Local Group(s)

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Summary. The properties of the galaxies of the Local Group are reviewed, followed by a brief discussion of nearby groups. The galaxy groups in our vicinity – the M81 group, the Cen A group, and the IC342/Maffei group – are in many respects Local Group analogs: Their luminosity functions, galaxy content, fractional galaxy type distribution, crossing times, masses, and zero-velocity surface radii are similar to those of the Local Group. Also, the nearby groups usually consist of two subgroups, some of which approach each other and may ultimately merge to form a fossil group. These poor groups contrast with the less evolved, loose and extended galaxy “clouds” such as the Scl group and the CVn I cloud. These are characterized by long crossing times, are dominated by gas-rich, late-type galaxies, and lack gas-deficient, low luminosity early-type dwarfs. These clouds may be groups still in formation. The local Hubble flow derived from the clouds and groups is very cold.

1 Why are galaxy groups interesting?

The most conspicuous gatherings of mass and luminous matter in the Universe are galaxy clusters. However, the majority of nearby galaxies – about 85% (205 110) – is observed to be located outside of clusters and can be found mainly in galaxy groups. While galaxy clusters reveal the location of the highest concentration of visible and dark matter, these less massive galaxy agglomerations trace the distribution of the filaments of the cosmic web and hence the extended distribution of dark matter in less dense regions. In terms of luminous matter, the fraction of mass locked up in stars increases with decreasing group size (14). Most of the stellar mass is in groups of the size of our Local Group, whereas massive clusters only contain 2% of the stellar mass in the Universe (14).

Galaxy groups come in a variety of different morphologies, shapes, and sizes, including, for instance, seemingly unbound “clouds” and “spurs” (205), loose groups, poor groups, compact groups, rich groups, etc. Precisely what constitutes a group is a question of definition and depends primarily on how many galaxies down to a certain limiting magnitude are found within a certain
The Local Group is the only place where we can study the ages, chemistry, star formation history, and kinematics of a range of different galaxies in exceptional detail based on their resolved stellar populations. Here we can truly connect stellar and extragalactic astrophysics. We can compare our observational findings with the predictions of cosmological models or, vice versa, test those predictions through targeted observations. Owing to our ability to resolve and study even the oldest populations and very faint stars in the closest galaxies and in our own Milky Way, we can conduct near-field cosmology
uncovering their detailed evolutionary histories based on their resolved fossil stellar record.

2.1 The Local Group census and galaxy distribution

In spite of their proximity and in spite of the large efforts invested into studying them over the past decades, the galaxies of the Local Group continue to provide surprises. As has also been found in other groups, the number of faint galaxies in the Local Group lies below theoretical expectations by about two orders of magnitude, a deficiency also known as the missing satellite problem or the cosmological substructure problem ([128, 168]). A number of solutions to solve this problem have been proposed, but none has proved fully satisfactory until now. This problem remains one of the key questions in structure formation in standard cold dark matter (CDM) models. Nonetheless, considerable progress has been made in recent years in identifying new Local Group members. Within a zero-velocity radius of approximately 1 Mpc ([118]) the current Local Group census comprises at least 42 galaxies (including the tidal streams of Sagittarius around the Milky Way and the great stellar stream around M31, [96, 97]).

The three most luminous Local Group members are its spiral galaxies, which form two subgroups: The M31 plus M33 subgroup and the Milky Way subgroup. In terms of mass and luminosity, the Milky Way and M31 are the two dominant galaxies and may be similarly massive ([45]). Each of these two galaxies is surrounded by an entourage of mainly low-mass, gas-deficient galaxies. In close proximity to M31, one compact elliptical and three dwarf elliptical (dE) galaxies are found. M31 is the only Local Group galaxy with dE companions. The remaining low-mass early-type dwarfs in the Local Group are all dwarf spheroidal (dSph) galaxies, the least massive (total masses estimated to be a few times $10^7$ M$_\odot$), least luminous ($M_V > -14$) type of galaxy known. (For a more detailed description of the different galaxy types of the Local Group, see [211, 65, 80].) The dSphs and the dEs are almost all found within a 300 kpc radius around the two dominant spirals. This radius also roughly corresponds to the size of the dark matter density profile of $\sim L_*$ galaxies (e.g., [163, 187]). The gas-rich, late-type irregular and dwarf irregular (dIrr) galaxies, in contrast, show a much less concentrated distribution and are the most frequent galaxy type at larger distances from the spirals.

This biased distribution is also apparent when considering the H$\upgamma$ mass of dwarf and satellite galaxies as a function of distance to the nearest principal galaxy: The upper limits for the H$\upgamma$ masses of dSphs are typically of the order of $10^5$ M$_\odot$ or less, whereas dIrrs usually have H$\upgamma$ masses of at least $10^7$ M$_\odot$ ([80]). In between, the so-called dIrr/dSph transition-type galaxies are located. These low-mass dwarf galaxies share some of the properties of dIrrs (such as a measurable gas content and recent star formation) and of dSphs (such as prominent old populations and low luminosities). Morphological segregation akin to that within the Local Group is also observed in other groups.
and indicates that environment plays an important role in shaping galaxy properties (e.g., [42]). The distribution of the galaxies in the Local Group is illustrated in, e.g., [61, 63].

More than half of the Local Group’s galaxies are dSph galaxies. At present, we know of 22 dSphs in the Local Group. Three of the M31 dSph companions were only detected and confirmed approximately seven years ago ([1, 2, 111, 71]). Two more M31 dSph companions were discovered during the past two years in the Sloan Digital Sky Survey (SDSS) and confirmed through follow-up observations by [227, 87, 229]. They are among the least luminous, lowest surface brightness dwarfs known. Altogether eight confirmed or likely dSph companions of M31 are now known. Additional faint dSphs may yet to be found, whereas other features (e.g., [169, 228]) are likely part of the giant stellar stream around M31 ([98, 46]). Recent additions to the Milky Way dSph census include three extremely low surface brightness dwarfs also found the SDSS ([218, 7, 230]), which increases the number of Galactic early-type companions to 12. The new dSph Boo is the faintest galaxy known so far with $M_V \sim -5.7$ ([7]), and the new CVn dSph seems to have the lowest surface brightness of any of these dwarfs ($\mu_V \sim 28$ mag arcsec$^{-2}$; [230]). The recent detections beg the question whether there is a lower-mass cut-off for dwarf galaxies with luminous baryonic matter. Finally, some seven years ago a new isolated Local Group dSph was discovered by [213], raising the number of these rare objects to two. Isolated dSphs are of particular interest since they seem to defy commonly held ideas about the creation of dSphs through, e.g., tidal or ram pressure stripping by massive galaxies. On the other hand, since we do not know the orbits of these more distant dSphs, we cannot exclude that they may once have had close encounters with the massive galaxies.

All recent galaxy discoveries added more objects to the faint end of the Local Group’s luminosity function. It is generally believed that the census is fairly complete for brighter galaxies (with the possible exception of the zone of avoidance.) Additional very low surface brightness objects may be uncovered in the coming years using large imaging sky surveys. We may expect that nearby groups also host a number of comparatively faint objects that have escaped detection so far. In spite of the recent impressive improvements in the census of nearby galaxies (see, e.g., [113, 152] and references therein) the numbers are still far too small to resolve the substructure crisis. It seems doubtful at present that new searches will add the hundreds of objects required to solve this problem – if the missing dark matter halos contain luminous matter as well.

Another promising avenue is the search for stellar streams in the halos of massive galaxies (e.g., [14, 172, 173, 220, 158, 193, 105, 183, 219, 5]), which may ultimately permit us to constrain the number of past accretion events, esp. once full phase-space information is added – one of the objectives of ESA’s Gaia satellite mission ([184]).

Interestingly, the companions of the Milky Way do not seem to show a random distribution. Instead, they appear to be arranged along one or two
polar great planes (e.g., [143, 109, 150, 52, 142]). An investigation of the satellite distribution around M31 revealed that most of its early-type companions lie along one single, almost polar great plane with high statistical significance ([78, 136], see also [162]). As shown by [136], this plane does not coincide with the great stellar stream around M31. It is unclear whether these apparent satellite anisotropies have a deeper physical significance. If the satellites orbit within the planes – a requirement if the planes have any physical reality – then the satellites may have formed following interactions or the break-up of a more massive progenitor (see, e.g., [143, 109, 196, 13]). Another possibility is that the planes are indicators of a prolate dark halo of the Milky Way and M31 (e.g., [89, 171, 226]). Or we may be seeing the left-over effects of matter accretion along large-scale dark matter filaments (see [129, 226, 146] for a more detailed discussion). [136] found that the M31 polar plane includes also M33 and points in the direction of the M81 group. – In the absence of actual orbits it remains difficult to assess the meaning of the observed polar alignments, if any. For the M31 subsystem the planar alignment comprises only a subsample of the total number of its satellites ([136]), which may lend support to the suggestion by [226] that such distributions may also originate from random samples. Unfortunately, the distance uncertainties for galaxies in nearby groups are still too large, preventing us from conducting a similar study there.

2.2 A few remarks about star formation histories

The star formation histories of the galaxies of the Local Group have been reviewed fairly frequently (e.g., [211, 64, 67]). Here we will only summarize some interesting characteristics that have emerged in recent years.

Old populations are ubiquitous in the galaxies of the Local Group, but their fractions vary ([64, 73]). For instances, horizontal branches are an unmistakable tracer of old populations and have been identified in all Local Group galaxies with sufficiently deep photometry. Here “old” refers to old Population II stars with ages $> 10$ Gyr. We have no evidence for the existence of possible Population III stars in external galaxies. For galaxies with deep main-sequence photometry (mainly Galactic populations and satellites of the Milky Way) there is evidence for a common epoch of early (Population II) star formation. Within the currently available accuracy of the age dating techniques ($< 1$ Gyr), the oldest detectable populations in the Milky Way and its surroundings are coeval ([73]). Moreover, there is no evidence for the suppression of star formation in the low-mass galaxies of the Local Group after the end of reionization ([73]), contrasting predictions of certain cosmological models that suggest that low-mass halos experience complete photo-evaporation ([4, 48, 201]).

All Local Group galaxies show evidence for extended star formation histories, but no two galaxies share the same star formation history, not even within the same morphological type (e.g., [21]). The spirals, irregulars, and
dIrrs all show evidence for active star formation over a Hubble time. In dwarf galaxies star formation proceeded largely continuously with amplitude variations. Strongly episodic star formation with long pauses in between is only seen in the Carina dSph (e.g., [167]). Even dSph galaxies with seemingly entirely old populations show large abundance spreads of more than 1 dex in [Fe/H] (e.g., [197]), which require star formation and enrichment over several Gyr (99, 157, 17). In contrast to many dIrrs, which are able to continue to form stars for another Hubble time (94), dSphs do not show any ongoing star formation activity and appear to be devoid of gas (54 and references therein). This is unexpected, since even simple mass loss from red giants should lead to detectable amounts of gas (e.g., [221]). The Milky Way is surrounded by several dSphs with substantial intermediate-age (2 to 10 Gyr) star formation activity. One of the Galactic companions, the Fornax dSph, even ended its star formation activity only as recently as about 200 Myr ago (74). For a more detailed discussion of the gas loss problem see [80].

Population gradients are obvious in spiral galaxies, but also many dwarf galaxies show spatial variations in their star formation histories (e.g., (63, 64)). Essentially all galaxies have extended “halos” of old Population II stars (e.g., [165]). Dfrrs tend to also show extended intermediate-age populations as traced by, e.g., carbon stars (e.g., [108]). Generally, the density distributions of different populations in irregular galaxies become increasingly more regular and extended with increasing age (e.g., [20, 223]), whereas the many scattered young star-forming regions are responsible for the irregular appearance. Large star-forming regions may remain active for several 10 to 100 Myr, revealing a complex substructure in ages (e.g., [37, 70, 212, 72, 35, 36]).

DE and dSph galaxies have usually experienced continuous star formation with decreasing intensity. Star formation tends to be longest-lasting in the centers of these galaxies, and in a number of cases radial age (and possibly metallicity) gradients are observed (see [61, 190, 65, 62, 191, 203, 137 for individual cases and 84 for a comprehensive study). Subpopulations may also be asymmetrically distributed (e.g., [199]). Overall, the Galactic dSph companions show a trend for increased intermediate-age population fractions with increasing Galactocentric distance, possibly indicating that star-forming material might have been removed earlier from closer companions (200, 61). However, neither the fairly isolated Local Group dSphs Cetus and Tucana fit this pattern, nor do the M31 low-surface-brightness companions (84).

In the past star formation histories of galaxies with resolved stellar populations were primarily based on photometry, and on the modelling of the observed color-magnitude diagrams (as pioneered by [204, 82]). Limitations of modelling techniques are discussed in (65). Additional complications may arise from rotation, multiplicity, unrecognized extinction effects, and transformation problems (e.g., [65, 192, 197, 224, 135, 60, 226]). While in many cases no other information but photometric data are available, information on special types of stars can provide important additional clues (e.g., [61, 63, 12, 5, 39, 80, 87]). Special types of stars can be identified photometri-
cally if, e.g., they exhibit unique spectral features that can be traced by special filter combinations (e.g., \[25, 26, 75, 52, 151, 174, 125, 21, 90, 86, 126, 134\]) or if they are variable (e.g., \[159, 140, 161, 141, 39, 189\]).

Photometric systems with improved metallicity sensitivity have been employed to break the photometric age-metallicity degeneracy (e.g., Washington and Strömgren photometry, \[56, 57, 68, 76, 92, 22\]). However, this degeneracy can best be addressed spectroscopically. This is now a realistic prospect for nearby galaxies (e.g., \[28, 22, 84, 197, 186, 203, 137, 138\]), largely thanks to the routine availability of optical 8 to 10-m telescopes.

2.3 A few remarks on abundances

While the absorption-line measurements for stellar abundances tend to require large telescopes and long integration times, emission lines can relatively easily be measured with medium-sized telescopes. In galaxies with active star formation the metallicity of young populations can be determined by measuring the emission lines of H\textsubscript{II} regions. This has not only been done for gas-rich galaxies such as dIrrs in the Local Group and its surroundings (e.g., \[200, 195, 106, 133\], but is routinely carried out also for much more distant galaxies with sufficiently strong emission lines (e.g., \[131\]). These measurements yield the present-day abundances, and individual element abundance ratios give us information about the modes of star formation.

Also nebular abundances derived from planetary nebulae can be obtained with only a modest investment of telescope time, yielding metallicity estimates for mainly intermediate-age populations (e.g., \[191, 100\]), which can be age-dated within certain limits (\[133, 16\]). Combining ages with the results from nebular abundances as well as stellar abundance measurements supports the existence of an age-metallicity relation, i.e., increasing enrichment with decreasing age (e.g., \[31, 202, 66, 133, 137\]). The comparison with chemical evolution models can then provide fairly detailed information about the enrichment history as well as the relative importance of closed-box evolution vs. outflows and galactic winds (e.g., \[164, 31, 144, 145, 91, 137\]).

For a given age, a given dIrr galaxy is usually assumed to be chemically well-mixed and homogeneous. However, there are indications in a few dIrrs for a metallicity spread in populations of similar ages based on age-datable star clusters (\[80\]) or on differing nebular abundances in H\textsubscript{II} regions (\[133\]). For dSphs, we do not yet have data that would permit us to quantify possible abundance spreads within populations of the same age, but as noted earlier dSphs exhibit large metallicity spreads overall, even in galaxies dominated entirely by old populations (e.g., \[197\]).

Interestingly, high-resolution studies of individual red giants in nearby dwarf galaxies indicate that at a given [Fe/H] their \([\alpha/Fe]\) ratios are on average lower by \(~0.2\) dex than those of equally metal-poor stars in the Galactic halo (e.g., \[93, 197, 198, 11, 58, 188\]). This makes these present-day dwarf galaxies – dIrrs and dSphs alike – unlikely major contributors of the build-up of the
Galactic halo and hence unlikely survivors of a once much more numerous population of primary Galactic building blocks. However, at low [Fe/H] there is consistency with the abundance ratios observed in the Galactic halo, leaving very early accretion as a plausible option (80, 49).

On global scales, galaxies tend to follow a luminosity–metallicity relation in the sense that more luminous galaxies are more metal-rich. This trend is seen for all Local Group galaxies, but the metallicity–luminosity relations of dSphs and dIrrs are offset from each other (191), an offset that persists even when comparing the same metallicity tracers and the same populations (80): DSphs have higher mean stellar metallicities at a given optical luminosity, which may imply more rapid star formation and enrichment at early times as compared to dIrrs (80). This suggests that the old populations in dSphs and dIrrs are intrinsically different. Transitions from gas-rich to gas-poor dwarfs seem plausible only for present-day dIrr/dSphs to present-day dSphs.

2.4 A few remarks on kinematics and dark matter

The internal kinematics of galaxies are not only a valuable tool to differentiate their components, populations, and evolutionary histories, but also provide information about galaxy masses. For the large spiral galaxies, a variety of approaches have been used to constrain their masses, including stellar and gas kinematics, the kinematics of star clusters, and of satellites. These data seem to suggest that the Milky Way and M31 may be of similar mass (189, 45, 18). This is somewhat unexpected considering the larger luminosity, larger bulge, larger number of globular clusters, and larger physical size of M31.

While the disks of spiral galaxies exhibit differential rotation, the more massive dIrrs show solid-body rotation. Low-mass dIrrs, dIrr/dSph and dSph galaxies are dominated by random motions and do not appear to be supported by rotation. DSphs may contain large amounts of dark matter (e.g., 53). This is inferred from the high velocity dispersion and the resulting high mass-to-light ratios derived under the assumption of virial equilibrium (160). Indirectly, a high dark matter content is also supported by the smooth, symmetrical morphology of some nearby dSphs (170) and by the observed lack of a significant depth extent (124). The radial velocity dispersion profiles of dSphs tend to be flat and fall off large radii (215, 216). While detailed modelling is still in progress, the current data favor that dSphs share a common halo mass scale of about $4 \cdot 10^7 \, M_\odot$, are dark-matter dominated, and have cored mass distributions (217).

Evidence for ongoing accretion events in the Local Group have been mentioned already in Section 2.1. Stellar streams may also be contributed by disrupted globular clusters (e.g., 177, 178, 8, 83) and can provide valuable information about the shape of the massive galaxy’s halo (e.g., 170, 14, 84, 183, 104, 152). The results can be compared to the halo shape derived from other indicators such as the halo globular cluster mass density profile, which seems to be partly of primordial origin (151). — A well-
known example of ongoing interactions is the triple system of the Magellanic Clouds and the Milky Way with the gaseous Magellanic Bridge and Magellanic Stream as interaction signatures. Tidal interactions are also apparent in the S-shaped surface density profile of the Galactic dSph Ursa Minor ([180]) and in the twisted isophotes of the M31 dE companions M32 and NGC 205 ([19]). These galaxies and other dSphs are likely to be accreted eventually. Moreover, dwarf-dwarf interactions and interactions with gas clouds may play an important role (e.g., [214, 33, 24]). The Local Group's wealth in low-mass, gas-deficient early-type dwarfs as well as the radius-morphology relation may both be indicative of the environmental impact on galaxy evolution.

3 Other nearby groups and Local Group analogs

In our immediate cosmic neighborhood we find poor, loose groups and “clouds” or filaments. The spatial and density distribution of nearby galaxies is beautifully illustrated in [207]. A few years ago we initiated a project with the Hubble Space Telescope and ground-based telescopes to study the properties of the groups and clouds within a ~5 Mpc around the Local Group, i.e., in the Local Volume ([79]). This project led to an improved galaxy census and resulted in knowledge of the approximate distances, luminosities, luminous stellar content, and approximate metallicities of a large number of nearby galaxies ([112, 113, 114, 115, 116, 117, 119, 159, 120, 151, 122, 123, 106, 130, 155, 133]; see also [27, 17, 102, 3, 182, 190]). Moreover, kinematic properties and global masses were derived, improving the characterization of these nearby groups (see also [29, 118, 121, 206, 110]). Many of the results presented in the following stem from this continuing project.

[185] find that galaxy groups are considerably more elongated than galaxy clusters, a trend that becomes most pronounced in very poor groups of galaxies. They suggest that the poorest groups of galaxies are still in the process of being assembled through galaxy infall, a scenario that is supported by the observed properties of nearby, extended galaxy “clouds” like Sculptor and CVn I ([101, 122, 123]): These elongated clouds show several subclumps and are not yet in dynamical equilibrium, since their crossing times are of the order of half a Hubble time. They contain mainly early-type dwarfs, and their luminosity functions show a lack of very low-luminosity dSph galaxies. CVn I may be even less evolved than Scl. CVn I, Scl, and the Local Group form a 10 Mpc filament that appears to be driven by the free Hubble flow ([123]).

In contrast to the clouds, the nearby, poor groups are Local Group analogs in many respects. They tend to be dominated by two massive galaxies: In the M81 group, the dominant galaxies are the spirals M81 and NGC 2403 ([119]). A prominent interaction between M81, and the irregular galaxies M82 and NGC 3077 is currently in progress (e.g., [222]), giving rise to impressive starburst phenomena in M82 (e.g., [175]) and possibly to the formation of tidal dwarfs from material torn out during past close encounters (e.g., [154]).
In the Centaurus A group the spiral M83 and the peculiar elliptical Cen A (NGC 5128) dominate the mass distribution ([120]). NGC 5128 seems to have experienced various accretion events in the past (e.g., [156, 166]). In the IC 342/Maffei group the main subgroups are centered around the spiral IC 342 and the elliptical Maffei I ([124]). In this group the faint galaxy census is still highly incomplete due to the high foreground extinction (e.g., [15]). In any case, all of these nearby groups reveal a “binary” substructure.

Just like the Local Group, the nearby groups also exhibit an increased frequency of early-type dwarfs, particularly of dSphs, and a comparable degree of morphological segregation ([66, 67]). The luminosity functions show the familiar rise at the faint end ([120, 122]). The differences in the fractional dwarf galaxy type distribution between clouds and Local Group analogs supports the idea of morphological transformations induced by denser environments. In accordance with this picture, transition-type dIrr/dSph galaxies and dIrrs tend to be found at larger distances from massive galaxies (e.g., [80]), and dwarf S0 galaxies are located in the outskirts of groups (and clusters; e.g., [6, 147]). Note that star-forming galaxies are more likely on radial orbits and may be falling in for the first time, whereas the orbits of galaxies dominated by older populations are more consistent with isotropy.

In the M81 group, the M81 subgroup and the NGC 2403 subgroup approach each other, similar to what is seen in the Local Group between M31 and the Milky Way. A third, smaller subgroup around the less luminous spiral NGC 4236 in the M81 group appears to be currently receding from the other two subgroups ([119]) and may actually even constitute a small group outside of the M81 group. In the Cen A group the two dominant subgroups also appear to be moving away from each other ([120]). We have insufficient data on the other groups. – Where subgroups approach each other the final result is expected to be one single large elliptical galaxy (see also [50]) and hence a fossil group ([103]).

The estimated crossing times in the nearby, poor groups range from 1.8 to 5.9 Gyr with a median around \( \sim 2.3 \) Gyr ([114]), suggesting that they are closer to reaching dynamical equilibrium than the unevolved clouds, although they are far from “fossilization”. The radii of the zero-velocity surfaces (beyond which galaxies are no longer bound) of the nearby groups and of the Local Group are of the order of 1 Mpc, and the total masses of the groups are approximately a few \( 10^{12} \) \( M_\odot \) ([119, 120, 124]). Within groups, the mass is closely correlated with the luminous matter and concentrated at the location of the massive galaxies (in agreement also with the findings by [143, 187]).

On larger scales, the nearby groups and clouds nicely delineate the local large-scale structure ([207]). The centers of the groups lie within a narrow layer with a thickness of only \( \pm 0.33 \) Mpc ([110]). The centroids of the groups show a small velocity dispersion with respect to the Hubble flow. Overall the local Hubble flow is remarkably cold ([118, 121]), indicating a low local matter density. [148] suggest that the local Hubble flow is best fit by \( \Lambda \)CDM models.
with signatures of the impact of dark energy already becoming noticeable at distances > 7 Mpc.

4 Summary

In the Local Group, old populations are ubiquitous in all galaxies, but their fractions vary. There appears to have been a common epoch of early (Population II) star formation. All galaxies show evidence for extended star formation episodes, but no two galaxies share the same detailed star formation history. There is no obvious cessation of star-formation activity after re-ionization in low-mass galaxies. The apparent correlation between increasing intermediate-age population fraction in dSph galaxies with increasing distance from the Milky Way is not seen in the M31 dSph companions. The morphological segregation and H\textsc{i} mass – distance correlation in the Local Group and other nearby groups hint at the importance of environment and interactions. This is also indicated by the observed ongoing interactions and by the increased fraction of low-luminosity, early-type dwarfs in groups as compared to loose, unvirialized “clouds” of galaxies. However, there is an offset in the metallicity-luminosity relation even for old populations that shows dSphs to be too metal-rich for their luminosity in comparison to dIrrs, making a simple transformation from dIrrs to dSphs unlikely. The origin and nature of dSphs remains a puzzle. Also, the meaning (if any) of the seemingly anisotropic distribution of the early-type companions of the Milky Way and of M31 along a polar great plane remains unclear as long as accurate orbits are lacking.

Nearby groups in the Local Volume are Local Group analogs in many respects. Their luminosity functions, galaxy content, and fractional type distribution are reminiscent of the Local Group. They show morphological segregation. Just like the Local Group, they are typically dominated by two luminous galaxies. The crossing times, group masses and radii resemble those of the Local Group. These poor groups may ultimately evolve into fossil groups once their subgroups merge. This stands in contrast to nearby galaxy “clouds”, which have long crossing times, are extended, have few early-type dwarfs and are dominated by gas-rich late-type galaxies. These clouds do not show a turn-up at the faint end of the galaxy luminosity function. Perhaps they are groups in formation. — The local Hubble flow is very quiet.

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