COLOR MAPPING CLUSTER COOLING FLOW GALAXIES

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Abstract. Some results from a new CCD color imaging survey of centrally dominant cluster galaxies selected for their X-ray properties are discussed.

Key words: cD galaxies, color gradients, cooling flows

1. Discussion

We have obtained U-,b-,V-, and I-band CCD images of 19 centrally-dominant galaxies in cluster cooling flows and 4 without cooling flows. Using photometry through synthetic elliptical apertures, we find that many objects exhibit blue color-profile anomalies with respect to the control sample and to gE photometry from the recent literature. The anomalies are stronger and extend to larger galactic radius with increasing mass-accretion rate ($\dot{m}_{CF}$) estimated from X-ray observations (McNamara and O'Connell 1991, Preprint). Scale sizes for the anomalously blue regions are ~ 5 kpc for the modest accretors ($\dot{m}_{CF} \lesssim 100$ $M_\odot$ yr^{-1}) and $\gtrsim 20$ kpc for some of the largest accretors ($\dot{m}_{CF} \gtrsim 200$ $M_\odot$ yr^{-1}).

These correlations are likely to be due to recent star formation induced by the cooling flows, rather than tidally-induced starbursts. The prevalence of color anomalies suggests that star formation has been occurring continuously for a substantial fraction of the Hubble time. However, in no case are the blue color anomalies consistent with star formation with the Local Initial Mass Function at the rates estimated from X-ray observations. In addition, the color anomalies extend to only ~5–10% of the cooling radii estimated from X-ray observations. If the $\dot{m}_{CF}$'s are correct, then most of the accreting gas must reside in very low-mass stars and/or opaque gas.

Despite the harsh cluster environment, about half of our sample objects have dust patches or lanes. Most of these objects also have evidence for recent star formation.

The non-accreting centrally-dominant galaxies have red, metal-rich nuclei and mild blueward-rising color gradients to $r \sim 5$ kpc. These gradients are likely due to metallicity gradients resulting from dissipative processes during the early stages of galaxy assembly. The halo color gradients usually flatten to a roughly constant color for $r \sim 5$–15 kpc that is $\sim 0.1 - 0.2$ mag bluer than the nucleus. The flattening of the halo gradients may be due to stripping or mergers of cluster galaxies, or other dissipationless processes. Some objects appear to have red halos at large radii; however, additional observations which are optimized for halo photometry with large-format CCD's are needed for confirmation.

Additional observations along similar lines, in a uniform photometric system, will provide valuable constraints on the variations in age and metallicity and dust content of dominant cluster galaxies. In addition to their intrinsic interest, such data may be useful when using these objects to constrain cosmological models.