



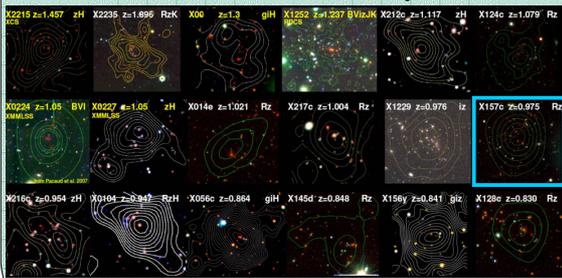
Multi-wavelength Properties of the Massive Galaxy Cluster XMMU J1230+1339 at $z \approx 1$

Results from the XMM-Newton Distant Cluster Project (XDCP)

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Abstract: We present a combined X-ray, optical imaging & spectroscopic study of the newly discovered massive cluster of galaxies XMMU J1230+1339 at a redshift of $z=0.975$. The cluster was detected as a serendipitous extended X-ray source in archival XMM-Newton data as part of the XMM-Newton Distant Cluster Project (see box I) and was subsequently followed-up with VLT spectroscopy, deep multi-band LBT imaging, and with APEX SZE observations (box II). XMMU J1230+1339 features an astonishingly rich galaxy population in the optical (box III+V). The high X-ray luminosity and ICM temperature of $T_X=6$ keV (box IV) yield a mass estimate of $M_{200} = 4\text{-}5 \cdot 10^{14} M_{\text{sun}}$ for the system. Several infalling sub-components have been identified that depict an active assembly phase of a massive cluster at a lookback time of 7.6 Gyrs (box VI).

I. Confirmed X-ray luminous galaxy clusters at $z > 0.8$ from the XDCP survey



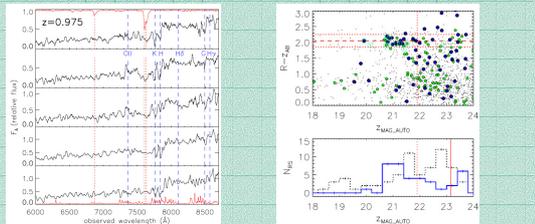
Status: 18 XDCP clusters at $z > 0.8$ spectroscopically confirmed (5 with spectroscopy from other teams, in yellow)

II. Multi-wavelength Data Set for XMMU J1230+1339

Observatory	Instrument	Data Type	Exposure Time
XMM-Newton	EPIC	X-ray	14ksec
XMM-Newton	EPIC	X-ray	12ksec
Chandra	ACIS-S	X-ray	38 ksec
VLT	FORS2	Rz imaging	1.5 ksec
VLT	FORS2	MXU spectroscopy	7.9 ksec
LBT	LBC	UBVriz imaging	29 ksec
APEX	APEX-SZ	mm	29 ksec

Upcoming Publications: Fassbender, R. et al., to be submitted; Lerchster M. et al., in prep [see also P6. 18 6]

III. Optical Properties of XMMU J1230+1339

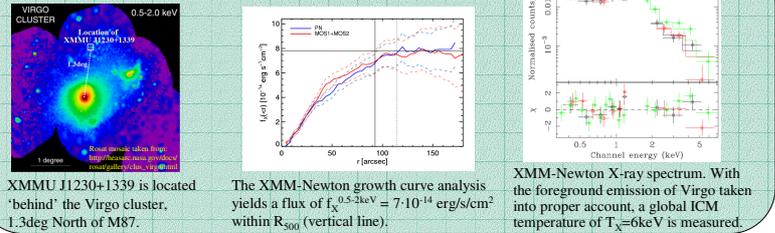


VLT FORS2 spectra of five selected cluster members. Color-magnitude diagram of the cluster environment showing a richly populated cluster red-sequence (top, large circles). The blue histogram (bottom) of galaxies with $R < 1$ Mpc and a color in between the dotted lines hints at a truncation at fainter magnitudes.

References:

- Fassbender, R. et al., 2009, to be submitted
- Lerchster, M. et al., in prep. [see also poster P6. 18 6]
- Santos, J.S., et al., 2009, 2009, A&A, 501, 49, astro-ph/0903.3853
- Fassbender, R., Böhringer, H., Lamer, G., Mullis, C.R., Rosati, P., Schwobe, A., Kohnert, J., Santos, J.S., 2008, A&A, 481, L73-L77
- Fassbender, R., 2007, PhD thesis, Ludwigs-Maximilians-Universität München, astro-ph/0806.0861
- H. Böhringer, C.R. Mullis, P. Rosati, G. Lamer, R. Fassbender, A. Schwobe and P. Schuecker, 2005, The Messenger, 120
- Mullis, C.R. et al., 2005, ApJ, 623, L85

IV. X-ray Properties



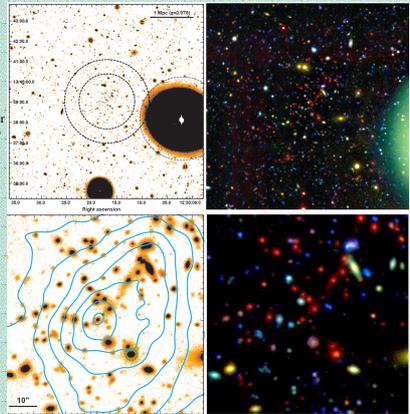
XMMU J1230+1339 is located 'behind' the Virgo cluster, 1.3deg North of M87. The XMM-Newton growth curve analysis yields a flux of $F_{X, 0.5-2\text{keV}} = 7 \cdot 10^{-14}$ erg/s/cm² within R_{500} (vertical line). XMM-Newton X-ray spectrum. With the foreground emission of Virgo taken into proper account, a global ICM temperature of $T_X=6$ keV is measured.

V. Optical Appearance

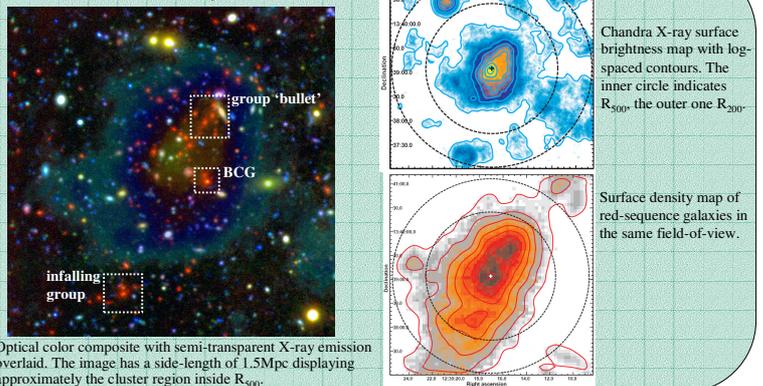
Top Left: Deep i+z-band image of the cluster environment. The black circles indicate R_{200} & R_{500} , the blue circle marks the Virgo elliptical NGC4477. Top right: RGB color image based on LBT images in i+z (red channel), V+r (green), and U+B (blue), with a comoving scale of 2x2 Mpc. Bottom: Zoom on the cluster center with a side-length of 560 kpc. Left: i+z image with Chandra X-ray contours overlaid. Right: Same region as color composite.

Cluster Characteristics:

$z = 0.975$
 $T_X = 6$ keV
 $F_{X, 0.5-2\text{keV}} = 7 \cdot 10^{-14}$ erg/s/cm²
 $L_{X, 0.5-2\text{keV}} = 2.5 \cdot 10^{44}$ erg/s
 $R_{200} = 1.1$ Mpc
 $M_{200} = 4\text{-}5 \cdot 10^{14} M_{\text{sun}}$



VI. Mass Assembly Features



Optical color composite with semi-transparent X-ray emission overlaid. The image has a side-length of 1.5Mpc displaying approximately the cluster region inside R_{500} .

Chandra X-ray surface brightness map with log-spaced contours. The inner circle indicates R_{200} , the outer one R_{500} .

Surface density map of red-sequence galaxies in the same field-of-view.