Abstract. We are carrying out a comprehensive multi-wavelength study of dwarf galaxies in the Local Volume (≤ 5 Mpc). After our all-sky survey more than doubled the dwarf census we are now measuring structural parameters, integrated properties, and velocities. Our 200-orbit HST snapshot program yields stellar content, star formation history, and TRGB distances. We can thus study the morphology–density relation in galaxy groups in three dimensions, the influence of environment on galaxy evolution, and the metallicity–surface brightness–luminosity relation.
1. Introduction

The “Local Volume” describes our extragalactic neighborhood out to $\sim 5$ Mpc and includes galaxies with velocities $\leq 500$ km s$^{-1}$. Apart from the Local Group, this volume contains several nearby galaxy groups as well as isolated field galaxies. The galaxy census becomes increasingly incomplete for smaller galaxies with low surface brightness, particularly for dwarf galaxies. Furthermore, while most dwarf galaxies in the Local Group have been studied in great detail, very little is known about the properties of dwarf galaxies beyond its boundaries.

For these reasons our group began a comprehensive study of dwarf galaxies in the Local Volume. Karachentseva & Karachentsev carried out careful searches of photographic plates (POSS, ESO-SERC) of 97% of the sky for new dwarf galaxy candidates and more than doubled the previously known census (e.g., Karachentseva & Karachentsev 1998; 2000; Karachentseva et al. 1999; 2000).

Ground-based verification and follow-up observations are currently being carried out involving southern and northern hemisphere telescopes at APO, BTA, CTIO, Keck, and MDM. The imaging observations allow us to determine the degree of resolution of the dwarf galaxies as a first measure of distance, to estimate their morphological type, and to determine structural parameters and integrated properties. Radio observations (Huchtmeier et al. 2000) tell us about their H$\alpha$ content and radial velocity. Ongoing optical spectroscopy is used to measure velocities and abundances.

2. Our HST snapshot survey

Detailed optical follow-up of our dwarf candidates is being pursued with WFPC2 aboard HST. We were awarded a total of 200 orbits for a snapshot survey of nearby dwarf galaxy candidates; one galaxy per orbit. Our targets include known and possible dwarfs in nearby galaxy groups and in the field, but also a few spirals and other massive galaxies to establish distances and relative positions within galaxy groups. Most of these galaxies are being studied for the first time.

While we could in principle obtain data for 200 galaxies, in practice the number will be lower due to the constraints in scheduling snapshot observations. At the time of the present workshop in March 2000 we had already obtained data for 37 galaxies, while 8 orbits were lost due to guide star acquisition failures and due to the gyro failure in late 1999.

We observe each target in two filters ($F606W$ and $F814W$) corresponding to $V$ and $I$. The non-standard $F606W$ filter was chosen over $F555W$ due to its greater sensitivity. The exposure time in each filter is 600 s, which allows us to reach $I \sim 25$ mag. Our data are automatically processed and reduced with the photometry package $HSTphot$ developed by Dolphin (2000).

2.1. Resolved stellar populations

Due to the short exposure times our data typically reach only the upper portion of the red giant branch for galaxies beyond the Local Group. Owing to the superior resolution of HST, however, these 10 min exposures with a 2.4-m space telescope are about 1 mag deeper than our 15 min exposures obtained with the 10-m Keck II telescope (Grebel & Guhathakurta 1999).
In dwarf galaxies with young populations our color-magnitude diagrams (CMDs) show clearly the young main sequence and supergiants. The locus of red supergiants and young asymptotic giant branch (AGB) stars can be strongly contaminated by Galactic foreground stars. The blue main sequence and blue He-burning stars allow us to trace ages ranging from a few million years to several 100 Myr. Where present, the horizontally tilted region of intermediate-age AGB stars just above the red giant branch (RGB) indicates populations older than \( \sim 1 \) Gyr. The RGB itself may comprise both intermediate-age and old (> 10 Gyr) stars. The foreground reddening can be derived from the extinction maps of Schlegel et al. (1998).

While we obtain detailed age information for young populations, our age resolution is poor for intermediate-age populations. We cannot unambiguously detect old populations due to the age degeneracy along the RGB and lack of deeper data that reach at least the horizontal branch. Nonetheless the data on stellar content are invaluable for constraining the star formation history and far supersede the information previously available from ground-based imaging.

### 2.2. Distances and metallicities

The tip of the RGB (TRGB) allows us to derive distances for our dwarfs. For the dwarf spheroidal (dSph) galaxies in our sample the location of the TRGB can be determined to \( \sim \pm 0.1 \) mag. The main sources of uncertainty are photometric blends, crowding, or, in some cases, sparsely populated RGBs. In dwarf irregulars (dIrrs) the determination of the TRGB magnitude is complicated by the contamination of the RGB stars with younger populations such as AGB stars. We estimate the distance uncertainty to be of the order of \( \pm 0.2 \) mag.

In heavily extincted galaxies of any type the apparent magnitude of the TRGB may be too close to the detection limit to allow us to derive anything else but a lower limit for the distance. This is the case for many of the members of the obscured IC342/Maffei group, while we are getting well-defined TRGBs for galaxies in groups such as Sculptor, Centaurus A, and M81.

Despite their drawbacks TRGB distances are the best available distance indicator in galaxies where Cepheids may be absent and RR Lyrae or the horizontal branch are close to or beyond the detection limit of most present-day telescopes. They provide an efficient means to derive distances for a large sample of targets. An interesting additional benefit is that these distances are helpful in calibrating the density fluctuation method recently developed for dSphs and dwarf ellipticals by Jerjen et al. (2000) since we have several dwarfs in common.

For those of our targets that suffer little foreground extinction and that are closer than \( \sim 3 \) Mpc the slope and mean color of the upper RGB can be used to estimate mean metallicities and to constrain the metallicity spread.

The mean metallicities derived this way, together with central surface brightness and absolute magnitude, follow the same trend defined by dwarf galaxies in the Local Group (Grebel & Guhathakurta 1999, Karachentsev et al. 2000).

### 2.3. Star clusters

Our survey shows a few extended, spherical objects that resemble globular clusters. Applying color selections and comparison with the known colors of Galactic
globular clusters allows us to identify potential globular cluster candidates and to estimate the specific globular cluster frequency.

Some of our targets appear to be nucleated. In other cases compact objects are being identified as background galaxies based on their morphological appearance and/or colors. Concentrations of blue stars are seen in several of the dIrrs in our sample and may represent young open clusters or OB associations.

3. Summary

Our Local Volume survey helps to improve the census of dwarf galaxies and to augment the faint end of the galaxy luminosity function. Our ground-based follow-up studies in optical and radio wavelengths yield structural parameters, integrated properties, morphological types, kinematic information, and an assessment of the gas content of the dwarf galaxy candidates. Our HST snapshot survey yields, for the first time, detailed information on the resolved stellar populations and a crude assessment of their star formation histories.

The TRGB distances allow us to derive probable group membership and the location of galaxies within galaxy groups. We thus obtain the three-dimensional structure of nearby groups. This together with our partial knowledge of the star formation episodes as well as the kinematic information helps us to understand the impact of environment on dwarf galaxy evolution, allowing a three-dimensional study of the morphology-density relation.

Acknowledgments. Support for this work was provided by NASA through grant GO–08192.97A from STScI, which is operated by AURA, Inc., under NASA contract NAS5–26555. EKG gratefully acknowledges support by NASA through grant HF–01108.01–98A from the Space Telescope Science Institute. EKG, IDK, and VEK were also supported through an Henri Chrétien International Research Grant administered by the American Astronomical Society.

References

Dolphin, A.E., 2000, PASP, in press (astro-ph/0006217)
Grebel, E.K., & Guhathakurta, P. 1999, ApJ, 511, L101
Huchtmeier, W.K., Karachentsev, I.D., Karachentseva, V.E., & Ehle, M. 2000, A&AS, 141, 469
Jerjen, H., Freeman, K.C., & Binggeli, B. 2000, AJ, 119, 166
Karachentsev, I.D., Karachentseva, V.E., Dolphin, A.E., Geisler, D., Grebel, E.K., Guhathakurta, P., Hodge, P.W., Sarajedini, A., Seitzer, P., Sharina, M.E. 2000, A&A, submitted
Karachentseva, V.E. & Karachentsev, I.D. 1998, A&AS, 127, 409
Karachentseva, V.E. & Karachentsev, I.D. 2000, A&AS, in press
Karachentseva, V.E., Karachentsev, I.D., Richter, G.M. 1999, A&AS, 135, 221
Karachentseva, V.E., Karachentsev, I.D., Suchkov, A.A., & Grebel, E.K. 2000, A&AS, submitted
Schlegel, D.J., Finkbeiner, D.P., Davis, M. 1998, ApJ, 500, 525