XMM-Newton analysis of a newly discovered, extremely X-ray luminous galaxy cluster at high redshift

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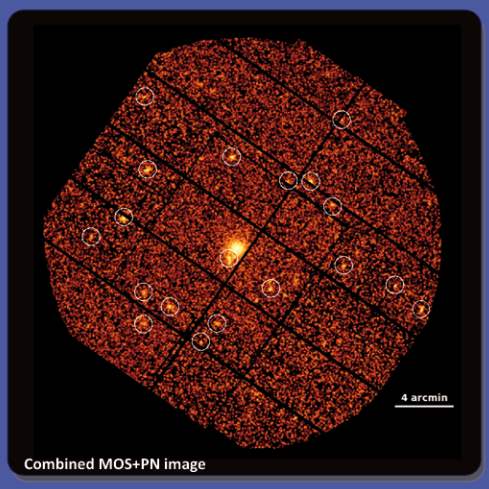
Abstract

Galaxy clusters, the largest virialized structures in the universe, provide an excellent method to test cosmology on large scales. Especially measurements at high redshifts can e.g. provide constraints for dark energy. The f_{gas} test as a direct cosmological probe is of special importance. Therefore, relaxed galaxy clusters at high redshifts are needed, but these objects are considered to be extremely rare in current structure formation models. Here we present first results from an XMM-Newton analysis of an extremely X-ray luminous, newly discovered and potentially cool core cluster at a redshift of z=0.9. We carefully account for background emission and PSF effects and model the cluster emission in three radial bins. Our preliminary results suggest that this cluster is indeed a good candidate for a cool core cluster and thus of extreme value for cosmology.



The cluster ClGJ120958.9+495352

Found by our team (Buddendiek et al. 2015) through a combined search of ROSAT All-Sky Survey and Sloan Digital Sky Survey data

$z = 0.9$

$M_{200,SZ} = (8.3 \pm 2.5) \times 10^{14} h^{-1} M_{\odot}$

$L_{x,RASS} = (20.3 \pm 6.2) \times 10^{44}$ erg/s

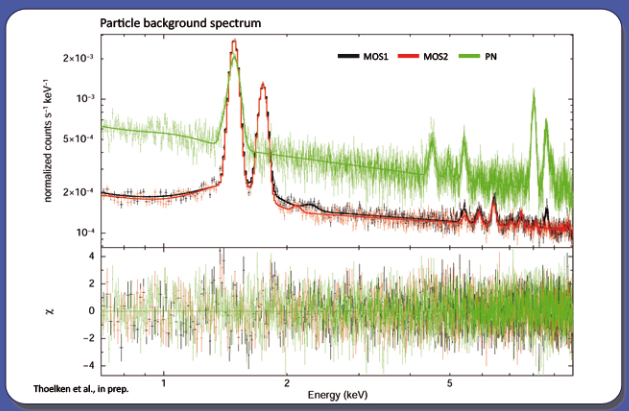
Total cleaned XMM-Newton exposure time: 17ks

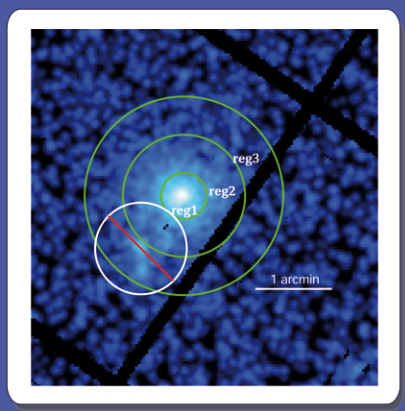
Background modeling

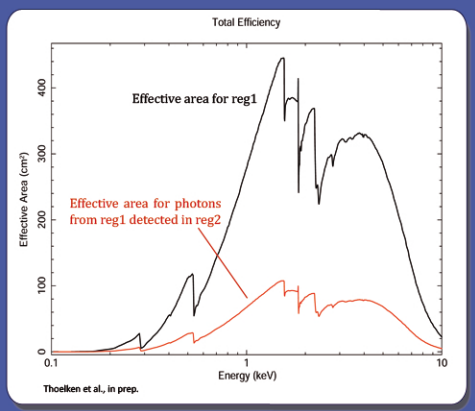
We use Filter-Wheel-Closed observations to model the particle background. It consists of continuum emission (power law) and several fluorescent lines (gaussians).

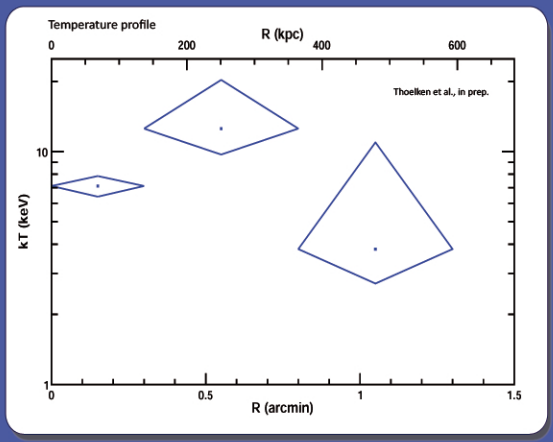
PSF correction

Due to the small extend of the cluster on the sky and the finite XMM-Newton PSF, „mixing“ of photons occurs between annuli, i.e. photons are detected in another region on the detector than they truly originate from on the sky. We account for this effect by creating cross-region Ancillary Response Files.





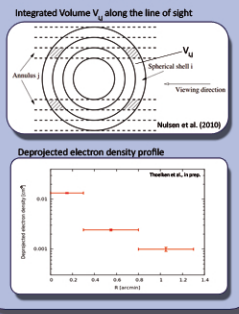




Matrix deprojection of density profile (Ettori et al. 2002):

Emission Integral in annulus j

$EI_j = \Sigma_{i=j} n_e n_H V_{i,j}$



Thoelken et al., in prep.

Preliminary results show clear indication for a cool core

Robust M_{tot} and M_{gas} estimates → Valuable object for cosmology

Ongoing project:
HST data in hand is currently being analyzed to confirm dynamical state. Interesting astrophysical object because of short time span for cooling. Chandra follow-up observation proposed to resolve core structure.

Geometrical deprojection of density profile yields

$M_{gas,2500} = (8.68 \pm 0.47) \times 10^{12} M_{\odot}$

$M_{tot,2500}$ from Buddendiek et al. (2015) SZ estimate and mass-concentration relation from Duffy et al. (2009)

$M_{tot,2500} = (9.36 \pm 2.65) \times 10^{13} M_{\odot}$

Gas mass fraction:

$f_{gas,2500} = 0.09 \pm 0.03$ (preliminary)

→ compatible with ΛCDM cosmology (Allen et al. 2008)

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