	1.54
U 5423	10 01 25.0	70 36 27	0.9	0.67	15.2	.16	10	340	39	–
P 29194	10 01 47.0	–27 05 27	2.0	0.75	16.0	.13	10	361	21	–
U 5427	10 01 48.1	29 36 34	1.2	0.67	15.0	.03	10	495	78	–
N 3115	10 02 44.6	–07 28 31	7.3	0.47	10.1	.11	–2	658	238	–
P 29300	10 03 12.0	–07 44 00	1.5	0.79	13.2	.18	–2	715	–	–
U 5456	10 04 40.0	10 36 25	1.6	0.50	13.7	.04	10	535	61	–
Leo–1	10 05 46.2	12 33 12	9.9	0.76	11.1	.09	–5	168	–	0.23

Table 1. Continued.

1	2	3	4	5	6	7	8	9	10	11
Sex A	10 08 32.0	–04 27 45	5.7	0.82	11.7	.07	10	323	63	1.41
Sex–sph	10 10 30.0	–01 22 00	90.0	0.40	12.0	.04	–5	230	–	.087
IC 2574	10 24 41.2	68 40 18	12.9	0.41	10.8	.07	9	46	115	3.78
U 5672	10 25 36.0	22 50 00	1.8	0.28	14.7	00	3	531	82	–
DDO 82	10 26 47.0	70 52 33	2.8	0.68	13.5	.10	9	40	–	–
N 3274	10 29 29.5	27 55 40	2.0	0.55	13.2	.05	6	537	157	–
U 5889	10 44 43.4	14 20 07	2.0	0.95	14.3	.05	9	572	44	–
U 5918	10 46 17.0	65 47 40	2.4	0.95	15.2	.01	10	338	62	–
K 73	10 49 28.2	69 48 42	0.6	0.95	18.2	.05	10	115	30	4.04
Leo–2	11 10 49.8	22 26 06	12.0	0.91	12.6	00	–5	90	–	0.22
N 3621	11 15 51.0	–32 32 24	12.4	0.46	9.7	.37	7	726	266	–
7 Zw 403	11 24 35.9	79 16 00	1.5	0.53	14.7	.11	10	–93	49	2.5
U 6541	11 30 45.2	49 30 43	1.4	0.58	14.4	00	10	246	31	–
N 3738	11 33 04.4	54 47 58	2.6	0.85	12.1	00	10	228	78	–
U 6572	11 33 25.2	45 33 43	2.0	0.55	14.2	00	10	230	96	–
U 6782	11 46 20.9	24 07 00	2.0	0.95	15.1	.03	10	524	84	–
U 6817	11 48 16.8	39 09 31	4.1	0.39	13.6	00	10	245	37	–
N 4068	12 01 29.7	52 52 01	3.2	0.53	13.1	00	10	210	51	–
U 7131	12 06 35.9	31 11 00	1.2	0.32	15.5	.05	9	253	117	–
N 4144	12 07 28.2	46 44 07	6.1	0.41	12.0	00	6	267	150	–
N 4150	12 08 01.2	30 40 54	2.3	0.70	12.4	.05	–2	244	–	–
N 4163	12 09 37.5	36 26 51	1.9	0.84	14.0	00	10	163	30	–
P 39032	12 11 13.0	–37 57 12	1.4	0.43	15.2	.40	10	613	25	–
N 4190	12 11 13.5	36 54 40	1.7	0.94	13.4	00	10	230	46	–
K 90	12 12 27.0	36 29 47	1.7	0.72	15.2	00	10	283	36	–
N 4214	12 13 08.7	36 36 19	8.4	0.86	10.2	00	10	290	62	–
U 7298	12 14 00.6	52 30 18	1.0	0.46	15.0	.04	10	171	32	–
N 4236	12 14 21.7	69 44 36	22.6	0.30	10.1	.05	8	0	162	3.24
N 4244	12 14 59.8	38 05 06	15.9	0.11	10.7	00	6	243	204	–
U 7321	12 15 02.3	22 49 01	5.6	0.07	14.1	.09	6	409	210	–
P 39573	12 15 42.0	–79 26 48	3.7	0.46	13.6	.51	6	430	41	–
U 7356	12 16 36.0	47 22 00	0.9	0.89	15.1	00	10	272	86	–
U 7505	12 22 47.7	26 59 29	1.5	0.17	15.4	.05	8	316	128	–
N 4395	12 23 20.8	33 49 22	12.3	0.81	10.6	00	9	320	109	–
P 40665	12 23 50.5	48 46 07	0.8	0.75	14.9	00	10	281	46	–
U 7559	12 24 37.1	37 25 09	3.2	0.62	14.1	00	10	218	59	–
U 7577	12 25 15.4	43 46 13	4.3	0.56	12.9	00	10	195	28	–
N 4449	12 25 45.1	44 22 15	6.2	0.79	10.0	00	10	201	136	–
U 7599	12 26 00.8	37 30 35	2.0	0.50	14.9	00	9	277	66	–
U 7605	12 26 11.0	35 59 40	1.1	0.73	15.0	00	10	307	35	–
U 7639	12 27 28.4	47 48 22	2.3	0.70	14.5	00	10	381	40	–
U 7698	12 30 24.9	31 48 53	6.5	0.69	13.1	.02	10	332	53	–
P 42275	12 36 17.9	33 01 30	1.0	0.70	17.0	.03	10	307	24	–
N 4605	12 37 47.4	61 53 00	5.9	0.41	10.8	00	5	143	133	–
U 7866	12 39 50.8	38 46 33	3.4	0.88	13.7	00	10	358	46	–
P 43048	12 43 18.0	–33 33 54	2.9	0.38	14.2	.27	10	586	79	–
U 7949	12 44 35.9	36 45 00	2.0	0.75	15.2	.01	10	333	30	–
P 43501	12 48 20.3	–13 11 12	1.1	0.82	15.5	.15	10	346	204	–
N 4736	12 48 32.3	41 23 28	12.3	0.88	8.9	00	2	309	214	–
U 8024	12 51 39.3	27 25 28	2.6	0.65	13.9	.03	10	375	85	–
F575–v3	12 53 14.4	19 29 36	1.25	0.47	15.8	.03	10	419	23	–
N 4826	12 54 16.8	21 57 18	10.3	0.48	9.3	.14	2	408	304	–

Table 1. Continued.

1	2	3	4	5	6	7	8	9	10	11
GR–8	12 56 10.0	14 29 13	1.1	0.91	14.7	.04	10	213	30	1.05
N 4945	13 02 30.9	–49 12 12	19.8	0.20	9.3	.84	6	560	360	–
IC 4182	13 03 29.9	37 52 23	6.0	0.92	11.7	00	9	320	40	4.95
DDO 165	13 04 39.3	67 58 16	3.5	0.54	12.9	.03	10	36	44	4.88
U 8215	13 05 50.4	47 05 24	1.0	0.70	15.9	00	10	218	31	–
N 5023	13 09 57.9	44 18 13	5.8	0.14	12.8	00	5	407	179	–
U 8308	13 11 10.0	46 35 00	1.1	0.55	15.4	00	10	164	36	–
U 8320	13 12 16.6	46 11 01	3.7	0.38	12.9	.00	10	194	60	–
U 8331	13 13 20.3	47 45 37	2.7	0.33	14.6	00	10	259	50	–
N 5102	13 19 07.0	–36 22 06	8.6	0.31	10.5	.19	–2	467	196	–
N 5128	13 22 32.9	–42 45 24	27.0	0.73	7.6	.48	–2	561	527	3.6
P 47171	13 24 42.0	–41 13 18	3.1	0.74	12.9	.34	10	514	75	–
N 5204	13 27 43.8	58 40 32	5.0	0.60	11.7	00	9	203	110	–
U 8508	13 28 47.9	55 10 00	1.7	0.59	14.5	00	10	62	49	–
N 5206	13 30 41.0	–47 53 42	3.2	0.82	11.6	.58	–2	577	–	–
N 5229	13 31 58.5	48 10 16	3.3	0.15	14.4	00	5	363	127	–
N 5238	13 32 42.6	51 52 09	1.7	0.82	13.9	00	8	232	36	–
P 48029	13 33 42.0	–28 58 54	1.2	0.42	15.5	.18	10	570	21	–
N 5236	13 34 10.9	–29 36 48	13.1	0.93	8.0	.14	5	515	212	4.8
P 48111	13 34 32.0	–27 47 30	1.3	0.77	15.0	.21	10	587	60	–
N 5237	13 34 40.0	–42 35 36	2.2	0.68	13.3	.40	3	373	–	–
U 8638	13 36 59.0	25 01 34	1.2	0.67	14.7	00	10	274	34	–
N 5253	13 37 05.0	–31 23 30	4.6	0.37	11.0	.12	–3	403	79	3.8
P 48368	13 37 29.0	–28 38 30	1.6	0.62	15.0	.17	10	579	30	–
U 8651	13 37 44.1	40 59 32	2.4	0.54	14.9	00	10	202	43	–
N 5264	13 38 47.0	–29 39 42	2.6	0.58	12.6	.17	10	477	41	–
P 48738	13 41 57.0	–41 35 50	2.7	0.52	14.0	.29	10	540	66:	–
P 49050	13 46 23.0	–35 48 48	4.6	0.80	11.0	.20	10	329	32	–
U 8760	13 48 41.5	38 16 05	2.2	0.32	14.4	00	10	192	32	–
U 8833	13 52 36.0	36 05 00	0.9	0.89	15.7	00	10	228	30	–
U 8837	13 52 55.2	54 08 58	4.2	0.32	13.8	00	10	144	77	–
N 5408	14 00 18.0	–41 08 30	1.9	0.62	12.2	.24	10	508	68	–
M 101	14 01 26.6	54 35 25	28.5	0.95	8.2	00	6	241	143	–
N 5474	14 03 15.3	53 54 05	5.0	0.90	11.3	00	6	277	40	–
N 5477	14 03 47.9	54 42 00	1.6	0.81	14.3	00	9	304	52	–
P 50779	14 09 17.9	–65 06 18	7.0	0.43	11.0	4.08	3	437	296	–
DDO 187	14 13 37.9	23 17 07	1.7	0.76	14.4	.01	10	154	33	4.40
N 5585	14 18 12.8	56 57 32	5.8	0.62	11.2	.00	4	305	146	–
U 9240	14 22 48.7	44 45 06	1.8	0.95	13.3	00	10	152	45	–
P 51659	14 24 47.9	–46 05 20	2.4	0.38	15.0	.58	10	393	37	–
U 9405	14 33 56.0	57 28 26	2.3	0.57	14.4	00	10	222	85	–
P 52591	14 40 09.0	–44 29 36	1.5	0.40	14.8	.55	8	597	–	–
P 53639	14 57 42.0	–48 05 42	2.6	0.92	13.8	1.09	10	586	63	–
Ursa Min	15 08 34.8	67 24 12	30.1	0.63	12.8	.04	–5	–261	–	.091
P 54392	15 10 46.9	–46 37 36	10.9	0.15	12.0	1.0	7	522	177	–
P 57888	16 16 36.0	–60 22 00	3.3	0.33	12.2	1.34	10	606	–	–
Draco	17 19 12.6	57 57 30	35.8	0.70	11.7	.07	–5	–296	–	.076
P 60851	17 42 11.9	–64 37 18	2.9	0.55	11.7	.28	10	307	100:	–
N 6503	17 49 58.7	70 09 26	7.0	0.36	10.9	.14	6	43	173	–
Sagittar	19 27 05.4	–17 46 59	2.9	0.76	13.8	.50	10	–78	32	0.79
N 6822	19 42 08.0	–14 55 29	15.4	0.92	9.3	.69	10	–56	63	0.52
N 6946	20 33 48.8	59 58 50	11.2	0.87	9.7	1.63	6	51	169	–

Table 1. Continued.

1	2	3	4	5	6	7	8	9	10	11
DDO 210	20 44 08.0	−13 02 00	2.3	0.52	15.0	.14	10	−137	21	1.50
P 65603	20 47 21.9	−69 23 30	5.9	0.15	11.3	.15	7	590	182	–
IC 5152	21 59 25.9	−51 32 18	5.5	0.73	11.1	.00	10	121	91	1.5
P 71431	23 23 47.6	−32 39 57	1.5	0.87	13.9	.05	10	61	34	–
Pegasus	23 26 02.8	14 28 16	5.1	0.59	13.3	.09	10	−183	23	1.75
P 72228	23 41 09.0	−32 14 12	3.6	0.17	13.6	.05	9	267	93	–
P 72675	23 49 26.0	−52 51 41	2.2	0.18	15.0	.05	10	577	–	–
N 7793	23 55 15.0	−32 52 06	9.6	0.67	9.7	.05	8	229	174	–
WLM	23 59 23.1	−15 43 43	11.6	0.34	11.0	.07	10	−120	57	0.95
Milky Way	–	–	9999.	0.20	−4.0	.00	3	0	440	.010

Notes to Table 1.

PGC 621.	Revised modulus $\mu_0 = 26.0$ is taken from $\langle B(3) \rangle = 19.8$ mag and $M_{\rm B}(3) = -6.2$ (Laustsen *et al.*, 1977), and HI data from Cesarsky *et al.* (1977).
NGC 55.	From M-stars $\mu_0 = 25.66$ (Pritchet *et al.*, 1987).
IC 10.	Modulus and $A_{\rm B}$ from Karachentsev and Tikhonov, 1993 (KT, 93).
NGC 147.	Revised modulus from Richter *et al.*, 1987 (RTH, 87).
NGC 185.	Revised μ_0 from RTH, 87.
NGC 205.	Modulus from Cepheids (Saha *et al.*, 1992).
NGC 221.	Revised μ_0 from RTH, 87.
M 31.	Distance from Cepheids by Madore and Freedman, 1991 (MF, 91).
NGC 253.	Distance from Davidge *et al.*, 1991; Davidge and Pritchet, 1990.
SMC.	Distance from RTH, 87, rotation from Torres and Carranza, 1987.
NGC 300.	Modulus from Cepheids (Graham, 1984) and red supergiants (Humphreys and Graham, 1986).
Sculptor.	RTH, 87.
LGS-3.	RTH, 87.
IC 1613.	Distance from Cepheids (MF, 91).
M33.	Modulus from Cepheids (MF, 91).
Phoenix.	Distance from van der Rydt *et al.*, 1991, HI data from Carignan *et al.*, 1991.
Maffei-1.	Distance and $A_{\rm B}$ according to Buta and McCall, 1983.
Fornax.	RTH, 87.
Maffei-2.	Revised modulus from Bottinelli *et al.*, 1971.
IC 342.	KT, 93.
UGCA 86.	KT, 93.
NGC 1569.	Distance from Karachentsev *et al.*, 1994, according to Waller, 1991, $D =$ 2.2 Mpc.
NGC 1560.	Modulus from Karachentsev *et al.*, 1991 (KTGBS, 91).
UGCA 92.	Preliminary estimate of distance by Karachentsev *et al.*, 1994.
NGC 1705.	HI data from Meurer *et al.*, 1992.
UGCA 105.	Distance from Tikhonov *et al.*, 1992 (TKBS, 92).
LMC.	Distance from RTH, 87, rotation from de Vaucouleurs and Freeman, 1972.
A0554+07.	HI data from Giovanelli and Haynes, 1982.
Carina.	RTH, 87.
NGC 2366.	Distance from Tikhonov *et al.*, 1991 (TBKG, 91).
NGC 2403.	Modulus from Cepheids (MF, 91).
Ho-2.	Distance from (TKBS, 92), detailed HI and H_α mapping by Puche *et al.*, 1992.
K52.	Distance from Tikhonov and Karachentsev, 1993 (TK, 93).
DDO 53.	Preliminary distance estimate by Karachentsev *et al.*, 1993.
UGC 4483.	Distance and photometry from (TK, 93).
F464-V3.	HI data from Schombert *et al.*, 1992 (SBSM, 92).
F465-V1.	SBSM, 92.

NGC 2915.	Distance from Mackie and Meurer, 1992.
Ho-1.	TKBS, 92.
NGC 2976.	KTGBS, 91.
BK3N.	Photometry and distance from (TK, 93).
M81.	Distance from Cepheids (MF, 91).
Ho-9.	Modulus from Georgiev *et al.*, 1991.
Leo A.	Revised distance from Sandage, 1986a.
Sextans B.	Distance from Cepheids (MF, 91).
NGC 3077.	Distance from Sharina, 1991.
NGC 3109.	Distance from Cepheids (MF, 91).
Leo-1.	Distance from brightest stars (Reid, Mould, 1991; Fox, Pritchet, 1987).
Sextans A.	Modulus from Cepheids (MF, 91), photometry of stellar population by Walker, 1987.
Sex sph.	Distance from Irwin *et al.*, 1990, Mateo *et al.*, 1991, velocity from da Costa, 1991.
IC 2574.	TBKG, 91.
K 73.	Photometry and distance from (TK, 93).
Leo-2.	RTH, 87.
7 Zw 403.	Preliminary distance estimate by Karachentsev *et al.*, 1993.
UGC 6572.	HI data from Haynes and Giovanelli, 1991.
NGC 4236.	Modulus from (TBKG, 91).
F575-v3.	SBSM, 92.
GR-8.	Distance from Apparicio *et al.*, 1988 and Carignan *et al.*, 1990.
IC 4182.	Distance from Sandage and Tammann, 1982.
DDO 165.	KTGBS, 91.
NGC 5128.	Distance from planetary nebulae (Jacoby *et al.*, 1990).
NGC 5236.	Distance from SN (Schmidt *et al.*, 1993).
NGC 5253.	Modulus from planetary nebulae (Phillips *et al.*, 1992).
M 101.	According to (MF, 91), distance is 7.5 Mpc.
DDO 187.	Distance from Apparicio *et al.*, 1988.
P 52591.	Optical velocity from Dressler, 1991.
Ursa Min.	RTH, 87.
Draco.	RTH, 87.
Sagittar.	Distance from revised data by Cesarsky *et al.*, 1977.
NGC 6822.	Distance from Cepheids (MF, 91).
DDO 210.	Distance 1.5 Mpc (RTH, 87) is unreliable, photometry of stellar population by Marconi *et al.*, 1990.
IC 5152.	Unreliable distance 1.5 Mpc (RTH, 87).
Pegasus.	Distance from Cepheids (Hoessel *et al.*, 1990), photometry from Sandage, 1986a.
WLM.	Distance from Cepheids (Sandage, Carlson, 1985).
Milky Way.	$A = 21$ Kpc and $\log(L/L_{\odot}) = 10.1$ adopted.

(6) – Apparent magnitude in the B-band according to PGC. In a number of cases the magnitudes and diameters of galaxies were specified from other sources (Karachentseva and Sharina, 1987).

(7) – The amount of interstellar light absorption in our Galaxy in the object direction according to Burstein and Heiles (1984).

(8) – Morphological type from Tully's (1988) catalogue. In some cases of the absence of the catalogued data on types and angular diameters of galaxies, we added our own estimates on the POSS prints and ESO survey films to make up for the deficiency.

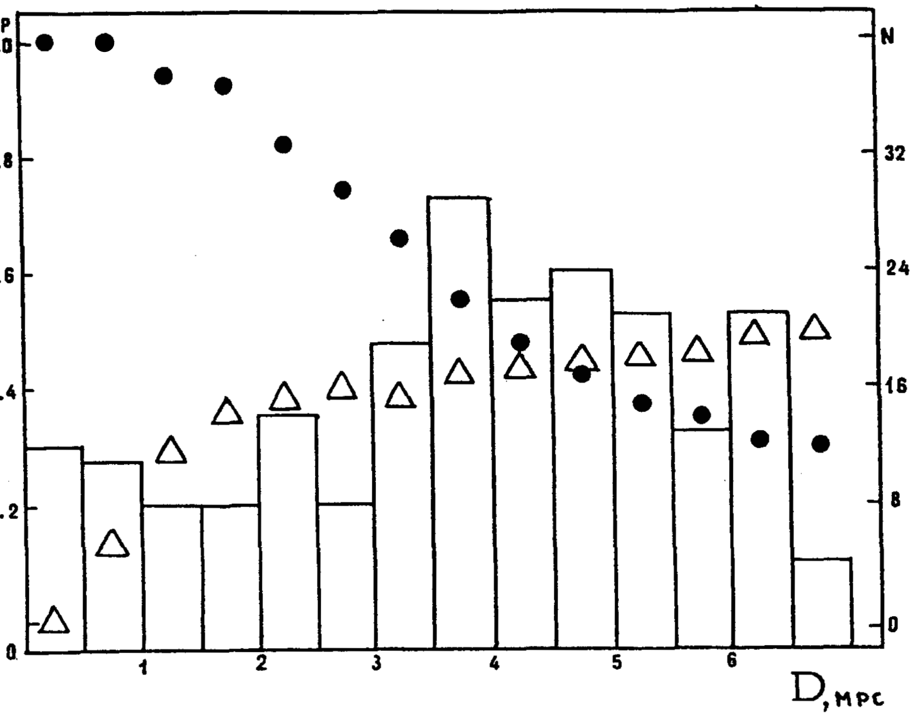

Figure 3 Distribution of the number of galaxies versus their distance in Mpc (the histogram and the right-hand scale). Filled circles represent the relative number of galaxies having photometric distance estimates. Triangles indicate the relative number of single unclusterized galaxies as a function of depth in Mpc.

(9) – Measured radial velocity in km/s.

(10) – The profile width of the 21-cm line at the level 50% of the maximum value. As a principal source of data on V_h and W_{50}, we have used the reference list by Bottinelli *et al.* (1990) supplemented from Schneider *et al.* (1990), Fouque *et al.* (1990) and Huchtmeier and Richter (1989). Colon marks some indirect estimates, $W_{50} = W_{20} - 18$.

(11) – Distance estimate (in Mpc) from the photometry of cepheids or brightest stars. The sources of data on D are indicated in the notes to the table.

Making up this summary we have excluded several curious cases: P 4095 with $V_h = -325$ km/s and $W_{20} = 58$, since it is not a galaxy, but a blank area near LGS-3; UGC 4740 = P 25374 which has V_h not 31 km/s (Bottinelli *et al.*, 1990), but +3144 km/s; P 64622 is not a galaxy, but a cometary nebula, which is corroborated by the object structure on our CCD-frame; P 71145 with $V_h = 16$ km/s, whose actual velocity is +1600 km/s (Longmore, 1992). Following Kraan-Korteweg and Tammann (1979), we disregarded the galaxies with $V_0 < 500$ km/s in the direction of the Virgo cluster. Neither are represented in our sample the nearby dwarf galaxies

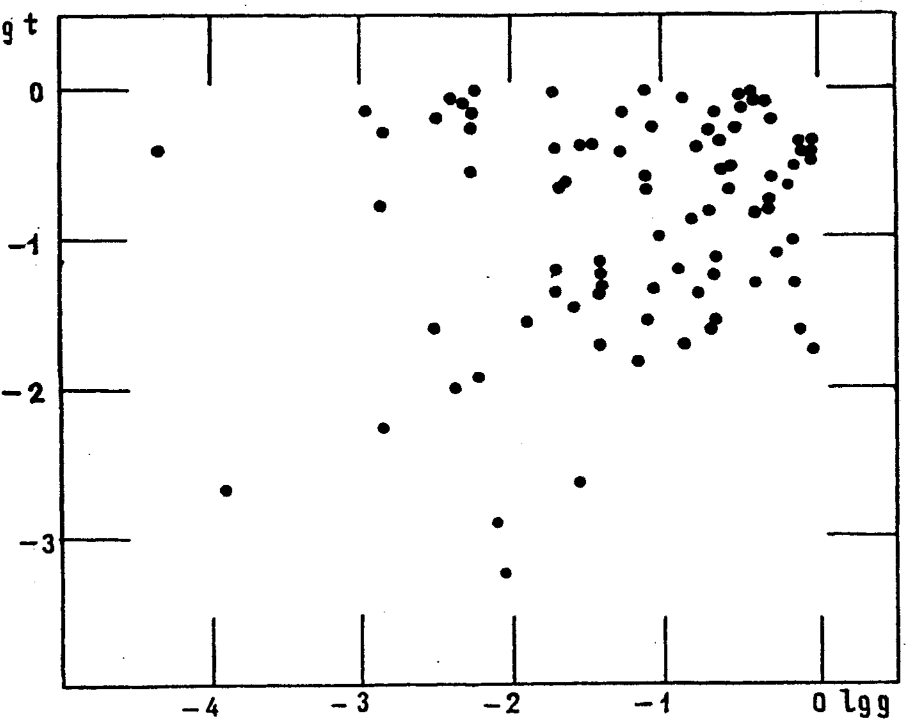

Figure 4 Distribution of pairs "companion-primary member" according to g and t factors defined in (10) and (11).

of the Andromeda 1, 2, 3, (Caldwell *et al.*, 1992; Mould and Kristian, 1990), Tucana (Lavery and Mighell, 1992), Arp 211 and some others, since the radial velocity estimates for them are lacking yet. This is one of the reasons of the difference between the list of nearby galaxies issued by Schmidt and Boller (1992) and our list.

The distance distribution, $D = V_0/75$, of the number of galaxies of this sample is represented by histogram in Figure 3. The character of the distribution shows that the sample is not complete in the outer parts of the volume. From our estimates there exist about (70–120) nearby galaxies with angular diameters of 0.4–1.0 arcminutes and distances 4–6.7 Mpc, which were left out in the published catalogues. For example we point out two galaxies of low surface brightness, $04^h19^m\!.4$ $+72°42'$ with $a = 4.5$ arcmin and $09^h46^m\!.2$ $+67°45'$ with $a = 2.4$ arcmin which are located near NGC 1560 and NGC 2976 and are previously unknown. A search for such objects is a separate task.

Table 2. Properties of bound systems of galaxies.

a) Milky Way, $\log \mathfrak{M} = 11.39$, $n = 9$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
LMC	12	1.70	-2.49	-1.61	10.41
Fornax	51	2.20	-0.71	-0.83	8.43
Leo-1	26	2.36	-1.11	-0.60	7.84
Sculptor	75	1.92	-0.65	-1.25	7.71
Leo-2	15	2.34	-1.62	-0.62	7.13
Phoenix	52	2.62	-0.28	-0.20	7.12
Sex-sph	31	1.94	-1.39	-1.23	6.75
Draco	50	1.88	-1.05	-1.32	6.65
Ursa Min.	56	1.96	-0.88	-1.20	6.37
Average	41	2.10	-1.13	-0.98	7.60

b) M 81, $\log \mathfrak{M} = 11.44$, $n = 9$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
M82	239	1.63	-0.02	-1.74	10.31
I 2574	80	2.28	-0.31	-0.76	10.05
N 3077	47	1.66	-1.39	-1.69	9.99
N 2976	33	1.98	-1.39	-1.20	9.73
DDO 82	84	2.24	-0.29	-0.81	8.63
Ho-9	81	1.01	-1.55	-2.65	8.61
DDO 53	41	2.69	-0.48	-0.13	8.38
7 Zw 403	9	2.77	-1.71	-0.01	8.28
BK3N	5	0.99	-3.90	-2.68	6.57
Average	69	1.92	-1.23	-1.30	8.95

c) M 31, $\log \mathfrak{M} = 11.79$, $n = 8$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
Milky Way	62	2.89	-0.41	-0.08	11.39
M 33	66	2.32	-0.79	-0.88	10.69
N 205	69	0.94	-2.11	-2.92	9.96
IC 10	20	2.46	-1.64	-0.65	9.88
N 221	97	0.73	-2.03	-3.25	9.74
N 185	100	1.98	-0.75	-1.37	9.42
IC 1613	57	2.72	-0.51	-0.26	8.91
LGS-3	38	2.46	-1.10	-0.65	6.54
Average	64	2.06	-1.17	-1.26	9.57

d) NGC 5128, $\log \mathfrak{M} = 12.01$, $n = 8$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
N 5236	9	2.99	−2.16	−0.02	11.47
N 4945	20	2.70	−1.66	−0.43	11.22
N 5206	12	2.59	−2.20	−0.57	10.38
N 5102	83	2.60	−0.51	−0.55	10.25
P 47171	43	2.02	−1.65	−1.41	9.42
P 48738	8	2.43	−2.79	−0.80	9.06
N 5408	28	2.69	−1.39	−0.41	8.99
N 5237	181	2.06	−0.37	−1.36	8.90
Average	48	2.51	−1.59	−0.69	9.96

e) M 101, $\log \mathfrak{M} = 11.37$, $n = 7$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
N 5585	78	2.52	−0.02	−0.36	10.28
N 5474	34	1.85	−1.41	−1.37	10.21
N 5204	40	2.72	−0.39	−0.05	9.83
U 9405	4	2.69	−2.30	−0.10	9.29
U 8837	102	2.02	−0.26	−1.10	9.15
N 5477	64	1.53	−1.16	−1.83	8.99
N 5238	32	2.65	−0.65	−0.16	8.98
Average	51	2.29	−0.88	−0.71	9.53

f) NGC 5236, $\log \mathfrak{M} = 11.47$, $n = 5$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
N 5253	115	2.15	−0.14	−0.95	9.25
P 48111	77	2.21	−0.42	−0.86	9.02
N 5264	35	1.89	−1.44	−1.35	8.61
P 48368	68	2.03	−0.70	−1.13	8.30
P 48029	57	1.75	−1.16	−1.56	7.69
Average	70	2.01	−0.77	−1.17	8.57

g) IC 342, $\log \mathfrak{M} = 11.24$, $n = 4$.

Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_k$
Maffei-1	5	2.62	−2.26	−0.24	11.02
UA 105	33	2.70	−0.45	−0.03	9.92
N 1560	75	2.45	−0.01	−0.40	9.89
UA 86	27	1.73	−1.57	−1.47	9.72
Average	35	2.38	−1.07	−0.54	10.14

h) Quartets.

Main	Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_1$	$\log \mathfrak{M}_k$
N 4736	IC 4182	4	2.59	−2.23	−0.15	11.17	9.83
	U 7866	33	2.45	−0.63	−0.36		9.07
	U 7949	2	2.61	−2.95	−0.12		8.51
N 4244	N 4214	40	2.02	−0.38	−0.74	10.42	10.25
	U 7559	24	2.08	−0.56	−0.53		8.96
	U 7599	36	2.18	−0.05	−0.39		8.85
N 4214	N 4395	22	2.42	−0.33	−0.08	10.25	10.20
	N 4190	59	1.51	−0.14	−1.31		8.77
	K 90	7	1.05	−2.36	−1.99		8.47
N 4395	U 7698	6	2.29	−1.24	−0.14	10.20	9.40
	U 7605	2	2.24	−2.48	−0.18		8.31
	P 42275	10	2.33	−0.86	−0.05		7.89
	Average	20	2.15	−1.18	−0.50	10.51	9.04

i) Triplets.

Main	Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_1$	$\log \mathfrak{M}_k$
N 2903	U 5086	13	1.23	−2.82	−2.24	11.28	8.51
	F 465-v1	64	2.46	−0.13	−0.39		8.07
N 253	N 247	70	2.27	−0.18	−0.64	11.12	10.52
	P 2902	67	2.39	−0.00	−0.41		7.73
N 2403	N 2366	14	2.33	−1.25	−0.42	10.91	9.59
	K 52	2	2.57	−2.37	−0.04		7.45
N 3115	P 29300	56	1.49	−0.68	−1.58	10.66	9.88
	P 29086	9	2.27	−1.49	−0.38		9.50
LMC	SMC	41	1.30	−0.85	−1.73	10.41	9.51
	Carina	46	1.39	−0.64	−1.56		8.53
	Average	38	1.97	−1.04	−0.94	10.88	8.93

j) Double.

Main	Companion	Y	$\log R$	$\log g$	$\log t$	$\log \mathfrak{M}_l$	$\log \mathfrak{M}_k$
Maffei-1	Maffei-2	20	1.44	-2.20	-1.93	11.02	10.95
N 4826	F575-v3	0	2.35	-4.35	-0.41	10.98	7.81
N 2784	P 25827	36	2.12	-0.56	-0.68	10.83	9.25
N 300	N 55	1	2.32	-2.82	-0.28	10.42	10.19
N 7793	P 621	37	2.08	-0.12	-0.53	10.41	7.31
N 4449	U 7577	8	1.57	-1.71	-1.22	10.24	8.40
N 2337	U 3698	8	1.29	-1.91	-1.54	10.05	8.71
N 4144	U 7356	11	2.12	-0.70	-0.27	10.01	8.37
N 625	P 6430	7	2.19	-1.07	-0.00	9.91	9.22
Ho-2	U 4483	7	2.04	-1.04	-0.24	9.70	8.41
N 4150	U 7131	11	1.51	-1.00	-0.99	9.53	8.91
N 185	N 147	51	1.11	-0.10	-1.62	9.42	9.35
UA 92	N 1569	14	1.65	-0.35	-0.64	9.06	9.04
Average		16	1.84	-1.37	-0.79	10.13	8.92

Figure 3 (filled circles) also shows that the relative number of galaxies with direct distance estimates drops rapidly toward the boundary of the volume under consideration. Within 4 Mpc only half of the galaxies have photometrical module, and at $D < 6.7$ Mpc their relative number is as small as 1/3. Such galaxies are especially scanty in the southern sky.

Applying conditions (10)–(13) we have selected all galaxies having one or several companions. The results of clustering are listed in Table 2, where the main components with their companions are arranged in the decreasing order of the multiplicity of the system. The companions that have companions of their own are underlined. The table columns contain: radial velocity difference (in km/s), linear projected separation (in Kpc), dimensionless parameters g and t, and the mass of the companion in solar masses, respectively. The total distribution of the group members on the $\{\lg g,\ \lg t\}$ plane is demonstrated in Figure 4. The triangles in Figure 3 indicate the relative number of unclusterized, single galaxies. It rises smoothly from zero at $D < 0.5$ Mpc to 50% for the whole volume considered. A steeper rise near the outer boundary is caused, evidently, by the fact that the part of companions in the boundary groups is cut off by the condition $V_0 < 500$ km/s. If one considered the relative number of grouped galaxies as a certain indicator of the criterion efficiency, then the criterion that we propose has approximately the same efficiency as other criteria mentioned above.

Let us examine in more detail the properties of the selected groups of galaxies.

4 SCENERY VIEWING

The character of clustering of galaxies does not allow to depict in one drawing the small and large details of the structure of the Local volume. Therefore, we represent

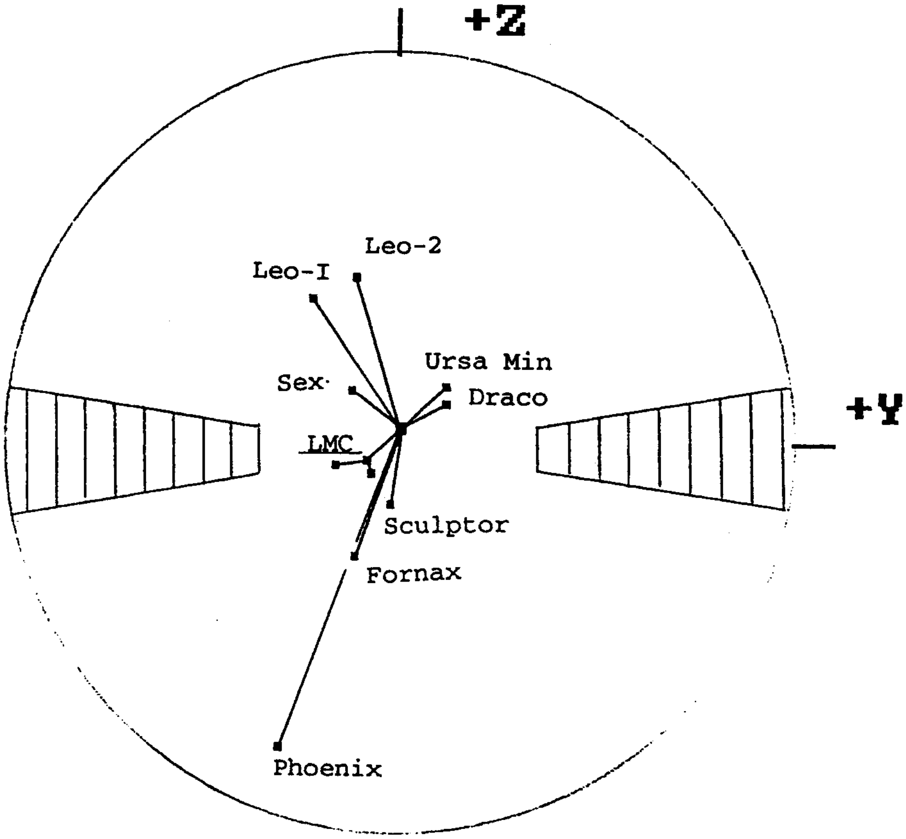

Figure 5 Distribution of galaxies in a sphere of radius $D = 0.5$ Mpc around the Milky Way. Z and Y are the Cartesian galactic coordinates. The region of maximum interstellar light absorption is shaded. The companions satisfying the criterion are linked with the primary by lines. Here and hereafter, names of the galaxies are given in an abbreviated form, full names are in Table 1.

maps of the distribution of nearby galaxies in the spheres with radii: 0.5, 1.2, 3.0 and 6.7 Mpc in Figures 5–8, respectively. The volume distributions are projected onto the Z, Y plane in galactic coordinates. The "zone of avoidance" due to the interstellar light absorption is located along the Y axis.

Figure 5 shows that the Small Magellanic Cloud and the dwarf spheroidal galaxy Carina are linked by gravitation with the Large Magellanic Cloud which, together with other eight galaxies, form the Local group. According to our criterion, there are no other "strange" galaxies inside a sphere of 0.5 Mpc radius and outside of this volume there are no other members of the Local group. As was noted by Mathewson (1985) and Haud (1988), all these dwarf companions, as well as high-velocity HI clouds are located in a plane crossing the poles of our Galaxy. It is called the Magellanic stream.

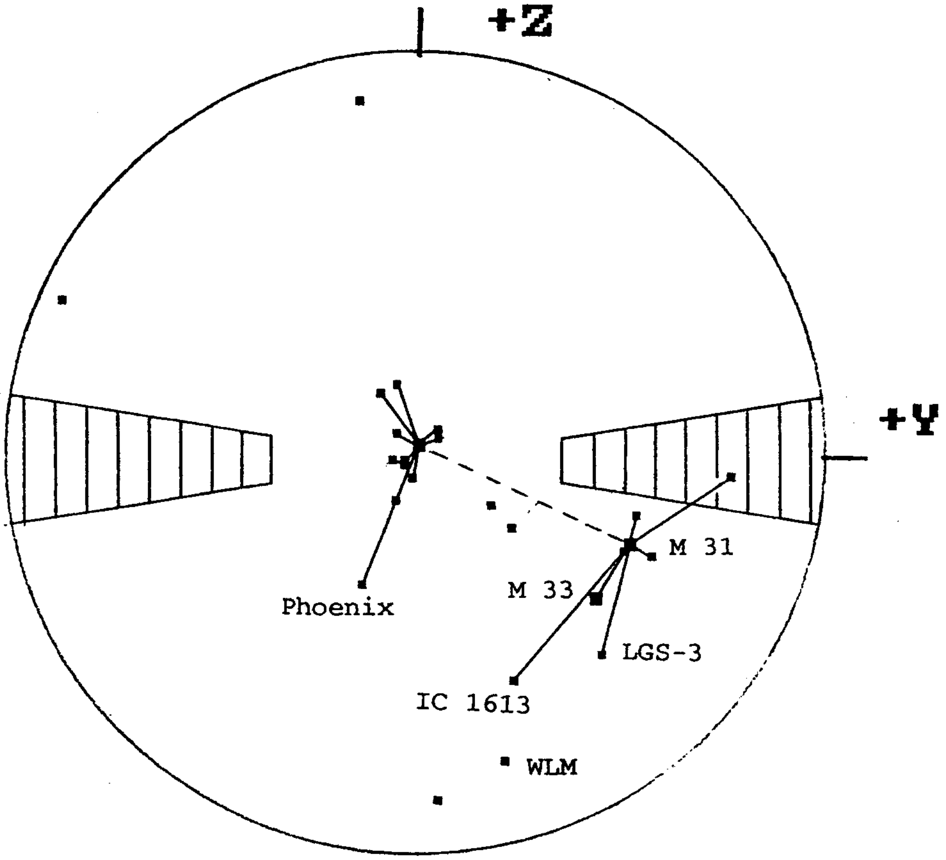

Figure 6 Distribution of neighbours in a sphere of radius 1.2 Mpc around our Galaxy in the same projection as in Figure 5.

Passing to the scale of 1.2 Mpc, we see a group of galaxies around M31 with a subsystem-pair of dwarf objects NGC 185 + NGC 147. Our Galaxy must rank among the M31 companions too. In this sense the Local group and the M31 group form the Local System of galaxies having three levels of hierarchy. Some galaxies, e.g. NGC 6822 and GR8, remain single objects by the criterion.

On a scale of 3 Mpc, the criterion finds companions of IC 342 and NGC 300 and in the whole volume being considered reveals the known groups M 81, NGC 5128 + NGC 5236 (Centaurus), NGC 4244 + NGC 4736 (Canes Venatici) and M 101. In Figures 7 and 8 the boundaries of these groups are marked with dashed lines. A remarkable feature of the distribution of nearby galaxies is also the presence of blank areas of different sizes. The nearest "hole" 1.5 Mpc in diameter separates the Local group and the M81 group. These voids are better visible in Figure 9, where the galaxies being far away from the supergalactic plane (|SGZ| > 1 Mpc) are excluded.

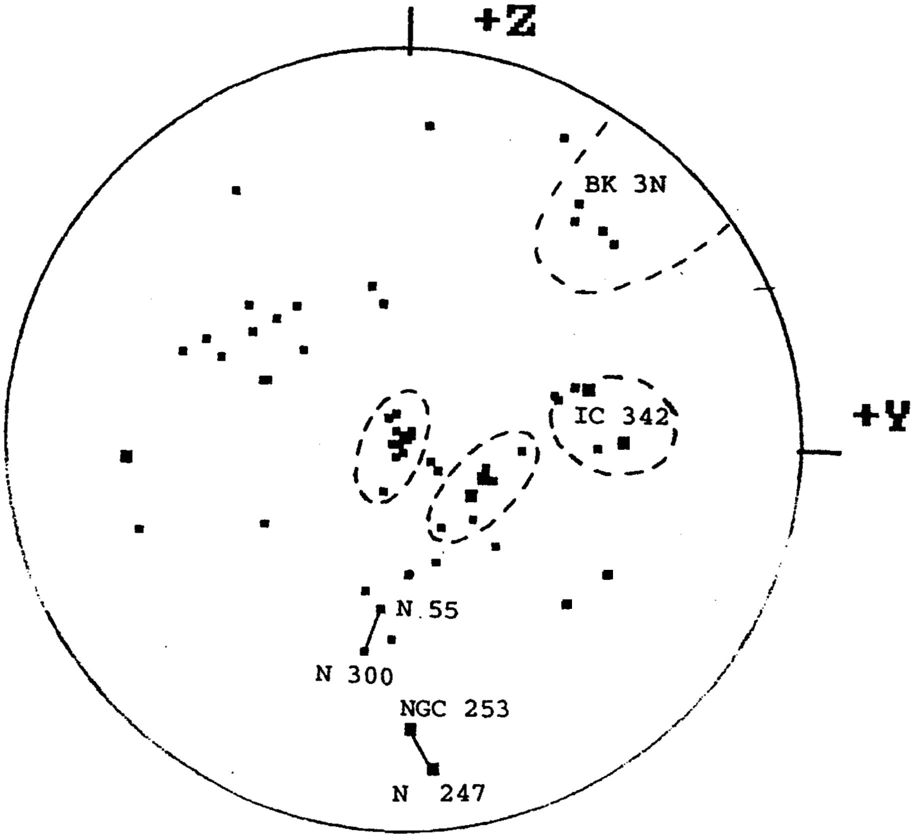

Figure 7 Distribution of galaxies in a sphere of 3 Mpc in radius. The groups found by the criterion are surrounded with lines.

The structure of the groups can be depicted in different ways. For several most populated groups, a cosubordination of galaxies is presented in Figures 10–13. Vertically, the galaxies are ranked in accordance with masses, whereas their horizontal arrangement is arbitrary. We have attempted to show the "strength" of the coupling for each companion with dashed and solid lines. The latter correspond to the case when the conditions $g_{ik} < 1$ are satisfied even at $\kappa = 1$, i.e. at $\mathfrak{M} = \mathfrak{M}_{25}$. Since the knowledge of the distances and masses of some galaxies is not very accurate yet, such a marking allows to estimate roughly the architecture stability of a group with respect to the effect of projection or errors of observational data. So, among the Milky Way companions only Phoenix is located near the threshold of the validity of the criterion. In the M 31 group, the transition $\kappa = 2 \rightarrow 1$ excludes our Galaxy alone from the companions. In other groups the situation changes more radically.

Inspection of the data in Figs. 10–13 and Table 2 shows that the initial assumption concerning the "planetary system" model is warranted almost for all the groups

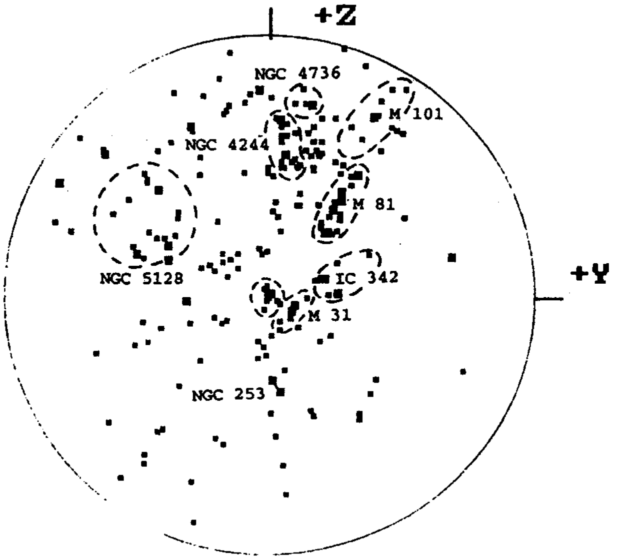

Figure 8 Distribution of galaxies of the Local volume with $D < 6.7$ Mpc in the Cartesian galactic coordinates Z, Y. The objects with a diameter larger than 10 kpc are shown by large symbols. Bound groups are surrounded with lines.

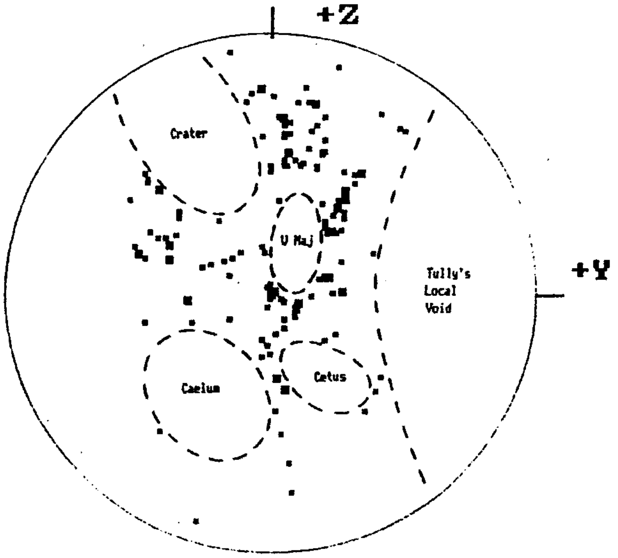

Figure 9 The same distribution, but without the galaxies |SGZ| > 1 Mpc apart from the supergalactic plane. The Local Void from Tully (1987) and some other void regions are marked.

selected by the criterion. Typical is the situation when more than 2/3 of the total mass of a group is concentrated in its primary component. A different peculiarity is characteristic of the group NGC 4244: three largest members differ in mass less than 2 times. The hierarchy of links in this group (see Figure 13) looks rather complex, and also the kinematics of its members is, apparently, far from being Keplerian. It should be noticed, however, that none of the galaxies in the group NGC 4244 has direct distance estimates so far. Future measurements of distance moduli may introduce significant corrections into the structure and content of this system.

5 THE DARK MATTER PROBLEM

Table 2 presents the mean values of the basic dynamical parameters for each group. The difference in these parameters between the groups turns out to be rather large. Attention is drawn by the small amplitude of mutual motions in all the groups. The velocity difference for them is $\langle Y_{\rm ik}\rangle = 42$ km/s on the average, and in some systems it is comparable with the radial velocity measurement errors.

Table 3. Mean parameters of the bound groups.

Group	$n+1$	$n_{\rm D}$	$\mathfrak{M}_1/\sum_{k>1}\mathfrak{M}_k$	$\langle\log R_{\rm ik}\rangle$	Mass excess by average	Mass excess by median
Milky Way	10	10	9.6	2.10[†]	−0.02[†]	−0.05[†]
M 81	10	8	5.8	1.92	−0.02	−0.39
M 31	9	9	2.0[††]	2.06	+0.04	+0.05
NGC 5128	9	1	2.0[††]	2.51	−0.38	−0.65
M 101	8	0	4.9	2.29	+0.33	+0.35
NGC 5236	6	2	84.8	2.01	+0.44	+0.30
IC 342	5	5	1.3	2.38	+0.14	−0.01
Quartets	16	1	–	2.15	+0.03	+0.26
Triplets	15	7	–	1.97	+0.17	+0.26
Double	26	11	–	1.84	−0.16	−0.04

[†] The mean projection factor differs by $(4/\pi)$ from the rest groups.
[††] Without companions of companions.

Table 3 contains the data which allow to judge of the dynamical situation in the selected groups. The first column indicates the name of the principal member of each group. The second and third columns present the total population of a system and the number of its members having direct distance estimates. The fourth column gives the mass ratio of the major component to the rest of the group galaxies. Here we have not taken into account the mass of the companions' satellites. The mean geometrical radius of a group is presented in the fifth column. The last two columns indicate the mass excess for a system on the logarithmic scale. These estimates have been made from both the mean value of the logarithm and the median of $g_{\rm ik}$ with

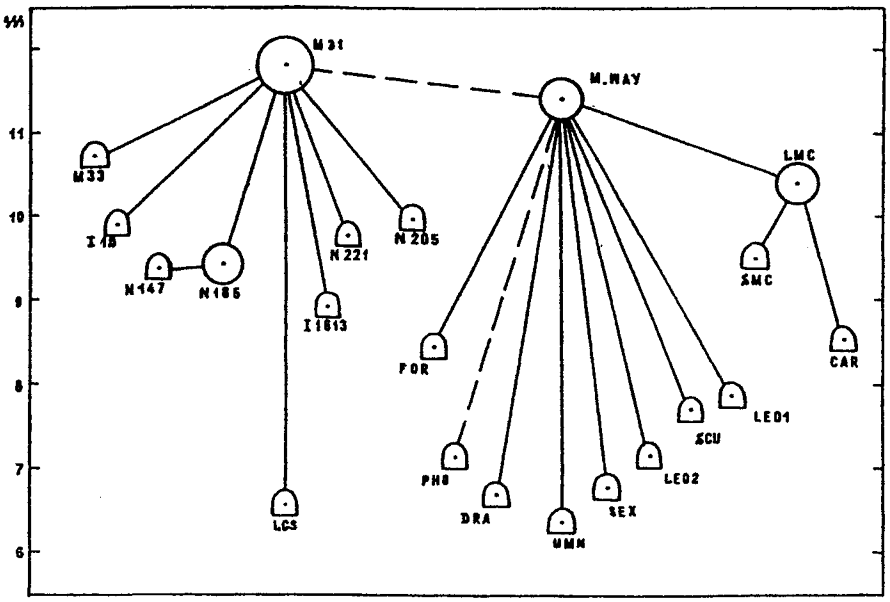

Figure 10 The structure of the Local System consisting of the M31 group and the group of companions of the Milky Way (the Local group). The vertical scale is the mass of galaxies in solar masses. The location of the galaxies along the horizontal axis is arbitrary. The solid lines link the primary with those companions, for which conditions (10) and (11) of the criteria are fulfilled even in the absence of dark halos ($\kappa = 1$).

respect to the values of (15) expected at circular motions of galaxies. In the last lines of Table 3 the finest system – quartets, triplets and pairs – are united.

As follows from these data, the mass excess is a weak function of the way it is estimated. For the whole sample of companions the mass excess is $\langle \mathfrak{M}E \rangle = dex\,(+0.03)$ when estimated from the mean and $dex\,(-0.05)$ if the median is used. Variations of $\mathfrak{M}E$ from group to group are somewhat higher than expected because of the projection factor. Note that the mass excess correlates neither with the group population nor with the mass concentration index, $\mathfrak{M}_1/\sum_{k>1}\mathfrak{M}_k$. The negative values of $\mathfrak{M}E$ may suggest that in some groups non-circular motions are dominating.

It should be noted that, according to (14) and Figure 2, the mean value of $\langle g_{ik} \rangle$ and therefore the mass excess depend on the assumption of the dominant type of motions in a group. In the extreme case of purely radial orbits for all the galaxies, the $\mathfrak{M}E$ estimate should be increased by a factor of 3 as compared to circular motions. We have no direct arguments which would allow this or that type of orbital motions to be preferred. Therefore the mean mass excess value in the systems being considered remains undetermined within the limits from $dex\,(+0.03)$ to $dex\,(+0.51)$.

If the volume between the members of a group is filled with a considerable quantity of dark matter, one should expect the mass excess to increase when passing

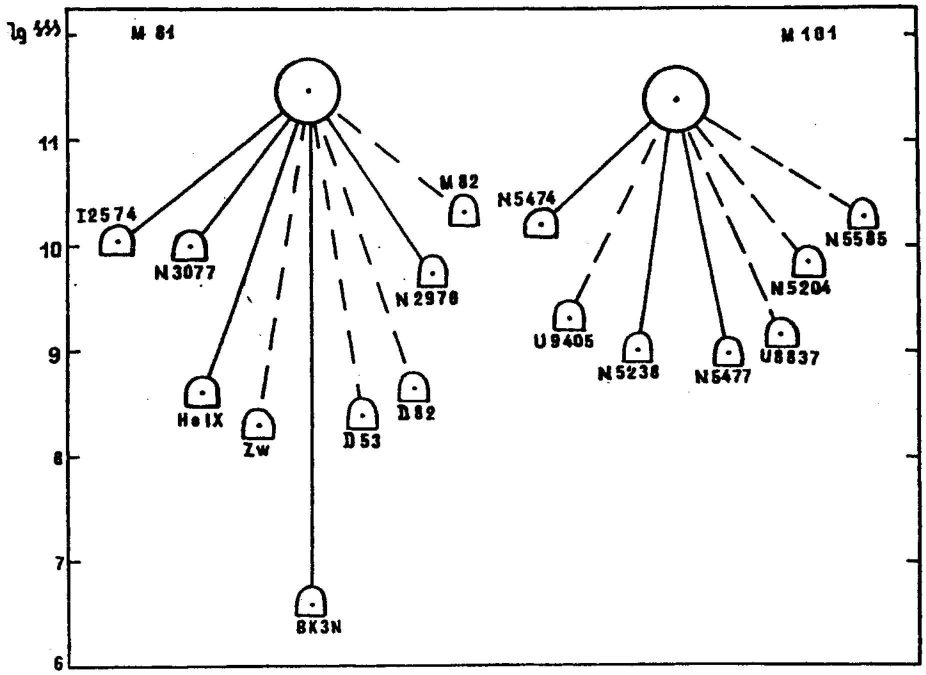

Figure 11 The structure of the groups of M81 and M101.

from compact systems to open ones. Such a dependence, namely $\mathfrak{M}_{\text{vir}}/L \propto R^{1/2}$, was noted by Tully (1987) and other authors. In our groups of galaxies, however, things are different. On the scale from 80 to 250 kpc the data of Table 3 do not give indications of increasing $\mathfrak{M}E$ with the group size. Therefore we prefer the case where the whole mass of a group is concentrated in its galaxies moving along the orbits close to circular ones. Then the afore mentioned small mass excess, about 20% at $e < 0.5$ on the average, may be ascribed to radial velocity measurement errors and/or to the presence of some number of spurious companions caused by projection.

Table 3 demonstrates the scarcity of up-to date information on distances even for the nearest groups. But for the Local system, only in the groups M81 and IC 342 the individual distances have been measured for almost all the galaxies. In this sense the groups Centaurus, Canes Venatici and M101 remain practically uninvestigated. It is in these systems that the mass excess variations turn out to be maximum, which is, probably, due to the unreliable determination of distance (and mass) for nearby galaxies via their radial velocities.

So, if one restricts himself to a consideration of three most populated and carefully studied groups, the Milky Way, M31 and M81, then the dynamical situation in them looks fully uniform: galaxies with masses $\mathfrak{M}_{25}$ and mini-halo ($\mathfrak{M}_{\text{H}} \simeq \mathfrak{M}_{25}$) travel around the main group member in an almost empty space ($\mathfrak{M}_{\text{DM}} \cong 0$) in orbits with a small eccentricity.

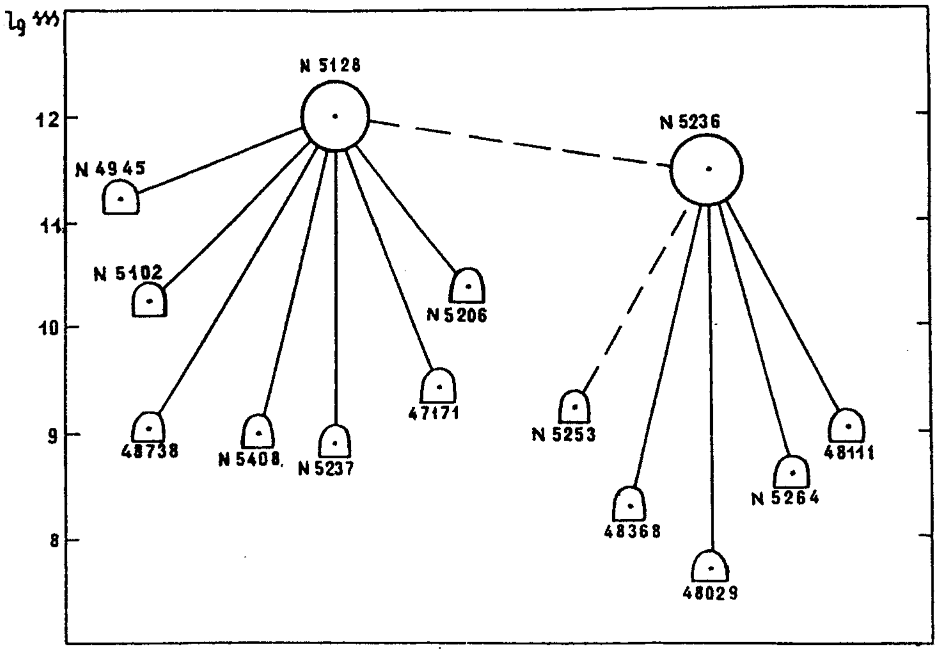

Figure 12 The structure of the group in Centaurus.

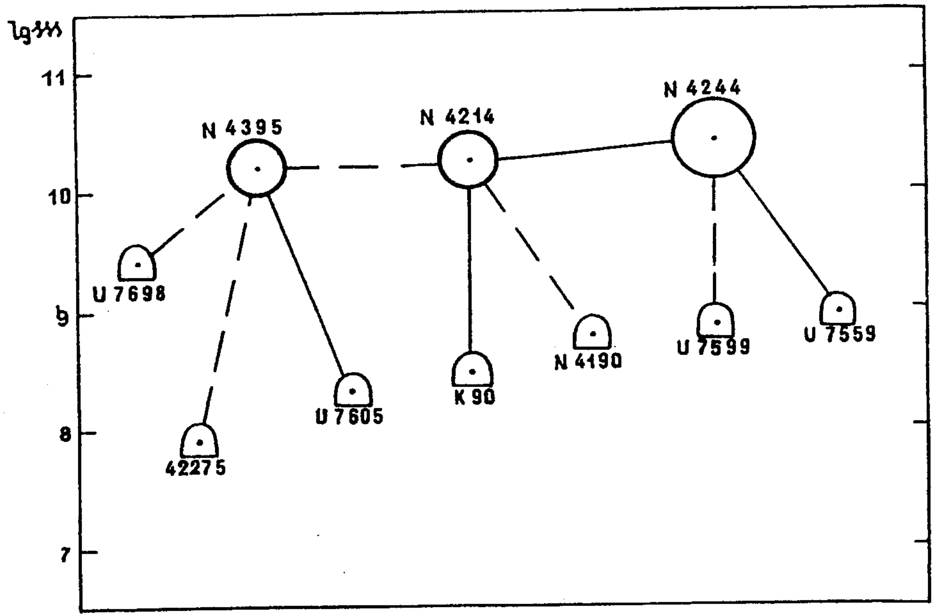

Figure 13 The structure of the group in Canes Venatici.

6 ON THE MOTIONS IN THE LOCAL VOLUME

A study of the velocity field of nearby galaxies is a problem which is not less important than the analysis of their clustering into systems of different scales. As was emphasized by Peebles (1989), the knowledge of accurate mutual motions of the nearest galaxies permits to make a choice between competing theories of the origin of galaxies. Since the classical paper by Yahil *et al.* (1977), many efforts have been undertaken to specify the peculiar velocity of the Milky Way and other neighbouring galaxies (Sandage, 1986b, Richter *et al.*, 1987, Giraud, 1986, 1990). A clarification of these matters is of major importance not only for the determination of the cosmological Hubble parameter *H* but also for an independent estimation of the mass of galaxies from perturbations of the local velocity field.

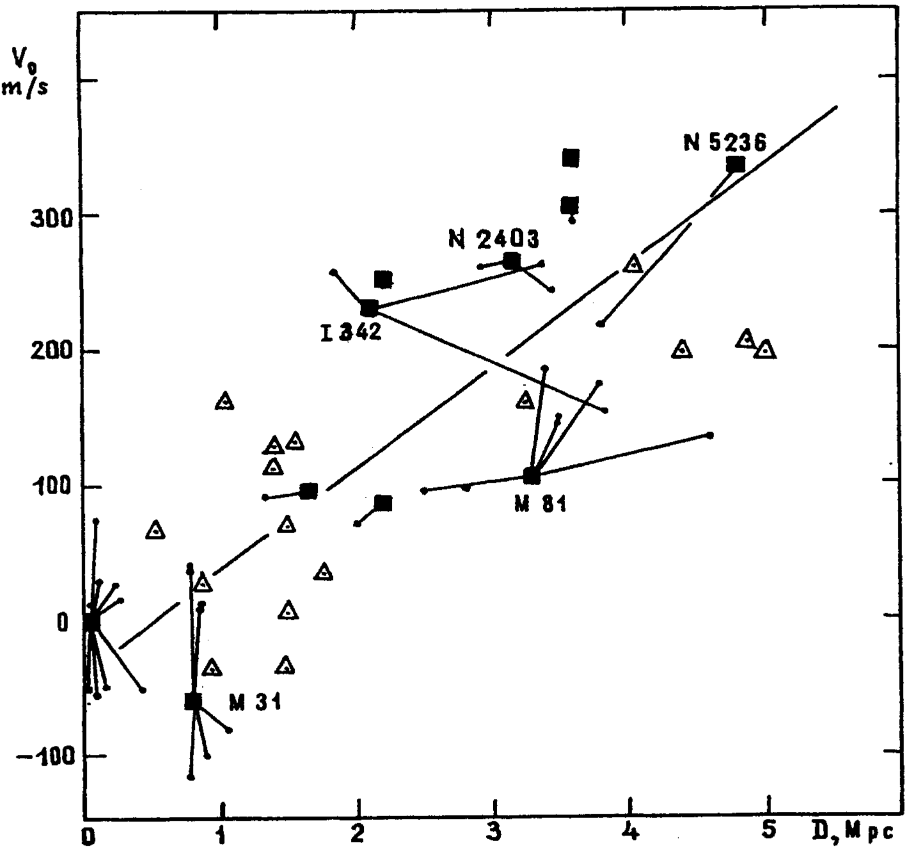

Figure 14 The diagram "corrected radial velocity – photometric distance" for the Local volume galaxies. The major of a system is indicated with a square, its companions are represented by dots. Triangles represent single galaxies. The straight line corresponds to H = 75 km/s Mpc.

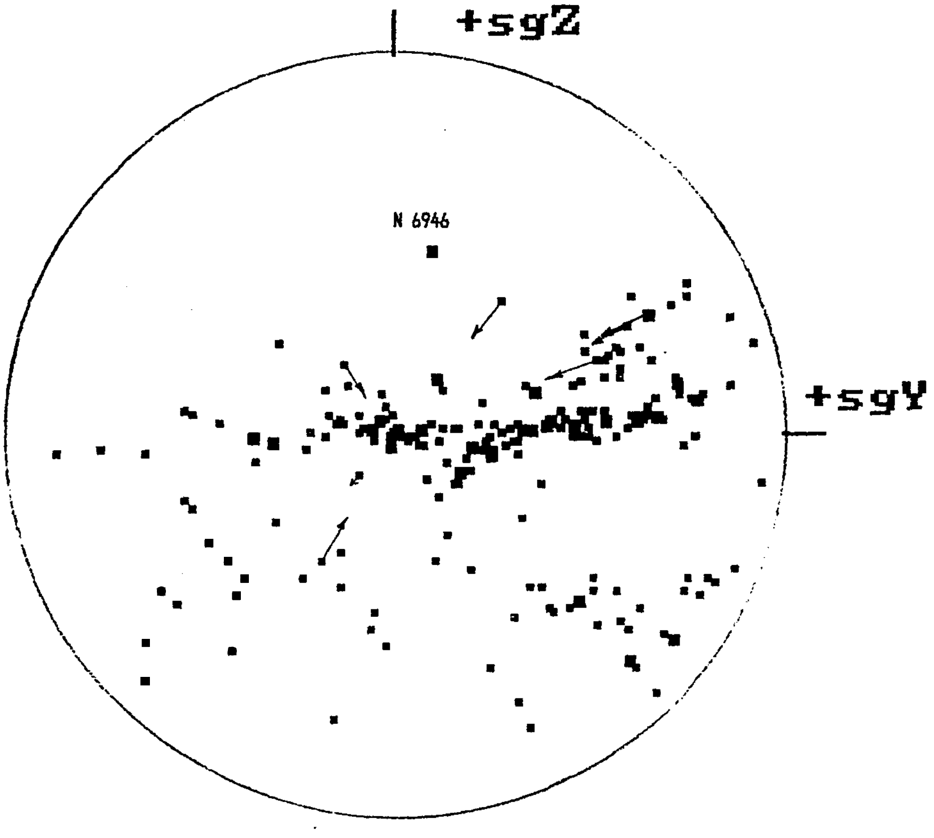

Figure 15 Distribution of galaxies with $D < 6.7$ Mpc in the Cartesian supergalactic coordinates {SGY, SGZ}. Peculiar velocities of the galaxies with $|\mathrm{SGZ}| > 1$ Mpc are pointed with arrows.

The new observational data collected in Table 2 differ considerably from the data used previously. This gives grounds to reconsider the problem of the determination of local motions. However, here we restrict ourselves only to some remarks.

Figure 14 presents the Hubble diagram for nearby galaxies in which the photometric distances are known. Squares mark the principal members of the multiple systems selected by our criterion. Small circles indicate their companions connected by lines with the principal member. Single galaxies are represented by triangles. Straight line corresponds to the Hubble parameter $H = 75$ km/s Mpc.

Note some peculiarities of the Hubble diagram. a) The "velocity-distance" relation for nearby galaxies shows an obvious deviation from the linearity. The regression line runs clearly off our Galaxy which probably suggests the existence of a peculiar velocity of the Galaxy caused by the local gravitational potential (Sandage, 1986b). b) The scatter of galaxies on the diagram increases with distance, which can be explained by errors in distance determinations, $\sigma(D)/D \cong 1/4$. c) The principal members of multiple systems have same standard deviations with respect to the linear Hubble relation as the field galaxies do. This quantity, $\sigma_V = 78$ km/s, is two times the mean amplitude of proper motions in the groups. Such a ratio seems unexpected and probably indicates that there exist regular non-Hubble motions of galaxies in the Local volume.

A certain corroboration of the idea of coherent small-scale motions is provided by Figure 15. The sample of nearby galaxies under consideration is presented here in the supergalactic coordinates. The axis SGY is directed to the center of the Virgo cluster and the light absorption zone is oriented approximately along the axis SGZ. The distribution of galaxies shows a distinct concentration towards the supergalactic plane. For the galaxies separated from the supergalactic "pancake" by more that 1 Mpc, their radial component of peculiar velocity, $V_{\rm pec} = V_0 - 75D$, is shown by an arrow. Nearly all such galaxies have negative peculiar velocities, i.e. they move down in the direction of the supergalactic plane. If this tendency is confirmed by future observations, grounds will appear for coherent motions to exist in the Local volume, which are different from the known phenomenon of the "Virgocentric flow" on a scale of $\sim$ 25 Mpc. Note that in this case the local value of the Hubble parameter will depend on the direction along which it is defined.

7 CONCLUSION

In order to reveal bound groups, we have employed the assumption of a planetary structure of systems of galaxies where companions travel in closed trajectories around a central massive object. In contrast to the earlier "totalitarian" modes of clustering, we take into account individual parameters of galaxies. The two-point approach with meeting the conditions of closed ($g_{ik} < 1$) and causally related ($t_{ik} \lessdot 1$) motions allows to use a "transparent" statistics of Keplerian orbits to estimate the mass of a system instead of applying the virial theorem. Of course, such a linear way of clustering does not prove its value when applied to highly populated systems.

The criterion of bound groups expressed by conditions (10)–(13) permits to describe the hierarchical clustering of galaxies. In this sense our criterion combines the capabilities of the clustering approach (Gott and Turner, 1976, Huchra and Geller, 1982) and the dendrography (Materne, 1978, Tully, 1987).

We have tested our criterion on a distance-limited sample of nearby galaxies with $V_0 < 500$ km/s. Among 215 such objects, 67 have photometrical distance estimates made from cepheids and brightest stars. The application of the criterion to them gives the following results:

- ⋆ The criterion unites into multiple systems 50 per cent of galaxies of the Local volume, moreover in a sphere of 0.5 Mpc radius around our Galaxy all the neighbours are members of the Local group.
- ⋆ For most of the selected groups more than 2/3 of the total mass is concentrated in the main component, which justifies the Keplerian approach.

- ⋆ The hierarchical structure of groups comprises from 1 to 3 levels and is dependent on the degree of mass concentration in the primary galaxy. A group with an outstanding primary component (M81, M101) has a simple one-level constitution, while "leaderless" groups (Canes Venatici and IC 342) are characterized by a complex structure.
- ⋆ Pairs and groups found by the criterion have a typical separation between the galaxies of 123 kpc and a mean mutual radial velocity of only 42 km/s, which is much less than in the groups selected by Huchra and Geller (1982) and other authors.
- ⋆ The mean excess of dark matter in groups turns out to be small, however its value depends on the type of the motion anticipated. If the orbits of the components are close to circular ones, then $\mathfrak{M}E = dex\,(+0.03)$. For strictly radial motions the mass excess will be three times as large.
- ⋆ On the scales from 80 to 250 kpc, we recognize no increase in mass excess from compact groups to open ones. This provides grounds to expect the absence of a considerable amount of dark matter in the volume between the group members and therefore to prefer the case of circular orbits.
- ⋆ The character of validity of the criterion is asymmetric. The conditions $\{g_{ik} < 1,\ t_{ik} < 1\}$ do not reject a truly bound pair at any angle of sight. However, spurious pairs whose contribution affects the mass estimate may satisfy these conditions.

We emphasize that the absence of direct distance measurements for many galaxies of the Local volume introduces a noticeable uncertainty into the mass estimate of a group. So far, photometrical distances for the majority of members are known only in the four nearest groups. The necessity to measure distance moduli in the Centaurus, Canes Venatici and M101 groups seems to us very urgent.

In the process of transition from Hubble distances, V_0/H, to the photometrical ones the landscape of the Local volume loses the specific "fingers of God" pattern caused by virial motions of galaxies. This tendency is obvious in spite of the absence of direct distance measurements for 2/3 of the sample in question. As a whole, the distribution of the nearest galaxies demonstrates the presence of the same features that are characteristic of the large-scale structure of the Universe. Here we reveal a compact system (M81), an elongated filament (M31 + IC342 + NGC 2403 + M81), a flat cloud (NGC 4244 + NGC 4736) and a void (between M81 and Local group). The similarity of the texture of the Universe on large and small scales is consistent with the idea of its fractal structure (Giavalisco *et al.*, 1990).

The problem of peculiar motions in the Local volume (Peebles, 1989) is of great importance for cosmogony of galaxies. From preliminary data apart from chaotic and virial velocities of nearby galaxies a tendency appeares for coherent motions directed to the Local supercluster plane. This may turn out to be the first direct evidence of a yet unaccomplished process of the formation of the Local "pancake". To check such an effect, new measurements of photometric moduli for galaxies located at large distances on both sides of the supergalactic plane are needed. Coordination of observational efforts for determination of distances to nearby galaxies on telescopes of the northern and southern hemispheres, which is now imperative, will allow to lay a reliable foundation for simulating a dynamical evolution of the Local universe (Peebles, 1990, Zheng *et al.*, 1991).

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