

Imaging of Distant Cluster Members at $Z = 0.4$ with HRCam

The existence of a large blue galaxy population, sometimes up to 20% of the core population, in distant rich clusters of galaxies is commonly known as the "Butcher-Oemler" effect (Butcher and Oemler, Ap.J., **285**, 426, 1984). This blue galaxy population contrasts with the predominantly red elliptical and S0 galaxies that exist in similar nearby clusters, such as the Coma Cluster and A1367. That these blue galaxies exist in clusters with look back times of only 2-3 billion years has greatly changed the picture of evolution of galaxies in rich clusters.

There has been much spectroscopic work on studying these blue cluster members. The conclusion from these studies is that the large majority of the blue population are "starburst" or "post-starburst" galaxies, with the remaining galaxies being normal spirals and galaxies with an AGN. Two questions remain to be answered about this blue population. What is the mechanism responsible for the starbursts in these galaxies? What is the morphology of these burst galaxies? These two questions may be answered through imaging observations of these blue galaxies obtained at sites with superior image quality such as the CFHT.

Imaging observations of this blue population at a redshift 0.2 have been obtained by Lavery and Henry (in preparation) on the UH 2.2-meter telescope of the MKO. They have found that more than 50% of the blue galaxies are disk systems, several being spiral galaxies, and that a significant fraction of the blue galaxies are in multiple or interacting systems. At this redshift, the galaxies are only 5" in size, but morphological structure is resolvable in images taken in 1" seeing. However, at a redshift of 0.4, the galaxies are only about 3" in size. So, in order to obtain similar images of the blue galaxies in these more distant clusters, the CFHT and HRCam, with its large aperture and sub-arcsecond image quality, is a necessity, and is in fact almost unique in this capability.

We have just begun a program of obtaining images of these blue galaxies in several clusters at redshifts of 0.4 to 0.6 using the HRCam with the SAIC 1024x1024 CCD. This large format CCD provides both an excellent scale for high-resolution imaging (0.13"/pixel) as well as a large field (2.3' on a side). Although, we have obtained several images of these clusters with a FWHM of 0.6" it is likely we can do better. Nevertheless, these images are already useful for examining the morphology of the blue galaxies.

Cl0024+1654 has a large emission line galaxy population and its blue population will be important for determining the starburst mechanism. One of the stronger emission line galaxies in Cl0024+1654 is #183, with an [O II] 3727 equivalent width of 40 Å (Dressler, Gunn and Schneider, Ap.J., **294**, 70, 1985). This galaxy has been classified as possible Seyfert 2 galaxies due to the strength of its emission lines, but this can also be interpreted as a galaxy in the very early phase of a starburst. At the other extreme, #192 has a spectrum with strong Balmer absorption, indicating a significant burst of star formation about 1 Gyr ago. Contour plots of the images of several systems are

presented in Figure 21. Galaxies #134, #183, and #192 have nearby galaxies that may be the interactor which triggered the starburst in the primary galaxy. The small galaxy 4" NE of #183 is #175, a red galaxy and a probable cluster member. The redshifts of the other companions are unknown. However, it is obvious that #192 is distorted and #134 shows an indication interacting with its companion. The figure also contains a plot of #83, a rather asymmetric galaxy with an [OII] 3727 equivalent width of 15Å. This system may have recently undergone an interaction. Lavery and Henry have suggested that low speed interactions in the cores of rich clusters are possible if say clouds of these gas-rich systems have only recently fallen into the cluster.

Such high quality images of these distant clusters also provides morphological information on the red galaxy population, construction of luminosity functions for the clusters, and the ability to look for the production of "arclets" through gravitational lensing for background galaxies by these rich clusters (Tyson, Valdes, and Wenk, Ap.J. Let., **349**, L1, 1990). We have discovered an additional gravitational arc in CL0024+1654, implying an additional lensed object. In addition, we have spatially resolved the primary arc. The structure present in the arc promises to provide interesting information on the nature of the lensed galaxy.

A more detailed analysis of all the galaxies in these clusters is in progress. With the superior image quality available at the MKO with the Canada-France-Hawaii Telescope, the study of the morphological properties of these quite distant "Butcher-Oemler" blue galaxies, and distant galaxies in general, need not wait for space-borne observations.

Michael Pierce (DAO)
Russell Lavery (Mt. Stromlo)
Robert McClure (DAO)

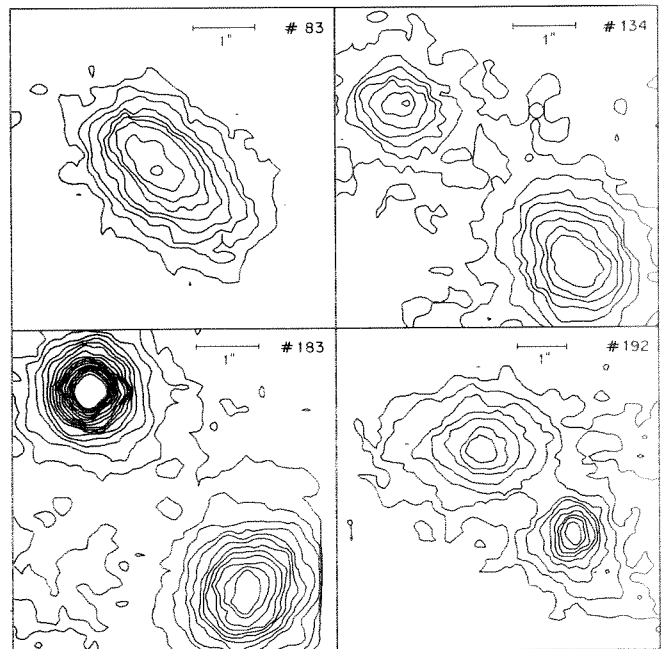


Fig. 21