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Two color photometry of dwarf galaxies within 10 Mpc

Torbjørn Bremnes

Astronomical Institute, University of Basel, Venusstrasse 7, CH-4102 Binningen. e-mail: bremnes@astro.unibas.ch

Abstract. Two-color CCD photometry of dwarf galaxies in and around the M 81, M 101 and CVn I groups is presented. These observations are part of a long term project aimed at obtaining surface photometry data of all known dwarf galaxies within 10 Mpc. The global photometric parameters derived will serve as the basis for a comparison between dwarf galaxies in different galactic environments.

1. Introduction

This work is part of the '10 Mpc project', consisting of systematic broadband multicolor CCD imaging of a volume-limited sample of dwarf galaxies within 10 Mpc. A list containing a large fraction of the galaxies in this volume was compiled in the '10 Mpc Catalogue' by Kraan-Korteweg & Tammann (1979), and recent work by numerous authors has resulted in many new candidates (e.g. Karachentseva & Karachentsev 1998). The total number of known galaxies in the volume today amounts to approx. 300. A large number of these are members of small to medium sized groups (e.g. IC 342, M 81, M 101, CVn I, CenA, IC342 and Scl) and a few are field galaxies. There is therefore a large span in galactic density at the positions of the different galaxies. Accurate distance measurements for a large fraction of these objects are also now becoming available, measured mostly by photometric methods (see for example Makarova & Karachentsev 1998, Karachentsev & Drozdovsky 1998 and references therein). It is therefore becoming possible to study a large volume-limited sample of nearby galaxies in detail. As the environments of these galaxies range from the low density field to medium/high density groups, they represent ideal candidates for the study of the galaxy structural parameters in low to medium/high density environments, as compared to the more thorougly studied high density clusters (e.g. Evans et al. 1990, Secker et al. 1997).

2. Observations

The observational data set described here consists of 61 dwarf galaxies from the northern hemisphere. These data have been obtained during observation runs in 1992, 1993, 1997 and 1998 at the Observatoire de Haute Provence 1.2-m telescope (Bremnes et al. 1998, 1999a,b). The sample consists of 25 galaxies in and around the M 81 group (out of a total of $\sim$ 40), eleven M 101 group members, ten field dwarfs in the projected vicinity of the M 101 group and 15 dwarf galaxies in the

CVn I cloud. Integrated magnitudes in B and R, effective radii, effective surface brightnesses, azimuthally averaged radial brightness profiles, color profiles as well as best fitting exponential fit parameters have been derived for the galaxies. The galaxies show a strong morphological segregation (Dressler 1980, Binggeli et al. 1990), almost all early type galaxies being satellites of larger galaxies or members of dense groups: there are seven dwarf elliptical (dE) galaxies in the interacting (Yun et al. 1994) M 81 group, whereas there is only one dE in the much looser M 101 group. The latter group also shows a notable deficit of faint galaxies as compared to the M 81 group[1]. The galaxies in the CVn I cloud are more of a mixed bag, as the sample in that region is not complete, because of bad observing conditions during the 1998 observing run.

3. Colors

A color-magnitude diagram for our sample is shown in Figure 1.

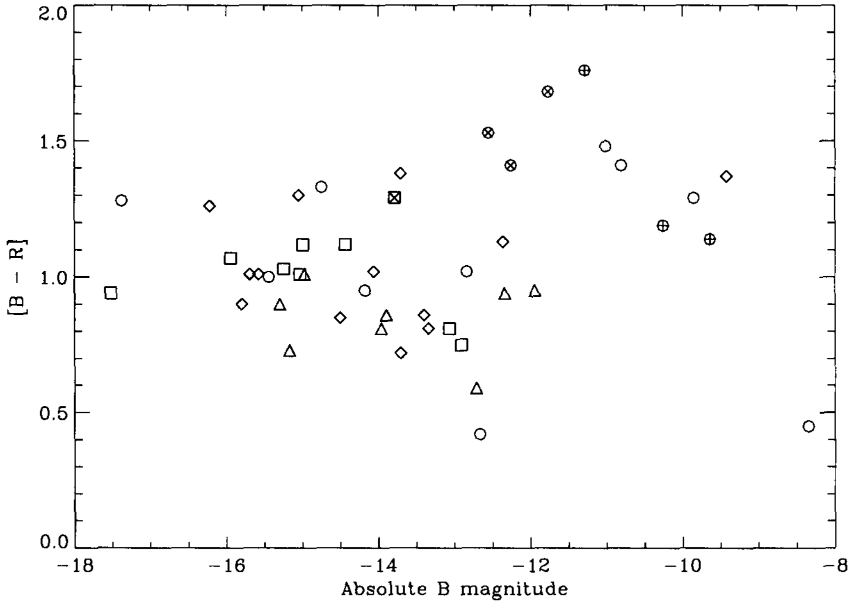

Figure 1. Color-Magnitude diagram for the dwarfs in our sample. Open symbols represent late type galaxies, +-symbols represent early types and ×-symbols represent dE,Ns. Circles show M 81 group members, squares M 101 group members, diamonds field galaxies around M 101 and triangles CVn I cloud members

[1] One must beware of incompleteness in the samples, as low surface brightness galaxies are still being discovered in deep searches (e.g. Armandroff et al. 1999, Caldwell et al. 1998)

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The members of the M 81 Group from our sample tend to be redder than galaxies from the other groups or the field. Redder than $B-R=1.2$, most galaxies are M 81 group members, many of which are of early type. The reddest object, BK8N, at $B-R=1.76$, is an unusual, relatively large patchy object described by Börngen et al. (1984), for which the classification, as a galaxy is problematic. Bremnes et al. (1998) classify it as probable Galactic cirrus. Another special galaxy is BK5N, at ($B=-10.46$, $B-R=1.19$), classified as a dE. Caldwell et al. (1998) report a background galaxy shining through its center. As the apparent color of the background object is rather red, the true position of this dE should be at slightly lower luminosity and bluer color (~ 0.2 mag). Bluer than $B-R=1.0$ there are only three M 81 group dwarfs. One is BK3N, a very small (with a radius at 26 mag/$\square''$ of $\sim 10''$) and faint galaxy located at 2.8 Mpc, classified Im. In such a galaxy the slightest star formation episode would shift its color towards the blue. The other two 'blue' objects are a possible isolated background galaxy (DDO 87, at $B-R=0.95$), and a small patchy irregular (UGC 4483, at $B-R=0.42$)[2].

The dE,N galaxies from this sample show a clear color-magnitude relation. This relation goes in the sense of fainter galaxies being redder. This is in agreement with the results found by Evans et al. (1990) for the Fornax cluster. They find a relatively tight relation for the dE,Ns of their sample with a slope of 0.25 ± 0.05 mag per unit total B_J magnitude (but see also Secker et al. 1997). The dE,Ns of our sample follow this relation closely. For the dEs the picture is more confused, the sample being very limited (at most 3 galaxies). The late type galaxies present a less well defined picture. They mostly populate the brighter and bluer part of the diagram, reflecting their higher relative starformation rates and presence of younger stellar populations. They also show a slight tendency for fainter galaxies to be bluer, which one can expect if the effect on color of star formation gets proportionally larger at faint overall magnitudes.

4. Discussion

An interesting point is the morphological segregation obeyed by dwarf galaxies, most early type galaxies living in dense environments, where tidal perturbations certainly play a role. One could put forward a possible scenario where progenitors of dwarf elliptical galaxies are "harassed" by their neighbors (Moore et al. 1998). They would therefore form stars earlier and/or faster, due to the tidal triggering of star formation, than the less-interacting galaxies. These galaxies would then evolve sooner into gas-poor dwarf elliptical galaxies with large populations of old stars, following the evolutionary path described by Evans et al. (1990).

Color and distance information is becoming available for a growing number of galaxies within 10 Mpc. Our long-term goal is to obtain an as complete as possible volume limited sample with surface photometry in at least two colors. One will then be able to study the photometric parameters of dwarf galaxies

[2]There are a dozen galaxies in the M 81 group that do not have both *B and R* photometry, so the group CM diagram remains unclear

in the field and in small groups in detail, as well as effects thereon of their environments. Such work is still in its infancy, and has until now been limited to clusters such as Coma or Fornax, where the galaxy density is much higher than in the local volume (LV). As galaxy evolution is strongly affected by the environment, it is important to extend such studies to the lower density regions like the LV. Questions one will then be able to answer are for example the shape of the luminosity-function (LF) at the faint end, eventual environmental effects on the LF, galaxy parameters as a function of environment etc.

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References

Armandroff, T. E., Davies, J. E. & Jacoby, G. H. 1999, in *The Low Surface Brightness Universe*, eds. J. I. Davies et al., ASP Conference series, 170

Binggeli, B., Tammann, G. A. & Sandage, A. 1987, AJ, 94, 251

Binggeli, B., Tarenghi, M. & Sandage, A. 1990, A&A, 228, 42

Börngen, F., Karachentseva, V. E. & Karachentsev, I. D. 1984, AN, 305, 53

Bremnes, T., Binggeli, B. & Prugniel, P. 1998, A&AS, 129, 313

Bremnes, T., Binggeli, B. & Prugniel, P. 1999a, A&AS, 137, 337

Bremnes, T., Binggeli, B. & Prugniel, P. 1999b, A&AS, in preparation

Caldwell, N., Armandroff, T., Da Costa, G. & Seitzer, P., 1997, AJ, 115, 535

Dressler, A. 1980, ApJ, 236, 351

Evans, R., Davies, J. I. & Phillipps, S. 1990, MNRAS, 245, 164

Karachentsev, I. D. & Drozdovsky, I. O. 1998, A&AS, 131, 1

Karachentseva, V. E. & Karachentsev, I. D. 1998 A&AS, 127, 409

Kraan-Korteweg, R. C. & Tammann, G. A. 1979, AN, 300, 181

Lesaffre, P., Prugniel, P., Binggeli, B. & Bremnes, T. 1999, in preparation

Makarova, L. N. & Karachentsev, I. D. 1998, A&AS, 133, 181

Moore, B., Lake, G. and Katz, N. 1998, ApJ, 495, 139

Secker J., Harris, W. E. & Plummer, J. D. 1997, PASP, 109, 1377

Yun, M. S., Ho, P. T. P. & Lo, K. Y. 1994, MNRAS, 372, 530