



ARCHES Integrated cluster finder

Alexey Mints, Axel Schwobe and the ARCHES
consortium

Leibniz-Institut für Astrophysik Potsdam (AIP), Germany

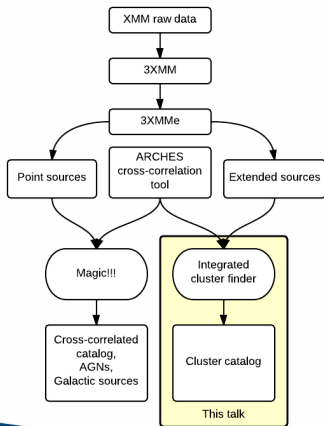
June 18, 2014



ARCHES

What is ARCHES

Astronomical Resource Cross-matching for High Energy Studies.



E5



ARCHES

Astronomical Research Cross-matching for High Energy Studies

An FP7-Space EC funded project (Jan 2013–Sept 2015)

C. Motch, on behalf of the ARCHES consortium




The ARCHES Consortium:

University of Leobenberg 171, Universität Wien, Institut für Astrophysik, 1090 Wien, Austria
 University of Southampton, School of Physics and Astronomy, University of Southampton, Highfield, Southampton, SO9 5NH, UK
 Institut de Física d'Espai, Universitat de València, 46100 Burjassot, Spain

ARCHES focuses on the XMM Survey Catalogue. New tools developed for cross-correlation with extensive archival resources, producing well-characterised multi-wavelength data in the form of spectral energy distributions (SEDs) for large sets of objects and in the form of a catalogue of clusters of galaxies. ARCHES produces products and investigates their usability in the framework of various science cases. All ARCHES products and tools will be made available to the general community. These data-driven resources will significantly increase the effective exploitation of the XMM-Newton data by the scientific community in the exploration of a wide range of frontier astrophysical questions.

An enhanced XMM catalogue

The enhanced XMM source catalogue created by ARCHES offers new quality control, detection of both the XMM-Newton and the *XMM-Newton* data, and a new set of parameters. It is a 12" resolution (10" x 10") full sky catalogue, but with enhanced data.

New unique identifiers are used for each XMM source. The XMM-Newton data are linked to the XMM-Newton data, and the XMM-Newton data are linked to the XMM-Newton data.

Key data are also available.

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A best list of archival catalogues for SEDs

Selected catalogues:

- Limited number of the best catalogues
- Maximum data coverage for the best catalogues
- Maximum data coverage for the best catalogues
- Maximum data coverage for the best catalogues

Result: 17 sets of archival catalogues for SEDs

Key data are also available.

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An enhanced cross-correlation tool

ARCHES has developed a virtual ground truth tool and a new software in a single data set. The tool is used to cross-correlate the XMM-Newton data with the XMM-Newton data.

Key data are also available.

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An integrated cluster finder

This program detects a software tool that searches for galaxy clusters in astronomical data sets. It is used to detect galaxy clusters in astronomical data sets.

Key data are also available.

Key data are also available.

Key data are also available.

Key data are also available.

Building spectral energy distributions

We use the XMM-Newton data to create a new catalogue of SEDs. The SEDs are used to create a new catalogue of SEDs.

Key data are also available.

Key data are also available.

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Relativistic test science cases

What is the nature of the dark matter?

What is the nature of the dark matter?

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Cluster test science cases

What is the nature of the dark matter?

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AIM test science cases

- What is the nature of the dark matter?
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Relativistic test science cases

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Cluster test science cases

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University of Leicester

University of Southampton



3XMMe – the heart of ARCHES

3XMM

- ▶ 3.2 years of data added after 2XMMi;
- ▶ 794 deg²;
- ▶ ~ 530000 detections/~ 370000 sources



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3XMM

- ▶ 3.2 years of data added after 2XMMi;
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3XMMe

- ▶ ~ 250000 sources (~ 340000 detections) with highest quality;
- ▶ Flags to mark sources as candidates for science themes (galactic, AGN, clusters);
- ▶ Flag to indicate where detections lie in fields affected by bright stars or galaxies;



ARCHES Integrated cluster finder

Goal Search for galaxy clusters and estimate their parameters (redshift, size, X-ray parameters) in multi-wavelength photometric and spectroscopic data, using X-ray information on the expected cluster positions.

Data Following catalogs are used (so far): SDSS DR9, CFHTLS (Deep and Wide), UKIDSS LAS DR9, AllWISE.

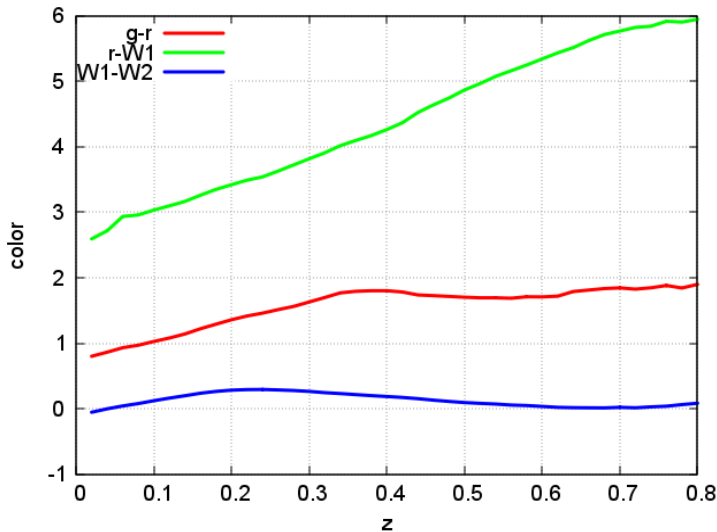
Spectra Spectroscopic data used: BOSS, VIPERS.

Future VHS, VIKING, DES, Pan-STARRS, PhotoZ surveys (SWIRE, ALHAMBRA etc.)

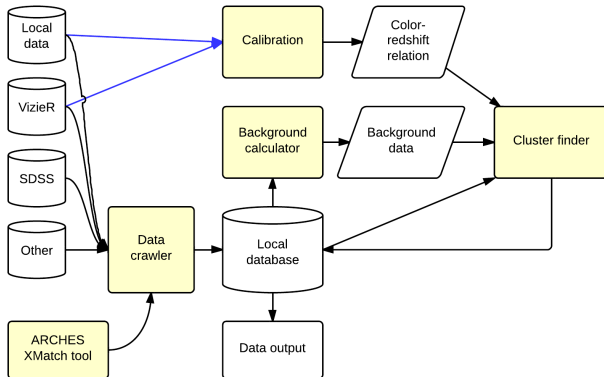
Cluster finder basics

- ▶ Utilize color-redshift relation to estimate redshift
- ▶ Use optical AND infrared colors to increase precision \Rightarrow we need a cross-match tool (ARCHES Xmatch)
- ▶ Use spectral observations to calibrate color-redshift relation.
- ▶ Estimate background and spurious detection probability.
- ▶ Inputs: position (X-ray source coordinates), luminosity function, density profile.
- ▶ Outputs: redshift, multiplicity, BCG position.

Color-redshift relation



Data flow



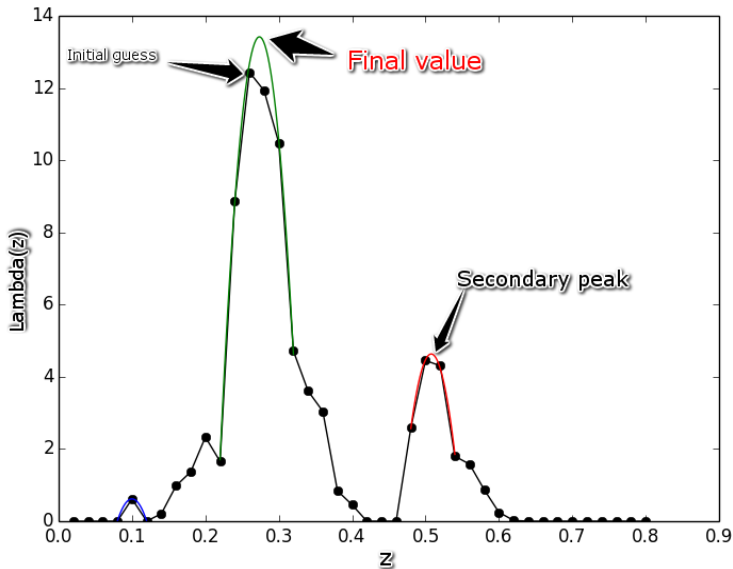
Multiplicity function $\lambda(z)$

$$\lambda(z) = \sum_{r < R_{\max}(z)} \frac{\lambda(z)u(z, x)}{\lambda(z)u(z, x) + b(z, x)}$$

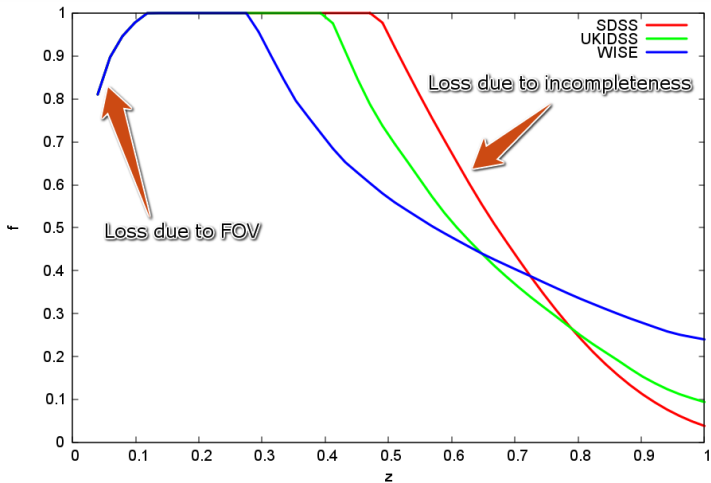
where x is a vector containing color and positional information, u – cluster profile, b – background.

$$R_{\max}(z) = \min(R_{1Mpc}(z), 8')$$

Peak finding



Completeness



The 2XMMi/SDSS Galaxy Cluster Survey

II. The optically confirmed cluster sample and the $L_X - T$ relation[★]

A. Takey^{1,2}, A. Schwobe¹, and G. Lamer¹

¹ Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany
e-mail: atakey@aip.de

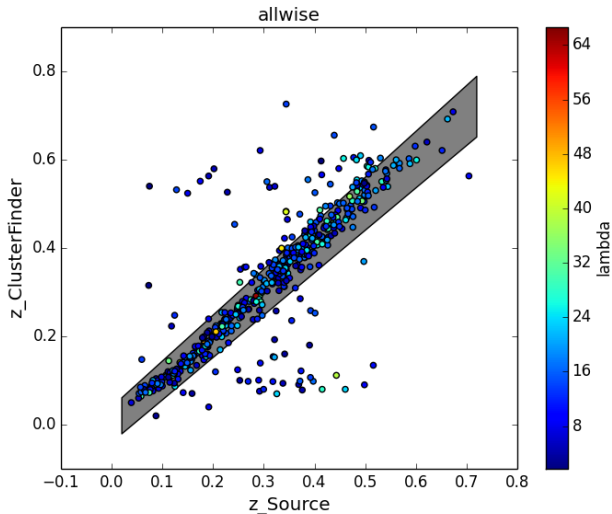
² National Research Institute of Astronomy and Geophysics (NRIAG), Helwan, Cairo, Egypt

- ▶ 2XMM – SDSS DR8 data;
- ▶ 530 clusters identified;
- ▶ 75% new X-ray clusters;
- ▶ 310 with spectroscopic redshifts of at least 1 member;

X-ray positions were used as input.

State of the art: ICF vs. Takey

85% have $|z_{icf} - z_{input}| < z_{err}$



Development status and plans

Status

- ~ 1500 X-Ray sources flagged for cluster science in 3XMMe.
- ~ 900 in SDSS DR9 footprint.
- ~ 600 “good” detections.

Plans

- Cluster finder and cluster catalog – to be ready by end of June 2014.
- 2nd part of the project – scaling relations ($L_X - T$).
- Catalog public release – July 2015.



Removed from 3XMMe:

- ▶ Bad mosaics, high background, hotspots
- ▶ Offaxis sources ($> 12'$)
- ▶ Low exposure observations

3XMMe cluster sources

- ▶ Extended sources with low extent error
- ▶ High galactic latitude ($|b| > 20^\circ$)
- ▶ $4' < \text{Offaxis} < 12'$
- ▶ High detection likelihood