The XCS: from Photons to Cosmology

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XCS

XMM Cluster Survey

Overview

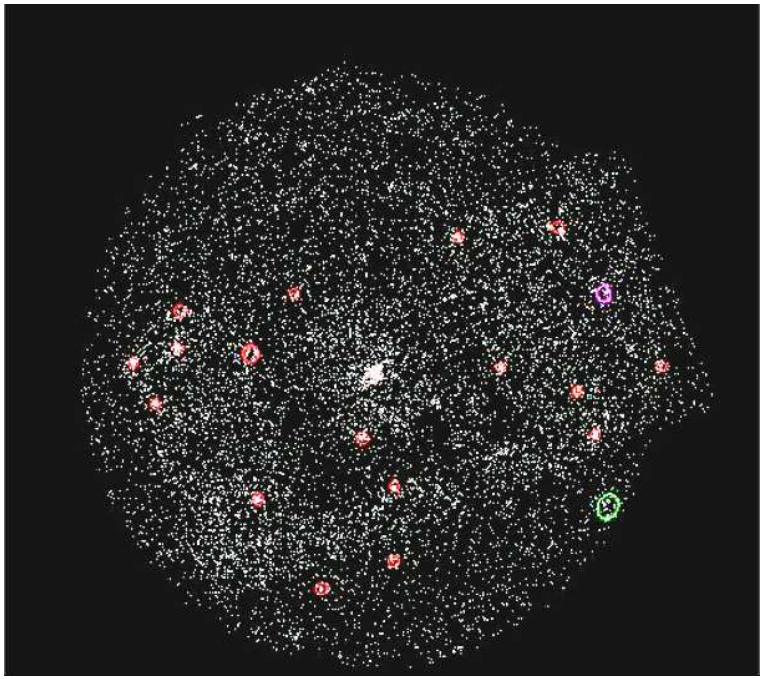
- The XMM Cluster Survey [XCS]
- Cluster detection
- Cluster classification
- Redshift estimates
- High redshift cluster J2215
- Scaling relations
- Cosmology

XMM Cluster Survey [XCS]

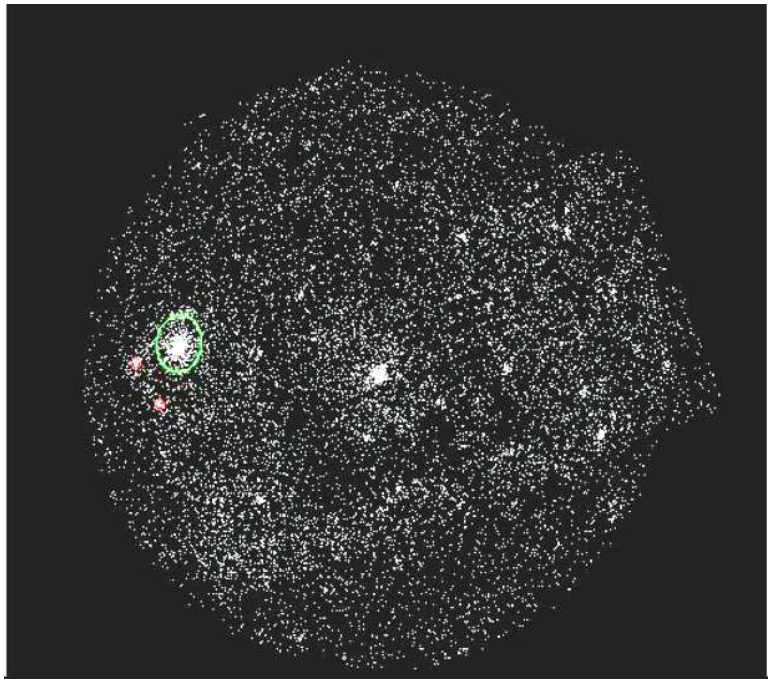
- The XCS
  - Archival pointings
  - Serendipitous detections
  - 170 sq. deg. present
  - 500 sq. deg. total
  - $0.1 < z < 2$
  - Currently: 1847 ^{all}XCS
  - Expect $\approx 2.10^3$ ^{500}XCS

XCS XMM Cluster Survey

Detecting clusters



Detecting real clusters



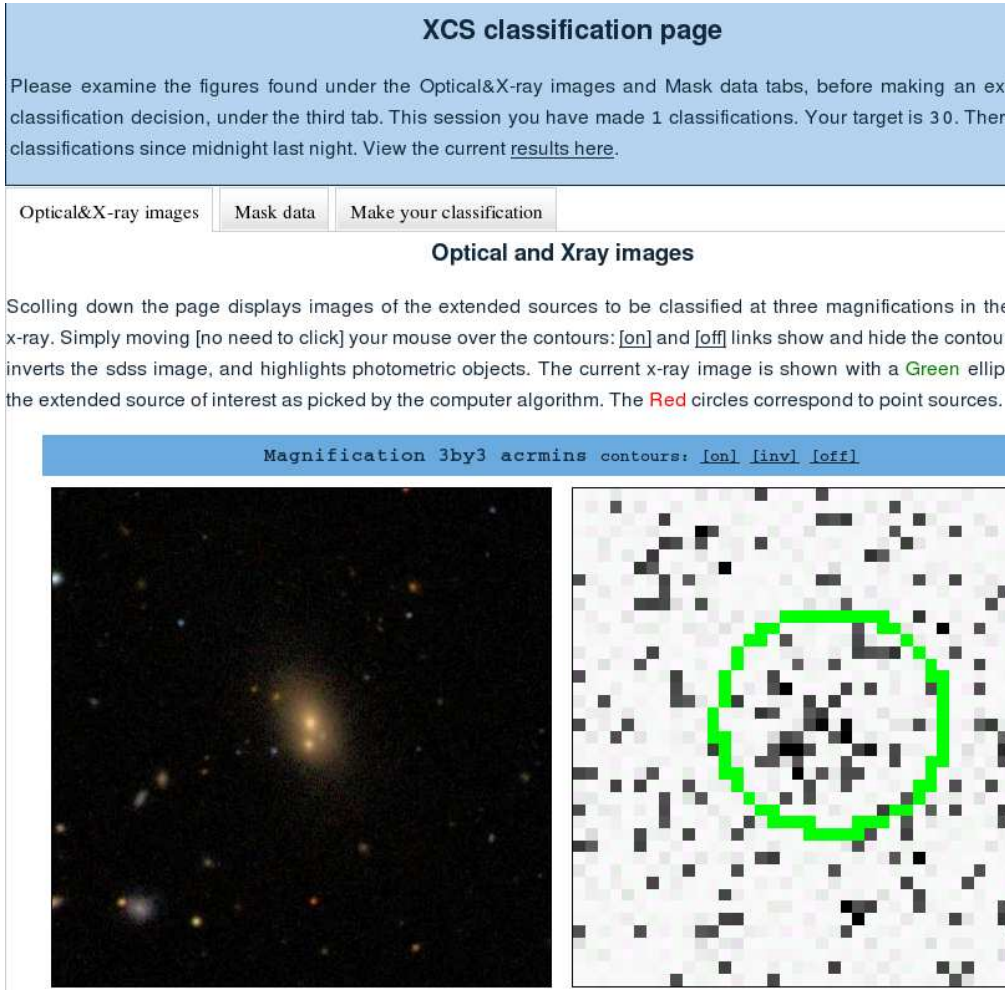
Detecting simulating clusters

- Color key
  - Extended sources, Green ellipses
  - Point sources, red circles
  - Unsure, Pink circles

From simulations we can recover our selection function.

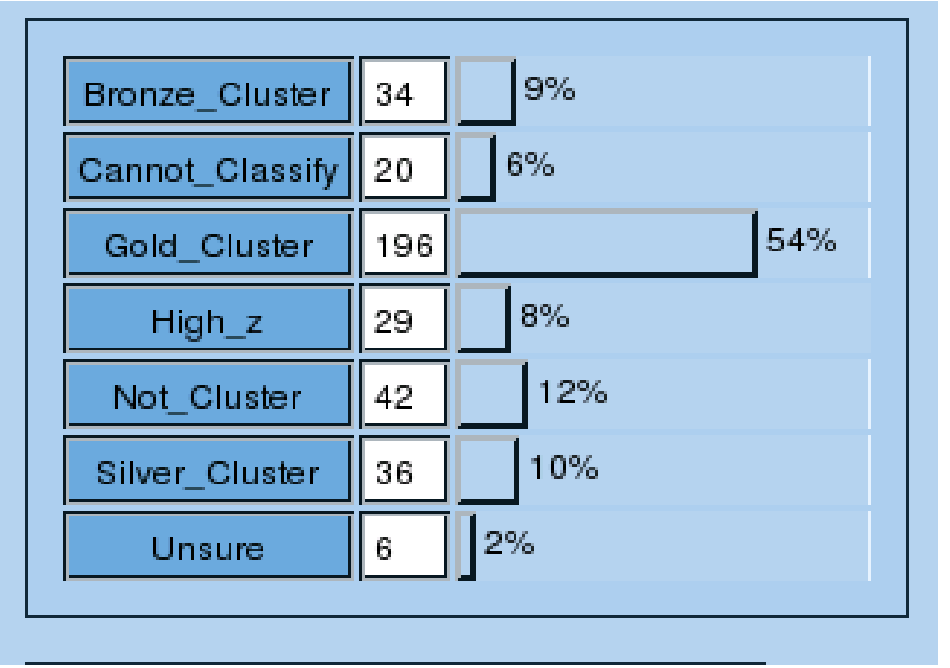
Cluster classification

- Cluster zoo
  - SDSS optical images
  - Centred on X-ray ra,dec
  - 610 XCS extended sources
  - Optical & X-ray overlays
  - X-ray photon density contours
  - 7 classification types
  - $9+$ classifications



Cluster classification

- Results
  - Gold sample
  - High Z
  - False detections
  - Cuts improve sample



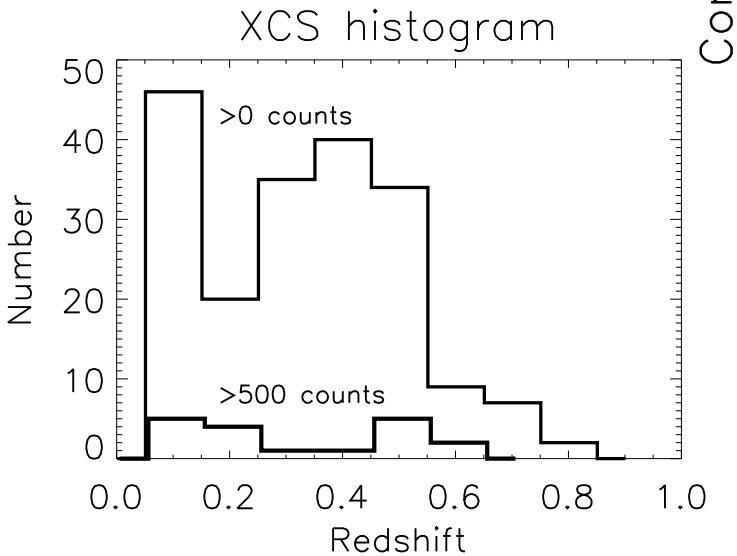
Classification accuracy improvements		
Soft Counts	% Gold Clusters	% All Clusters
> 0	18	55
> 200	41	77
> 500	54	81

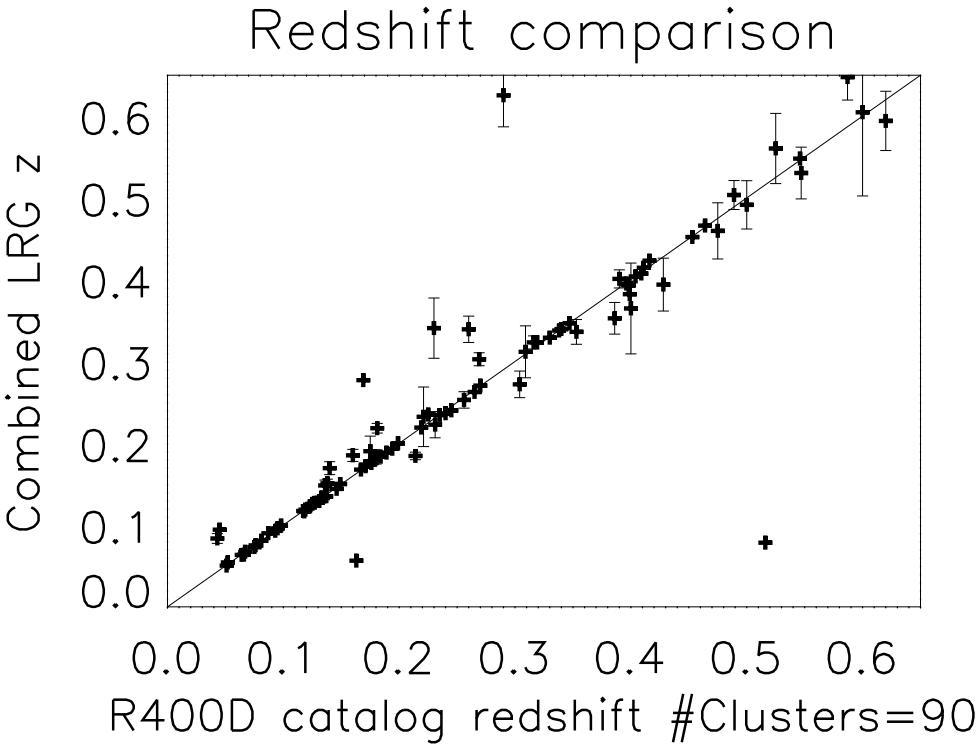
XCS XMM Cluster Survey

Redshift estimates

Empirically, we see LRGs inhabit the central regions of clusters. Can we use archival LRGs to assign redshifts to X-ray detected clusters for free?

- $ROSAT 400$ sq. deg.
  - Spectroscopic redshifts
- Compare with SDSS LRGs
- Spec and Photo redshifts
- Good Agreement

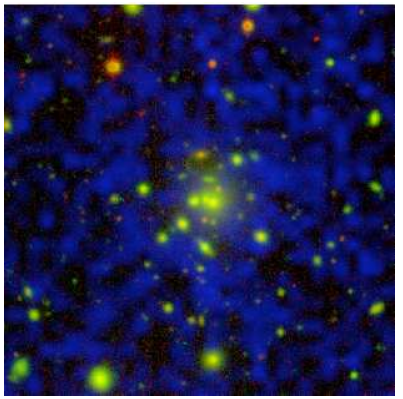




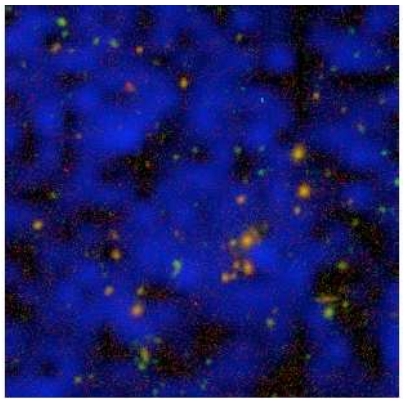
- 193 free XCS cluster redshifts

Redshift estimates

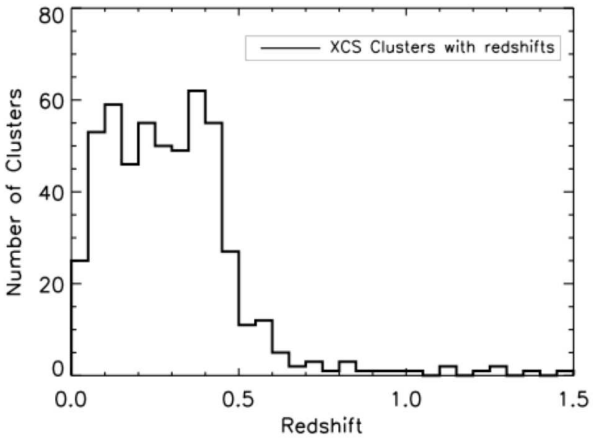
Dedicated XCS photometric follow up $NOAO + XCS = NXS$



$z = 0.27 \pm 0.02$



$z = 0.53 \pm 0.01$



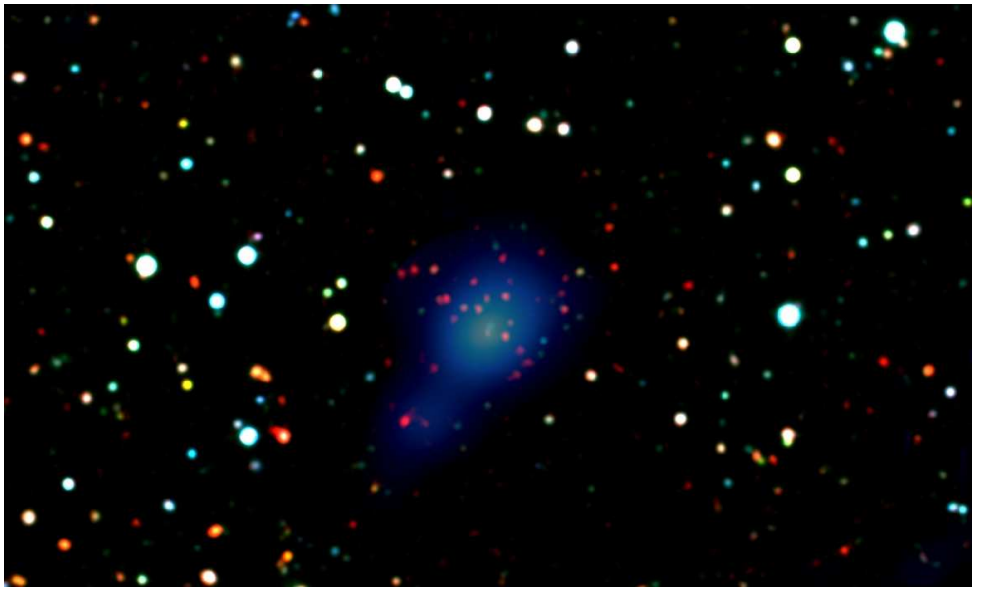
- More than 300 redshifts
- 136 for ^{500}XCS clusters

Merhtens et al, in prep

High redshift cluster

The most distant spectroscopically confirmed cluster of galaxies found to date. XMM-XCS J2215.9-1738 or J2215. Standford et al astro-ph/0606075, Hilton et al astro-ph/0708.3258

- 5 pointings of a $z = 2.215$ quasar
- Total time $273ks$
- $z = 1.45$
- Temp$> 6keV$



Original optical image

High redshift cluster

The most distant spectroscopically confirmed cluster of galaxies found to date. XMM-XCS J2215.9-1738 or J2215. Standford et al astro-ph/0606075, Hilton et al astro-ph/0708.3258

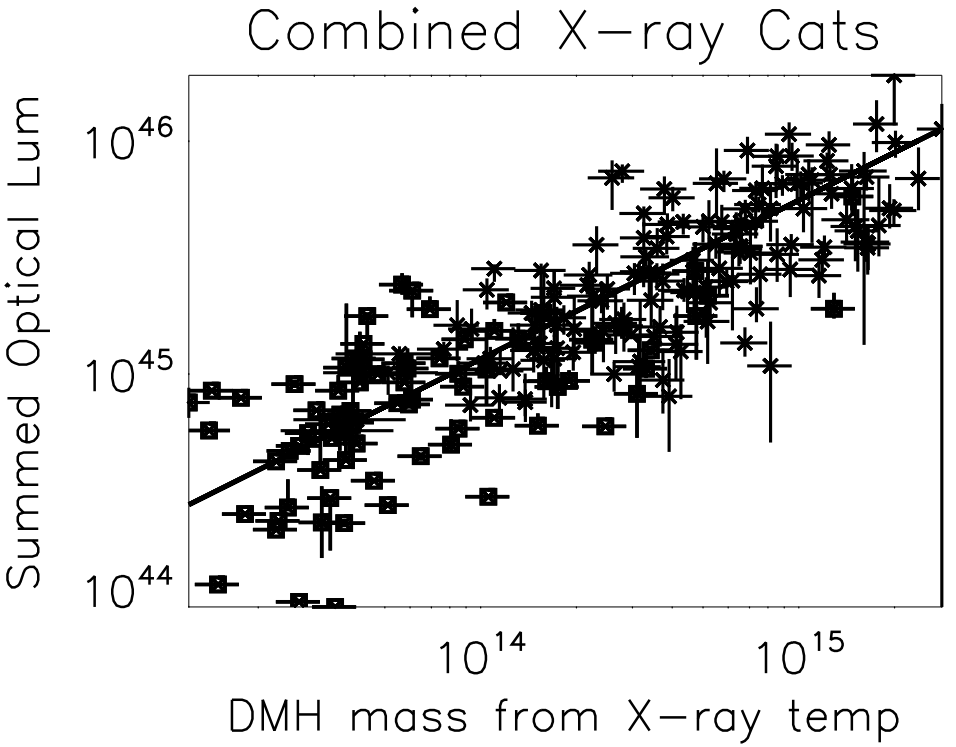
- 5 pointings of a $z = 2.215$ quasar
- Total time $273ks$
- $z = 1.45$
- Temp$> 6keV$
- HST enhanced image
- $\sigma_v = 580 \pm 140 kms^{-1}$
- Expect to find ≈ 10 in sample

XCS XMM Cluster Survey

Scaling relations

Combining optical [large numbers, no masses] and X-ray [small numbers, masses] cluster catalogues to obtain a mass proxy applicable to optically selected clusters.

- Xray
  - eBCS,BCS,$R400$D, XCS
  - reprocessed equally
  - Tx -> Mass [Dai et al]
- Optical
  - SDSS DR6
  - $L_{opt} \propto T_X \propto Mass$
  - Mass estimates to optical clusters
  - Implications for DES, DUNE ...



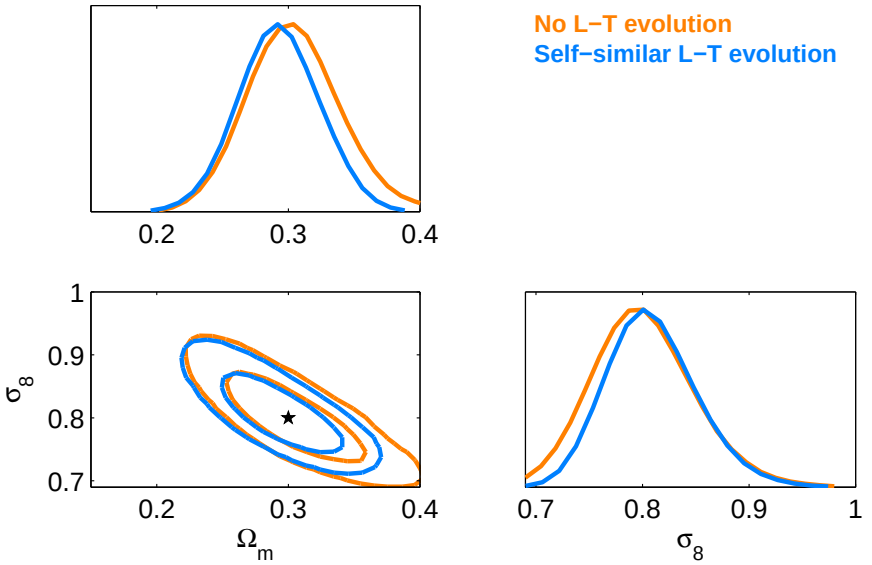
Empirical relationship:

$$L_{opt} = 10^{35^{+0.35}_{-0.35}} (Mass)^{0.7^{+0.22}_{-0.21}}$$

Hoyle et al, in prep

Cosmology

Predicted realistic cosmological constraints from the final ^{500}XCS 500 sq. deg. using clusters with measured temperatures, and assuming photometric errors.



Expected Accuracy		
Ω_M	$= 0.3$	± 0.3
σ_8	$= 0.8$	± 0.05
$L_X - T_X$	slope	13%
	normalisation	6%

Sahlén et al astro-ph/0802.4462