THE LUMINOSITY DISTRIBUTION OF LOCAL GROUP GALAXIES

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ABSTRACT

From a rediscussion of Local Group membership and of distances to individual galaxies, we obtain M_V values for 35 probable and possible Local Group members. The luminosity function of these objects is well fitted by a Schechter function with faint-end slope $\alpha = -1.1 \pm 0.1$. The probability that the luminosity distribution of the Local Group is a single Schechter function with α steeper than -1.3 is less than 1%. However, more complicated luminosity functions, such as multicomponent Schechter functions with steep faint-end slopes, cannot be ruled out. There is some evidence that the luminosity distribution of dwarf spheroidal galaxies in the Local Group is steeper than that of dwarf irregular galaxies.

Key words: galaxies: luminosity function, mass function — Local Group

1. INTRODUCTION

The galaxy luminosity distribution, or luminosity function (LF),[1] $\phi(L)$ plays an important role in our understanding of the properties of galaxies, galaxy evolution, and galaxy formation. The connection between $\phi(L)$ and galaxy formation is through the primordial density fluctuation spectrum, $\delta\rho/\rho \propto k^n$, where k is wavenumber. If the universe consisted only of weakly interacting particles (e.g., "cold dark matter" [CDM]), then the mass function of "halos" would be determined solely by n and could be computed using a simple physical recipe for the gravitational clustering and merging of halos (e.g., Press & Schechter 1974). However, it is the baryons, rather than the dark matter, that we observe directly; hence the luminosity function $\phi(L)$ depends on gas physics and radiation processes (e.g., cooling, radiative transfer, star formation, and energy input from supernovae, to name just a few). It follows that the luminosity function is sensitive not only to the fluctuation spectrum $\delta\rho/\rho$ but also to the detailed history of galaxy formation and evolution in different environments.

Generally the luminosity function of galaxies is parameterized by a Schechter (1976) function,

$$\phi(L) = \phi^* e^{-(L/L^*)}(L/L^*)^\alpha , \qquad (1)$$

where L^* is a characteristic luminosity defining the transition between a power law at faint magnitudes and an exponential cutoff at bright magnitudes. (Further information concerning the Schechter function can be found in Felten 1985.) L^* corresponds roughly to the brightness of the Milky Way. For a CDM fluctuation spectrum with $n = 1$, the power-law exponent α is theoretically predicted to be approximately -2 on the scale of galaxies (Bardeen et al. 1986), though this result is very sensitive to the detailed physical processes involved in the calculation (cf. Babul & Ferguson 1996; Frenk et al. 1996; Kauffmann et al. 1999).

What is known empirically about the shape of the luminosity distribution in the nearby universe? Values of α in the range -0.7 to -1.0 have been obtained for bright galaxies within 2–3 mag of L^* (e.g., Loveday et al. 1992; Marzke et al. 1994a; Marzke, Huchra, & Geller 1994b; Lin et al. 1996), with a hint of a turnup in the LF at magnitudes fainter than about $M_R = -17$ in the work of Lin et al. The field luminosity distribution derived from the second Southern Sky Redshift Survey (SSRS2) (Marzke et al. 1998) indicates a relatively flat value of $\alpha \simeq -1$ for E/S0's (including dwarf spheroidals) and spirals, and a steep $\alpha = -1.8$ value for dwarf irregulars and peculiars; this steepening of the LF for late-type star-forming systems also appears in the work of Bromley et al. (1998), who subdivided the Las Campanas Redshift Survey according to emission-line strength. Côté et al. (1999) have found a very steep ($\alpha = -2.1$) luminosity distribution for nearby H I–rich low surface brightness galaxies, and Schneider, Spitzak, & Rosenberg (1998) find a steep upturn in the H I mass function for low-mass objects ($M_{\rm H I} \lesssim 10^8\ M_\odot$).

Turning to other environments, Loveday (1997) finds that the luminosity distribution of dwarf galaxies surrounding luminous ($\sim L^*$) galaxies is steep: this can be interpreted either as a turnup in a supposedly universal field luminosity distribution or alternately as an enhanced probability that dwarfs form in the vicinity of luminous, massive galaxies. Galaxies in groups exhibit a slope $\alpha \simeq -1$ (Muriel, Valotto, & Lambas 1998). There is evidence that compact group luminosity distributions cannot be fitted by a single Schechter function (Hunsberger, Charlton, & Zaritsky 1998) but instead show $\alpha = -0.5$ at the bright end and $\alpha \simeq -1.2$ below $M_R \simeq -16$. There is also some indication that cluster LFs must be fitted with multiple Schechter functions (e.g., Trentham 1999; Lopez-Cruz et al. 1997), with a steep upturn at faint magnitudes (e.g., Trentham 1998a; Phillipps et al. 1998). Phillipps et al. (1999) suggest the existence of an environmental dependence of dwarf-to-giant ratio (i.e., α) in clusters. The faintest galaxies in the steep luminosity distribution population in clusters are, based on their colors (Trentham 1998a, 1999), dwarf spheroidals, whereas in the field they appear to be gas-rich dwarf irregulars (Marzke et al. 1998). (It should, however, be noted that the Marzke et al. dIr/peculiar sample is drawn from a small local volume and comprises only 4% of the total SSRS2 sample.)

On the basis of the discussion given above, it appears that the simple paradigm of a universal Schechter function (that

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[1] The *luminosity function* is expressed in units of number density (e.g., number per Mpc³), whereas the *luminosity distribution* simply gives the shape of the luminosity function without density normalization.

fits the LF of galaxies in all environments) is now untenable. There is growing evidence that the LF is not a simple Schechter function, that it depends on environment, and that it also depends on galaxy morphological class and/or gas content within a given environment. No clear physical picture has emerged that would allow one to understand current observational evidence on the shape and environmental dependence of the LF.

The Local Group represents a unique opportunity for the study of the luminosity distribution in relatively low density environments. The manner in which faint Local Group galaxies are detected is completely different from that for other groups (because most Local Group galaxies are easily resolved into stars); hence, surface brightness selection effects operate differently in the Local Group than they do in more distant groups. Subtraction of foreground and background contaminating objects is irrelevant for Local Group galaxies, something that is of course not the case for more distant clusters. The numbers of galaxies in poor groups are so low that it has usually been possible to study only the *composite* LF of poor groups (rather than the LF of any group individually)—here the Local Group again is an exception. Furthermore, the census of Local Group members extends to considerably fainter absolute magni-

tudes ($M_V \simeq -8.5$) than do any other samples for which the luminosity distribution has been measured (though incompleteness must be severe at the faint end). Thus a study of the Local Group luminosity distribution is of considerable importance.

What is known about the Local Group luminosity distribution? Tully (1988) derived a composite luminosity function for six nearby groups (including the Local Group) and found $\alpha = -1 \pm 0.2$. Van den Bergh (1992) demonstrated that the integral luminosity function of the Local Group was consistent with $\alpha = -1.1$ but did not rule out the possibility that other values of α fitted the data equally well. More recently, Mateo (1998) has shown that the LF of galaxies in the vicinity of the Local Group (but extending out beyond the usually accepted LG boundary of $R = 1$ Mpc) is consistent with that derived for poor groups (Ferguson & Sandage 1991). Again, this statement does not preclude the possibility that other luminosity distributions fit equally well.

Over the past few years substantial additional data have been accumulated on Local Group membership and absolute magnitudes, and so the time seems ripe for a fresh, and more detailed, attack on the problem of the Local Group luminosity distribution.

TABLE 1
DERIVED PROPERTIES OF PROBABLE LOCAL GROUP GALAXIES

Name	Alias	DDO Type	$(m-M)_0$	M_V	l (deg)	b (deg)	D (kpc)	$\cos\theta$
M31	NGC 224	Sb I–II	24.4	−21.2	121.17	−21.57	760	0.88
Milky Way	Galaxy	S(B)bc I–II:	14.5	−20.9:	000.00	00.00	8	−0.15
M33	NGC 598	Sc II–III	24.5	−18.9	133.61	−31.33	795	0.73
LMC	...	Ir III–IV	18.5	−18.5	280.19	−33.29	50	−0.80
SMC	...	Ir IV/IV–V	18.85	−17.1	302.81	−44.33	59	−0.61
M32	NGC 221	E2	24.4	−16.5	121.15	−21.98	760	0.88
NGC 205	...	Sph	24.4	−16.4	120.72	−21.14	760	0.88
IC 10	...	Ir IV:	24.1	−16.3	118.97	−03.34	660	0.94
NGC 6822	...	Ir IV–V	23.5	−16.0	025.34	−18.39	500	0.29
NGC 185	...	Sph	24.1	−15.6	120.79	−14.48	660	0.91
IC 1613	...	Ir V	23.3	−15.3	129.73	−60.56	725	0.47
NGC 147	...	Sph	24.1	−15.1	119.82	−14.25	660	0.92
WLM	DDO 221	Ir IV–V	24.85	−14.4	075.85	−73.63	925	0.32
Sagittarius	...	dSph(t)	17.0	−13.8::	005.61	−14.09	24	−0.04
Fornax	...	dSph	20.7	−13.1	237.24	−65.66	138	−0.25
Pegasus	DDO 216	Ir V	24.4	−12.3	094.77	−43.55	760	0.76
Leo I	Regulus	dSph	22.0	−11.9	225.98	+49.11	250	−0.44
And I.............	...	dSph	24.55	−11.8	121.69	−24.85	810	0.86
And II............	...	dSph	24.2	−11.8	128.91	−29.15	700	0.78
Leo A	DDO 69	Ir V	24.2	−11.5	196.90	+52.41	690	−0.14
Aquarius[a]	DDO 210	Ir V	25.05	−11.3	034.04	−31.35	1025	0.40
Sag DIG[a]	...	Ir V	25.7:	−10.7:	021.13	−16.23	1300:	0.22
Pegasus II	And VI	dSph	24.45	−10.6	106.01	−36.30	830	0.83
Pisces.............	LGS 3	dIr/dSph	24.55	−10.4	126.77	−40.88	810	0.71
And III..........	...	dSph	24.4	−10.2	119.31	−26.25	760	0.86
And V...........	...	dSph	24.55	−10.2	126.22	−15.12	810	0.87
Leo II	...	dSph	21.6	−10.1	220.14	+67.23	210	−0.26
Phoenix	...	dIr/dSph	23.0	−9.8	272.19	−68.95	395	−0.30
Sculptor	...	dSph	19.7	−9.8	287.69	−83.16	87	−0.06
Tucana	...	dSph	24.7	−9.6	322.91	−47.37	870	−0.44
Cassiopeia	And VII	dSph	24.2	−9.5	109.46	−09.95	690	0.98
Sextans...........	...	dSph	19.7	−9.5	243.50	+42.27	86	−0.65
Carina............	...	dSph	20.0	−9.4	260.11	−22.22	100	−0.85
Draco	...	dSph	19.5	−8.6	086.37	+34.71	79	0.77
Ursa Minor......	...	dSph	19.0	−8.5	104.88	+44.90	63	0.66

NOTE.—Colons denote uncertain values.
[a] Membership in Local Group not yet firmly established.

2. THE LOCAL GROUP CATALOG

The Local Group of galaxies was first described by Hubble (1936) in his book *The Realm of the Nebulae*. He listed M31, M32, M33, the Magellanic Clouds, NGC 205, NGC 6822, and IC 1613 as probable members of the small group of galaxies associated with our Milky Way system. Inspection of the prints of the Palomar Sky Survey (van den Bergh 1962) shows that a large fraction of all of galaxies occur in small groups and clusters that resemble the Local Group. This shows that our Galaxy is located in a rather typical region of space. Since Hubble's pioneering work the number of galaxies that are known to belong to the Local Group has increased by four or five per decade to over 30. A listing of data on presently known Local Group members (van den Bergh 2000) is given in Table 1.

Selection of Local Group members proceeded in three steps. First, galaxies with distances from the Local Group centroid (Courteau & van den Bergh 1999) less than or about 1.5 Mpc were regarded as suspected Group members. Second, it was required that Local Group members should lie close to the relation between radial velocity V_r and cos θ for well-established Local Group members, where θ is the distance from the solar apex (Courteau & van den Bergh 1999). Finally, Local Group members should not appear to be associated with groups of galaxies that are centered well beyond the limits of the Local Group.

On the basis of these criteria van den Bergh (1994, 2000) concluded that the following objects should be excluded from Local Group membership: (1) UKS 2323−326, (2) Maffei 1 and its companions, (3) UGCA 86, (4) NGC 1560, (5) NGC 1569, (6) NGC 5237, (7) DDO 187, (8) Cassiopeia 1, and (9) NGC 55. A particularly strong concentration of these Local Group suspects, which includes objects 2, 3, 4, 5, and 8 listed above, occurs in the direction of the IC 342/Maffei Group (Krismer, Tully, & Gioia 1995). Objects 1 and 9 appear in the direction of the Sculptor (=South Polar) Group; in the case of object 9, Jerjen, Freeman, & Binggeli (1998) find $D = 1.66 \pm 0.2$ kpc, which gives a distance 1.65 Mpc from the Local Group centroid. Finally, the discovery of a Cepheid (Tolstoy et al. 1995) in DDO 155 (=GR 8) suggests that this object is located at a distance of 2.2 Mpc, which places it well beyond the usually accepted limits of the Local Group. Dohm-Palmer et al. (1998) obtain a similar distance to DDO 155 from the tip of the red giant branch.

Also excluded from Local Group membership are the galaxies NGC 3109, Antlia, Sextans A, and Sextans B. These objects, which are located relatively close together on the sky, all have distances of 1.3–1.5 Mpc from the Milky Way and, of more relevance, distances of ∼1.7 Mpc from the Local Group centroid. Furthermore, these objects possess a mean radial velocity of +114 ± 12 km s^{-1} relative to the relation between V_r and cos θ for well-established Local Group members (van den Bergh 1999). This suggests that these galaxies form a small group just beyond the zero-velocity surface of the Local Group. [This surface is at a distance $R(\mathrm{LG}) = 1.18 \pm 0.15$ Mpc from the Local Group centroid (Courteau & van den Bergh 1999).]

How does the Local Group membership defined above compare with that of Mateo (1998)? The principal differences are that the Mateo catalog does not contain several recently discovered satellites of M31 but does include nine objects beyond 1 Mpc (NGC 55, EGB 0427+63, Sextans A, Sextans B, NGC 3109, Antlia, GR 8, IC 5152, and UKS 2323−326). Most of these were discussed above. EGB 0427+63 has a distance of 2.2 Mpc (Karachentsev, Tikhonov, & Sazonova 1994) and thus lies well outside the Local Group. From a color-magnitude diagram, Zijlstra & Minniti (1999) find that IC 5152 has a distance from the Milky Way of 1.70 ± 0.16 Mpc, a result that agrees with the Cepheid distance of 1.6 Mpc (Caldwell & Schommer 1988); the distance of this galaxy from the Local Group centroid is therefore 1.8 Mpc, again beyond the Local Group.

A more detailed discussion of Local Group membership and of the outer boundary of the Local Group can be found in van den Bergh (2000).

3. LUMINOSITY DISTRIBUTION OF THE LOCAL GROUP

Because Local Group galaxies are situated so nearby, it is possible to study their luminosity distribution down to very faint absolute magnitudes. Nevertheless, these data are, no doubt, still quite incomplete for $M_V > -10$. This is shown most clearly by the fact that only one galaxy fainter than this limit has so far been discovered in the Andromeda subgroup of the Local Group, whereas five such faint objects are presently known in the Milky Way subgroup of the Local Group. On the other hand, a survey of a 20,000 deg^2 area at high Galactic latitudes by Irwin (1994) resulted in the discovery of only a single new Local Group member. Furthermore, no new optically visible Local Group galaxies have turned up in the survey of compact high-latitude high-velocity clouds (Braun & Burton 1999). Taken at face value these results might be taken to suggest that the luminosity distribution of the Local Group no longer increases below $M_V \simeq -8$. It is noted in passing that very large low surface brightness galaxies in the Local Group, such as those that have been discovered in the Virgo Cluster (Impey, Bothun, & Malin 1988), in the Fornax Cluster (Bothun, Impey, & Malin 1991), and in the M81 Group (Caldwell et al. 1998), may have also eluded us.

The data in Table 1 can be used to study the luminosity distribution of Local Group galaxies. Histograms plotting this distribution are shown in Figure 1. The upper histogram clearly shows an increased number of objects at faint absolute magnitudes. The separation by morphological type (*bottom two panels*) shows that most of this increase is due to galaxies that are dwarf spheroidals.

A somewhat smoother visual impression of the Local Group luminosity distribution may be obtained by plotting the *cumulative* luminosity distribution, which is compared in Figure 2 with several different cumulative Schechter functions. In Figure 2, the cumulative numbers are normalized at $M_V = -10$ because it is unlikely that the data are complete at fainter magnitudes. This figure shows that a Schechter function with $\alpha \simeq -1.1$ and $M_V^* = -20$ is an acceptable fit to the data (cf. van den Bergh 1992; Mateo 1998) and that there is some evidence for a steepening to $\alpha < -1.3$ at faint magnitudes. (Because of incompleteness effects, this is an upper limit on the faint-end slope.)

To parameterize the luminosity distribution of the Local Group, we fit the data from Table 1 to a Schechter (1976) function (eq. [1]). As discussed in § 1, this function possesses a power-law luminosity dependence with exponent α and an exponential cutoff at $L > L^*$. In a plot of log $\phi(M)$ versus absolute magnitude M, the faint end of the Schechter function is linear, with slope $a = -0.4(\alpha + 1)$. In detail, we fit the unbinned Local Group absolute magnitude data to a
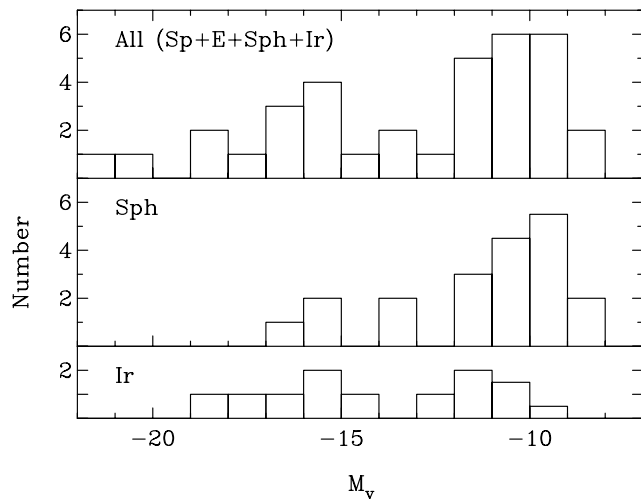
FIG. 1.—Histogram of the luminosity distribution of Local Group members, with absolute magnitude data taken from Table 1. The top panel gives the luminosity distribution for all Local Group members, and the middle and bottom panels show the luminosity distributions for Ir/dIr and Sph/dSph morphological types. Four galaxies appear in the top panel but not in the lower panels: the spirals M31, the Milky Way, and M33; and the elliptical M32. The galaxies Pisces and Phoenix (dIr/dSph) are counted with weight 0.5 in each of the lower two panels.

Schechter function using maximum likelihood techniques. The small number of objects involved dictates that we use a Poisson, rather than Gaussian, estimator of likelihood. The very small population of luminous galaxies ($L \gtrsim L^*$) also means that it is not possible to obtain a robust estimation of M_V^*; hence, we fit only α (and of course a normalization constant proportional to ϕ^*), with a few different trial values of M_V^* (which make virtually *no* difference to the fitted value of α). The sparsenesss of the data set furthermore prevents us from considering luminosity distributions that are a combination of two or more fitting functions (as found for Coma and other rich clusters by Trentham 1998a;
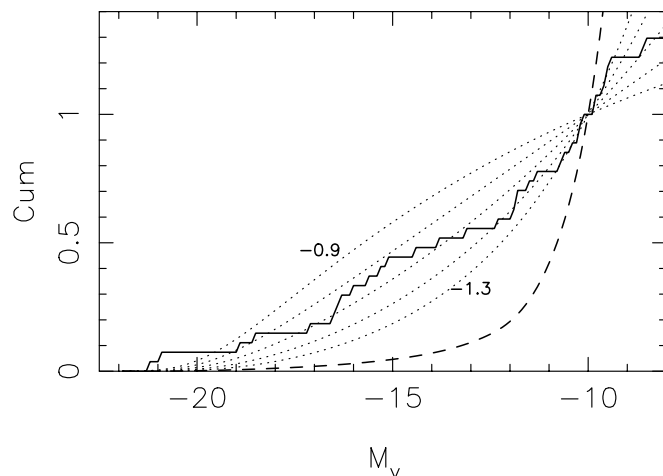

FIG. 2.—Cumulative distribution of absolute magnitudes of Local Group members (*solid line*), compared with cumulative Schechter functions (*dotted lines*). The Schechter functions are computed with $M_V^* = -20$ and five different α-values (-0.9 to -1.3 in steps of 0.1). The cumulative functions are all normalized at $M_V = -10$ because it seems likely that the data are incomplete below this level. The dashed line shows the empirical luminosity function (in cumulative form) of Trentham (1998b).

see also Ferguson & Sandage 1991; Binggeli, Sandage, & Tammann 1988). However, as will be seen, it is nevertheless possible to constrain such functions by isolating different magnitude ranges.

The maximum likelihood program was tested with artificial data sets drawn from a distribution of absolute magnitudes that followed a Schechter function. From thousands of simulations, the maximum likelihood program was found to return almost precisely the input value of α in the mean, even for very small numbers of objects ($N < 10$). Furthermore, the error estimates (see below) were also found to be accurate.

Table 2 gives the maximum likelihood value of α for various fits to the Local Group data (different magnitude ranges and selections of morphological types), together with several different error estimators for this quantity. The first error estimate is simply a 1 σ error: this is derived by finding that region of the maximum likelihood probability distribution that is centered on the fitted value of α and that includes 68% of the probability. Also given in Table 2 are 95% and 99% confidence limits for the upper bound on α (i.e., the values of α for which the probability is 95% and 99% that α is steeper than this). Finally, Table 2 also shows the percentage probability that α is steeper than (less than) -1.3.

Considering the entire data set (faint limit $M_V = -8$), it is apparent that a value $\alpha = -1.07 \pm 0.05$ is a best fit, with a 95% probability that $\alpha < -0.98$. Since the Local Group luminosity distribution is known to be incomplete at such faint magnitudes, we instead consider limiting the choice of objects at the faint end. However, regardless of the choice of parameters, the value $\alpha \simeq -1.1 \pm 0.1$ emerges. The probability that α is steeper than -1.3 is less than 1%.

The only exception to this is for galaxies fainter than $M_V = -15$; for such objects slopes as steep as $\alpha = -1.5$ are derived. However, (1) these slopes have large errors (± 0.2 or even greater) because they are based both on small numbers of objects and also on a limited range of M_V; (2) the 95% probability upper limit for α (lower limit on steepness) continues to hover around $\alpha = -1$, and the probability that $\alpha < -1.3$ is only 85%; and (3) the effect goes away if one instead considers objects brighter than $M_V = -16$. Thus, we consider this apparent steepening of the luminosity distribution at faint absolute magnitudes to be tantalizing but *not* proved.

Note that the derived slope is not very sensitive to the precise value of the faint cutoff for the fit. This is probably because of incompleteness at the faint end but also because, even with a faint-end upturn in the luminosity distribution, the majority of objects contributing to the fit are at brighter magnitudes.

The derived value of the slope α is not sensitive to the assumed outer boundary of the Local Group. Relative to the Local Group centroid, the shell between 1.18 Mpc (the zero-velocity surface according to Courteau & van den Bergh 1999) and 1.6 Mpc contains only a single galaxy, Sag DIG. Removing this galaxy from our sample does not alter any of the results above. Mateo (1998) includes nine galaxies in his Local Group catalog that, because of their distance, do not appear in our catalog (see § 2). Including these nine objects in our fits makes α less steep by less than 0.1. It should be noted that even this small effect can be entirely explained by incompleteness at the low-luminosity end of the sample of galaxies beyond 1.18 Mpc. We also stress that

TABLE 2

MAXIMUM LIKELIHOOD FITS TO LOCAL GROUP DATA

M_V(br)	M_V(ft)	α	α(95%)	α(99%)	$P(\alpha < -1.3)$ (%)
A. All morphological types:					
-22......	-8	-1.07 ± 0.05	-0.98	-0.94	0.00
-22......	-10	-1.09 ± 0.07	-0.96	-0.91	0.50
-22......	-11	-1.02 ± 0.08	-0.88	-0.83	0.18
-22......	-12	-0.91 ± 0.10	-0.74	-0.66	0.02
-18......	-8	-1.10 ± 0.07	-0.99	-0.93	0.40
-18......	-10	-1.17 ± 0.10	-0.99	-0.94	11.31
-18......	-11	-1.09 ± 0.13	-0.87	-0.77	6.52
-18......	-12	-0.92 ± 0.18	-0.61	-0.45	2.13
-16......	-8	-1.09 ± 0.09	-0.94	-0.88	1.82
-16......	-10	-1.21 ± 0.14	-0.95	-0.87	30.11
-16......	-11	-1.06 ± 0.20	-0.72	-0.57	15.15
-16......	-12	-0.62 ± 0.35	0.05	0.32	2.38
-15......	-8	-1.18 ± 0.11	-0.98	-0.92	17.93
-15......	-10	-1.50 ± 0.21	-1.14	-1.01	85.87
-15......	-11	-1.48 ± 0.33	-0.94	-0.71	73.27
B. Sph/dSph data only:					
-17......	-9	-1.33 ± 0.12	-1.13	-1.05	62.53
-17......	-10	-1.31 ± 0.16	-1.04	-0.94	58.55
-17......	-11	-1.11 ± 0.22	-0.73	-0.57	23.66
-15......	-9	-1.52 ± 0.18	-1.24	-1.12	90.72
-15......	-10	-1.66 ± 0.29	-1.23	-1.05	92.01
-15......	-11	-1.44 ± 0.46	-0.72	-0.42	66.92
C. Ir/dIr data only:					
-16......	-9	-1.02 ± 0.17	-0.70	-0.58	7.90
-16......	-10	-1.09 ± 0.22	-0.72	-0.56	20.69
-16......	-11	-1.01 ± 0.31	-0.48	-0.26	20.49
-15......	-10	-1.40 ± 0.33	-0.90	-0.66	66.20

NOTES.—M_V(br) and M_V(ft) give the range of absolute magnitude over which the fit was done. The error in α corresponds to a 1 σ error, and α(95%) and α(99%) are the values for which the probability is 95% (99%) that the true value of α lies below the tabulated values. $P(\alpha < -1.3)$ is the probability that $\alpha < -1.3$.

the available evidence does *not* support the inclusion of these nine galaxies in our Local Group catalog (see discussion in § 2).

Most of the apparent steepening in α for faint objects is due to the dwarf spheroidals in the Local Group, as can be seen from Figure 1. Fitting a power-law slope to these objects alone shows a steeper value of α than for the entire data set, but again the effect is only marginally significant. From a Kolmogorov-Smirnov two-sample test, the difference between the luminosity distributions of dIr's and dSph's is significant only at the 90% level. Unfortunately, the observations of M81 Group dwarfs (e.g., van Driel et al. 1998) do not enable us to throw additional light on this problem. This is because these authors were not able to determine morphological classes for the two faintest magnitude bins in their survey.

Trentham (1998b) has derived a composite luminosity function for galaxies in clusters and has shown that it can be applied to galaxies in the field as well. The cumulative form of this empirical luminosity function (for which α steepens toward fainter M_V) is plotted as the dashed line in Figure 2. A Kolmogorov-Smirnov test excludes the possibility that Local Group galaxies are drawn from this parent population at greater than 99% probability.

Finally, we have compared the distribution of B magnitudes of galaxies in the M81 Group (van Driel et al. 1998) with the luminosity distribution of M_V of Local Group galaxies, under the assumptions that $(m-M)_B = 28.8$ and

$\langle B-V \rangle = 0.5$ for the M81 galaxies. From a comparison between the (presumably more or less complete) data on galaxies with M_V brighter than -10 and B brighter than 17.5, a Kolmogorov-Smirnov test shows no significant difference between the M81 ($N = 38$) and Local Group luminosity distributions ($N = 27$). This suggests that the Local Group and M81 LFs are broadly similar and are drawn from similar parent populations.

4. DISCUSSION AND CONCLUSIONS

A Schechter function with $\alpha \simeq -1.1 \pm 0.1$ provides a good fit to new data for the luminosity distribution of the Local Group. This result is in agreement with the luminosity distribution found for poor groups (e.g., Ferguson & Sandage 1991; Muriel et al. 1998) and is probably consistent with the work of Hunsberger et al. (1998), who found $\alpha \simeq -0.5$ for $M_R < -18$ and -1.2 for $M_R > -18$. Our result is comparable to various determinations of α in the field (e.g., Loveday et al. 1992; Marzke et al. 1994a, 1994b; Lin et al. 1996; Marzke et al. 1998) and is insensitive to the manner in which the Local Group is defined.

There is evidence for a steepening in α below $M_V = -15$; as discussed in § 1, this effect has been observed in other environments. However, the steepening of the field luminosity distribution observed by Marzke et al. (1998) is in the dIr population, in contrast to the situation in the Local Group, for which the dIr population possesses a flat $\alpha \approx -1$ and for which the dSph population appears to

possess steeper α (though this difference is significant only at the $\sim 90\%$ level in our work).

The steepening in α that we observe at faint magnitudes is limited in significance by small number statistics, and almost certainly α is steeper than our fits would indicate because of magnitude-dependent incompleteness. Clearly, much further observational work is needed to improve the completeness of the census of Local Group members at faint absolute magnitudes.

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