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Galaxy Cluster Masses at Moderate Redshifts

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The masses of galaxy clusters are dominated by dark matter, and a robust determination of their masses has the potential of indicating how much dark matter exists on large scales in the universe, and the cosmological parameter Omega.

X-ray observations of galaxy clusters provide a direct measure of both the gas mass in the intra-cluster medium, and also the total gravitating mass of the cluster. We used new and archival ROSAT observations to measure these quantities for a sample of intermediate redshift clusters which have also been subject to intensive dynamical studies, in order to compare the mass estimates from different methods.

We used data from 12 of the CNOC cluster sample at $0.18 < z < 0.55$ for this study. A direct comparison of dynamical mass estimates from Carlberg, Yee & Ellingson (1997) yielded surprisingly good results. The X-ray/dynamical mass ratios have a mean of 0.96+- 0.10, indicating that for this sample, both methods are probably yielding very robust mass estimates. Comparison with mass estimates from gravitational lensing studies from the literature showed a small systematic with weak lensing estimates, and large discrepancies with strong lensing estimates. This latter is not surprising, given that these measurements are made close to the central core, where optical and Xray estimates are less certain, and where substructure and the effects of individual galaxies will be more pronounced. These results are presented in Lewis, Ellingson, Morris \& Carlberg, 1998, submitted to the Astrophysical Journal. (Note that Lewis is Ellingson's Ph.D. thesis, who received direct support from this grant and is using this investigation as part of his thesis.)

Two additional papers are in preparation. The first provides a comparison of the mass profiles as measured in Xrays and in galaxy dynamics. These profiles are difficult to determine for individual clusters, and are subject to asphericity and other individual quirks of each cluster. However, a composite profile for each method will allow us to test our assumptions of hydrostatic/dynamical equilibrium in the sample as a whole. A second paper provides a more detailed look at the cluster MS0906+11, which is a merging system. Future work on these data will include comparisons of the cluster galaxy populations and the extent of the intra-cluster medium, and a more homogeneous analysis of gravitational lensing.