# THE LOCAL GROUP

Size ~ 1 Mpc

2 big spirals

most of the rest are dwarfs :

dIrr (eg SMC)

dSph (eg Fornax)

**Table 4.1** Galaxies of the Local Group within 1 Mpc of the Sun: the Milky Way and its satellites are listed in **boldface**; M31 and its companions are listed in *italics*

| *Galaxy* | *Type* | $d$ (kpc) | $L_V$ ($10^7 L_\odot$) | $V_r(\odot)$ (km s$^{-1}$) | $l$ (*deg*) | $b$ (*deg*) | $\mathcal{M}$(HI) ($10^6 \mathcal{M}_\odot$) |
|---|---|---|---|---|---|---|---|
| *M31* (NGC 224) | Sb | 770 | 2700 | −299 | 121 | −22 | 5700 |
| **Milky Way** | Sbc | 8 | 1500 | −10 | 0 | 0 | 4000 |
| M33 (NGC 598) | Sc | 850 | 550 | −183 | 134 | −31 | 1500 |
| **Large MC** | SBm | 49 | 170 | 274 | 280 | −33 | 700 |
| *NGC 205* | dE | 850 | 40 | −241 | 121 | −21 | 0.4 |
| **Small MC** | Irr | 58 | 34 | 148 | 303 | −44 | 650 |
| *M32* (NGC 221) | E2 | 750 | 30 | −203 | 121 | −22 | none |
| NGC 6822 | Irr | 490 | 30 | −56 | 25 | −18 | c |
| IC 10 | Irr | 820 | 20 | −344 | 119 | −3 | 150 |
| *NGC 147* | dE | 760 | 12 | −193 | 120 | −14 | none |
| *NGC 185* | dE | 600 | 10 | −202 | 121 | −15 | 0.1 |
| IC 1613 (DDO 8) | dIrr | 715 | 10 | −231 | 130 | −61 | 60 |
| Pegasus (DDO 216) | dIrr | 760 | 8 | −183 | 95 | −44 | 3 |
| WLM (DDO 221) | dIrr | 970 | 4 | −120 | 76 | −74 | 80 |
| Leo A (DDO 69) | dIrr | 690 | 2 | 20 | 197 | 52 | 20 |
| **Fornax** | dSph | 120 | 1.4 | 53 | 237 | −66 | none |
| **Sagittarius** | dSph | 25 | 1 | 170 | 6 | −14 | none |
| *And I* | dSph | 770 | 0.5 | −370 | 122 | −25 | none |
| **Leo I** (DDO 74) | dSph | 270 | 0.5 | 285 | 226 | 49 | none |
| *And VII/Cas dSph* | dSph | 760 | 0.5 | −307 | 110 | −10 | — |
| *And II* | dSph | 590 | 0.3 | −188 | 129 | −29 | — |
| *And VI/Peg dSph* | dSph | 830 | 0.3 | −341 | 106 | −36 | — |
| Aquarius (DDO 210) | dIrr | 950 | 0.2 | −137 | 34 | −31 | 3 |
| **Sculptor** | dSph | 72 | 0.14 | 107 | 288 | −83 | $\lesssim$0.1c |
| Sagittarius DIG | dIrr | 800 | 0.1 | −78 | 21 | −16 | 4 |
| *And III* | dSph | 770 | 0.1 | −352 | 119 | −26 | <0.1 |
| Phoenix | dIrr/dSph | 420 | 0.08 | 56 | 272 | −69 | 0.2 |
| Cetus | dSph | 775 | 0.08 | — | 101 | −73 | — |
| LGS3 (Pisces) | dIrr/dSph | 810 | 0.06 | −281 | 127 | −41 | 0.2 |
| **Leo II** (DDO 93) | dSph | 207 | 0.06 | 76 | 220 | 67 | none |
| Tucana | dSph | 870 | 0.05 | — | 323 | −47 | none |
| **Sextans** | dSph | 83 | 0.04 | 225 | 244 | 42 | none |
| **Carina** | dSph | 100 | 0.03 | 223 | 260 | −22 | none |
| *And V* | dSph | 810 | 0.03 | −387 | 126 | −15 | — |
| **Ursa Minor** | dSph | 64 | 0.02 | −247 | 105 | 45 | none |
| **Draco** (DDO 216) | dSph | 72 | 0.02 | −293 | 86 | 35 | none |

Note: $d$ is measured from the Sun; $V_r(\odot)$ is the radial velocity with respect to the Sun.
c: HI is confused with Galactic emission (NGC 6822) or gas of the Magellanic Stream (Sculptor).

in 'late type' galaxies, spirals, and irregulars, and poor in the 'early type' giant ellipticals and S0 galaxies.

In the Local Group, mutual gravitational attraction is strong enough to have overcome the general expansion of the Universe. Allowing for the Sun's motion around the Galaxy, we find that the Milky Way and the Andromeda Galaxy are approaching each other instead of receding, closing at about 120 km s$^{-1}$. We can measure proper motions only for the Milky Way's immediate satellite galaxies.

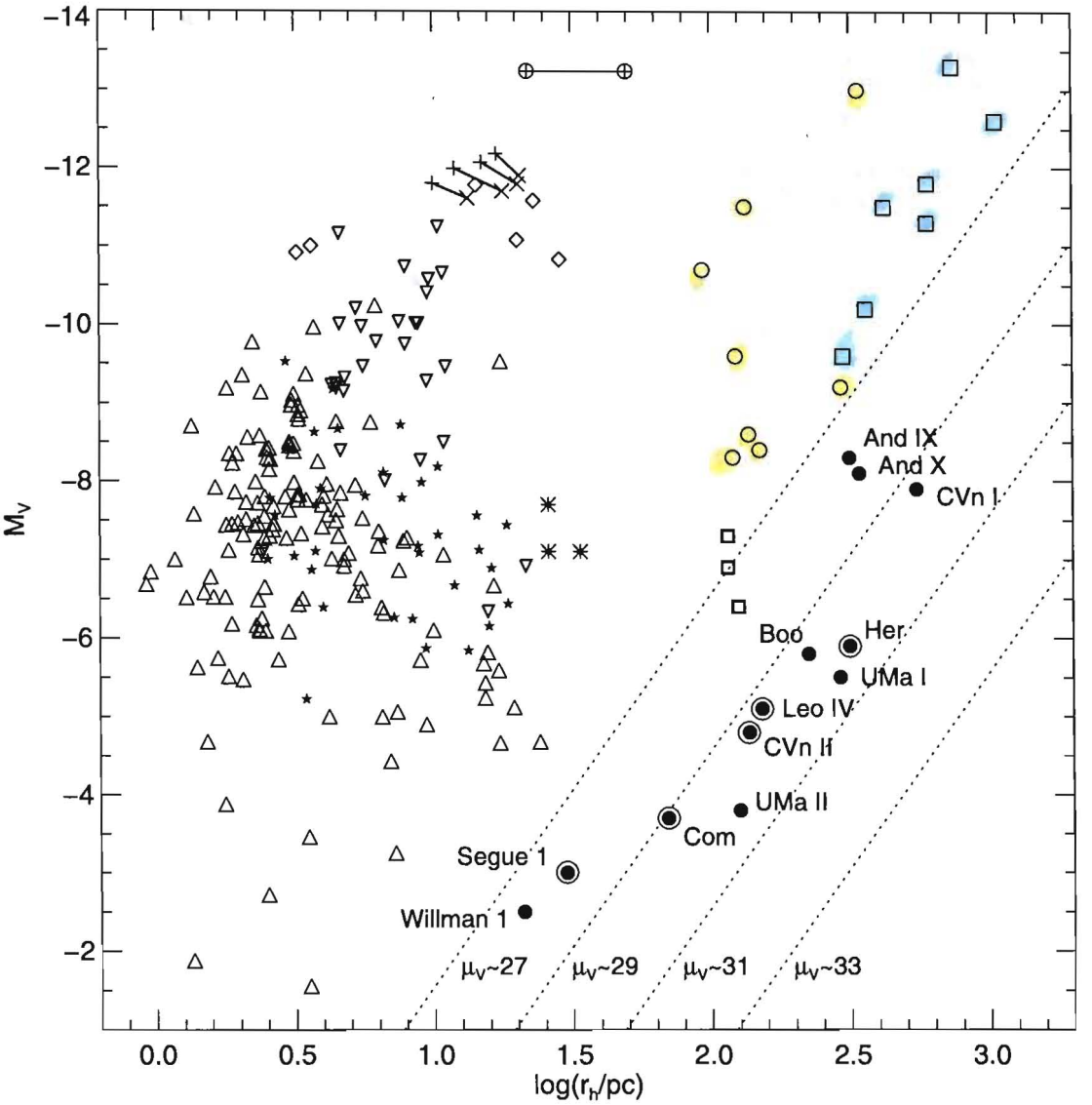


FIG. 8.—Location of different classes of objects in the plane of absolute magnitude vs. half-light radius. Lines of constant surface brightness are marked. Filled circles are the SDSS discoveries including the 10 Milky Way satellites (Willman et al. 2005a, 2006; Zucker et al. 2006a, 2006b; Belokurov et al. 2006b), as well as And IX and X (Zucker et al. 2004, 2006c). Open circles are eight previously known Milky Way dSphs with Sgr omitted (Irwin & Hatzidimitriou 1995; Mateo 1998), squares are the M31 dSphs (McConnachie & Irwin 2006), bold squares are three new M31 dSphs recently discovered by Martin et al. (2006), and triangles are the Galactic globular clusters (Harris 1996). A variety of other extragalactic objects are also plotted: asterisks are the extended M31 globular clusters discovered by Huxor et al. (2005), plus signs and crosses are UCDs in Fornax from Mieske et al. (2002) and De Propris et al. (2005), respectively, diamonds are the so-called Virgo dwarf-globular transition objects (Hașegan et al. 2005), and filled stars and inverted triangles are globular clusters from the nearby giant elliptical NGC 5128 from Harris et al. (2002) and Gómez et al. (2006), respectively. Different measurements of the same object are connected by straight lines. The straight line connecting the Earth symbols refer to measurements by Mieske et al. (2002) and Drinkwater et al. (2003) of UCD3 in Fornax.

Major I, Willman 1, Canes Venatici I, Bootes, and Ursa Major II—can be usefully taken together as a group. They were all discovered in the same data set with similar methods, although this does not necessarily imply any underlying physical commonality. The locations of the 10 SDSS objects in the Galactic sky are shown in Figure 7, together with the nine previously known dSphs. Prior to SDSS, it had long been suspected that there may be some missing dSphs at low Galactic latitude in the zone of avoidance (see, e.g., Mateo 1998). However, the SDSS objects all lie at high Galactic latitude, as the survey is concentrated around the north Galactic pole. It is difficult to escape the conclusion that there are many more Milky Way companions waiting to be discovered. Assuming that (1) all dwarf satellites in the area of sky covered by SDSS have been found and (2) the distribution of dwarf satellites is isotropic, then there may be ~50 dwarfs in all. In fact, both assumptions are surely incorrect. Systematic surveys for all satellites in SDSS DR5 are underway (S. Koposov et al. 2007, in preparation) and will undoubtedly uncover further candidates. The spatial distribution of dwarf galaxies is a controversial issue, although the most recent analysis of the simulation data suggests that dwarf satellites may lie preferentially along the major axis of the mass distribution of the host galaxy (see, e.g., Zentner et al. 2005; Yang et al. 2006 and references therein). If so, then our extrapolation to a total of ~50 dwarfs may still be a underestimate.

Figure 8 shows objects plotted in the plane of absolute magnitude and half-light radius. This includes the 10 SDSS discoveries in the Milky Way (*filled circles*) and the eight Milky Way dSphs omitting Sgr (*open circles*). We have added to the sample of SDSS discoveries two dSphs found around M31, namely, And IX and X (Zucker et al. 2004, 2006c). Also shown are a number of populations of extragalactic objects, such as the M31 dSphs, including the most recent three discoveries by Martin et al.

Dwarf galaxies (smaller than LMC/SMC) have remarkably complex star formation histories, in general, despite the fact that some have similar masses to globular clusters.

→ Skillman CMDs