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WINGS: a photometric, morphological and spectroscopic library of nearby cluster galaxies

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Abstract. WINGS is a two-band (B and V), wide-field imaging survey of a complete, all-sky X-ray selected sample of nearby clusters. This sample comprises 78 clusters in the redshift range z=0.04-0.07. The aim of this survey is to provide the astronomical community with a complete set of homogeneous, CCD-based surface photometry and morphological data of cluster galaxies located within 1.5 Mpc from the cluster center. For each cluster, photometric data of about 2500 galaxies (down to V$\sim$23) and detailed morphological information of about 500 galaxies (down to V$\sim$21) are obtained by using specially designed automatic tools.
We also illustrate a long term spectroscopic follow-up carried out with the WHT-WYFFOS and AAT-2dF multi-fiber spectrographs. Star formation rates and histories, as well as metallicity estimates will be derived for about 350 galaxies per cluster from the line indices and equivalent widths measurements, allowing us to explore the link between the spectral properties and the morphological evolution in high- to low-density environments, and across a wide range in cluster X-ray luminosities and optical properties.

Key words. Galaxies: Clusters – Galaxies: Evolution – Galaxies: Structure

1. Introduction

Clusters of galaxies are the largest, yet well defined, known entities in the Universe. An adequate photometric and spectroscopic information on nearby clusters is crucial for studying the morphology and the stellar populations of galaxies in a systematic way, as well as for setting the zero-point for evolutionary studies.

Galaxy clusters display a large variation in their own structure and in morphological galaxy content. Therefore, a wide and

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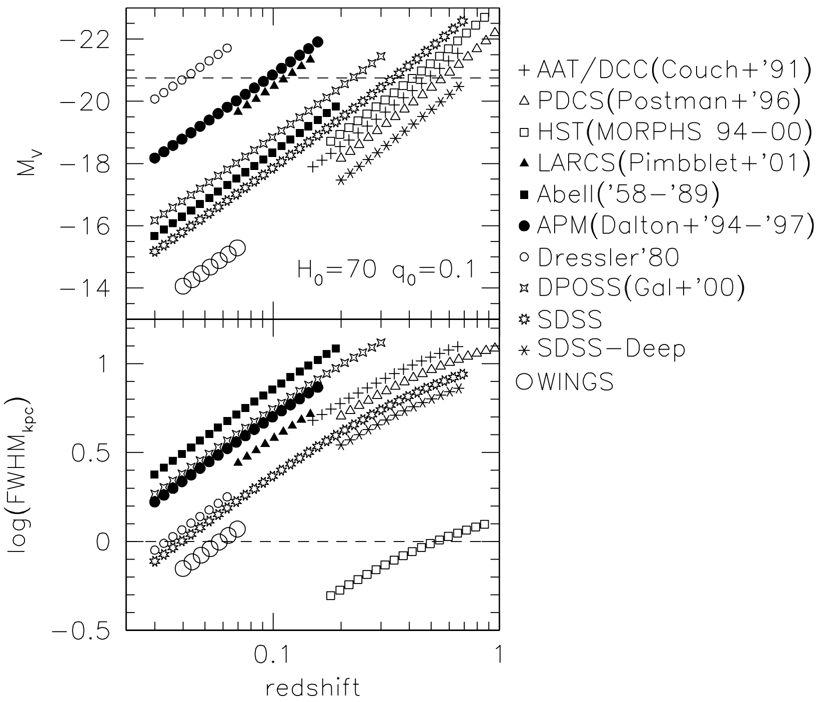

Fig. 1. Limiting absolute magnitude and space resolution (in Kpc) as a function of redshift for most of the available and ongoing extragalactic surveys.

well-defined sample is needed to investigate in a systematic way what cluster properties are driving the variations in galactic properties.

Here we present the first results of a two-band (B and V) wide-field imaging survey (WINGS) of a complete, all-sky X-ray selected sample of 78 clusters in the redshift range z=0.04-0.07. The photometric WINGS survey has been conceived to fill in the lack of a systematic investigation of nearby clusters and their galaxy content. This is schematically illustrated in Fig. 1, where the limiting absolute magnitude and space resolution (in kpc) are reported as a function of redshift for most of the available and ongoing galaxy surveys. It can be seen that WINGS is the deepest ($M_V \sim$-14), best resolution (FWHM $\sim$ 1 kpc) survey of a complete sample of galaxies in nearby clusters to date. For instance, even if the nominal resolution (FWHM in kpc) of WINGS is only slightly better than that of the survey of Dressler (1980), its data quality (CCD) is definitively better and its deepness is incomparably better ($\sim$6 mag) with respect to the Dressler's survey.

2. The photometric survey

The data collection has been completed in seven observing runs at the INT and ESO-2.2m telescopes. For each cluster, photometric data of about 2500 galaxies (down to $V \sim 23$) and detailed morphological information of about 500 galaxies (down to $V \sim 21$) are obtained by using specially designed automatic tools.

To analyze the distribution of galaxies of the different morphological types

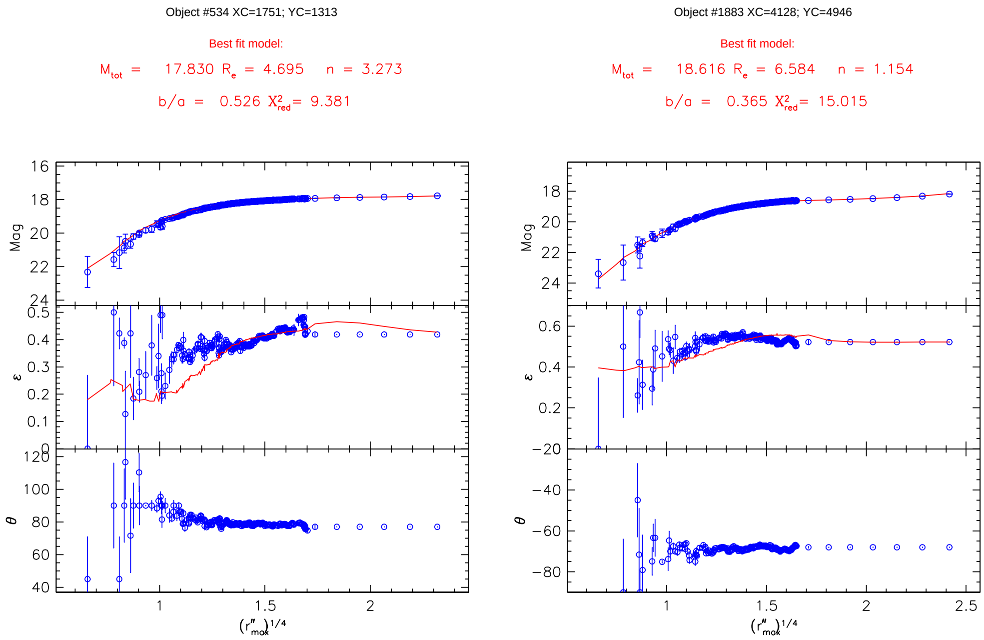

Fig. 2. Two examples of our morphological analysis obtained by fitting the surface brightness profile with the Sersic model. On the left: an elliptical galaxy is well described by a Sersic index greater than 3. On the right: a spiral galaxy has a Sersic index near to 1.

in the clusters, we need some efficient and automatic tool for surface photometry and morphological classification of galaxies. The package GASPHOT (Pignatelli, Fasano 2003, in preparation) is able to produce automatically the luminosity and geometrical profiles for a large number of galaxies as well as to perform the fit of the profiles with the Sersic and/or de Vaucouleurs+exponential models. In particular, it provides us with total magnitude, effective radius (r_e) and Sersic index (n) of each galaxy (see, for example, Fig. 2).

For each cluster we detect about 2500 galaxies, contained in our "deep galaxy catalogs". The completeness of these galaxy catalogs is typically achieved down to $V \sim 22$. Additional catalogs for surface photometry and morphology of galaxies have been extracted from the "deep catalogs", including only galaxies with threshold area ~ 200 pixels. The completeness of these "bright catalogs" is typically achieved down to $V \sim 20$, and contains about 500 galaxies per cluster.

This second catalog has been processed and classified by GASPHOT. Now we are comparing the results with the morphological classifications derived from visual inspection of the images. The aim of this comparison is to combine the most significant profile parameters to obtain an automatic, coherent morphological classification.

All the galaxies observed in each cluster have been plotted in the color-magnitude diagram (m_V vs. $(B-V)$) of the cluster (see Fig. 3 for an example). The homogeneity in color and the closeness in space define a precise color-magnitude sequence for each cluster. We can take advantage of this very useful property in separating the cluster members from the field galaxies.

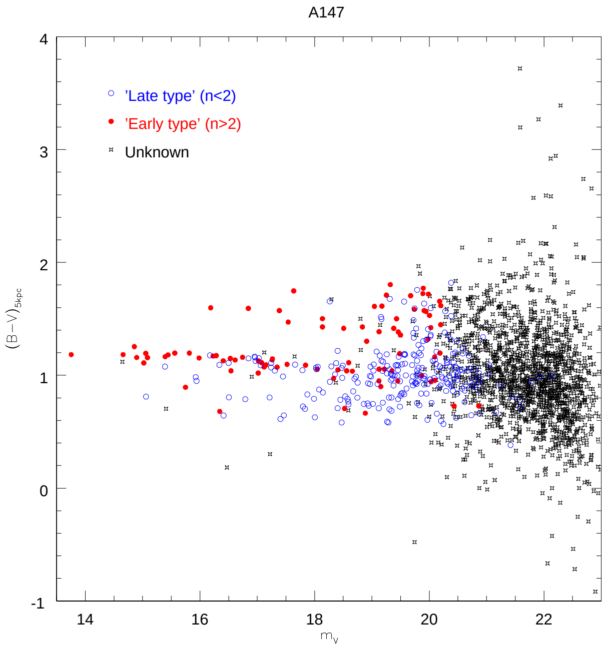

Fig. 3. The color-magnitude diagram of the Abell cluster A147. It is possible to identify another cluster in the same field. The red sequence of this farther cluster has a $(B-V) \sim 0.6$ mag redder than that of the galaxies in A147. Full and open dots represent "early-type" and "late-type" galaxies, respectively.

3. The spectroscopic survey

As a natural follow up of the photometric survey, we are carrying out a long term spectroscopic program with the WHT-WYFFOS and AAT-2dF multi-fiber spectrographs.

For about 350 galaxies per cluster, we plan to get spectra in the range $3800 \div 8000$ Å at intermediate resolution ($6 \div 9$ Å), in order to retrieve redshifts, equivalent widths and line indices of emission and absorption lines.

Star formation rates and histories, as well as metallicity estimates will be derived from these spectroscopic data. This will allow us to explore the link between the spectral properties and the morphological evolution in high to low-density environments, and across a wide range in cluster X-ray luminosities and optical properties.

4. Conclusions

We presented a spectrophotometric survey of a complete, all-sky X-ray selected sample of nearby cluster galaxies.

Once completed, the survey will provide approximate magnitudes and colors for about 200000 galaxies, complete morphological information for about 35000, and redshifts and line indices for about 27000 galaxies.

The whole catalogs will be available on line for public use at the Web site http://web.pd.astro.it/wings/.

References

Dressler, A. 1980, ApJS 42, 565.

Dressler, A., Oemler, A. Jr., Couch, W. J., Smail, I., Ellis, R. S., Barger, A., Butcher, H., Poggianti, B. M. & Sharples, R. M. 1997, ApJ 490, 577.