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THE ASCA CLUSTER PROJECT

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The ASCA Cluster Project (ACP) is a compilation of data for over 200 galaxy clusters and groups observed with the ASCA X-ray satellite. We homogeneously reduce and fit data from the GIS and SIS instruments on ASCA to obtain isothermal temperatures, redshifts, luminosities, and abundances for the clusters. We show that the x-ray derived cluster redshift is a good match to the optically derived redshift for clusters with temperatures above 3.0 keV, and that the luminosity–temperature relation shows no downturn at lower temperatures. Trends in cluster metal abundance with temperature are discussed.

1 Introduction

There exists no large, homogeneously reduced, published compilation of cluster properties from a single source. We decided to make one as a resource for our work on clusters, and as a good catalog for other astronomers to use as a reference when analyzing the wealth of data arriving from Chandra and XMM.

Our poster at this conference reports on the data sample, the homogeneous reduction method, and some initial results from the project.

2 Data Sample

The data in this catalog is taken from the ASCA public archives maintained by the HEASARC at Goddard Space Flight Center. All the ASCA public observations from the start of the mission through Jan 1, 2000, and marked as a cluster of galaxies are included. After being selected based on the designation "cluster of galaxies," the coordinates of the selected fields are sent to NED to verify the presence of a known cluster in the field. We also included fields classified under a different designation but are known to contain a cluster. 263 clusters were chosen from the public archives this way.

We used data from both the GIS and the SIS detectors in our sample. In cases were there are more than one observation of the cluster, we chose the better one, which was generally the one with more counts. We also require that the observation have at least 500 counts in the extraction region so that we can obtain reasonable fits to the extracted spectrum.

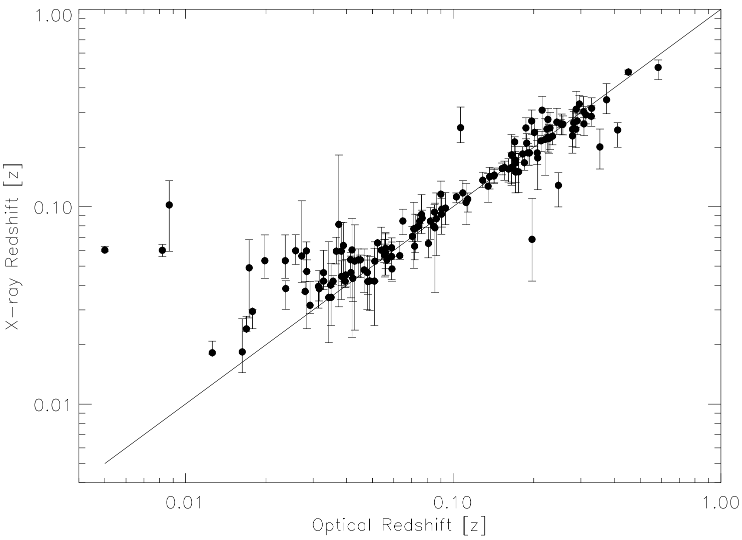

Figure 1: X-ray versus optical redshift.

We applied no cuts in redshift, luminosity, or any other cluster parameter. Our goal is to produce the largest possible sample of homogeneously reduced ASCA clusters.

3 Method

We use a simple automated reduction routine applied equally to each cluster to ensure homogeneously reduced data. Extraction regions for the spectral fitting are produced from the NED positions. The actual cluster emission is used to refine the extraction regions by fitting to the cluster peak. Backgrounds are taken from the same fields as the clusters. We have also used background data from blank fields, but have noticed little difference in the results.

After the cluster is defined and the extraction regions computed, spectra are automatically extracted from the clusters. The MEKAL isothermal plasma model with galactic absorption is used to fit the spectra within the XSPEC spectral fitting package. First, an x-ray redshift is computed. Then, the model is set to the cluster's optical redshift, and the cluster temperature, luminosity, and metal abundance are determined.

Complex spectral models and complicated extraction regions are not employed so that we can automate the process to accommodate over 200 clusters. In general, point sources are not removed from the field unless they dominate the cluster emission.

4 Some results

4.1 X-ray cluster redshifts

A large catalog of over x-ray cluster redshifts has been produced. Figure 1 shows that the x-ray determined redshifts closely agree with the optical redshifts for redshifts above about 0.03. This indicates that x-ray observations are a reliable method of calculating cluster redshifts. Below a redshift of 0.03, the archives are dominated by cooler clusters that excite the iron L lines instead of the iron K lines. The position of the iron L line is very sensitive to temperature; redshifts of cooler clusters determined from iron L lines are much more sensitive to the cluster temperature than those determined from iron K lines.

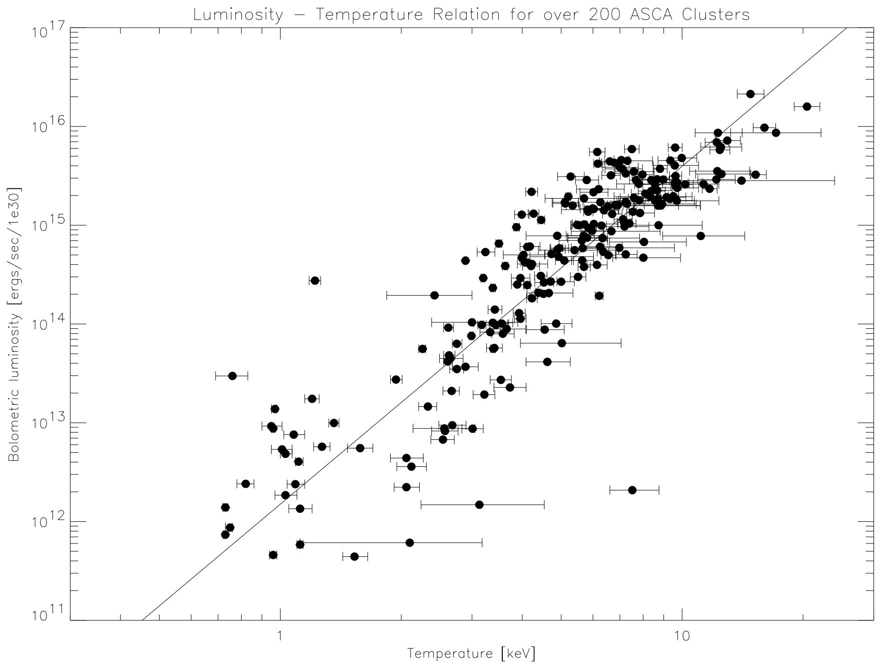

Figure 2: Luminosity–Temperature relation.

4.2 Luminosity-temperature relation

We have also compiled a luminosity—temperature relation that extends from massive clusters down through the group level (see D. Horner's[1] talk in these proceedings). The relation is shown in Figure 2, and is well fit by the expression

$$L_{\rm bol} \propto T^{3.42\pm0.18},$$

and does not show a downturn at cooler temperatures.

4.3 Cluster metal abundances

When the cluster abundances are plotted against their temperatures as in Figure 3, two interesting trends can be seen in the data. The predominant trend is for abundances to fall from a high of 0.4–0.5 at 2.5 keV to 0.2 at about 8 keV. However, below 2.5 keV the data goes strongly against this trend and shows a marked downturn; probably because of the different physics known to be important in groups. The median cluster abundance of about 0.3 shown in Figure 3 lies within expectations.

5 The ROSAT cluster project

The ROSAT Cluster Project is planned to complement the data from the ASCA Cluster Project. ASCA's spectral capabilities allow us to obtain cluster temperatures, abundances, and luminosities, but ROSAT's superior angular resolution allows for better fitting of cluster surface brightness profiles.

The ROSAT Cluster Project has obtained surface brightness profiles for over 200 clusters in the ROSAT public archives. For the approximately 100 clusters in both the ASCA and ROSAT catalogs, we will be able to obtain cluster masses by combining ASCA temperatures and luminosities with ROSAT surface brightness profiles.

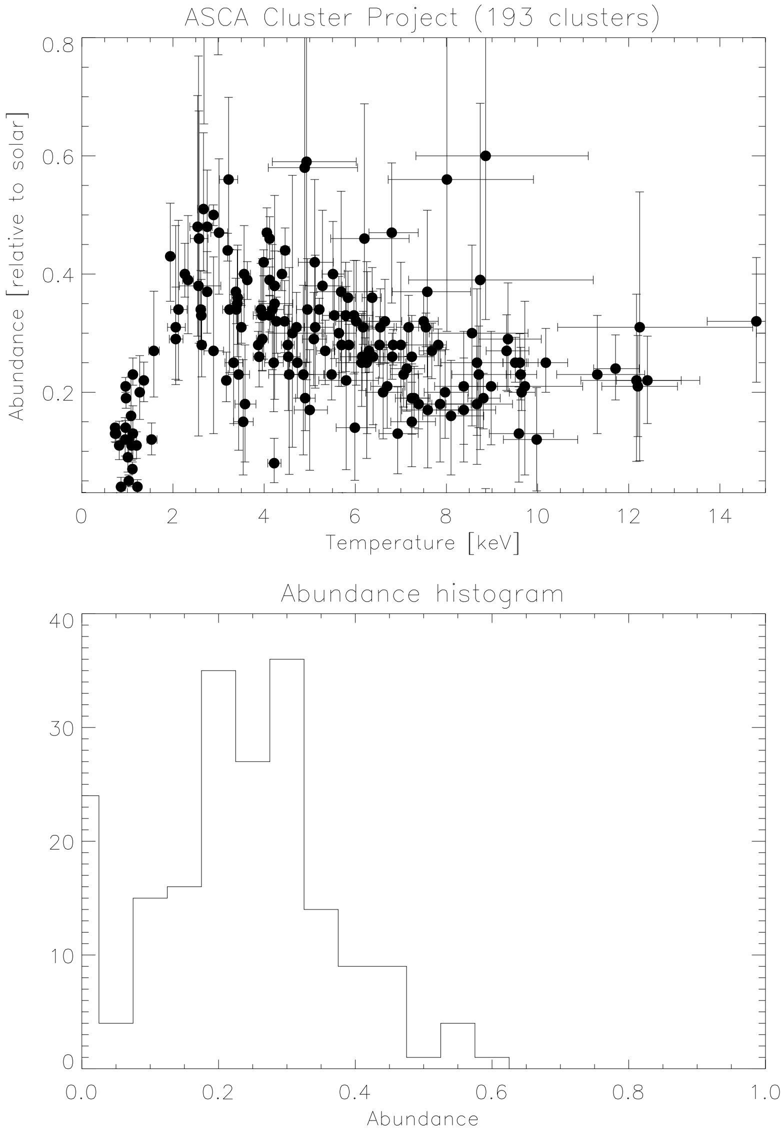

Figure 3: Abundance–Temperature relation.

6 Conclusions

The ASCA Cluster Project has put together a large catalog of cluster properties homogeneously determined from data obtained with the ASCA satellite. Some initial results of the project show that x-ray cluster redshifts are a very feasible alternative to optical redshift determinations, and that the luminosity–temperature relation does not show a downturn at lower temperatures. Cluster metal abundances also show a variation with temperature. The ROSAT Cluster Project, a complement to the ACP, has been started with the objective of determining masses and mass fractions for the clusters common to both the ROSAT and ASCA public archives.

References

1. Horner, D. J. in *Constructing the Universe with Clusters of Galaxies*, ed. F. Durret & D. Gerbal (Paris, 2000).