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Compact Galaxies in the Virgo Field

M. J. Drinkwater

Anglo-Australian Observatory, Coonabarabran, NSW 2357, Australia

E. Hardy

Dépt. de Physique, Université Laval, Québec, Qué. G1K 7P4, Canada

J. M. Yearlsey

MAPS, University of Sussex, Brighton BN1 9QH, United Kingdom

Abstract. We present the preliminary results of a search for new blue compact dwarf (BCD) galaxies in the Virgo cluster. Our search is based on the automated selection of compact galaxies from digitised scans of UK Schmidt plates and is designed to put quantitative limits on the luminosity function of compact galaxies in Virgo.

We have selected a sample of 310 candidate BCD galaxies and have obtained radial velocities for 177 of them using the UK Schmidt FLAIR-II multi-object fibre spectrograph. We have confirmed two new members of the cluster. One is classified as a member (but without velocity) in the Binggeli, Sandage and Tammann (1985) catalogue (VCC) and the other does not appear in the VCC and is therefore probably a new BCD. The other 175 galaxies are background objects at higher redshift, including one classified as "BCD or background" in the VCC which we now confirm to be a background object.

1. Introduction

Being the dominant nearby cluster, Virgo is particularly well-suited to studies of the distribution and luminosity functions of dwarf galaxies. Only in such clusters can any attempt be made to measure the luminosity function for different types of galaxy including the rarer dwarf irregular types (Binggeli, Sandage and Tammann, 1988). The latter work is based on the Virgo Cluster Catalogue (VCC) (Binggeli et al. 1985) which lists 2096 galaxies in the Virgo region and describes 1277 as members, although only 572 have measured radial velocities. In a recent compilation Binggeli, Popescu and Tammann (1993) present new velocities for 144 VCC galaxies. They note that many galaxies classified "background" in VCC may turn out to be cluster members once velocities are available.

This incompleteness may be particularly important for blue compact dwarf (BCD) galaxies—dwarf irregulars with high surface brightness. Drinkwater and Hardy (1991) looked at the extreme, very compact end of the distribution of known BCDs and suggested that more might be present but misclassified as

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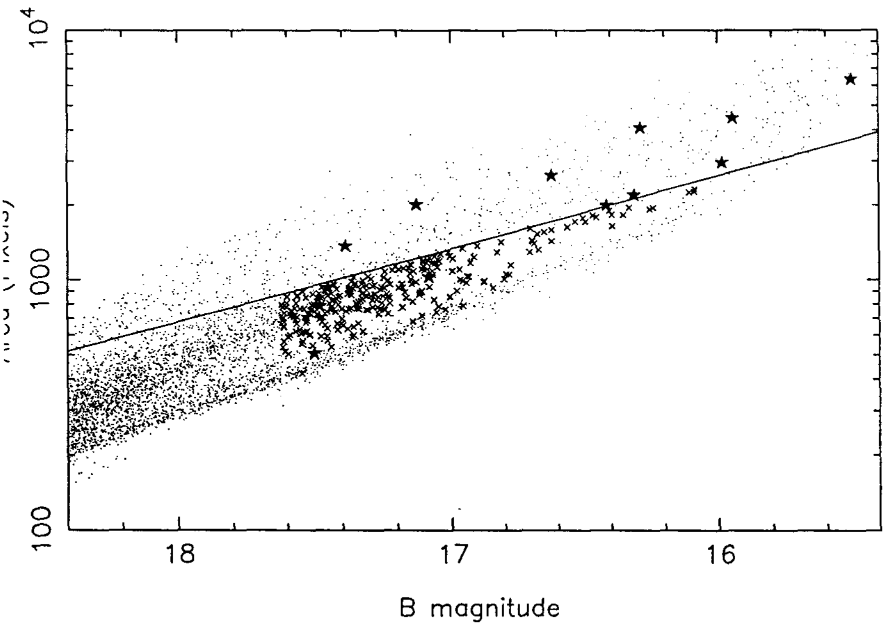

Figure 1. An image-classification diagram for galaxies and "merged" objects in the central region of the Virgo cluster. The area is given in units of pixels (1 pixel has an area of $\approx$ 0.29 square arcsec). Known BCDs are plotted as stars and the new BCD candidates are plotted as crosses. The objects lying along the lower locus of points are mostly "merged" objects dominated by a foreground star.

background galaxies or even stars. In this paper we describe a new search for BCDs in the Virgo cluster based on the automated analysis of digitised Schmidt plate data and subsequent multi-object fibre spectroscopy.

2. BCD candidate selection

The region of sky studied is based on a U.K. Schmidt field centred on the Virgo Cluster ($12^h26^m30^s + 13°15'30''$ 1950). We selected the most compact galaxies in the field using objective criteria based on image parameters measured from the Schmidt plate by the Automatic Plate Measuring (APM) facility.

The APM classifies objects as "galaxies", "stars" or "merged", the latter term indicating a star-star or star-galaxy pair that cannot be resolved. Some known BCD galaxies were classified "merged" because of the presence of either a compact star-forming region or a close foreground star; we therefore chose our sample to include both "galaxies" and "merged" objects. Our selection is illustrated in Fig. 1 which plots image area against magnitude for all the objects classified as "galaxies" or "merged" on the B_J plate. At a given magnitude, objects with the smallest area are the most compact and we selected objects lying below the sloping line in Fig. 1 as BCD candidates. We imposed a magnitude

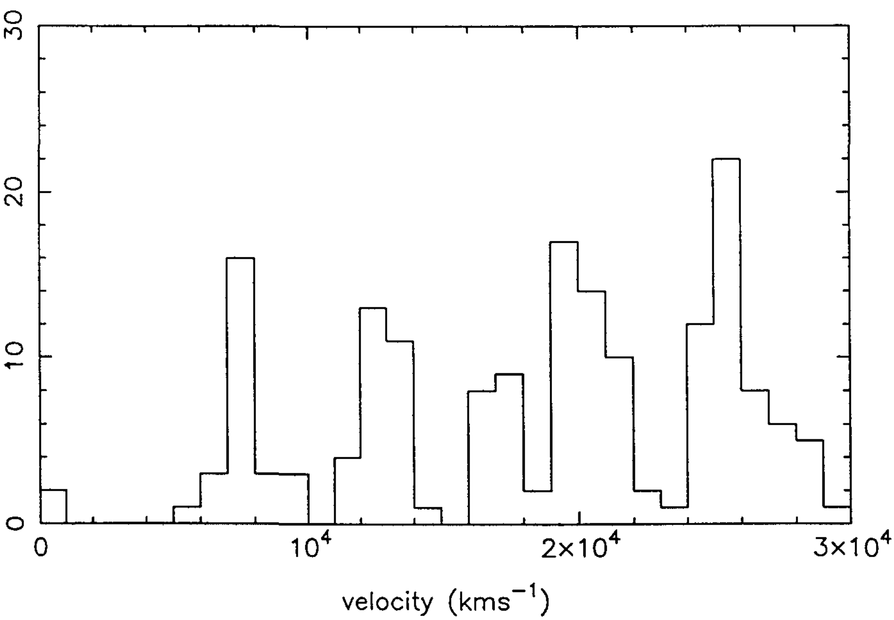

Figure 2. Velocity histogram of the BCD candidate galaxies. Note that members of the Virgo cluster have velocities $v \leq 2500$ kms^{-1}.

limit of $B_J < 17.6$ so that the velocities could be measured in a single night with FLAIR-II, defining a sample of 310 galaxies.

3. Spectroscopy

We used the UK Schmidt FLAIR-II multi-object spectrograph (Watson et al. 1993) during two observing runs in March 1992 and March 1993 to observe a total of 210 members of the BCD sample. The spectral dispersion was 6.1Å per pixel giving a spectral range of 3600–7900Å and we used 100μm (6.7 arcsec) fibres. All the data were processed using the IRAF[1] image analysis software to obtain one-dimensional, wavelength-calibrated spectra.

The spectra were then analysed using the IRAF "add-on" package RVSAO (Kurtz et al. 1991) to measure the radial velocities. We obtained velocities for 177 of the galaxies observed using a combination of emission- and absorption-line methods. In cases when velocities from both methods were obtained for the same galaxy, we used the one with the lower error—usually the emission line velocity. We present these results in the form of a velocity histogram in Fig. 2.

[1](IRAF is distributed by the National Optical Astronomy Observatories, which is operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under cooperative agreement with the National Science Foundation.)

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4. BCD Luminosity Function

Two of the BCD candidates were found to have velocities consistent with Virgo cluster membership (i.e. $v \leq 2500$ kms^{-1}). One of these (12 29 28.0 +13 21 33) is already in the VCC classified "ImV?". The other (12 28 54.9 +13 11 33) is a new member, although it requires confirmation with higher spatial resolution spectroscopy as it may possibly be a star lying in front of a background galaxy. Of the remaining galaxies with larger velocities we note there is one (12 31 40.5 +12 05 12) listed in the VCC as a possible BCD cluster member which we now show to be a background object. Only two other VCC galaxies were in our sample; in both cases we confirmed their previous classification as background objects.

Within our objective selection limits we can now measure the numbers of Virgo BCDs with a well-defined completeness limit. We will present formal limits on the numbers of galaxies in a later paper; the main conclusion we make here is that Binggeli et al. (1985) did not miss a significant number of BCDs in the VCC catalogue so the drop in the BCD luminosity function measured by Binggeli et al. (1988) is confirmed.

5. Background Distribution of compact galaxies

The remaining 175 galaxies that lie behind the cluster make up a very interesting sample because they have the unusual selection based on compactness. The distribution of absolute magnitudes of the galaxies peaks at around $M_B = -21$ (no k-corrections). This is consistent with these galaxies having been drawn from a standard luminosity function. The velocity histogram in Fig. 2 shows evidence of a non-uniform spatial distribution, notably the peak at 7000 kms^{-1} due to the Coma supercluster (as noted by Binggeli et al. 1993).

6. Summary

We have used imaging and spectroscopic data from the UK Schmidt Telescope to generate a new sample of candidate BCD galaxies in the Virgo cluster. Our data confirm that one galaxy classified "BCD or background" in the VCC is indeed background and that one galaxy classified as "ImV?" is a cluster member. In addition we find one new compact galaxy that is probably a BCD in the cluster. Our results show that BCD luminosity functions derived from the VCC are reasonably accurate.

Acknowledgements

This work has made use of data from the UK Schmidt Telescope of the AAO in two forms. First we analysed Schmidt plates provided by the UK Schmidt Unit, Royal Observatory Edinburgh. These were digitised by the APM facility, Royal Greenwich Observatory, and we thank Mike Irwin for providing that service. Secondly we have used the Schmidt for spectroscopic observations with the the FLAIR-II system and we thank Quentin Parker and Fred Watson for all their assistance at the telescope. We also wish to thank Gerhardt Meurer for kindly supplying some additional photometric calibration.

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