The Size-Luminosity Relation of Disk Galaxies in EDisCS Clusters

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Abstract

We present the size-luminosity relation (SLR) for disk galaxies observed in eight clusters from the ESO Distant Cluster Survey (EDisCS). These clusters, at redshifts 0.4 < z < 0.8, were observed with the *Hubble Space Telescope's* Advanced Camera for Surveys. While we observe a change in the SLR with redshift, namely that there is an absence of low surface brightness galaxies at high redshift, we demonstrate that this could be a product of selection effects and thus is not a confirmation of evolution. We also compare the SLR for cluster and field galaxies in each redshift bin and see no significant effects of environment on the SLR.

Description of the Survey

EDisCS is a survey of 20 fields with clusters in the range 0.4 < z < 1.0. All 20 fields were observed in multiple bands with the Very Large Telescope (VLT), and ten of these were observed with HST/ACS in I_{814}. More than 100 galaxies in each field were targeted for spectroscopy with VLT/FORS2. (White et al. 2005)

Sample Selection

Structural parameters for galaxies in the HST-imaged clusters were obtained using the fitting program Galaxy IMage 2D (GIM2D; Simard et al. 2002). Disk galaxies were selected using a combination of cuts in bulge-to-total ratio and image smoothness. Cluster and field galaxies were distinguished using photometric redshift information, a process which was calibrated using the avaliable spectroscopic redshifts (Pello et al. 2006).

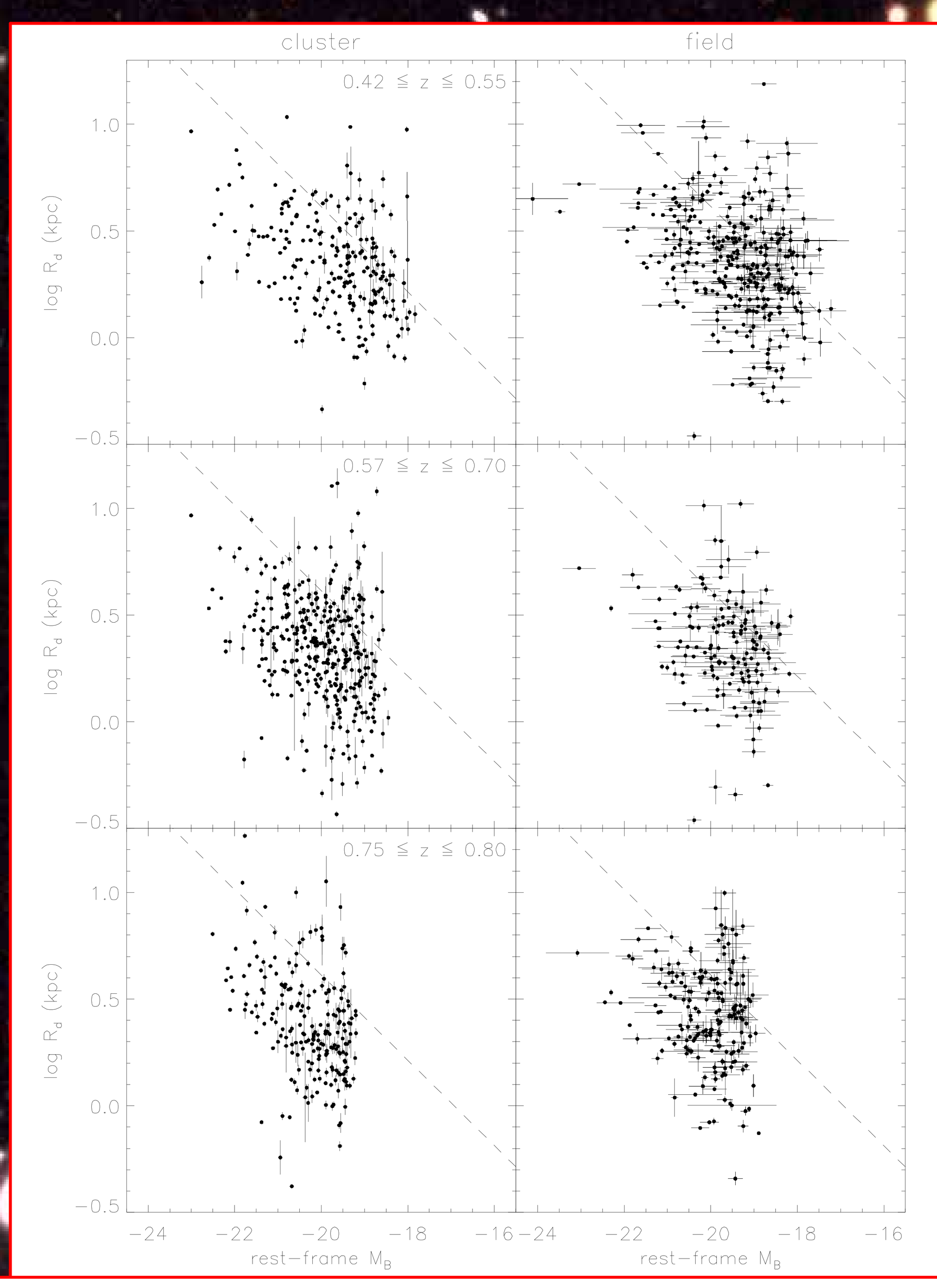

Figure 1: The Size-Luminosity Relation – disk scale length vs. rest-frame *B*-band absolute magnitude as a function of redshift and environment. The dotted line is the canonical Freeman relation for a disk with central surface brightness $\mu_{0,B} = 21.65$ mag arcsec^{-2} (Freeman 1970).
Left: galaxies established as cluster members on the basis of their photometric redshift. Rest-frame M_B for cluster galaxies is calculated assuming the galaxy is at the established cluster redshift.
Right: field galaxies, taken from images with no cluster at the targeted redshift for each bin. The error bars are larger since M_B was calculated from the photometric redshift. The SLR does not appear to be significantly different for cluster and field galaxies.
Top to bottom: Change in the SLR with increasing redshift. In higher redshift bins, fewer galaxies are seen with low surface brightness.

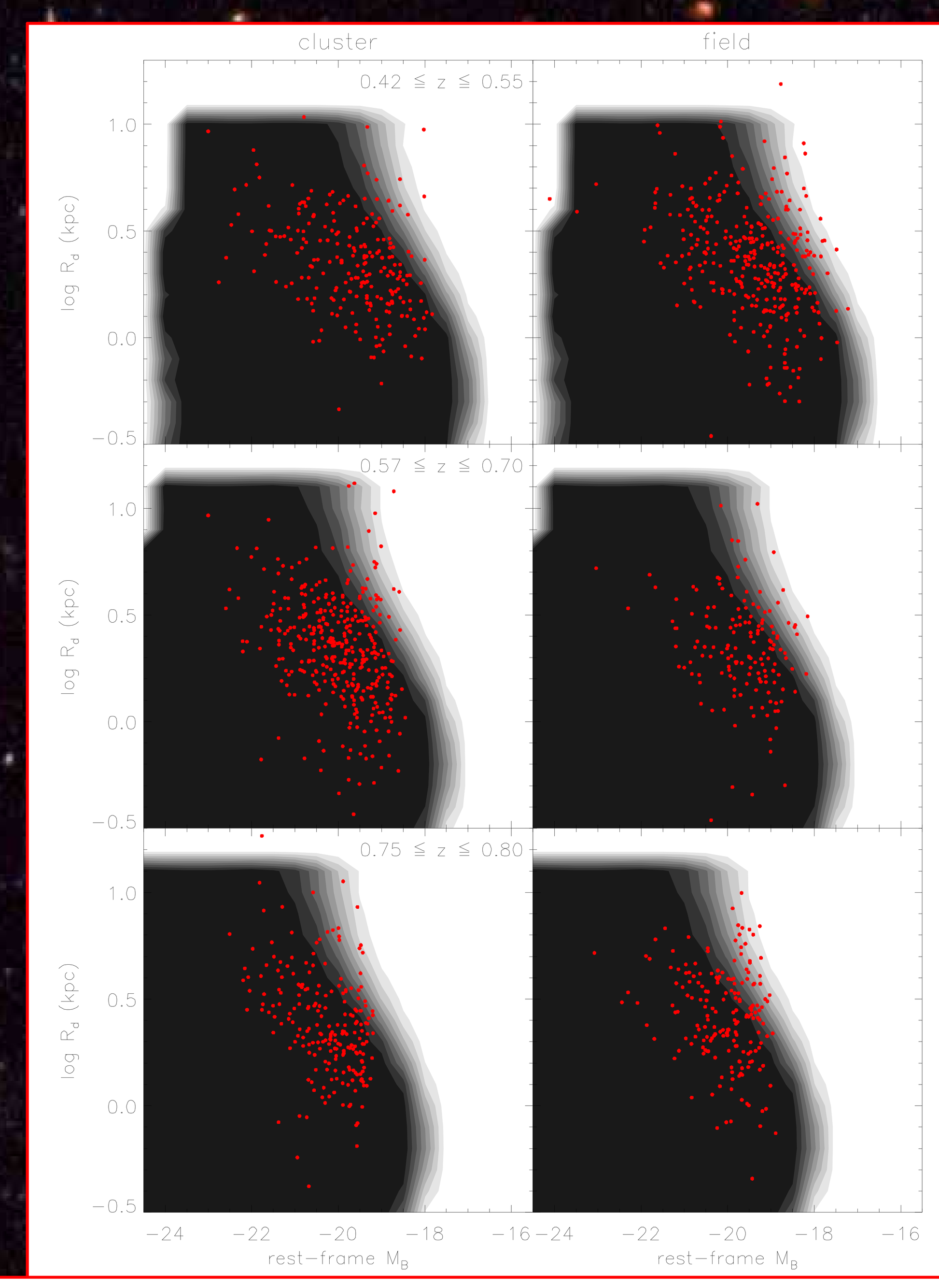

Figure 2: SLR data overplotted on the selection function for each redshift bin. Black = > 90% of galaxies detected, with each successive contour stepping down by 10%. The selection function was determined by generating simulated galaxies with GIM2D, inserting them into empty parts of the original science images, and determining the percentage detected by SExtractor with the same parameters used in the original detection. Simulated galaxies were transformed from observed to rest-frame properties for each redshift bin using a median k-correction determined from the photometric redshift catalog. Low surface brightness galaxies could not have been detected in the higher redshift bins, so the apparent evolution in the SLR may be due only to selection effects and not reflect a change in the physical properties of the galaxies.

Future Work

We have derived a theoretical probability distribution for the SLR based on a simple model of galaxy formation and empirical distribution functions for mass and angular momentum. We will apply the selection function to this distribution to obtain the expected observed SLR, and use it as a basis for statistical tests to quantify any differences in the SLR with redshift and environment. Comparing this model to our observations will provide constraints for galaxy evolution models, particularly models of star formation.

References

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