Results from the REFLEX Cluster Survey

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Abstract. Based on the ROSAT All-Sky Survey we have conducted a large redshift survey as an ESO key programme to identify and secure redshifts for the X-ray brightest clusters found in the southern hemisphere. We present first results for a highly controlled sample for a flux limit of $3 \cdot 10^{-12}$ erg s\textsuperscript{-1} cm\textsuperscript{-2} (0.1 - 2.4 keV) comprising 475 clusters (87% with redshifts). The logN-logS function of the sample shows an almost perfect Euclidian slope and a preliminary X-ray luminosity function is presented.

1 Introduction

For the study of the structure of the present day Universe on very large scales ($\geq 50h^{-1}$ Mpc) the use of galaxy clusters constitutes a very interesting alternative to the conventional galaxy redshift surveys for several reasons. One can study a larger volume with a smaller number of objects. The spatial correlation in the cluster distribution is strongly magnified with respect to the galaxy and to the mass distribution (Kaiser 1984). The biasing factor relating the cluster distribution power spectrum to the mass density fluctuations can be calculated \textit{ab-initio} (e.g. Bardeen et al. 1986, Mo & White, 1996).

X-ray astronomy offers a unique tool to efficiently detect and characterize galaxy clusters out to large distances. Originating in the hot intracluster plasma that fills the gravitational potential well of the clusters, the X-ray emission is an equally robust parameter for a mass estimate of a clusters as the galaxy velocity dispersion. With the survey described here, named ROSAT ESO Flux Limited X-ray (REFLEX) Cluster Survey, we exploit the unique opportunity provided by the ROSAT All-Sky Survey (Trümper 1993, Voges et al. 1996) to construct a cluster sample for cosmological studies. The cluster candidates found are then optically identified and redshifts are measured in
the frame of an ESO key programme (Böhringer 1994, Guzzo et al. 1995).

2 Cluster Identification

In the ROSAT All-Sky Survey atlas only the brightest and well extended X-ray cluster sources are readily identified, while the main part of the identifications has to be based on further optical information. For a first identification we use the COSMOS data base (e.g. Heydon-Dumbleton et al. 1989), originating from the UK Schmidt Survey, providing star/galaxy separation down to \( b_j \sim 20.5 \) mag. The price paid for a high completeness (low detection threshold) is a contamination of the candidate list by more than 30% non-cluster sources. This contamination is reduced by a direct inspection of the photographic plates, the detailed X-ray properties, and the available literature information. The residual contamination (up to 10%) is generally recognized and discarded in the follow-up observations, which will be completed at the end of the year 1998. Presently we have constructed a first catalogue of bright clusters down to an X-ray flux limit of \( 3 \cdot 10^{-12} \text{ erg s}^{-1} \text{ cm}^{-2} \) (in the ROSAT band 0.1 - 2.4 keV) comprising 475 objects. Interestingly, only 53% of these clusters are found in the ACO catalogue (Abell, Corwin, & Olowin, 1989) and further 10% in the supplementary list, while most of the others were previously unknown (e.g. Fig. 1).
3 Overall Properties of the REFLEX Clusters

The following results are based on the sample of 475 X-ray bright clusters (with 413 cluster redshifts obtained so far). A plot of the number counts of the population as a function of X-ray flux is shown in Fig. 2. The logarithmic graph is well described by an Euclidian slope of $-3/2$. This is expected for such nearby clusters with a median redshift of $z \sim 0.08$.

The X-ray luminosity function is a very important characteristic of the sample, since it is most closely related to the mass function of the clusters and used as an important calibrator of the amplitude of the cosmic density fluctuation power spectrum (e.g. White et al. 1993). A preliminary version of the REFLEX X-ray luminosity function is shown in Fig. 3. The function was computed when ($\sim 80\%$) of the redshifts had been determined. But it already recovers the densities reached in previous surveys (e.g. De Grandi 1996, Ebeling et al. 1997) as shown in Fig. 3.

4 Conclusions

Despite the present incompleteness in redshifts which we essentially hope to fill by scheduled observations till the end of 1998, the high quality and completeness of the data set is already reflected in the present results. The large volume covered and the high accuracy of the sample makes the REFLEX survey ideal for the study of the large-scale structure. An extended REFLEX sample down to a flux limit of $2 \cdot 10^{-12}$ erg s$^{-1}$ cm$^{-2}$ is prepared and redshifts are available for more than 70% of the objects. This set will contain about 750 clusters. Finally, a complementary ROSAT Survey cluster identification programme is being conducted in the Northern Sky in a collaboration of MPE
Figure 3: X-ray luminosity function for 80% of the clusters in the REFLEX sample is compared to earlier ROSAT Survey studies by Ebeling et al. 1997 and De Grandi 1996.

and J. Huchra, R. Giacconi, P. Rosati and B. McLean which will soon reach a similar depth and provide an all-sky view on the X-ray cluster distribution.

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