

MUTI-COLOR IMAGING OF CLUSTERS OF GALAXIES WITH MOSAIC CCD CAMERAS

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1. Introduction

At present, the photometric data for clusters at $z \lesssim 0.2$ mainly come from photographic photometry. The lack of CCD data for such clusters is simply due to the fact that no CCD camera had been available until recently that covers the wide extension of clusters within a reasonable amount of observing time. We have developed a large mosaic CCD camera and conducted multicolor imaging observations of $z \lesssim 0.2$ clusters using the 40-inch Swope telescope at Las Campanas Observatory.

2. 5K×8K Mosaic CCD Camera

Our mosaic CCD camera consists of forty 1K×1K CCDs located on a grid of the 8×5 array. The CCDs are TC-215 with 12-micron pixels manufactured by Texas Instruments Japan. The spacing between adjacent CCDs is slightly smaller than twice the side of the CCD. The image of a contiguous field, which consists of 14,500×9,280 pixels, is composed of four offset exposures. Figure 1 shows the camera as of April 1996. A brief description of the camera is given by Kashikawa *et al.* (1995a)

3. Observations and Data Reductions

We observed more than a dozen nearby ($z \lesssim 0.2$) clusters of galaxies in the *B*, *V*, and *R* bands in 1994–5. The camera evolved during this period from the 4×7 array to the 5×8. At the Cassegrain focus of the Swope telescope,

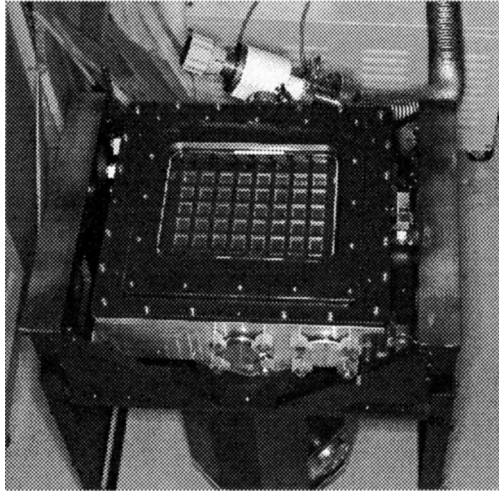


Figure 1. The 5K×8K mosaic CCD camera

the camera (5×8 array) gave a field of view of about $1^\circ 41' \times 0^\circ 90' = 1.27$ square degrees with the resolution of $0.35 \text{ arcsec pixel}^{-1}$.

The data are processed with a software package dedicated to our camera. In addition to the pre-processings common to CCD data such as bias/dark subtraction and flat fielding, we need to do the frame mosaicking and PSF equalization, which are pre-processings characteristic of our camera. The former is to establish a consistent coordinate system and a consistent flux scale while the latter is to assure the uniformity of object detection and extracted parameters, over a contiguous field composed of four separate offset exposures taken by 40 different chips. The mosaicked and PSF-equalized data of a contiguous field is subjected to the more or less usual image analysis consisting of object detection, measurement of photometric and shape parameters, and star/galaxy discrimination.

4. Results

Based on the R -band data of four clusters, A1656 (Coma; $z = 0.02$), A1367 ($z = 0.02$), A1644 ($z = 0.05$), and A1631 ($z = 0.05$), we detected a significant cluster-to-cluster variation in the faint part ($M_R \gtrsim -18 \text{ mag}$) of the luminosity function of early-type galaxies (Kashikawa *et al.* 1995b). The data for A1656 and A1367 were obtained with our old mosaic CCD camera attached to the Kiso Schmidt telescope (Sekiguchi *et al.* 1992).

Our morphological classification (Doi *et al.* 1993) is based solely on the shape of the luminosity distribution in a single color band (R band), which is subject to the seeing effect. In order to examine the reliability of our

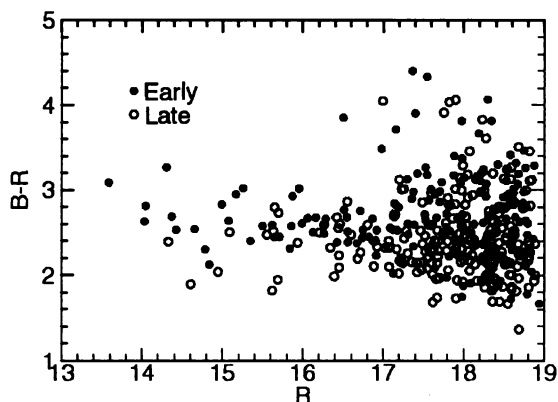


Figure 2. $B - R$ colors (zero point arbitrary) of galaxies in A1631 as a function of R magnitude

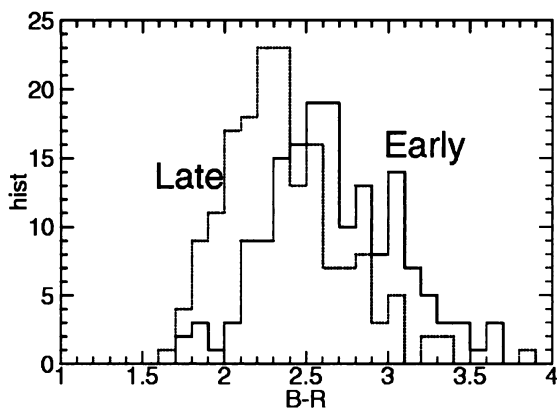


Figure 3. $B - R$ colors (zero point arbitrary) of galaxies in A1631 as a function of $B - R$ colors

classification we analyzed the B -band data of A1631 and obtained the $B - R$ color for galaxies. The colors are computed from the aperture magnitudes. Aperture radius is set to be $1.5r_e$, where r_e is the *isophotal equivalent* radius measured in the R band, *i.e.*, $r_e = \{(isophotal\ image\ area)/\pi\}^{1/2}$. The internal photometric accuracy is estimated as $\lesssim 0.08$ mag in r.m.s. in $m_R < 18.5$.

Figure 2 shows the $B - R$ relative color as a function of R magnitude while Figure 3 shows the histograms for the two types. The histogram of

the early-type is shifted to the red with respect to that of the late-type by about 0.3 mag. This systematic difference is taken to be evidence that our morphological classification is broadly valid at $z \sim 0.05$.

References

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