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Optical Counterparts of Distant Clusters of Galaxies

and the follow-up strategy for eRosita extended sources

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Motivation

The XMM-*Newton* Distant Cluster Project (*XDCP)* is an international collaboration searching for X-ray selected galaxy clusters beyond redshift 1 for studies of structure formation and cluster evolution.

In this context, we analyze all extended sources in archival, deep (stacked) XMM-*Newton* observations targetting LBQS2212. The long clean exposure time of ~250 ks allows us to pick up distant/weak clusters, yealding predictions for number density counts and sample completeness.

We performed the X-ray source detection and revealed 9 extended sources. A total of 290 spectra have been reduced and analyzed, recorded with VLT/FORS2 as part of the BLOX survey (ref. 3) and our own program, with a total exposure of 24 hours. The spectra have been used to calibrate photometric redshifts obtained from CFHT-D4 data.

The success of retrieving all X-ray sources in this study as optical overdensities highlights the importance of optical surveys to identify the large number (~10^5) of expected eRosita extended sources.

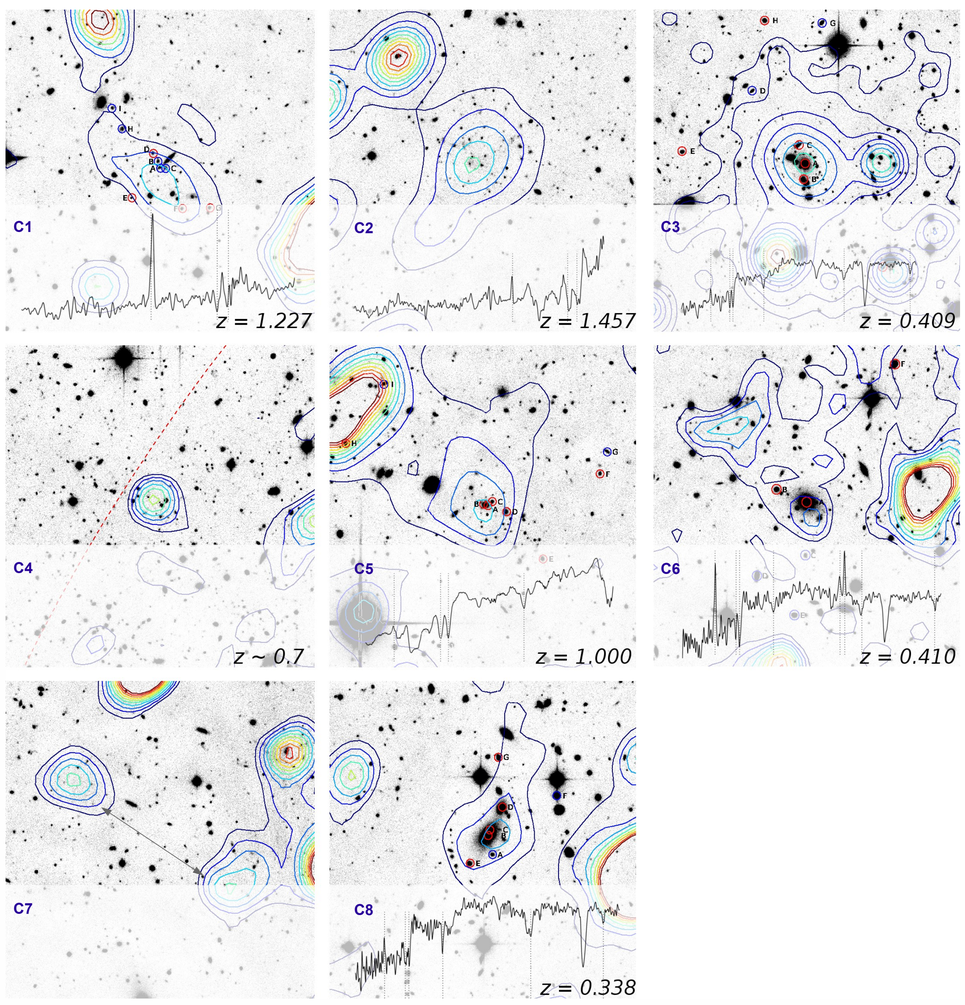

Figure 1 CFHT-LS *Z*-band images (ref. 4) centered on all 9 extended X-ray sources. Contours display the X-ray surface brightness. All objects were confirmed to be clusters of galaxies, except for C7, which shows two extended X-ray structures (double arrow) without an optical counterpart. Mean spectra of cluster members are overplotted. The mean spectra contain a selection of 6 to 11 spectra (blue and red circles are star-forming and passive members galaxies, respectively), with two execptions. First, the most distant cluster C2 (ref. 1) contains merely 2 member spectra (extracted from the literature) and, secondly, C7 is photometrically estimated only (ref. 2,3), which also is at the very edge of the XMM-*Newton* field of view (red dotted line).

Results and Outlook

This single observation contains 7 confirmed clusters of galaxies, of which three (two new) are distant ($z \geq 1$). The depth allows us to make cosmological number density estimates for extended X-ray sources in the universe. Yet, final conclusions await spectral model fluxes.

Furthermore, we confirm the completeness of the X-ray selection and the effectiveness of optical selection technique presented: all clusters are rediscovered ph0tometrically, however no new ones appear with high significance.

eRosita may benefit from large optical surveys to identify clusters of galaxies by means of photometric redshifts.

The publication with the detailed analysis is in preparation (de Hoon+2011, in prep).

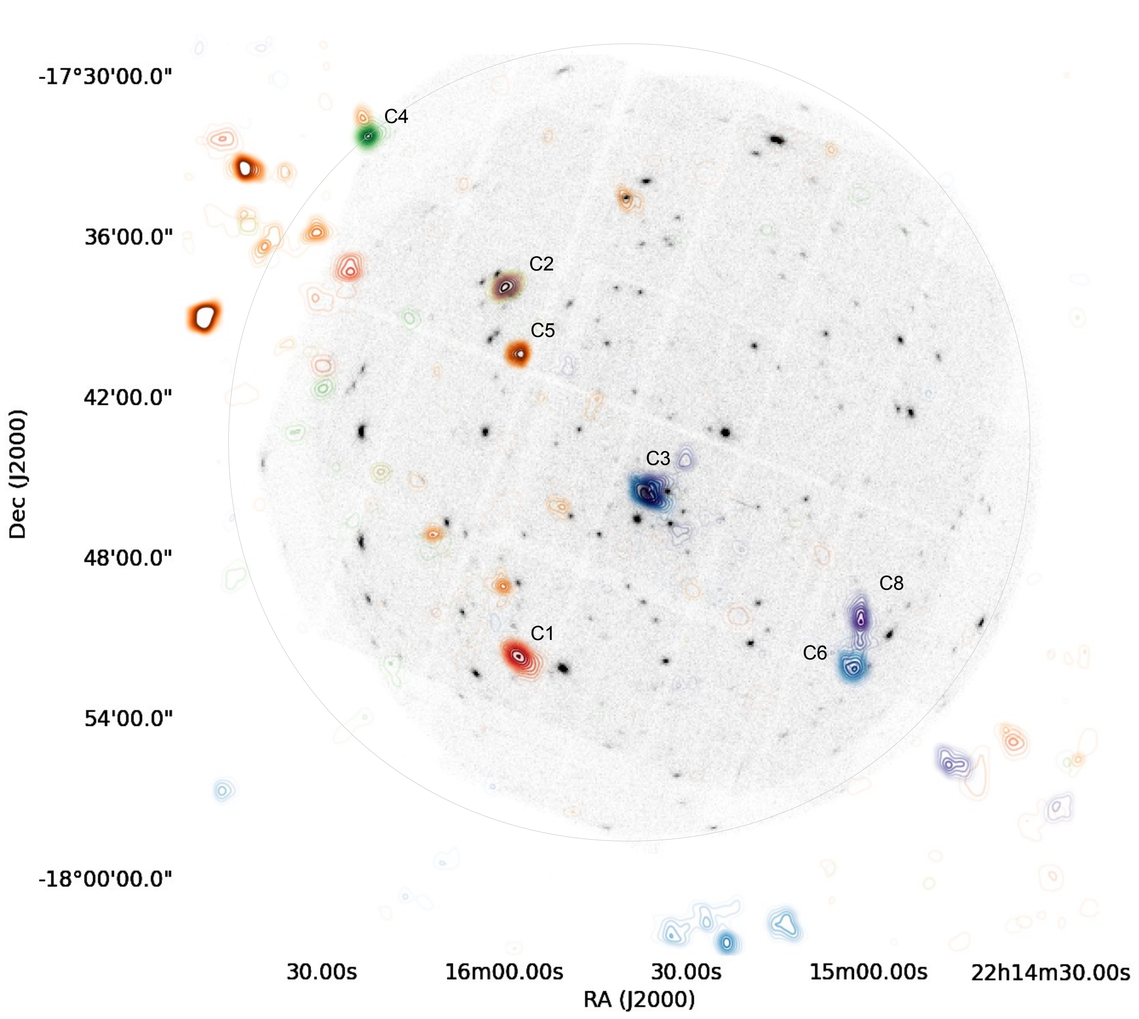

Figure 2 Overdensities of galaxies. The background image is the stacked XMM-*Newton* pointing on LBQS-2212. The contours display the overdensities of galaxies with poissonian likelihoods > 5 above the background distribution. Different colors correspond to photometric redshift intervals (purple: *0.25<z<0.35*, blue: *0.4<z<0.5*, green: *0.75<z<0.85*, orange: *0.95<z<1.05*, red: *1.15<z<1.25*, dark pink: *1.35<z<1.45*). Note that the central object shows a high galaxy density at 2 redshift intervals. In the range *0.25<z<1.45* no other structures have been detected than displayed in this figure. The labels correspond to identifiers from figure 1. The circle roughly indicates the XMM-*Newton* FoV. Some of the X-ray faint overdensities have also been found independently by Bielby+2010.

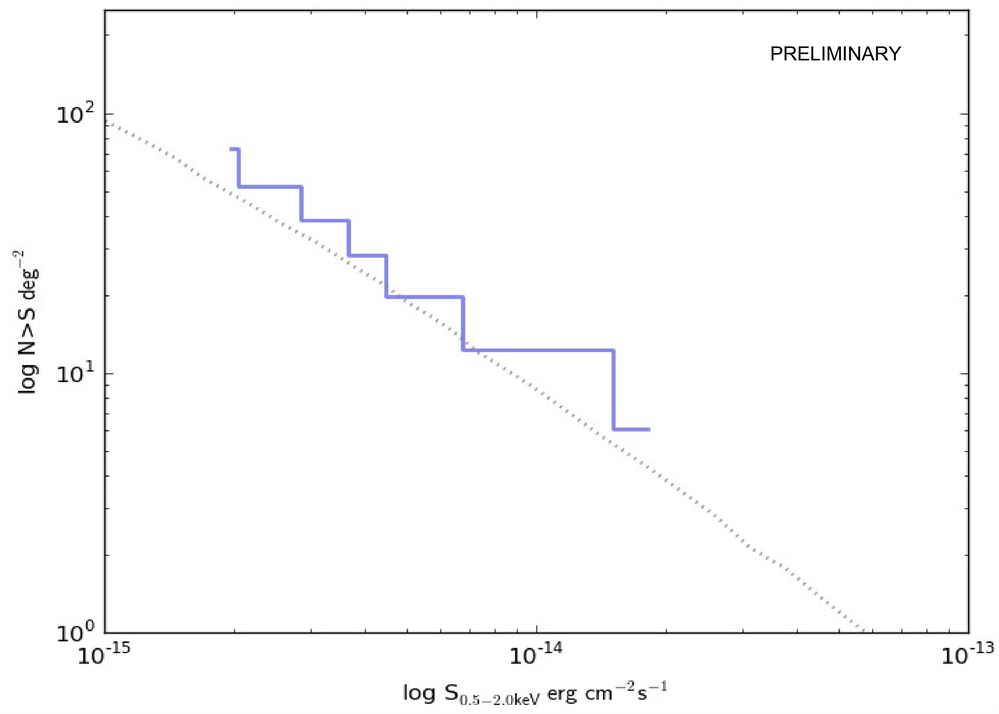

Figure 3 Preliminary number density of clusters of galaxies (discrete distribution). The fluxes estimated by the SAS source detection correspond to S_{200} rather than S_{500}. Therefore, the fluxes are devided by a factor of 2 to enable comparison with literature values (work in progress). For comparison, the model from Rosati+2002 is plotted (dotted), which also happens to be a good fit to the cluster density derived from the Subaru-XMM Deep Field (ref. 5).

References

(1) Stanford+2006, ApJ 646 13; Hilton+2010, ApJ 718 133 (2) Olsen+2007, A&A 461 81 (3) Detrich+2007, A&A 470 821 (4) Gwyn 2011, arXiv:1101.1084 (5) Finoguenov+2010, MNRAS 403 2063; Rosati+2002, ARA&A 40 539 (6) Bielby+2010, A&A 523 66