THE ASTROPHYSICAL JOURNAL, 257:423–437, 1982 June 15

GROUPS OF GALAXIES I. NEARBY GROUPS

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Received 1981 August 18; accepted 1981 January 6

ABSTRACT

We present generalized techniques for finding density enhancements in the quasi–three-dimensional space known as redshift space. We use one of these techniques to examine the effects of varying selection criteria on the dynamical parameters derived for groups of galaxies. There is a broad range of selection parameters which yields well defined and well behaved groups. We present a whole sky catalog of nearby groups with outer number density enhancement greater than 20. The median M/L for our groups is ~ 170, corresponding to a cosmological density of $\Omega = 0.1$. We include a two-dimensional projection of several contours near the Virgo cluster. The clustering exhibits *both* concentric and hierarchical structure.

Subject headings: cosmology — galaxies: clusters of — galaxy: redshifts

I. INTRODUCTION

Dynamical studies of groups of galaxies are an important method for estimating galaxy masses (Rood, Rothman, and Turnrose 1970; Sandage and Tammann 1975; Turner and Gott 1976*a*; Geller and Peebles 1973; Materne and Tammann 1974; Press and Davis 1982). Most previous identifications of group members have been based either on limited or subjective data (de Vaucouleurs 1975; Holmberg 1969; Karachentseva 1973) or on two-dimensional criteria (Turner and Gott 1976*a*; Materne 1978, 1979). Members of de Vaucouleurs groups, for example, were identified on the basis of similarity in redshift, apparent magnitude, and morphology as well as on positional coincidence. This method suffers from poorly defined sampling and selection criteria. The two-dimensional method of Turner and Gott identifies group members on the basis of angular separation by finding regions in which the surface number density of galaxies is enhanced. This technique suffers because the projected spatial separations vary with distance—relatively nearby groups of large angular scale cannot be identified. Because this technique is applied to a magnitude-limited sample, the galaxy luminosity function is sampled differently for groups at different distances. This method will not yield the same groups when applied to samples which cover the same region of the sky but which have different limiting magnitudes.

The techniques we discuss below were developed to avoid some of these problems: they are well defined, objective, and easily applied, and they can be adapted to remove selection biases. We conduct a parameter-space search to examine the sensitivity of group characteristics to the selection criteria. For the purposes of this discussion we adopt the conventional definition of a group of an association of galaxies which are likely to be physically (and dynamically) associated; more precisely, they are density enhancements in redshift space.

Section II discusses the technique we use for the analysis of some groups along with several possible variations on this technique. These techniques can be applied to a variety of samples (galaxy redshift catalogs). Here we apply this technique to a magnitude-limited catalog of galaxies which covers the whole sky to 13.2 m_B [in the Zwicky or de Vaucouleurs $B(0)$ magnitude system, Huchra 1976]. The group analysis of the CfA redshift survey (Davis *et al.* 1982: Huchra *et al.* 1982) will be presented in Paper II (Geller and Huchra 1982). In § III we discuss the parameter search and evaluate the statistical reliability of membership selection as a function of search parameters. Section IV contains a discussion of the average characteristics of the groups and shows that over a large range of selection parameters, the typical root mean square velocity dispersion in groups and the typical mass-to-light ratio are relatively stable.

II. TECHNIQUES

Three basic pieces of information are generally available for the study of the galaxy distribution: positions, redshifts, and magnitudes. Morphological information, which may, in fact, be irrelevant to group membership, is usually not available for faint galaxies. Magnitude similarity is a poor criterion for group membership because the galaxy luminosity function is broad. We are therefore left with the quasi–three-dimensional information embodied in the position and redshift data.

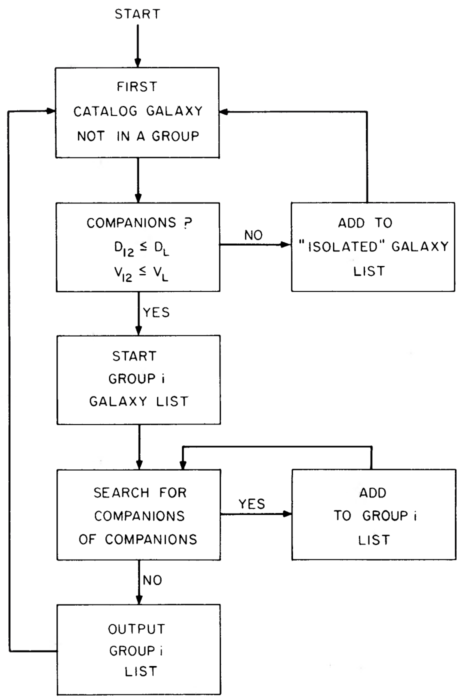

FIG. 1.—Flow chart for group selection algorithm

The method used to select group members should satisfy several basic requirements. The algorithm should be easy to apply and to implement on a computer. It must handle as many selection effects as possible, must yield reproducible results, and must not build in strong preconceptions about the group dynamics. Ideally one should be able to vary the selection criteria.

The approach we take is the most general method for finding isodensity contours for the galaxy distribution. We apply the technique to a magnitude-limited redshift catalog. The procedure is outlined in Figure 1. We first choose a galaxy in the catalog which has not been previously assigned to a group. We search around it for companions with projected separation from the first galaxy:

$$D_{12} = 2 \sin(\theta/2) V/H_0 \le D_L(V_1, V_2, m_1, m_2), \quad (1)$$

where

$$V = (V_1 + V_2)/2,$$

and velocity difference

$$V_{12} = |V_1 - V_2| \le V_L(V_1, V_2, m_1, m_2), \quad (2)$$

where V_1 and V_2 refer to the redshifts of the galaxy and its companion, m_1 and m_2 are their magnitudes, and θ is their angular separation. We use a Hubble constant $H_0 = 100$ km s^{-1} Mpc^{-1}, but actual identification of groups does not depend on the H_0 used. If no compan- are found, the galaxy is entered in a list of "isolated" galaxies. All companions found are added to the list of group members. The surroundings of each companion are then searched. This process is repeated until no further members can be found.

There is a variety of prescriptions for D_L and V_L. The most straightforward way is to choose a fixed D_L and V_L. This procedure is naive because, while it accounts for the change of projected separation with distance, it ignores all other selection effects. The method we adopt is designed specifically to compensate for variation in the sampling of the galaxy luminosity function as a function of the distance of the group. We assume that the luminosity function is independent of distance and position and that at larger distances only the fainter galaxies are missing. For each pair we take

$$D_L = D_0 \left[\int_{-\infty}^{M_{12}} \Phi(M)\, dM \Big/ \int_{-\infty}^{M_{\rm lim}} \Phi(M)\, dM \right]^{-1/3}, \quad (3)$$

where

$$M_{\rm lim} = m_{\rm lim} - 25 - 5 \log(V_F/H_0)$$

and

$$M_{12} = m_{\rm lim} - 25 - 5 \log(V/H_0),$$

$\Phi(M)$ is the differential galaxy luminosity function for the sample (the number of galaxies per Mpc per magnitude interval), and D_0 is the projected separation in Mpc chosen at some fiducial redshift V_F. This prescription weights the volume searched by the number density of galaxies that could be observed in a magnitude-limited sample taken at the distance V. The corresponding number density contour surrounding each group represents a fixed number density enhancement relative to the mean number density of

$$\frac{\delta\rho_N}{\rho_N} = \frac{3}{4\pi D_0^3} \left[\int_{-\infty}^{M_{\rm lim}} \Phi(M)\, dM \right]^{-1} - 1. \quad (4)$$

The limiting velocity difference is scaled, as suggested by P. Schechter, in the same way as D:

$$V_L = V_0 \left[\int_{-\infty}^{M_{12}} \Phi(M)\, dM \Big/ \int_{-\infty}^{M_{\rm lim}} \Phi(M)\, dM \right]^{-1/3}. \quad (5)$$

The ratio V_0/D_0 is related to an assumed cosmological mean density (Gott and Rees 1975; Sargent and Turner 1977; Geller and Huchra 1982). The pairwise selection procedure defined by equations (3) and (5) is commutative; if galaxy 1 finds companion galaxy 2, companion galaxy 2 will find galaxy 1. Commutativity means that for any particular galaxy catalog and choice of selection parameters, a unique group catalog results. The weighted box technique described by equations (3)–(5) can be easily applied on a grid of values of D_0 and V_0 in order to investigate the sensitivity of group characteristics to the selection parameters.

Another method is to leave the velocity cut unscaled. The advantage of not scaling velocity is that we do not build in a bias of velocity dispersion with distance. On the other hand, if V_0 in equation (5) is large enough, there will not be a significant correlation.

Alternatively, a search algorithm could be designed to identify luminosity density contours by replacing equation (3) by

$$D_{LL} = D_0 \left[\int_{-L_{12}}^{\infty} L\phi(L)\,dL \Big/ \int_{-L_{\rm lim}}^{\infty} L\phi(L)\,dL \right]^{-1/3}, \tag{6}$$

where

$$L_{12} = (L_1 + L_2)/2$$

is the average luminosity of the pair and

$$L_{\rm lim} = C \,\text{dex}\,(-M_{\rm lim}/2.5),$$

with C a constant depending on the magnitude system. Our tests with this algorithm show that with a magnitude-limited sample, this technique and the first algorithm produce similar group catalogs.

Another measure of the separation between two galaxies is

$$s = \left(V_1^2 + V_2^2 - 2V_1V_2\cos\theta\right)^{1/2}/H_0 \tag{7}$$

(Davis, Geller, and Huchra 1978, hereafter DGH). A pairwise group selection algorithm would require either a number or luminosity-weighted s. An algorithm using this metric will produce groups with exceedingly small velocity dispersion and unacceptably long crossing times. The velocity dispersion obtained for any group would be less than the Hubble velocity corresponding to the limiting separation s. This difficulty could be reduced by scaling the $(V_1^2 + V_2^2)$ term in equation (7) by a factor smaller than the Hubble constant H_0. The actual choice of scaling factor is again linked to a cosmological model.

All pairwise techniques discussed so far are commutative. There are other methods which may be of interest for special applications. An example is the procedures used by Press and Schechter (1974) to obtain a statistical measure of the amplitude distribution of spherical density enhancements from an N-body simulation. Although a procedure of this kind may be of interest for finding statistics of the distribution (Gott and Turner 1977), it does not produce a unique catalog.

III. GALAXY CATALOG AND LUMINOSITY FUNCTION

We have searched for groups using a whole sky catalog of 1312 galaxies brighter than $m_B = 13.2$ with complete redshift information (Huchra *et al.* 1982). This catalog is similar to but not identical to the Revised Shapley-Ames Catalog of Sandage and Tammann. We correct the velocity of each galaxy (coordinates α_i and δ_i) in the sample for a dipole Virgo-centric flow,

$$V_{\rm LSC} = V_{\rm IN}[\sin\delta_i \sin\delta_V + \cos\delta_i \cos\delta_V \cos(\alpha_i - \alpha_V)], \tag{8}$$

where $V_{\rm LSC}$ is the correction, α_V and δ_V are the right ascension and declination of the center of the Virgo cluster (Huchra and Davis 1982), and $V_{\rm IN}$ is the assumed infall velocity, taken here to be 300 km s^{-1}. To avoid the singularity at 0 km s^{-1}, we give all galaxies with $V < 300$ km s^{-1} an "indicative" distance of 300 km s^{-1} $H_0{}^{-1}$. This procedure allows us to keep the negative velocity members of Virgo and other nearby groups. We present and analyze a catalog of groups with velocities less than 4000 km s^{-1}. The search for individual members is made out to a limiting velocity of 8000 km s^{-1}. These procedures avoid throwing out either low or high velocity members for nearby groups or groups near the 4000 km s^{-1} cut, respectively, and thus biasing the group velocity dispersions. At velocities larger than 4000 km s^{-1}, uncertainties in the luminosity function (we are on the exponential portion at the bright end) produce large uncertainties in the scaling of D_0 and V_0.

The luminosity function we use to calculate the group luminosity and the scaling of D_0 and V_0 is derived directly from this catalog. We choose for simplicity to parameterize it in the Schechter (1974) form with

$$\alpha = -1.02, \qquad M^* = -19.06, \qquad \phi^* = 0.0277.$$

Because we are primarily interested in producing a finding list of groups and analyzing dynamics, we do not include any absorption correction in either the luminosity function or the group selection. In principle, the effect of absorption on group selection can be removed in a manner analogous to the one used to account for variation in the sampling of the luminosity function (eqs. [3]–[6]).

IV. RAMIFICATIONS

Several results are immediately apparent upon our application of this technique to the galaxy catalog. First, the group centers are insensitive to the choice of parameters except in cases where the cutoffs V_0 and D_0 are

TABLE 1
NUMBER OF INTERLOPERS

D_0(Mpc)	V_0 (km s^{-1}) 200	400	600	∞	$\delta\rho/\rho$
		At $V_F=1000$			
0.37	0.08	0.16	0.2	0.5	100
0.63	0.2	0.4	0.6	1.3	20
0.78	0.34	0.65	0.88	2.1	10
1.40	1.1	2.1	2.8	6.7	1
		Scaled to $V=2000$			
0.37	0.14	0.33	0.50	1.0	100
0.63	0.41	0.95	1.5	2.8	20
0.78	0.64	1.5	2.3	4.3	10
1.40	2.0	4.7	7.2	13.8	1

extreme. More precisely, if the density enhancement specified is too high, few groups are found; and if the separation parameter D_0 becomes an appreciable fraction of the sample depth, the galaxies are lumped into only a few groups of large size. Second, the geometry of groups is not constrained by the selection procedure and the outer boundary of every group corresponds to a roughly defined fixed density enhancement contour. All the groups have a density greater than the density of this outer contour. Third, for any particular galaxy, we can estimate the number of accidental associations (interlopers) for any set of selection parameters.

Table 1 gives the probable number of interlopers (n_I) within a specified D_L and V_L of a galaxy at a fiducial velocity $V_F=1000$ km s^{-1} and at 2000 km s^{-1}, near the mean velocity for the sample. This number is

$$n_I=\pi\left(\frac{D_L}{V_G/H_0}\right)^2 \mathfrak{N}\left[\frac{n_{v_L}(V_G)}{n_T}\right], \tag{9}$$

where $\mathfrak{N}$ is the surface number density of galaxies in the sample, n_T is the total number of galaxies in the sample, and $n_{V_L}(V_G)$ is the number of galaxies within V_L of V_G. These estimates are valid for individual group members at V_G. For the bright galaxy catalog analysed here, the histogram of velocities peaks near 1000 km s^{-1}. Thus the number of interlopers quoted is near the maximum expected—it is slightly larger at 2000 km s^{-1} because the surface area searched is larger and the peak in the velocity distribution is very broad (because of Virgo). The number of interlopers decreases at larger velocities when the velocity histogram trails off. In principle one picks up less than n_I interlopers per galaxy searched because of overlap of the volume searched.

A rough estimate of the typical number of group members within a specified distance of a given galaxy can be obtained from the correlation function. The mean number of galaxies in excess of random (n_C) within r of a given galaxy is

$$n_C=4\pi\rho N\int_0^r \xi(r')\,d^3r', \tag{10}$$

where the correlation function is

$$\xi(r)=(r_c/r)^\gamma$$

with $r_C=5$ Mpc and $\gamma=1.8$ (DGH; Davis *et al.* 1982). We estimate ρ_N by computing the number density of galaxies at the fiducial velocity (distance). For $V_F=1000$ km s^{-1}, $\rho_N=0.038$ galaxies Mpc^{-3}. The proportion of interlopers can now be estimated roughly from (12) and (13). If $V_L=400$ km s^{-1}, the fraction of interlopers within 1 Mpc of a galaxy is $n_I/n_C=0.15$. Table 1 gives the expected number of interlopers computed for a range of selection parameters.

A major advantage of this group selection algorithm is that we can choose a V_L such that the velocity dispersion of the groups is not severely constrained. For a given V_L, the *maximum* velocity dispersion, $\sigma_{v,\max}$, that could be obtained from this technique for a group of n_G galaxies that is maximally strung out in redshift is

$$\sigma_{v,\max}(n_g,V_0)=\frac{V_L}{[2(N_G-1)]^{1/2}}\times\left[\sum_{j=1}^{I(n_G/2)}(n_G+1-2j)^2\right]^{1/2}, \tag{11}$$

where $I(n_G/2)$ is the greatest integer less than or equal to $n_G/2$. In general, the velocity dispersion of a group is defined as

$$\sigma_v=\left[\frac{1}{(n_G-1)}\sum_1^{n_G}(V_i-V_G)^2\right]^{1/2}, \tag{12}$$

where V_G is the mean group velocity and V_i is the velocity of the ith member. Table 2 gives the ratios of $\sigma_{v,\max}$ and $\sigma_{v,\text{mean}}=\sigma_{v,\max}/\sqrt{n_G}$ to V_L computed for several values of n_G. It is easily seen here that if we were limited to a $V_L=H_0D_L$, the velocity dispersions would be minuscule unless we were to use very large D_L's, corresponding to very small density enhancement contours. In general, any time V_L is constrained to be small, the velocity dispersions are likely to be biased to even smaller values—especially for small groups! This problem is evident in some of the earlier group finding techniques (Materne 1978, 1979; Tully 1980). We show in § IV that the actual velocity dispersions are not

TABLE 2

VELOCITY DISPERSION LIMITS

n	$\sigma_{v,\max}/V_L$	$\sigma_{v,\text{mean}}/V_L$
2	1	0.5
3	1.1	0.6
4	1.3	0.7
⋮		
10 ...	~3	~1

severely biased by the selection parameters for reasonable values of V_0.

"Reasonable" values D_0 and V_0 are determined by several semiquantitative constraints. As we have discussed, taking V_0 too small severely limits the velocity dispersions. Furthermore, V_0 must be larger than the measurement errors, generally 50–100 km s^{-1} for a single measurement. If D_0 is too small, the corresponding density enhancement contour is so large that only very tight binaries are found. Table 1 shows that the number of interlopers increases as D_0 and/or V_0 increases. If D_0 is too large, the density enhancement is too low—the groups are unlikely to be real. These constraints are shown schematically in Figure 2.

For any selection V_0 and D_0 some fraction of the galaxies in the sample are not assigned to any group. The number of these single galaxies depends on higher-order moments of the galaxy distribution and the galaxy catalog limits, just as do the groups selected (Fall *et al.* 1976; Huchra and Thuan 1977; Soniera and Peebles 1977).

V. THE GROUP CATALOG

Table 3 is the catalog of groups we obtain with $D_0 = 0.63$ Mpc (corresponding to a "volume" number density enhancement of 20 for the galaxy catalog) and with $V_0 = 400$ km s^{-1}. Only groups containing more than two members are shown. The groups and the galaxies in the groups are listed as they are found in a declination ordered list. Note that for single application of this finding technique, declination ordering is not necessary, but when large numbers of runs are made to map the parameter space, substantial savings in computer time result from this ordering. The table lists the galaxy name, "corrected" velocity, apparent magnitude, morphological type in de Vaucouleurs's T notation, and the galactic longitude and latitude for the galaxies in each group. Our choice of a catalog to display is based on the results of a parameter search described in the next section.

We compare our group catalog to the catalog of nearby groups found by de Vaucouleurs (1975, hereafter DV) in Table 4. The agreement is phenomenal; in a few cases we have split his groups into two subgroups. At this density enhancement, we lump together into three single groups the three largest associations of his groups: Virgo, Ursa Major plus Canes Venatici plus Coma I, and Leo. Nine DV groups do not appear in our catalog. Five of these are split into binaries, pairs of binaries, and isolated galaxies and are marked with a B in Table 4; the others are missed completely. These last groups either fall completely below the density = 20 contour, or, in the case of DV 38 (for which de Vaucouleurs had no velocities) and DV 24 (for which he had only one velocity) the galaxies are simply not together in velocity space. It is interesting to note that at this contour,

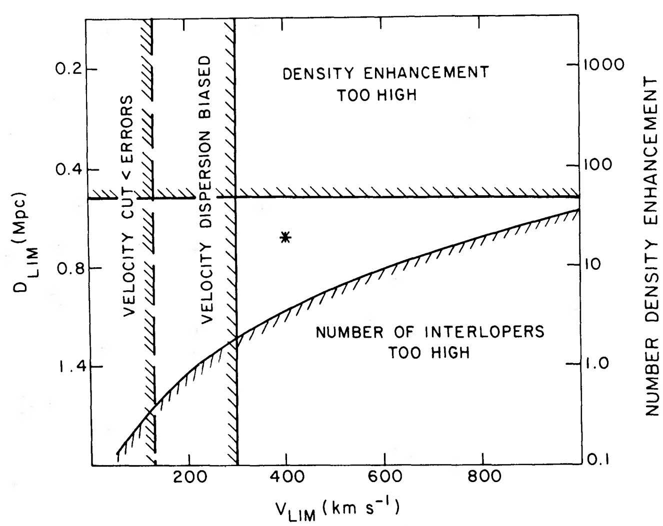

FIG. 2.—Group selection parameters. The region of "reasonable" search parameters is outlined.

1982ApJ...257..423H

TABLE 3

The Group Catalog

GROUP 1	3 GALAXIES				
N2442	1125	11.81	3	281.32	-21.51
N2434	1023	12.72	-5	281.01	-21.55
N2397	991	13.08	2	280.31	-22.60
GROUP 2	3 GALAXIES				
I4710	496	12.34	9	327.85	-22.66
N6684	699	11.75	-2	330.33	-24.20
N6744	629	9.78	4	332.21	-26.15
GROUP 3	18 GALAXIES				
N2082	1036	13.10	3	273.82	-31.75
N1947	947	12.39	-3	273.34	-33.43
N1796	638	13.18	0	270.63	-36.55
N1688	876	12.66	5	269.40	-38.53
N1672	989	11.29	3	268.80	-38.99
I2056	732	12.66	-3	271.38	-42.24
N1559	937	11.06	6	274.53	-41.19
N1543	1041	11.71	-2	268.43	-43.53
N1574	532	11.62	-3	266.90	-42.58
N1533	413	12.02	-3	266.47	-44.42
N1546	790	12.71	-2	266.11	-43.82
N1553	920	10.57	-2	265.64	-43.67
N1549	793	11.05	-5	265.43	-43.79
N1566	1128	10.09	4	264.34	-43.38
N1617	642	11.40	1	263.35	-41.83
N1515	769	12.02	4	264.11	-45.85
N1705	276	13.12	-3	261.11	-38.74
N1596	1128	12.27	-2	264.09	-42.31
GROUP 4	3 GALAXIES				
N6769	3710	12.80	3	336.07	-26.63
N6770	3620	13.14	3	336.07	-26.67
N6782	3543	12.79	-1	336.83	-27.24
GROUP 5	4 GALAXIES				
N6753	2928	12.10	3	339.68	-25.14
N6758	3154	12.84	-5	340.55	-25.32
N6780	3302	13.16	5	341.41	-26.46
I4837	2502	12.84	6	342.38	-25.18
GROUP 6	3 GALAXIES				
N1249	643	12.00	6	268.24	-53.40
I1933	699	13.09	6	265.54	-51.62
I1954	752	12.25	3	263.67	-51.18
GROUP 7	3 GALAXIES				
N7155	1613	13.06	-2	347.03	-49.78
N7144	1864	12.20	-5	349.17	-49.60
N7145	1641	12.65	-5	349.68	-49.79
GROUP 8	10 GALAXIES				
N1494	744	12.53	7	257.19	-48.23
N1527	737	12.36	-3	255.15	-46.71
N1433	699	10.90	1	255.72	-51.20
N1493	693	12.10	6	253.22	-48.85
I2035	1100	12.60	-2	251.68	-46.96
N1512	539	11.60	1	248.68	-48.16
N1448	808	11.70	6	251.54	-51.39
N1411	631	12.16	-3	251.02	-52.51
N1487	524	12.60	10	247.48	-49.76
N1291	482	10.20	0	247.56	-57.03
GROUP 9	4 GALAXIES				
N6861	2652	12.43	-3	350.86	-32.21
N6868	2595	12.31	-5	350.91	-32.64
N6851	2856	13.18	-3	350.89	-31.58
N6893	2961	12.85	-2	351.24	-34.43
GROUP 10	3 GALAXIES				
N7213	1527	11.57	1	349.56	-52.58
I5201	1706	11.72	6	350.21	-54.89
I5181	1829	12.79	-2	351.03	-53.60
GROUP 11	4 GALAXIES				
N7107	1982	13.15	8	354.88	-48.58
N7079	2470	12.47	-2	356.29	-46.93
N7097	2197	12.77	-5	358.35	-48.49
N7070	2198	12.74	6	357.77	-46.65
GROUP 12	9 GALAXIES				
N7531	1306	12.00	4	346.39	-64.50
N7496	1201	12.08	3	347.81	-63.80
N7552	1316	11.44	2	348.11	-65.22
N7582	1177	11.84	2	348.05	-65.68
N7599	1418	12.25	5	348.06	-65.90
N7590	1235	12.18	4	348.19	-65.84
I5267	1452	11.65	-2	350.20	-61.80
N7412	1454	12.04	3	351.89	-61.87
I5325	1186	12.48	4	347.69	-67.87
GROUP 13	9 GALAXIES				
N625	65	12.58	9	273.69	-73.12
N0300	-172	9.90	7	299.24	-79.41
N0055	-171	8.10	9	332.87	-75.73
SCULPTOR	-115	9.00	-5	287.84	-83.17
N7793	-56	10.43	8	364.54	-77.18
N0253	-36	8.19	5	97.24	-87.98
N0045	215	11.20	8	55.84	-80.64
N0247	-109	9.93	7	114.01	-83.56
N0024	303	12.10	5	43.60	-80.44
GROUP 14	8 GALAXIES				
N4645	2549	13.14	-5	301.47	21.08
N4696	2926	12.38	-4	302.41	21.55
N4650	2940	13.10	0	301.48	22.10
N4767	3029	12.89	-5	303.44	23.14
N4507	3468	12.84	-1	299.64	22.85
N4373	3357	12.27	-2	297.50	22.83
N4679	4744	13.00	4	302.11	23.28
I3370	2877	12.44	-5	297.93	23.29
GROUP 15	10 GALAXIES				
N7424	605	11.46	6	354.78	-62.76
N7462	818	12.96	-5	354.39	-63.80
N7456	950	12.16	6	357.15	-64.14
I5273	1049	11.89	6	361.62	-64.25
N7418	1200	12.02	6	363.43	-63.86
N7410	1387	11.61	1	357.99	-62.83
I1459	1381	11.30	-5	364.63	-64.11
N7421	1587	12.86	0	362.70	-63.84
I5269	1880	13.15	-2	365.54	-64.32
I5271	1500	12.60	3	370.75	-64.77
GROUP 16	4 GALAXIES				
N1792	879	11.33	4	241.71	-36.46
N1808	643	11.07	1	241.21	-35.90
N1800	399	12.90	-1	234.45	-35.13
N1744	441	12.06	7	227.00	-35.03
GROUP 17	23 GALAXIES				
N1316	1449	9.90	-2	240.18	-56.69
N1317	1548	11.96	1	240.00	-56.70
N1365	1302	10.20	3	237.96	-54.60
N1351	1143	13.10	-3	235.80	-55.27
N1326	1011	11.75	-1	238.78	-56.52
N1404	1559	11.34	-5	236.96	-53.55
N1379	1037	12.60	-5	236.76	-54.12
N1399	1095	11.15	-5	236.74	-53.63
N1427	1219	12.50	-5	236.64	-52.86
N1381	1428	12.80	-2	236.50	-54.02
N1380	1513	11.30	-2	235.93	-54.06
N1350	1441	11.80	2	233.63	-55.16
N1387	890	12.30	-3	236.86	-53.93
N1374	903	12.70	-5	236.39	-54.28
N1339	925	12.94	-5	231.23	-55.78
N1389	727	12.90	-5	237.26	-53.89
N1437	785	12.77	1	237.38	-52.59
I2006	1026	12.84	-5	237.56	-50.47
N1386	574	12.40	1	237.68	-53.94
N1406	772	12.89	4	229.80	-53.33
N1344	931	11.79	-5	229.07	-55.68
N1366	551	13.00	-1	229.45	-54.49
N1425	1173	11.81	3	227.53	-52.59
GROUP 18	8 GALAXIES				
N3275	3084	12.64	2	273.92	18.09
N3347	2815	12.20	3	275.86	19.65
N3258	2693	13.14	-5	272.90	18.81
N3271	3672	13.06	-2	273.05	19.20
N3268	2649	13.07	-5	272.95	19.18
N3281	3286	12.70	3	273.01	19.77
N3358	2803	12.57	0	276.02	19.71
N3223	2743	11.99	3	270.80	19.08
GROUP 19	4 GALAXIES				
N5102	405	10.60	-3	309.73	25.83
A1346-35	325	12.00	0	315.85	25.34
N5253	417	11.14	0	314.86	30.10
N5236	549	8.22	5	314.58	31.96
GROUP 20	3 GALAXIES				
I3253	2692	12.56	5	296.49	27.89
T1211-342	2813	13.00	0	294.13	27.72
N4304	2582	12.69	0	295.97	28.99
GROUP 21	4 GALAXIES				
N3087	2531	13.00	-5	266.90	16.32
I2522	2858	12.94	5	265.51	16.63
N3038	2589	12.90	1	264.60	16.39
N3095	2730	12.52	5	265.27	18.52
GROUP 22	3 GALAXIES				
I4296	3635	11.90	-5	313.54	27.96
N5140	3731	13.20	-2	311.38	28.42
N5193	3653	12.88	-3	312.60	28.86
GROUP 23	3 GALAXIES				
I5020	2933	13.10	-1	369.24	-34.33
N6925	2662	12.10	4	371.26	-34.69
N6923	2843	12.90	3	372.46	-33.88
GROUP 24	3 GALAXIES				
I1783	2964	13.10	1	236.74	-72.06
N0857	2897	13.00	0	233.13	-71.73
I1788	3056	13.20	3	230.47	-71.15
GROUP 25	3 GALAXIES				
N1532	871	11.44	2	233.18	-46.57
N1531	802	13.00	-5	233.15	-46.59
N1537	1042	12.00	-3	231.46	-46.11

TABLE 3—*Continued*

GROUP 26	3 GALAXIES				
N5494	2728	12.74	5	322.84	29.08
N5464	2726	13.10	10	321.85	30.07
I4351	2629	12.44	3	319.90	31.36
GROUP 27	4 GALAXIES				
N4105	1886	12.10	-5	291.46	32.10
N4106	2168	12.49	-1	291.49	32.11
I 764	2115	12.44	5	292.34	32.27
I2995	1835	12.68	5	290.78	33.84
GROUP 28	4 GALAXIES				
N3904	1590	12.43	-5	286.99	31.65
N3923	1769	11.40	-5	287.28	32.21
N3885	1931	13.13	0	285.93	32.79
N3936	2004	13.17	3	286.99	34.12
GROUP 29	4 GALAXIES				
N3089	2549	13.07	3	262.99	20.92
I2537	2703	12.74	5	263.23	22.10
N3078	2408	12.51	-5	261.78	21.79
N3054	2103	12.31	3	260.20	22.13
GROUP 30	4 GALAXIES				
N1292	1098	12.92	5	222.45	-57.53
N1302	1371	11.62	0	219.70	-56.93
N1255	1362	11.97	4	218.63	-58.26
N1201	1393	11.88	-2	218.57	-60.40
GROUP 31	3 GALAXIES				
N5101	1897	11.93	0	311.14	34.95
N5061	2107	12.00	-5	310.24	35.66
N5085	2016	12.07	5	311.28	37.95
GROUP 32	21 GALAXIES				
N1398	1076	10.73	2	221.55	-52.78
N1371	1127	11.81	1	218.97	-53.34
N1385	1180	11.79	6	218.47	-52.72
N1395	1384	11.65	-5	216.21	-52.12
N1415	1250	12.70	0	215.73	-51.44
N1426	1128	12.86	-5	215.23	-50.92
N1439	1356	12.90	-5	215.16	-50.42
I1953	1570	12.57	7	213.28	-52.76
N1353	1266	12.50	3	212.03	-52.94
N1325	1282	12.56	4	212.31	-54.84
N1359	1647	12.85	9	210.20	-52.13
N1332	1156	11.59	-3	212.21	-54.36
N1300	1228	11.34	4	208.16	-55.23
N1297	1244	12.99	-3	207.61	-55.21
N1407	1463	11.43	-5	209.63	-50.38
N1232	1410	10.73	5	208.78	-57.81
N1452	1601	12.88	0	210.37	-49.26
N1440	1232	13.04	-2	209.81	-49.19
N1461	1155	12.85	-2	207.65	-47.75
N1187	1096	11.20	5	212.11	-60.06
N1179	1466	12.06	6	204.70	-58.80
GROUP 33	10 GALAXIES				
N3955	1339	12.98	0	286.14	37.82
N3956	1679	12.63	5	285.22	40.32
N3981	1903	12.57	4	285.56	41.10
N3957	1872	12.94	0	284.83	41.28
N4027	1717	11.90	8	286.39	41.93
N4039	1684	13.00	9	286.96	42.45
N4038	1693	11.17	9	286.95	42.46
N4024	1738	13.11	-3	285.74	42.75
N4033	1569	12.96	-5	286.18	43.36
N4050	1962	12.34	2	286.37	44.92
GROUP 34	3 GALAXIES				
N2223	2435	12.18	3	230.88	-15.84
N2207	2485	11.54	4	228.68	-17.02
N2196	2091	12.56	1	228.71	-18.09
GROUP 35	3 GALAXIES				
N5084	1812	12.30	-2	311.76	40.54
N5134	1775	12.63	3	313.42	41.03
N5087	1912	12.49	-3	312.03	41.74
GROUP 36	3 GALAXIES				
N2986	2313	12.74	-5	255.06	23.73
N2935	2168	12.24	3	253.59	22.56
N2983	1934	12.91	-1	254.33	24.19
GROUP 37	3 GALAXIES				
N3091	3635	12.81	-5	256.77	27.50
N3124	3509	12.48	4	257.72	28.83
N3052	3524	12.97	5	254.87	27.28
GROUP 38	4 GALAXIES				
N2848	1947	12.55	5	247.05	22.69
N2811	2428	12.69	1	246.20	22.09
N2781	2112	12.64	-1	244.19	22.14
N2763	1796	12.91	6	244.03	20.84
GROUP 39	3 GALAXIES				
N5044	2806	12.24	-5	311.22	46.10
N5073	2828	13.00	5	312.94	47.46
N5077	2948	12.66	-5	313.55	49.63
GROUP 40	3 GALAXIES				
A1511-15	2255	12.53	7	346.25	35.16
N5878	2257	12.60	3	347.19	36.09
N5915	2426	12.71	2	349.90	35.74
GROUP 41	166 GALAXIES				
N4984	1363	12.07	-1	309.14	47.14
N4856	1352	11.68	0	305.77	47.79
N4802	1129	12.00	-2	304.63	50.80
N4700	1521	12.71	5	302.02	51.46
N4781	1019	12.10	7	304.13	52.32
N4742	1444	12.76	-5	303.08	52.41
N4790	1485	12.94	5	304.34	52.61
N4594	1237	9.52	1	298.47	51.15
N4699	1638	10.60	3	301.90	54.19
N4818	1291	12.01	2	305.21	54.33
N4775	1712	12.20	7	303.98	56.24
N4731	1639	11.60	6	302.73	56.48
N4958	1659	11.73	-2	309.09	54.68
N4951	1332	12.68	6	309.04	56.21
N4697	1356	10.58	-5	301.63	57.06
N4995	1855	12.11	3	310.79	54.76
N4981	1830	12.34	4	310.62	55.83
N4597	1190	12.68	9	297.79	56.95
N4691	1281	11.81	0	301.38	59.52
N4504	1124	11.92	6	294.64	55.00
N4546	1185	11.62	-3	295.22	58.84
N4684	1750	12.41	-1	300.84	60.13
N4753	1460	11.00	0	303.42	61.67
N4487	1160	11.82	6	294.24	54.47
N4666	1687	11.73	5	299.55	62.37
N4632	1865	12.38	5	298.09	62.70
N4904	1347	12.82	6	308.14	62.76
N4771	1332	12.93	7	304.03	64.13
N4643	1528	11.64	0	298.19	64.77
N4517A	1696	12.89	8	292.49	62.86
N4845	1249	12.33	2	306.76	64.40
N4772	1231	12.37	1	304.12	65.03
N4900	1238	12.17	5	308.44	65.27
N4636	1122	11.01	-5	297.76	65.48
N4665	974	11.70	0	299.09	65.89
N4808	977	12.64	6	305.76	67.14
N4592	1243	12.45	8	296.40	62.19
N4536	1992	11.21	4	292.95	64.73
N4527	1910	11.68	4	292.60	65.18
N4688	1177	12.73	6	300.56	67.20
N4420	1852	12.94	4	288.51	64.67
N4765	950	12.90	0	304.10	67.33
N4701	890	12.94	6	301.51	66.26
N4630	876	13.10	10	297.31	66.74
N4586	1010	12.88	1	294.62	66.99
N4713	858	12.31	7	301.93	68.18
N4580	1194	12.87	1	293.86	68.01
N4517	1294	11.43	6	292.74	62.61
N4496A	1947	11.99	9	290.56	66.34
N4385	2306	12.85	-1	288.78	62.74
N4303	1741	10.28	4	284.39	66.28
N4303A	1754	10.90	4	284.39	66.28
N4457	1049	12.00	0	289.11	65.84
N4526	806	10.97	-2	290.16	70.13
N4698	1224	11.81	2	300.60	71.35
N4324	1866	12.60	-1	284.56	67.11
N4339	1464	12.83	-5	284.19	67.94
N4260	2032	12.70	1	281.54	67.64
N4215	2278	13.04	-1	279.19	67.63
N4472	1199	9.84	-5	286.89	70.20
N4469	703	12.41	0	286.10	70.91
N4424	639	12.57	1	283.91	71.40
N4417	1050	12.43	-2	283.46	71.53
N4442	724	11.70	-2	284.15	71.82
N4380	1171	12.37	3	281.91	71.82
N4550	605	12.73	-1	288.10	74.64
N4733	1262	13.20	-3	302.65	73.79
N4694	1404	12.64	-2	300.09	73.83
N4660	1341	12.30	-5	296.77	73.99
N4762	1237	11.53	-2	304.25	74.10
N4261	2385	11.84	-5	281.79	67.37
N4365	1435	11.18	-5	283.79	69.19
N4434	1268	13.20	-5	285.22	70.20
N4273	2569	12.51	5	282.55	66.96
N4180	2306	13.20	2	276.79	67.94
N4281	2915	12.41	-1	282.75	67.04
N4235	2786	12.86	1	279.17	68.47
N4519	1436	12.47	7	289.19	71.05
N4307	1255	12.87	3	280.62	70.63
N4178	558	12.10	8	271.83	71.37
N4294	571	12.67	6	277.05	72.85
N4299	440	13.06	8	277.36	72.88
N4621	670	11.28	-5	294.35	74.36
N4440	959	13.09	1	281.41	74.18
N4552	548	11.30	-5	287.89	74.97
N4402	455	12.91	3	278.80	74.78
N4435	948	12.03	-2	280.14	74.89
N4216	350	11.17	3	270.50	73.74
N4429	1345	11.43	-1	282.37	73.02
N4564	1341	12.24	-5	289.54	73.92
N4371	1156	12.25	-1	279.68	73.37
N4503	1577	12.68	-3	286.12	73.42
N4528	1594	12.98	-3	287.66	73.68
N4478	1591	12.57	-5	283.42	74.39
N4486	1507	10.30	-4	283.78	74.49
N4267	1217	12.17	-3	273.99	73.87
N4374	1243	10.82	-5	278.17	74.48
N4413	316	13.04	3	279.83	74.35
N4571	577	12.12	7	287.50	76.66
N4548	784	11.19	3	285.67	76.83
N4312	376	12.93	2	271.38	76.61
N4754	1606	11.77	-3	303.72	74.19
N4638	1374	12.48	-3	295.16	74.19
N4649	1322	10.30	-5	295.83	74.31
N4647	1677	12.34	5	295.73	74.34
N4880	1710	12.70	0	311.34	75.21
N4654	1269	11.28	6	295.40	75.89
N4639	1196	12.50	4	294.33	75.99
N4579	1744	10.72	3	290.39	74.37
N4606	1871	13.11	1	293.21	74.59
N4689	1792	11.87	4	299.02	76.61

TABLE 3—*Continued*

GROUP 41 (con't)					
N4378	2730	12.34	1	286.14	66.94
N4570	1933	12.24	-2	292.46	69.82
N4313	1672	13.20	2	277.73	73.26
	255	11.20	-6	284.00	74.39
N4438	261	11.30	0	280.32	74.83
N4206	915	13.00	4	270.17	73.55
N4302	1260	12.76	5	272.52	75.70
N4237	1170	12.78	4	267.25	75.77
N4379	1271	12.77	-3	273.75	76.97
N4212	134	12.08	4	268.87	74.36
N4192	83	11.21	2	265.44	74.97
N4477	1582	11.62	-2	281.53	75.62
N4459	1443	11.95	-1	280.14	75.85
N4298	1375	12.34	5	272.35	75.67
N4608	2083	12.48	-2	294.38	72.86
N4596	2071	11.88	-1	293.29	72.83
N4474	1853	12.95	-2	280.83	76.02
N4377	1603	13.20	-3	275.36	76.21
N4262	1589	12.67	-3	270.12	75.67
N4419	49	12.23	1	276.44	76.64
N4651	1041	11.61	5	293.05	79.12
N4489	1162	13.20	-5	277.16	78.59
N4866	2227	12.36	-1	311.59	76.92
N4710	1374	12.28	-1	300.79	78.03
N4461	2149	12.37	-1	281.22	75.11
N4568	2453	11.98	4	289.86	73.74
N4567	2407	12.37	4	289.76	73.75
N4532	2200	12.59	10	291.04	68.94
N4612	2038	12.59	-2	295.72	70.04
N4623	1996	13.03	-1	296.04	70.43
N4535	2159	10.90	5	290.06	70.65
N4522	2526	12.74	6	288.92	71.56
N4578	2508	12.48	-2	291.70	72.13
N4406	-4	10.75	-5	279.12	74.64
N4569	-16	10.58	2	288.46	75.62
N4037	1139	12.74	3	260.00	71.97
N4350	1482	12.30	-2	270.13	77.78
N4340	1167	12.25	-1	269.76	77.77
N4498	1729	12.80	6	277.85	78.76
N4382	1000	10.43	-1	267.73	79.24
N4394	1157	11.90	3	268.22	79.32
N4293	1173	11.70	0	262.83	78.84
N4421	1924	12.35	0	275.78	77.03
N4321	1799	10.26	4	271.14	76.91
N4383	1929	12.90	1	272.11	77.76
N4405	1977	12.90	0	273.42	77.59
N4539	1535	13.17	1	278.56	80.28
N4388	2730	12.69	3	279.09	74.33
N4473	2462	11.61	-5	281.63	75.40
N4501	2501	10.49	3	282.36	76.52
N4470	2561	12.90	1	286.95	70.02
N4450	2197	11.29	2	273.92	78.65
N4254	2693	10.52	5	270.42	75.20
N4168	2520	12.77	-5	267.65	73.34
N4189	2313	12.96	6	268.34	73.71
GROUP 42	3 GALAXIES				
N4902	2743	11.86	3	306.42	48.28
N4899	2761	12.70	5	306.43	48.85
N4891	2743	13.00	4	306.48	49.37
GROUP 43	3 GALAXIES				
-2-33-15	2513	12.37	9	302.10	52.74
N4658	2527	12.86	4	300.15	52.74
N4682	2428	13.10	4	301.25	52.80
GROUP 44	6 GALAXIES				
N1042	1108	11.81	6	182.07	-58.18
N1052	1216	12.12	-5	182.01	-57.93
N1035	978	13.15	5	181.36	-58.16
N1084	1153	11.38	5	182.47	-56.56
N991	1276	12.64	5	178.75	-58.24
N1022	1251	12.51	1	179.02	-57.36
GROUP 45	4 GALAXIES				
N0636	1567	12.66	-5	155.06	-67.36
N0615	1623	12.50	3	152.56	-67.67
N0596	1584	12.31	-5	150.91	-67.62
N0584	1644	11.71	-5	149.79	-67.65
GROUP 46	4 GALAXIES				
N5426	2789	12.91	5	333.25	52.51
N5427	2745	12.06	5	333.28	52.55
N5468	3029	12.40	6	334.88	52.69
N5493	2815	12.66	-2	336.95	52.45
GROUP 47	4 GALAXIES				
N1358	3823	12.74	0	190.59	-45.55
N1376	3909	12.97	6	191.21	-44.82
N1417	3889	12.80	3	191.78	-43.63
N1453	3664	13.10	-5	191.80	-42.29
GROUP 48	4 GALAXIES				
N1087	1279	11.74	5	173.75	-51.64
N1073	1002	11.80	5	170.92	-50.73
N1068	910	9.81	3	172.09	-51.93
N1055	775	11.77	3	171.33	-51.75
GROUP 49	10 GALAXIES				
N5713	2102	11.99	4	351.01	52.12
N5750	1936	12.58	0	352.87	51.17
N5740	1855	12.89	3	354.49	52.84
N5746	1955	11.81	3	354.97	52.96
N5690	1964	12.76	5	353.16	54.44
N5638	1882	12.67	-5	351.66	56.51
N5668	1822	12.31	7	354.43	56.75
N5576	1755	12.16	-5	348.72	57.95
N5566	1804	11.62	2	349.27	58.57
N5701	1751	12.16	0	357.46	56.37
GROUP 50	10 GALAXIES				
N5831	1913	13.05	-5	359.40	48.98
N5846	1955	11.76	-5	360.42	48.81
N5813	2184	12.09	-5	359.20	49.84
N5806	1585	12.70	3	359.09	50.19
N5838	1661	12.14	-3	360.74	49.33
N5854	1862	12.93	-1	361.88	49.18
N5864	2089	12.89	-2	362.86	49.16
N5850	2740	12.25	3	360.52	48.63
N5775	1910	12.48	5	359.45	52.42
N5774	1829	12.98	7	359.41	52.49
GROUP 51	3 GALAXIES				
N4179	1437	12.21	-2	281.61	62.57
N4116	1484	12.71	8	277.86	63.41
N4123	1491	12.04	5	277.97	63.63
GROUP 52	4 GALAXIES				
N0470	2194	12.75	3	136.64	-58.70
N0474	2205	12.51	-2	136.79	-58.69
N0520	1986	12.75	0	138.71	-58.06
N0488	2101	11.41	3	136.83	-56.79
GROUP 53	4 GALAXIES				
N3630	1639	13.01	-2	256.95	57.45
N3640	1429	11.82	-5	256.90	57.80
N3664	1524	13.01	9	258.00	58.39
N3611	1751	13.02	1	253.99	58.20
GROUP 54	3 GALAXIES				
N3156	1361	13.19	-2	238.25	45.14
N3166	1406	11.44	0	238.16	45.53
N3169	1367	11.50	1	238.21	45.66
GROUP 55	3 GALAXIES				
N5300	1393	12.03	5	335.73	63.15
N5364	1489	11.31	4	340.72	63.04
N5363	1372	11.46	0	340.96	63.25
GROUP 56	30 GALAXIES				
N3705	1180	11.95	2	252.01	63.78
N3666	1232	12.54	5	246.38	64.17
N3627	895	9.89	3	241.94	64.41
N3623	978	10.51	1	241.32	64.22
N3628	1022	10.43	3	240.85	64.79
N3593	860	11.91	0	240.43	63.21
N3596	1370	12.07	5	236.88	64.43
N3489	852	11.24	-1	234.39	60.92
N3655	1680	12.93	5	235.57	66.97
N3379	1064	10.83	-5	233.48	57.64
N3384	871	10.84	-3	233.50	57.75
N3412	1016	12.00	-2	232.87	58.72
N3377	838	11.75	-5	231.18	58.33
N3681	1435	12.70	4	236.14	67.85
N3684	1353	12.63	4	235.99	68.08
N3608	1389	12.31	-5	230.38	66.50
N3626	1668	12.11	-1	230.74	67.22
N3351	914	10.75	3	233.94	56.37
N3368	1033	10.32	2	234.42	57.01
N3389	1404	12.41	5	233.70	57.74
N3338	1442	11.59	5	230.32	57.03
N3346	1415	12.34	6	228.81	57.88
N3686	1261	12.24	4	235.69	68.28
N3607	1142	11.42	-2	230.58	66.43
N3599	1040	13.00	-2	230.07	66.14
N3370	1483	12.30	5	225.35	59.67
N3507	1160	11.40	3	227.12	63.58
N3455	1271	13.10	3	226.85	61.30
N3457	1327	13.00	15	226.26	61.49
N3485	1566	12.85	3	232.62	61.34
GROUP 57	6 GALAXIES				
N3239	1023	12.23	10	221.63	54.83
N3227	1353	11.75	1	216.99	55.45
N3226	1428	12.77	-5	216.92	55.44
N3189	1467	12.20	1	213.03	54.86
N3193	1536	12.37	-5	212.95	54.95
N3162	1460	12.20	4	211.04	54.09
GROUP 58	4 GALAXIES				
I1727	377	12.20	15	137.96	-33.89
N0672	361	11.76	6	138.03	-33.77
N 855	545	13.00	-7	144.39	-31.51
N0784	155	12.47	9	140.91	-31.59
GROUP 59	3 GALAXIES				
N0684	3463	13.20	3	138.55	-33.43
N670	3741	13.04	-2	137.76	-33.36
N 661	3804	13.00	-7	136.70	-32.73
GROUP 60	90 GALAXIES				
N4559	1092	10.56	6	198.31	86.47
N4448	973	12.29	2	195.22	84.67
N4525	1419	13.00	6	172.58	84.99
N4251	1287	12.03	-2	202.90	82.55
N4278	907	11.58	-5	193.66	82.77
N4245	1167	12.57	0	192.48	82.16
N4274	1191	11.50	2	191.42	82.61
N4314	1164	11.61	1	187.69	83.07
N4414	1014	11.21	5	174.44	83.18
N4136	718	11.80	5	193.60	80.34
N4631	919	10.04	7	142.76	84.21
N4203	1375	11.80	-3	172.93	80.07
N4020	1027	13.20	7	193.89	78.05
N4150	519	12.83	-2	190.39	80.46
N4062	1047	12.17	5	185.18	78.64
N4656	944	11.18	9	140.40	84.70
N4395	610	10.84	9	162.12	81.53
N4534	1165	13.20	7	145.66	80.81

TABLE 3—*Continued*

GROUP 60	cont'd				
N4214	588	10.38	10	160.27	78.07
N4190	432	13.20	10	160.59	77.57
N4244	540	10.92	6	154.54	77.15
N4485	773	12.00	10	137.97	74.81
N4736	633	8.91	2	123.31	75.99
N4618	876	11.60	9	130.59	75.81
N4625	871	13.00	9	130.20	75.69
N4490	895	10.29	7	137.97	74.86
N4449	516	10.08	10	136.82	72.39
N4460	876	12.47	-1	135.82	71.69
N4242	817	11.90	8	140.76	70.30
N4144	574	12.29	6	143.14	69.00
N4258	780	9.19	4	138.30	68.83
N4183	1239	12.51	6	145.36	71.71
N4389	1035	12.97	4	136.73	70.73
N4346	1080	12.49	-2	136.58	69.38
N4143	1088	12.40	-2	149.14	72.39
N4111	1098	12.08	-1	149.51	71.68
N4051	1010	11.23	4	148.86	70.07
N4096	870	11.31	5	143.53	67.79
N4218	1041	13.20	1	138.87	67.87
N4157	1097	11.80	3	138.44	65.39
I 750	1012	13.00	27	153.94	71.09
N4138	1345	12.80	-1	147.27	71.39
N4013	1131	12.43	3	151.81	70.08
N4217	1347	11.81	3	139.87	68.84
N4220	1270	12.56	-1	138.93	68.12
N4151	1250	11.48	2	155.06	75.05
N4145	1312	11.68	7	154.23	74.61
N3938	1106	11.02	5	153.86	69.31
N4010	1212	13.10	6	146.68	67.35
N3877	1203	12.00	5	150.70	65.95
N3949	1091	11.66	4	147.62	66.40
N4085	1064	13.11	5	140.59	65.17
N4088	1067	11.39	4	140.33	65.00
N3985	1288	13.00	9	145.92	66.26
N4100	1394	11.98	4	141.09	65.90
N4026	1190	12.13	-2	141.91	64.20
N4102	1182	12.67	3	138.06	63.07
N4369	1358	12.84	1	145.74	76.51
N3782	994	13.10	6	154.42	65.96
N3928	1295	13.10	-5	147.13	65.53
N3893	1272	11.10	5	148.12	65.21
N3726	1153	11.09	5	155.38	64.87
N3769	1021	12.50	3	152.66	64.74
N3870	1023	13.20	-2	146.99	63.74
N3917	1274	12.48	6	143.65	62.78
N3953	1348	11.11	4	142.19	62.57
N3992	1363	10.80	4	140.08	61.91
N3982	1503	12.45	3	138.81	60.26
N3972	1146	12.90	4	138.82	60.04
N3998	1344	11.79	-2	138.12	60.06
N3729	1338	12.26	1	146.62	60.27
N3898	1471	11.60	2	139.77	58.94
N3804	1694	12.72	6	141.61	58.28
N3756	1587	12.42	4	144.56	59.58
N3733	1476	13.20	5	144.35	58.96
N3657	1539	13.10	5	149.20	59.49
N3718	1316	11.72	1	147.00	60.20
N3631	1463	11.27	5	149.51	59.02
N3838	1612	12.70	0	139.28	56.97
N3674	2189	13.10	-2	143.83	56.47
N3780	2703	12.47	5	141.88	58.11
1126+57	2751	12.60	5	143.18	56.62
N3669	2244	12.90	6	143.33	55.85
N3619	1950	12.86	-1	144.44	55.34
N3613	2355	12.25	-5	144.33	55.09
N3610	2067	12.14	-5	143.52	54.44
N3642	1888	11.96	4	142.54	54.51
N3888	2670	13.00	5	140.28	58.94
N3690	3305	12.73	9	141.89	55.40
I 694	3421	11.80	9	141.89	55.40
GROUP 61	3 GALAXIES				
N3414	1629	12.23	-2	204.04	63.41
N3504	1754	11.80	2	204.56	66.05
N3512	1615	13.12	5	204.47	66.23
GROUP 62	3 GALAXIES				
N3245	1562	12.04	-2	201.88	58.22
N3277	1614	12.60	2	202.14	59.44
N3254	1463	12.41	4	200.09	58.75
GROUP 63	7 GALAXIES				
N0598	-206	6.47	5	133.63	-31.34
N0404	-21	11.47	-5	127.03	-27.00
N0221	-142	9.39	-6	121.16	-21.96
N0224	-237	4.61	3	121.17	-21.56
N0205	-176	9.71	-5	120.71	-21.12
N0185	-126	10.92	-5	120.79	-14.47
N0147	-83	11.48	-5	119.82	-14.24
GROUP 64	3 GALAXIES				
N2964	1488	12.37	4	194.59	49.03
N3003	1660	12.52	4	192.33	50.34
N3067	1643	12.91	2	194.20	52.32
GROUP 65	6 GALAXIES				
N3424	1722	13.20	3	193.01	63.56
N3430	1812	12.39	5	192.88	63.63
N3395	1854	12.46	6	192.90	63.13
N3396	1874	12.90	10	192.89	63.15
N3442	1970	13.20	1	190.67	63.72
N3381	1840	12.80	3	189.21	62.67
GROUP 66	3 GALAXIES				
N2770	2099	12.10	5	191.55	42.20
N2778	2173	13.10	-7	189.11	43.00
N2859	1849	11.96	-1	190.14	45.41
GROUP 67	8 GALAXIES				
N0925	543	10.96	7	144.89	-25.17
N 959	589	12.50	8	145.09	-22.99
N 949	619	13.14	-1	144.05	-21.63
N1058	516	12.26	1	146.41	-20.37
I0239	910	12.14	5	144.33	-19.49
N1023	658	10.65	-2	145.02	-19.09
N1003	643	12.45	5	144.00	-17.54
N0891	563	11.24	5	140.38	-17.41
GROUP 68	3 GALAXIES				
N5033	1201	10.85	5	98.16	79.44
N5005	1345	10.85	4	101.65	79.25
N5112	1296	12.72	6	96.09	76.74
GROUP 69	10 GALAXIES				
N5313	2937	13.07	3	83.36	72.35
N5353	2515	12.39	-2	82.62	71.64
N5354	2757	12.85	-2	82.66	71.60
N5350	2700	12.70	3	82.86	71.57
N5371	2906	11.59	4	82.17	71.19
N5362	2524	13.16	3	84.47	70.73
N5320	2957	13.10	5	86.41	71.32
N5290	2926	13.00	3	89.31	71.70
N5383	2605	12.14	3	84.83	70.07
N5297	2764	12.72	4	93.03	69.92
GROUP 70	3 GALAXIES				
N3614	2620	12.42	5	161.53	63.78
N3595	2531	13.00	15	159.26	62.33
N3583	2414	12.20	3	158.10	61.63
GROUP 71	4 GALAXIES				
N2537	601	12.55	10	173.79	32.96
N2541	734	12.14	6	170.16	33.47
N2552	699	12.54	10	169.08	34.29
N2500	689	12.39	7	167.98	31.56
GROUP 72	4 GALAXIES				
N5301	1911	12.70	3	96.70	68.11
N5377	2148	12.43	1	94.93	66.20
N5448	2378	12.53	1	95.75	64.00
N5480	2216	12.90	5	96.89	62.43
GROUP 73	3 GALAXIES				
N5689	2523	13.17	0	87.02	60.48
N5676	2487	11.87	4	88.71	60.38
N5660	2681	12.44	5	89.57	60.64
GROUP 74	3 GALAXIES				
N2841	860	10.27	3	166.93	44.15
N2756	1094	13.20	3	163.58	41.66
N2681	921	11.34	0	167.31	39.68
GROUP 75	3 GALAXIES				
N5474	631	11.74	6	100.83	60.18
N5457	607	8.58	6	102.05	59.74
N5585	662	11.66	7	101.01	56.47
GROUP 76	4 GALAXIES				
N5687	2480	12.90	-3	95.41	56.75
N5631	2338	12.84	-2	99.54	56.00
N5678	2579	12.30	3	100.06	54.50
N5667	2359	13.10	6	102.04	53.43
GROUP 77	4 GALAXIES				
N5473	2362	12.66	-3	102.27	59.18
N5485	2342	12.80	-2	101.81	58.90
N5422	2192	12.83	-2	103.52	59.27
N5443	2381	13.20	3	103.80	58.60
GROUP 78	4 GALAXIES				
N5866	1035	11.19	-1	92.05	52.49
N5906	955	11.40	5	91.59	51.08
N5879	1134	12.32	4	93.24	51.39
N5963	1018	13.00	20	90.00	48.86
GROUP 79	3 GALAXIES				
N3958	3639	13.10	1	136.67	57.20
N3963	3502	12.52	4	136.49	57.11
N3894	3572	12.90	-5	137.10	55.94
GROUP 80	5 GALAXIES				
N2685	1113	12.35	-2	157.75	38.89
N2742	1510	12.41	5	155.10	39.95
N2726	1672	13.10	1	155.90	39.78
N2768	1606	11.48	-5	155.46	40.56
N2654	1572	13.05	2	156.11	37.81

TABLE 3—*Continued*

GROUP 81	4 GALAXIES				
N5376	2417	13.07	3	108.57	55.79
N5389	2185	13.20	0	108.58	55.53
N5322	2155	11.45	-5	110.28	55.48
N5308	2388	12.70	-3	111.25	54.86
GROUP 82	3 GALAXIES				
N3945	1537	11.91	-1	135.32	55.02
N4036	1722	11.87	-3	132.97	54.24
N4041	1554	11.93	4	132.68	54.03
GROUP 83	7 GALAXIES				
N4545	3071	13.10	5	126.09	53.48
N4521	3291	13.00	0	126.32	53.05
N4332	3170	13.20	1	127.59	51.01
N4256	2903	12.70	3	128.20	50.87
N4108	2807	13.00	5	129.55	49.36
N4128	2636	13.00	-2	128.69	47.86
N4250	2443	13.00	-1	126.94	46.04
GROUP 84	3 GALAXIES				
N1569	82	12.02	10	143.68	11.25
I0342	214	10.50	6	138.17	10.59
N1560	166	12.37	7	138.36	16.03
GROUP 85	3 GALAXIES				
N2403	351	9.07	6	150.55	29.18
N2366	328	11.69	10	146.40	28.54
HOLM II	409	11.44	10	144.27	32.67
GROUP 86	5 GALAXIES				
N2976	288	11.09	5	143.89	40.89
I2574	336	11.20	9	140.19	43.59
N3077	289	11.12	0	141.88	41.66
N3031	236	7.88	2	142.07	40.89
N3034	527	9.57	0	141.39	40.55
GROUP 87	4 GALAXIES				
N3516	2843	12.86	-2	133.22	42.39
N3348	3129	12.45	-5	134.62	41.34
N3147	3011	11.52	4	136.27	39.45
N3183	3377	12.97	4	135.24	39.14
GROUP 88	7 GALAXIES				
N4750	1844	12.60	2	123.07	44.23
N4589	2307	12.40	-5	124.23	42.88
N4648	1825	12.60	-5	123.82	42.67
N4319	2003	13.00	2	125.44	41.64
N4291	2032	12.83	-5	125.55	41.58
N4386	1967	12.90	-3	125.17	41.47
N4133	1679	13.10	3	126.65	41.88
GROUP 89	4 GALAXIES				
N2629	3914	12.80	-7	140.94	34.20
I 520	3795	13.01	2	140.17	34.45
N2523	3681	13.01	4	141.01	31.81
MK 12	4196	12.70	20	140.43	30.04
GROUP 90	3 GALAXIES				
I529	2538	12.00	5	138.97	35.93
N2634	2536	12.60	-7	139.79	33.94
N2633	2423	12.94	3	139.65	33.87
GROUP 91	3 GALAXIES				
N2748	1766	12.66	4	136.23	34.35
N2715	1617	12.32	5	134.71	33.31
N2655	1665	11.22	0	134.90	32.68
GROUP 92	3 GALAXIES				
N2268	2502	12.48	4	129.21	27.55
N2300	2201	12.44	-2	127.67	27.81
N2276	2697	12.25	5	127.62	27.72

approximately 60% of the galaxies in the volume searched fall in groups, 26% are isolated (or too near the edge of our sample—e.g., in the galactic plane), and 14% are in doubles. These fractions do not change appreciably at a density contour of 10—the fraction in groups rises to 68%. In fact, if the cut is made at a density contour of 100, the fraction in groups is still ~40%. Single galaxies are not listed, for the same reasons outlined in Huchra and Thuan (1977): most of these galaxies are not truly isolated but rather lie near the edges of the sample in either velocity, magnitude, or position. Searches to fainter limiting magnitudes almost always yield companions for these galaxies.

Figure 3 is a two-dimensional projection of the quasi-three-dimensional density contours for the $\sim 60° \times 60°$ region centered at 12^h and 0°. The large dashed and dotted density enhancement contour cutting diagonally across the entire region outlines the supergalactic plane. The solid contour centered near 12^h30^m and 13° outlines the central concentration of the Virgo cluster. The dashed contour centered near 11^h and 15° encompasses the four concentrations in Leo. It is clear that the local supercluster is not spherically symmetric.

Theoretical models of galaxy clustering have assumed hierarchical or self-similar clustering (Press and Schechter 1974; Efstathiou, Fall, and Hogan 1979; Peebles 1980). In this nearby sample, the hierarchical nature of the clustering is particularly evident near the supergalactic plane, but for some other concentrations (e.g., the one at 12^h and $-20°$) the structure is nearly concentric. The number of contours at a particular level which lie within the contours of the next lower level gives information about the high order moments of the galaxy distribution.

VI. ANALYSIS

The groups in the catalog (Table 3) are all number density enhancements greater than 20. Groups of fixed minimum number density contour are identified by the procedure outlined in Figure 1 with both V_0 and D_0 scaled by equations (3) and (5) to account for the variation in sampling the galaxy luminosity function with distance. Figure 4 shows the variation of the search limits, V_L and D_L, with the mean redshift of the galaxy pair, V. The fiducial values for $V_F = 1000$ km s^{-1}, $V_0 = 400$ km s^{-1} and $D_0 = 0.63$ Mpc are indicated.

We can easily construct a set of group catalogs by varying V_0 and D_0. For each of these catalogs we calculate a set of number-weighted dynamical parameters: the line-of-sight velocity dispersion uncorrected for measurement error (eq. [12]), the mean harmonic radius

$$r_H = \frac{\pi V_G}{H_0} \sin\left\{\left[n_G(n_G-1)\sum_{j<i}^{N}\sum_{i=1}^{N}\frac{1}{\theta_{ij}}\right]^{-1}\right\}, \quad (13)$$

where θ_{ij} is the angular separation of the ith and jth group members, the mean pairwise separation,

$$r_p = \frac{8V_G}{\pi H_0} \sin\left[\frac{1}{n_G(n_G-1)}\sum_{j<i}^{N}\sum_{i=1}^{N}\theta_{ij}\right], \quad (14)$$

which is a measure of the size of the group, the virial

TABLE 4

COMPARISON WITH DE VAUCOULEURS'S GROUPS

DV Group No.	HG Group No.	Other Names
0	63	Local
1	13	Sculptor
2	85,86	M81
3,10,13,17,32,34	60	Ursa Major + CVn + Coma
4	19	Centaurus
5	75	M101
6	74,71	N2841
7	58,67	N1023
9,11,49	56	Leo
15	44,48	
16,22	3	N1566
18,19,20,25,26,35,46	41	Virgo
21	8	
27	12,15	Grus
29	49	
30	78	
31	32	Eridanus
33	45	
36	34	
37	73	
40	52	
41	80	
42	64,66	
43	65	
44	27,28	
45	7,10	
47	57	
48	61	
50	50	
52	9	
53	17	Fornax
54	62	

NOTE.—Missing DV Groups: 8(B), 12, 14(B), 23(B), 24, 28(B), 38, 39(2B), 51.

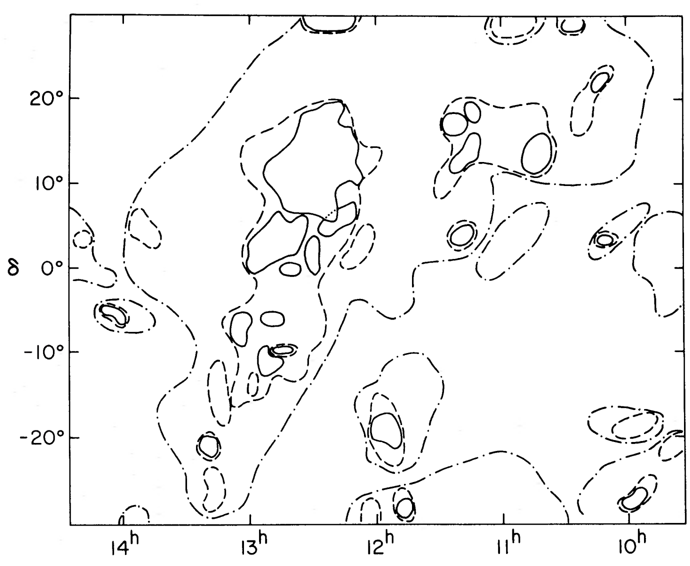

FIG. 3.—A contour plot for the region around 12^h, 0°. Contours shown are density enhancements of 2 (*dashed and dotted line*), 20 (*dashed line*), and 100 (*solid line*). In one region near 12^h20^m and +7° the dotted line indicates the underlying contour of a background group, because this is a two-dimensional representation of a three-dimensional contour plot. The group at 12^h40^m and −10°, and the group at 13^h and −14°, are also background groups.

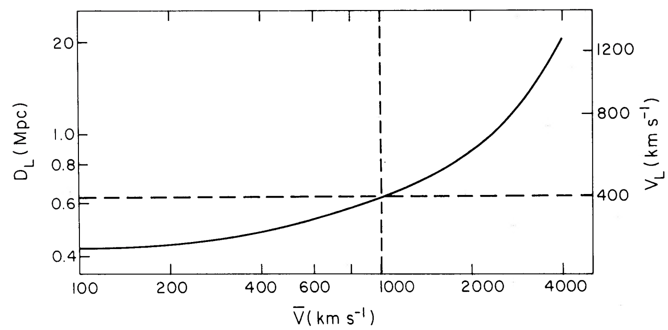

FIG. 4.—Selection parameters as a function of distance. This schematic shows the effect of correction for the available part of the luminosity function.

$$M_{\odot}/L_{\odot}=6.96\times10^{8}\sigma^{2}r_{H}/L_{\odot}, \tag{15}$$

where $L_{\odot}$ is the total group luminosity in solar units corrected for incomplete sampling, σ is in km s^{-1}, and r_H is in Mpc, and the virial crossing time (in units of the Hubble time H_0) is

$$t_{v}=\frac{3}{5^{3/2}}r_{H}/\sigma. \tag{16}$$

The quantities in equations (12)–(16) are listed in Table 5 for the groups in the catalog. Also listed are the mean right ascension and declination, total apparent magnitudes, and V_G. Our group selection algorithm does not, of course, guarantee that the groups we find are bound, virialized systems. The larger the $\delta\rho_N/\rho_N$, the more likely the groups are to be bound. For $\delta\rho_N/\rho_N>10$, most of the groups in the catalog have crossing times much less than $H_0{}^{-1}$. We therefore take equation (15) as an approximate mass indicator; we have also calculated the estimator suggested by Bahcall and Tremaine (1981) and for most groups the two estimates are the same to within the statistical uncertainties. Note that for groups with small numbers of members, the uncertainty in the velocity dispersion and hence in the M/L is very large (Danese, DeZotti, and di Tullio 1980).

Seven of our groups have mass-to-light ratios in excess of 1000. Group 14 probably contains an interloper, NGC 4679. Groups 16, 58, and 84 have very small redshifts, and we are probably underestimating the group luminosity because the distance is only poorly known.

Table 6 gives the median σ_v, and M/L as well as the number of groups (the number of binaries is shown in parentheses) as a function of the selection criteria. Use of the median rather than the mean decreases the sensitivity to condensations which have dynamical parameters in the tail of the distribution (see Fig. 5). In particular, use of the median also de-weights groups which have large velocity dispersions and/or mass-to-light ratios because of large numbers of interlopers. Table 5 shows that many of the groups with the largest M/L ratios have a small number of members and are thus most subject to contamination. For 0.6 Mpc $< D_0 <$ 0.8 Mpc and 300 km $s^{-1} < V_0 <$ 500 km s^{-1} the variations in the median dynamical parameters are small compared with the probable errors in their determination. We identify this range in which the group parameters are least sensitive to the selection criteria as the range in which the groups are most likely to be real, physical associations.

From Table 6 we can see quantitatively the effects of the limits on group selection presented schematically in Figure 2. At $V_0=200$, the velocity dispersion appears to be biased toward small values. From Table 2 we see that for the typical group from three to four members, the average velocity dispersion is limited to 0.6–0.7 V_0. For $V_0=200$ km s^{-1}, the median values of the velocity dispersion are perilously close to this limit and the means are at the limit: in other words, for this V we get out what we put in. This restriction of the velocity dispersion has been a major flaw in some earlier group selection attempts (Materne 1978; Tully 1980). At $V_0=$ 300–400 km s^{-1}, $\sigma_{v,\text{mean}}\approx0.3\ V_0$; at these limits the dispersion is well below the selection limit. At $D_0=1.0$ Mpc, the interloper fraction is high (see Table 4); the dynamical parameters thus vary strongly as a function of V_0. At $D_0=0.37$ Mpc the number density enhancement is 100 and the number of groups is small. Note that the apparent optimal parameter choice coincides with the range for which the number of groups found is maximized.

The catalog (Table 3) is representative of the parameter range for which variation in the derived dynamical quantities is small. Figures 5*a*, 5*b*, and 5*c* are histograms of the line-of-sight velocity dispersions, the sizes (r_p), and the crossing times for the groups in the catalog. The three groups with velocity dispersions greater than 500 km s^{-1} are Virgo, Ursa Major, and the available piece (brightest galaxies) of the Centaurus cluster—all known to be large and relatively massive groups or

TABLE 5

GROUP PARAMETERS

GNO	NOG	RA	DEC	VR	SIGV	AMAG	MGRP	M/L	CT	RH	RP
1	3	731.0	-69 9	1046	70	11.2	5.87E+11	105	0.07	0.17	0.23
2	3	1844.2	-6523	608	103	9.5	3.94E+12	483	0.14	0.53	0.48
3	18	432.9	-5757	810	240	8.4	2.58E+13	622	0.07	0.64	1.05
4	3	1915.9	-6024	3624	84	11.7	4.96E+11	2	0.03	0.10	0.49
5	4	1911.7	-56 2	2972	349	11.2	1.01E+14	821	0.09	1.19	1.09
6	3	321.0	-5251	698	54	11.2	7.92E+11	332	0.19	0.38	0.37
7	3	2150.8	-4847	1706	138	11.4	4.70E+12	292	0.07	0.36	0.44
8	10	349.9	-4516	696	178	9.1	1.58E+13	958	0.11	0.72	0.74
9	4	20 6.8	-4827	2766	171	11.1	1.51E+13	161	0.12	0.74	0.93
10	3	2211.6	-4640	1687	152	10.7	1.17E+13	417	0.13	0.73	0.63
11	4	2133.2	-4351	2212	200	11.3	3.08E+13	781	0.15	1.11	0.98
12	9	2310.5	-4255	1305	113	9.6	2.70E+12	63	0.07	0.30	0.72
13	9	035.5	-3114	-8	170	6.9	1.63E+13	771	0.13	0.81	0.86
14	8	1238.2	-3959	3236	673	10.5	5.57E+14	1614	0.07	1.77	1.97
15	10	2255.5	-3812	1236	386	9.5	5.92E+13	1527	0.04	0.57	0.79
16	4	5 3.0	-3326	591	220	10.1	1.54E+13	3531	0.06	0.46	0.92
17	23	333.3	-3450	1087	307	8.3	2.62E+13	293	0.04	0.40	0.74
18	8	1030.3	-3521	2968	356	10.3	5.55E+13	214	0.05	0.63	1.37
19	4	1334.2	-3317	424	93	8.0	3.08E+12	198	0.15	0.51	0.51
20	3	1217.2	-3355	2696	116	11.5	1.14E+13	200	0.29	1.23	1.07
21	4	954.3	-3240	2677	147	11.3	1.83E+13	264	0.22	1.21	1.12
22	3	1329.1	-3326	3673	51	11.3	2.52E+12	9	0.72	1.38	1.18
23	3	2029.2	-3217	2813	138	11.4	1.76E+13	220	0.26	1.33	1.19
24	3	210.6	-3216	2972	80	11.9	4.73E+12	77	0.36	1.07	0.96
25	3	410.7	-3235	905	124	10.8	2.05E+11	34	0.00	0.02	0.17
26	3	14 2.9	-2945	2694	57	11.5	3.24E+12	56	0.69	1.45	1.37
27	4	12 4.8	-29 1	2001	165	10.9	1.25E+12	31	0.01	0.07	0.54
28	4	1147.3	-2757	1823	184	10.8	1.52E+13	447	0.09	0.64	0.63
29	4	956.8	-2653	2441	255	11.1	5.03E+13	817	0.12	1.11	1.01
30	4	311.8	-2633	1306	139	10.5	1.03E+13	561	0.15	0.76	0.69
31	3	1317.3	-2558	2007	105	10.8	7.39E+12	168	0.24	0.96	0.96
32	21	329.3	-2115	1301	171	8.6	2.31E+13	215	0.18	1.14	1.47
33	10	1155.8	-1859	1716	178	9.9	5.44E+12	82	0.04	0.25	0.89
34	3	615.6	-2159	2337	215	10.8	3.69E+13	536	0.14	1.15	1.14
35	3	1319.3	-2056	1833	71	11.3	3.85E+12	178	0.19	0.64	0.52
36	3	939.3	-2044	2138	191	11.4	1.89E+13	628	0.10	0.75	0.69
37	3	958.1	-1855	3556	68	11.5	6.08E+12	31	0.73	1.87	1.64
38	4	911.3	-1535	2070	271	11.2	5.11E+13	1542	0.10	1.00	0.97
39	3	1315.4	-1422	2861	77	11.4	7.57E+12	90	0.65	1.85	1.66
40	3	1513.6	-14 5	2313	98	11.4	7.91E+12	204	0.32	1.18	1.11
41	166	1232.7	740	1439	615	6.2	2.21E+14	188	0.04	0.84	3.17
42	3	1258.3	-1342	2749	10	11.2	4.76E+11	6	0.35	0.49	0.44
43	3	1244.5	- 949	2489	54	11.5	9.61E+11	22	0.24	0.48	0.44
44	6	237.7	- 755	1164	110	10.2	2.42E+12	131	0.07	0.29	0.37
45	4	132.1	- 726	1605	35	10.7	3.20E+11	13	0.29	0.38	0.40
46	4	14 3.6	- 524	2844	126	11.0	2.21E+12	18	0.04	0.20	0.82
47	4	337.3	- 451	3821	111	11.4	1.40E+13	42	0.39	1.62	1.63
48	4	241.1	0 7	991	213	9.4	9.03E+12	340	0.04	0.28	0.28
49	10	1433.2	246	1883	109	9.7	1.07E+13	113	0.32	1.30	1.61
50	10	15 0.4	228	1973	322	9.9	3.66E+13	409	0.04	0.51	0.87
51	3	12 7.0	234	1471	29	11.1	1.37E+11	10	0.20	0.22	0.44
52	4	119.0	342	2122	102	10.7	1.54E+12	27	0.06	0.21	0.63
53	4	1118.2	347	1586	139	11.1	5.28E+12	307	0.08	0.39	0.45
54	3	1011.0	335	1378	25	10.6	5.19E+10	3	0.09	0.10	0.11
55	3	1351.0	459	1418	62	10.4	6.17E+11	24	0.10	0.23	0.51
56	30	11 3.3	15 5	1205	251	7.8	3.89E+13	207	0.10	0.89	1.59
57	6	1017.6	2049	1378	184	10.3	3.34E+12	133	0.02	0.14	0.84
58	4	154.9	2737	359	160	10.8	1.21E+12	1373	0.01	0.07	0.29
59	3	144.5	2750	3669	181	11.9	2.29E+13	133	0.15	1.00	0.94
60	90	12 0.0	4540	1276	557	6.7	7.04E+13	120	0.02	0.33	3.35
61	3	1056.8	2816	1666	77	11.1	9.04E+11	45	0.08	0.22	0.70
62	3	1027.0	29 5	1546	77	11.1	2.06E+12	134	0.17	0.50	0.41
63	7	048.9	4044	-141	74	4.4	8.14E+11	4	0.08	0.22	0.61
64	3	947.0	3247	1597	95	11.4	6.64E+12	510	0.30	1.05	0.89
65	6	1048.1	3340	1845	81	10.8	4.76E+11	15	0.03	0.10	0.41
66	3	912.3	3425	2040	170	11.1	2.79E+13	796	0.22	1.40	1.19
67	8	231.0	3752	630	123	9.4	5.35E+12	521	0.11	0.51	0.56
68	3	1313.1	3743	1281	73	10.0	1.77E+12	66	0.17	0.47	0.58
69	10	1349.9	4123	2759	171	10.1	8.33E+12	33	0.06	0.41	1.01
70	3	1113.2	4726	2522	103	11.3	7.49E+12	127	0.26	1.01	1.00
71	4	8 8.6	49 6	681	56	10.9	1.08E+12	368	0.23	0.49	0.48
72	4	1356.0	4833	2163	194	11.1	4.19E+13	1051	0.22	1.60	1.57
73	3	1430.9	4929	2564	103	11.2	3.92E+12	58	0.14	0.53	0.50
74	3	9 4.7	5214	958	121	9.9	1.01E+13	647	0.22	0.99	0.81
75	3	14 7.7	55 9	634	28	8.5	1.46E+11	6	0.26	0.27	0.36
76	4	1429.5	5720	2439	112	11.2	1.39E+13	253	0.38	1.59	1.53
77	4	14 2.0	5527	2319	86	11.3	2.26E+12	54	0.14	0.44	0.41
78	4	1515.1	5635	1035	74	10.3	1.95E+12	148	0.18	0.51	0.51
79	3	1150.2	59 2	3571	68	11.6	1.02E+12	5	0.12	0.31	0.70
80	5	857.9	60 4	1495	221	10.6	1.85E+13	789	0.07	0.54	0.57
81	4	1350.3	6020	2286	135	10.8	5.82E+12	95	0.09	0.46	0.55
82	3	1156.4	6150	1604	102	10.7	1.94E+12	76	0.07	0.27	0.43
83	7	1217.9	6650	2903	301	10.9	9.78E+13	648	0.14	1.55	2.25
84	3	411.7	68 8	154	67	10.1	1.51E+12	1354	0.19	0.48	0.40
85	3	743.1	6838	363	41	8.9	5.47E+11	106	0.30	0.46	0.39
86	5	958.1	69 0	335	113	7.5	1.18E+12	79	0.03	0.13	0.15
87	4	1034.3	7330	3090	224	10.8	5.43E+13	267	0.19	1.55	1.62
88	7	1227.1	7456	1951	199	10.6	1.05E+13	228	0.05	0.38	0.71
89	4	821.1	7346	3897	221	11.4	6.73E+13	189	0.24	1.98	2.35
90	3	853.0	74 8	2499	66	11.2	7.50E+11	13	0.10	0.25	0.81
91	3	859.6	7747	1682	76	10.7	2.12E+12	74	0.18	0.52	0.54
92	3	7 9.2	8523	2467	250	11.2	7.79E+12	133	0.02	0.18	0.53

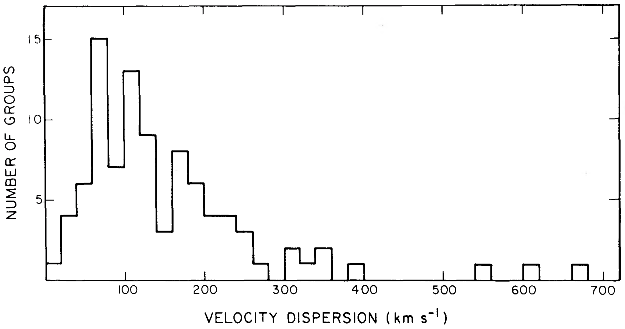

FIG. 5*a*

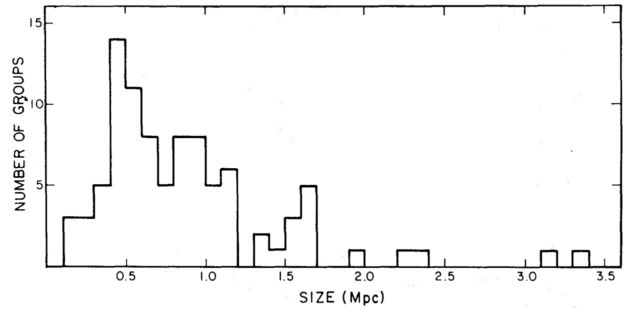

FIG. 5*b*

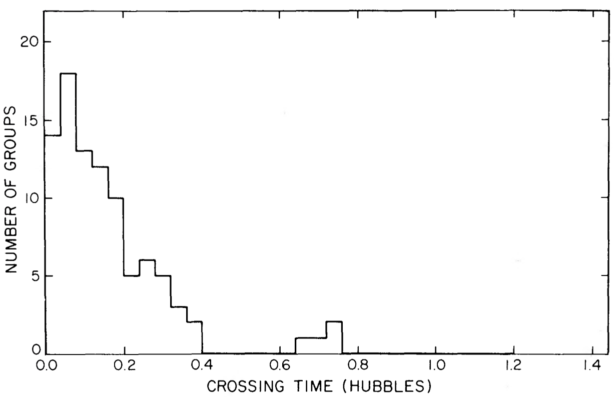

FIG. 5*c*

FIG. 5.—Histograms of dynamical parameters for the galaxy groups, (*a*) Line of sight velocity dispersion; (*b*) size, defined as the mean pairwise separation; (*c*) crossing time in units of the Hubble time.

TABLE 6

VARIATION OF DYNAMICAL PARAMETERS WITH SELECTION CRITERIA

D_0	V_0 200	300	400	500
	A. Velocity Dispersion σ_v			
0.37	102	124	132	142
0.63	103	114	122	136
0.78	100	116	139	165
1.01	104	140	184	230
	B. M/L			
0.37	78	131	152	156
0.63	107	136	170	198
0.78	125	145	201	209
1.01	140	205	302	425
	C. Number of Groups			
0.37	72(109)	83(102)	77(102)	79(99)
0.63	94(87)	93(84)	92(83)	93(80)
0.78	96(67)	88(69)	93(62)	93(60)
1.01	86(55)	78(52)	58(52)	65(40)

clusters. The velocity dispersions are in agreement with previously published values. It is interesting to note that the computed virial mass-to-light ratios for Virgo and Ursa Major are 190 and 120 in solar units, near the median for other, much smaller groups. The mean velocity dispersion for the sample is 155 km s^{-1} at a scale of 0.7 Mpc (mean group size). This number weighted average is about a factor of 2 lower than the pair-weighted velocity dispersion found by DGH for application of the statistical virial theorem to a sample including the Virgo cluster. This discrepancy occurs because the large velocity dispersion groups contain a large number of members and thus contribute strongly to the pairwise estimate.

All of the crossing times are less than 1.0; in fact, only four are greater than 0.4, and all four of these are triples at large distances. Therefore the virial theorem should provide us with reasonable estimates of the masses.

We make no attempt to correct the individual group velocity dispersions for the measurement errors in individual galaxy velocities. The mean quoted error for the ~1300 galaxies in the sample is only 26 km s^{-1}; the median is only 20 km s^{-1}. Subtraction of the error in quadrature from the median group dispersion of 122 km s^{-1} gives 120 km s^{-1}. Clearly the M/L's for the few groups with velocity dispersions less than 50 km s^{-1} must be regarded with caution, but the median estimator of typical group characteristics is insensitive to these uncertainties.

The statistical properties of the technique will be discussed in more detail in Paper II, where we analyze a much larger sample of groups to a greater distance. There we will also apply the technique to a set of *n*-body simulations in order to investigate possible systematics. As an example of the lack of systematics introduced by our techniques we show in Figure 6 a plot of log M/L as a function of distance. There is no significant correlation.

VII. SUMMARY

The main purpose of this paper is to present a straightforward group selection procedure for which

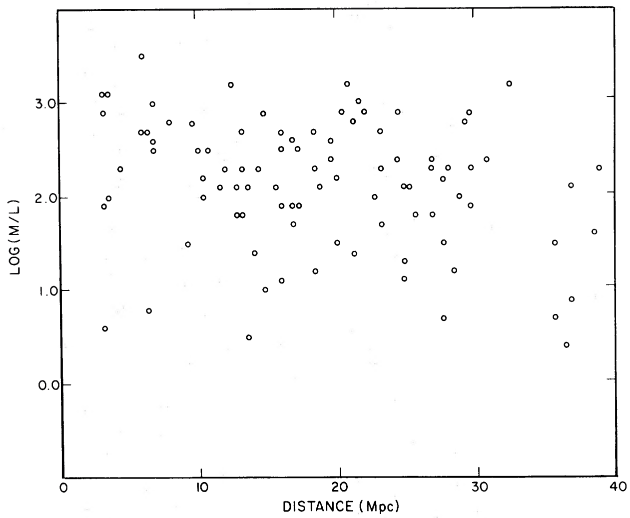

FIG. 6.— M/L as a function of distance

biases can be easily examined. We have shown that there exists a range of selection parameters for which the dynamical parameters of the selected groups are stable. The M/L obtained is roughly 170 in solar units. If this value is applied to the mean luminosity density found in the CfA redshift survey (Davis and Huchra 1982), the mean cosmological mass density is 0.1, in reasonable agreement with almost all previous determinations from group dynamics but smaller than that derived from analyses of the Local Supercluster (Davis *et al.* 1980; Aaronson *et al.* 1980). Even our largest groups (Virgo, Ursa Major) are consistent with a low value for M/L. In this sample there is no evidence for a dependence of M/L on group size. Paper II, which is an analysis of the whole CfA redshift survey, contains a detailed discussion of groups of galaxies as cosmological probes.

We have tried a wide variety of techniques and for reasonable selection criteria found not only the same dynamical results but also similar group membership. It does not matter how one looks for number or luminosity density enhancements in redshift space, as long as no biases are introduced and the selection is not allowed to become degenerate.

The group catalog is presented as a statistical sample. We do not investigate the detailed properties of each group, but we note that many of the well known and well studied nearby groups appear in the sample. There are mass and crossing time estimators other than the virial theorem (Bahcall and Tremaine 1981; Jackson 1975; Gott and Turner 1977). Although we have not presented these quantities, we have in fact calculated them. Even though the distribution of values of a parameter is sensitive to the particular definition, the median values of interest vary by less than 50%. We have not included the binaries because they are maximally sensitive to both the interloper problem and selection biases, but their inclusion would not substantially change any of the above results.

We thank Paul Schechter, Marc Davis, Scott Tremaine, Bill Press, and Dave Latham for interesting (and sometimes even useful) comments and discussions. W. Jacob, S. Rapp, and D. Danby helped in the preparation of the galaxy catalog. We also thank Brent Tully, A. Sandage, and G. Tammann for communicating data in advance of publication. M. J. G. thanks the Institute of Astronomy, Cambridge for partial support of this work. Typing services, as usual, were provided by Fang, Inc.

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