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The BMW Deep X–ray Cluster Survey

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Abstract. We briefly describe the main features and first results of the BMW survey of serendipitous X–ray clusters, based on the still unexploited ROSAT–HRI archival observations. The sky coverage, surface density and first deep CCD images of the candidates indicate that this sample can represent an excellent complement to the existing PSPC deep cluster surveys.

1 Deep X–ray Cluster Surveys and the BMW Project

In the last few years, X–ray selected samples of clusters of galaxies have become a formidable tool for cosmology. Deep surveys using ROSAT PSPC archival data have been used to study the evolution of the cluster abundance and X–ray luminosity function (XLF, e.g. Borgani et al. 1999). The lack of evolution observed for $L \lesssim L^* \simeq 4 \cdot 10^{44}\,h^2$ erg s^{-1} out to $z \sim 0.8$ favours low values for Ω_M under reasonable assumptions about the evolution of the $L-T$ relation. At the same time, the original evidence from the EMSS (Henry et al. 1992) of significant evolution at the very bright end of the XLF has been confirmed (Vikhlinin et al. 1998, Rosati et al. 2000 and references therein). The main statistical limitation of this conclusion rests with the small sky coverage of the ROSAT deep surveys, which clashes with the intrinsic rarity of highly luminous clusters. XMM–Newton and Chandra are already attracting justified attention as the likely source for future samples, but no significant sets of serendipitously selected clusters can be reasonably expected from these observatories for at least another 2 years. This presents the window of opportunity for our survey, which uses data from the ROSAT High–Resolution Imager (HRI) archive. With respect to the PSPC, the HRI has lower sensitivity and higher instrument background. However, the HRI offers superior angular resolution, and the archive contains many very long observations. Our results indicate that it is actually a surprisingly good source of samples of high-redshift clusters.

The Brera Multi-scale Wavelet (BMW) project has currently completed the systematic analysis of about 3100 HRI pointings using a multi–scale wavelet algorithm (Lazzati et al. 1999). This resulted in a catalog of ~ 19000 serendipitous sources with measured fluxes and extensions (Campana et al. 1999, Panzera et al. 2000). A clever selection of the HRI energy channels produced a reduction of the background noise by a factor of ~ 3, thus greatly

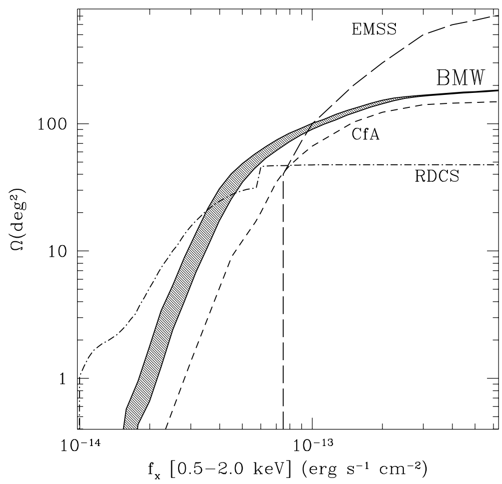

Fig. 1. Sky coverage of the BMW fields for typical extended sources, compared to some previous X–ray cluster surveys (see Rosati et al. 2000 for relevant references). Note the good compromise reached between a fairly large area at intermediate fluxes (~ 100 sq. deg. around $\sim 10^{-13}$ erg cm^{-2} s^{-1}), and the depth of the sample (1 sq. deg. at 2.5×10^{-14} erg cm^{-2} s^{-1}). The overall sky coverage is not only a function of flux, but depends also on the source extension. Being constructed from a different instrument with greater angular resolution, the BMW sample provides an important independent check on possible biases inherent in the PSPC data used for most surveys so far

improving the ability to detect low–surface–brightness sources as clusters. Cluster candidates were isolated on the basis of their extension, selecting at a high significance level (corresponding to $> 5\sigma$) and using only the well–sampled HRI area between 3 and 15 arcmin off-axis. After excluding fields with $|b_{II}| \leq 20$ or pointed on the LMC and SMC, we ended up with a list of more than 500 candidates, which were visually classified on the DSS2 to reject obvious contaminants (95 rejections, mostly multiple detections of substructures in nearby, very extended Abell clusters, plus a few nearby galaxies). Our present goal is to complete first the identification of a high–quality sample of 164 candidates that remain after excluding cluster–targeted HRI fields (to avoid the bias produced by the cluster–cluster angular correlation function, for which we have a clear positive detection in these fields) and then selecting the deeper HRI exposures ($t \geq 10{,}000$ sec). 80% of the sources in this sample show no counterpart in the DSS2 and are therefore strong candidates for being distant ($z > 0.4$) clusters. Optical follow–up is now underway with telescopes in both emispheres (mostly the TNG in La Palma and the ESO 3.6 m telescopes), using multi-band imaging to detect the presence of a galaxy overdensity while confirming its reality through photometric red-

shifts. We have recently reached a total of almost 40 candidates for which deep imaging has been secured. Preliminary analysis of these observations suggests a success rate (i.e. evidence for a galaxy overdensity correlated with the X–ray source) of about 80%. For the still unidentified 20% fraction, we plan further NIR imaging using SOFI at NTT and SQIID at the 4 m KPNO telescope.

In parallel, the very last $\sim$ 1000 HRI fields from the archive (several with long exposures), are currently being analysed and are expected to contribute an extra $\sim$ 40% average increase in the sample size and sky coverage.

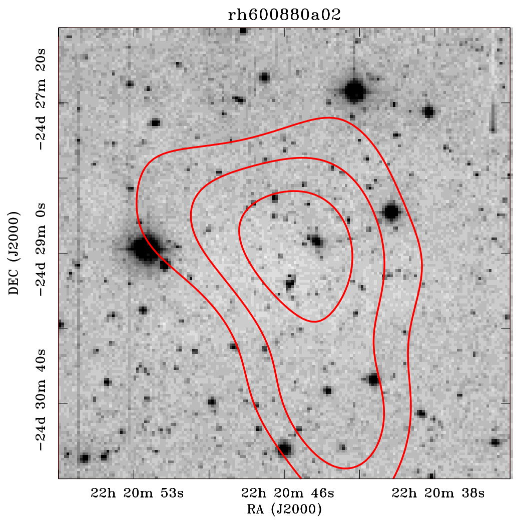

Fig. 2. *R* image (15 min, ESO 3.6 m + EFOSC2) of BMW222045-242, a cD–dominated poor cluster at $z \simeq 0.5$ identified during the first follow–up run of the BMW candidates

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