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Building a z≥1 X-ray Selected Galaxy Cluster Sample for Cosmic Evolution Studies

The XMM-Newton Distant Cluster Project

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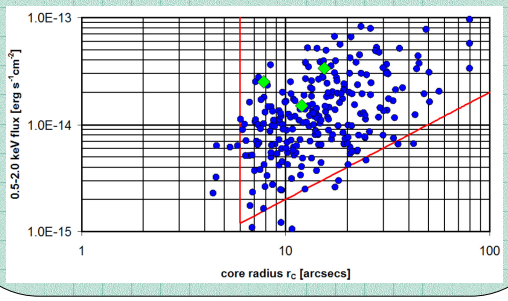
Abstract: Investigating X-ray luminous galaxy clusters at high redshift (z>~1) provides a challenging but fundamental constraint on evolutionary studies of the largest virialized structures in the Universe, the baryonic matter component in form of the hot intracluster medium (ICM), their galaxy populations, and the effects of the mysterious Dark Energy. The XMM-Newton Distant Cluster Project (XDCP) is a new generation serendipitous X-ray survey focused on the most distant galaxy clusters, based on (i) the selection of extended X-ray sources, (ii) their identification as clusters and redshift estimation via two-band imaging, and (iii) their final spectroscopic confirmation. We have analyzed 80 deg^2 (469 fields) of deep XMM-Newton archival X-ray data and selected almost 1000 extended sources as galaxy cluster candidates, 75% of which could be identified as clusters or groups at z<~0.6 using available optical data. We have obtained follow-up imaging for the majority of the ~250 remaining distant cluster candidates with typical 0.5-2.0keV X-ray fluxes of ~10^{-14} erg s^{-1}cm^{-2} and are currently engaged in the spectroscopic confirmation of photometrically identified systems at z~0.9-1.7.

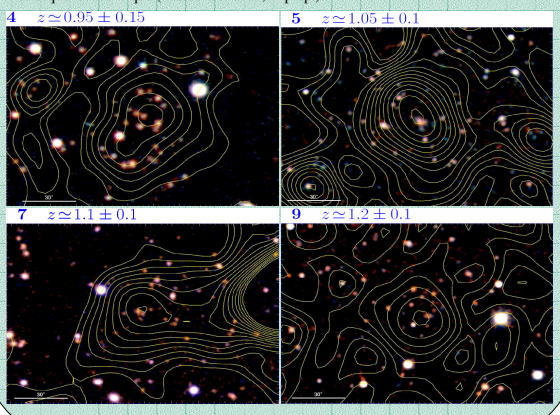
I. X-ray Selection of Distant Cluster Candidates

X-ray properties (0.5-2.0 keV flux vs. core radius) of the 250 XDCP distant cluster candidates. The parameter space of detected candidates is confined by the XMM resolution limit (vertical red line) at core radii of about 6 arcsec and the background limit (lower red line), where the cluster surface brightness drops below the detection threshold. Green diamonds indicate the positions of the currently three most distant spectroscopically confirmed clusters in the Southern hemisphere, from left to right: XMMU J2235-25 at z=1.39, XCS J2215-17 at z=1.45, and RDCS J1252-29 at z=1.24.

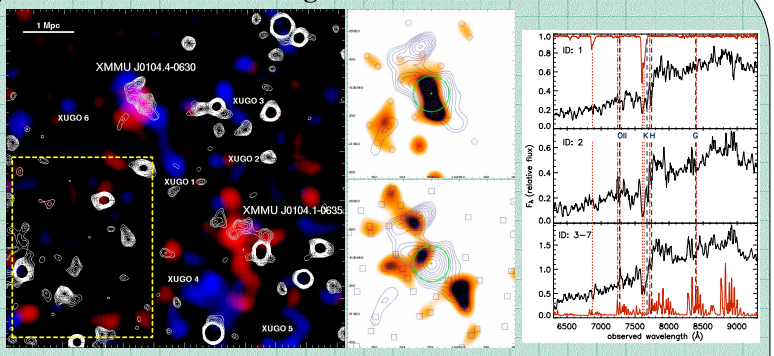


II. Photometrically Identified High-z Clusters

Four examples of photometrically identified (see Poster by Jan Kohnert) high-redshift galaxy clusters. The images show 2.5'x2' z+H band color composites with X-ray contours overlaid in yellow. The photometric redshift estimates are based on a new z-H red sequence technique (Fassbender et al., in prep.).

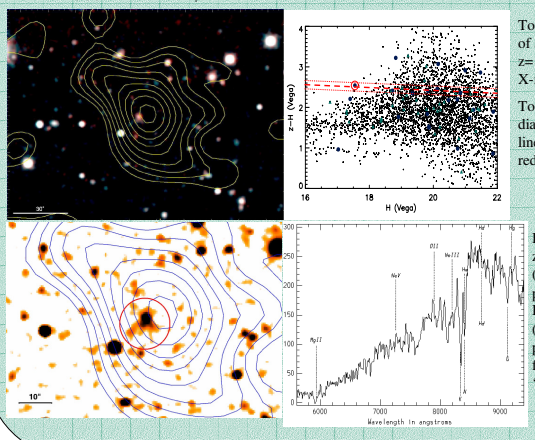


III. Indications for Large-Scale Structure at z=0.95



Left: Red (red-sequence ±0.15mag) and blue (0.3mag bluer) galaxy overdensities in the 14'x14' field surrounding the spectroscopically confirmed cluster XMMU J0104.4-0630 at z=0.95 (Fassbender et al., 2008) encoded with the corresponding color; X-ray contours are overlaid in white. XMMU J0104.4-0630 and its probable associated superlcluster member XMM J0104.1-0635 correspond to 7-sigma overdensity peaks in the red population.
Center: 3'x3' view on the red (top) and bluer (bottom) galaxy population of XMMU J0104.4-0630. A galaxy color transition at cluster-centric distances of 1-2 core radii (green circle, 150kpc) is clearly visible.
Right: Spectra of XMMU J0104.4-0630 at z=0.95.

IV. The latest Spectroscopic Confirmation – A M_{500}~$10^{14}M_\odot$ Cluster at z=1.11 with a BCG in Formation



Top left: 2.5'x2' z+H color composite of a newly discovered galaxy cluster at z=1.11 (Fassbender et al., in prep) with X-ray contours overlaid in yellow.

Top right: z-H color magnitude diagram. The red-sequence (dashed line) yielded an initial photometric redshift estimate of z~1.05±0.1

Bottom left: 1.25'x1' high-contrast zoom on the brightest cluster galaxy (red circle) caught during an active phase of BCG mass assembly. The BCG color (top) and the spectrum (right) are fully consistent with a passively evolving galaxy providing further observational support for a 'dry merging' scenario.

References:
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