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LBT/MODS spectra of distant X-ray selected galaxy clusters

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Motivation and survey technique

Galaxy clusters are known to be the largest self-gravitating structures in the Universe, hence their properties are sensitive tools for cosmology. Since the hot intra-cluster-medium of massive galaxy clusters appears bright in X-rays, a common technique for identifying new objects is to correlate extended X-ray sources with optical/near-IR catalogues and imaging data.

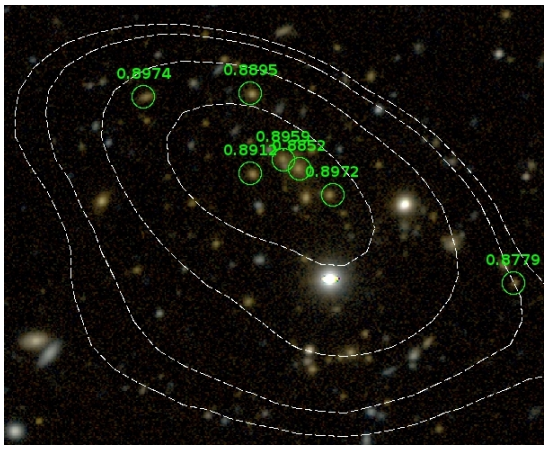

Figure 1: RGB image of 2XMMp J123759.3+180332. Cluster galaxies are marked, their redshift is indicated and white dotted lines refer to X-ray contours.

Our goal is to discover new clusters at high redshift, z$\geq$0.8, which are of particular interest for cosmology. The member galaxies of those distant clusters are too faint to be seen in the optical by current large area imaging surveys, most notably the SDSS. We therefore select extended sources from the 2XMM catalogue, where no cluster galaxies are detected in SDSS images. Promising fields are chosen for deep imaging at the LBT/LBC and tentative cluster galaxies are spectroscopically examined using LBT/MODS.

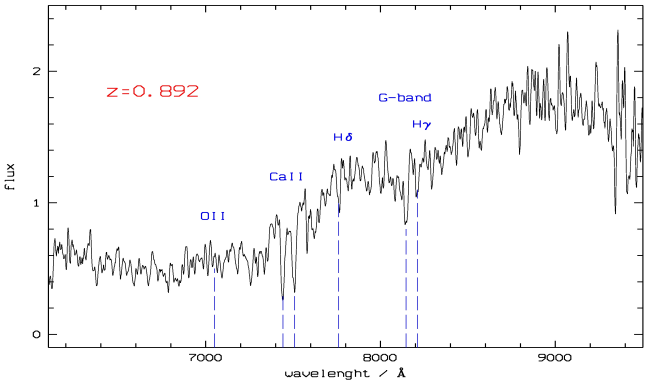

Figure 2: Average spectrum of all confirmed cluster galaxies from 2XMMp J123759.3+180332. Note the prominence of CaII feature and D4000 break - typical for passive galaxies.

Redshift determination

Using two band LBT/LBC imaging, we were able to screen the colour-magnitude-diagram and select galaxies with similar colour residing in the vicinity of the X-ray emission for further spectroscopic analysis. We have successfully used the multi object spectrograph LBT/MODS for acquiring spectra of tentative cluster galaxies down to m_r = 22.5. For spectral data reduction we adapted our ESO-MIDAS based multi object spectroscopy pipeline (mosp). The spectra from all fields were visually screened and examined to get a first impression about the object type and redshift. Galaxy spectra showing the prominent CaII H&K absorption feature were fitted using a double-Gaussian function to compute the redshift. Averaging redshifts of all cluster galaxies within a radius of $\sim$1Mpc from the X-ray center allowed us to calculate the redshift of the galaxy cluster.

Table 1: Current sample of galaxy clusters spectroscopically confirmed with the LBT/MODS. Name, number of associated cluster galaxies, mean redshift, redshift of the BCG and X-ray luminosity (L_{500}) are listed. In the two cases marked by a colon the X-ray spectra are very poor, hence the luminosity is calculated using its catalogued X-ray flux.

cluster (2XMMp_)	#gals	z_{mean}	z_{BCG}	$L_{500}/10^{44}$erg s^{-1}
J083026.2+524133	3	0.985	0.990	13.4
J092120.2+371735	3	0.991	0.991	0.5:
J093437.4+551340	10	0.836	0.838	0.6
J105319.8+440817	6	0.893	0.897	3
J120815.5+250001	5	0.993	0.995	3.4
J123759.3+180332	11	0.892	0.885	5.6
J133853.9+482033	10	0.751	0.755	0.5:

Results and ongoing work

So far we have confirmed the existence and determined the redshifts of 7 distant galaxy clusters. Among them is the most X-ray luminous cluster at z$\sim$1, 2XMMp J083026.2+524133 (Lamer et al. 2008). Its high X-ray photon counts allowed us to determine an X-ray redshift, which was now confirmed by this LBT/MODS spectroscopy campaign.

Current work is focused on refining the selection criteria to reach faint galaxy cluster at z=1 and beyond. We compiled a catalogue of extended X-ray sources without SDSS-counterparts. The allWISE images and catalogue were used for additional aid: due to a (W1 – W2) colour-redshift-dependence for passive galaxies (Gettings et al. 2012) we are able to screen our initial catalogue for red sources, presumably high redshift galaxies and hence distant galaxy clusters. By now we have identified 3 good candidates from deep imaging with LBT/LBC awaiting spectroscopic confirmation with LBT/MODS.

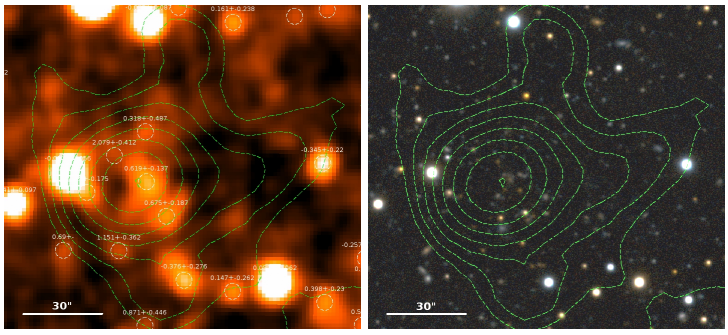

Figure 3: WISE image (*left*) of a newly selected cluster candidate with X-ray contours and W1–W2 colours indicated and the same field with LBT/LBC follow-up imaging (*right*).