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# MAGYC: A MULTIWAVELENGTH GALAXY CLUSTERS WEB-SERVICE

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**Abstract.** MAGYC (MultiwAvelength GalaxY Clusters) is a web service dedicated to multiwavelength validation and/or analysis of galaxy clusters using data and analysis tools located in two separated observatories. The free portal offers to do cross-checks with exiting cluster catalogs, to retrieve information on surveys and pointed observations, and to run detection algorithms. This tool, conceived as a service to the cluster community, relies on technical and scientific expertise from several french teams and is aiming at evolving with data and technics improvements. The service is available online at : `https://magyc.osups.universite-paris-saclay.fr`.

Keywords: Cosmology, Galaxy Clusters, Online Service

## 1 Introduction

Clusters of galaxies are the largest gravitationally bound objects in our Universe and represent a particularly powerful cosmological probe. Composed of dark matter, hot gas and galaxies, clusters can be observed in different wavelengths, each revealing only part of their properties. Moreover, some observations need confirmation in other wavelengths to assess their reliability. Having multi-wavelength observations and expertise allows to provide confirmation (ex. redshift), galaxy, gas or dark matter properties of new candidate clusters and confirmed clusters. The aim of MAGYC is to provide properties coming from multi-observation but coherent analysis in a (or several) given positions on the sky, with a galaxy cluster point of view. The query interface is shown in Fig .1.

## 2 Available analyses

### *2.1 Cross matches*

A cross match within a radius of 10 arcmin is performed with a list of galaxy cluster catalogs by OV cone-search. The current list is composed of:

- SDSS cluster catalog from Wen et al. (2012) [Table 'J/ApJS/199/34' in CDS-Vizier]
- SDSS cluster catalog from Rykoff et al. (2016) (Redmapper DR8) [Table 'J/ApJS/224/1/cat_dr8' in CDS-Vizier]
- SZ clusters from the meta catalog SZMC (Douspis (2015), available at `szcluster-db.ias.u-psud.fr`)
- X-ray clusters from the meta catalog MCXC from Piffaretti et al. (2011) [Table 'J/A+A/534/A109' in CDS-Vizier]

The closest cluster from the given position is given with typical properties, including the name and original index in the above catalogs. If no match is found, the table will show "-". If the cross-match has failed (database not available) the table will show "-1".

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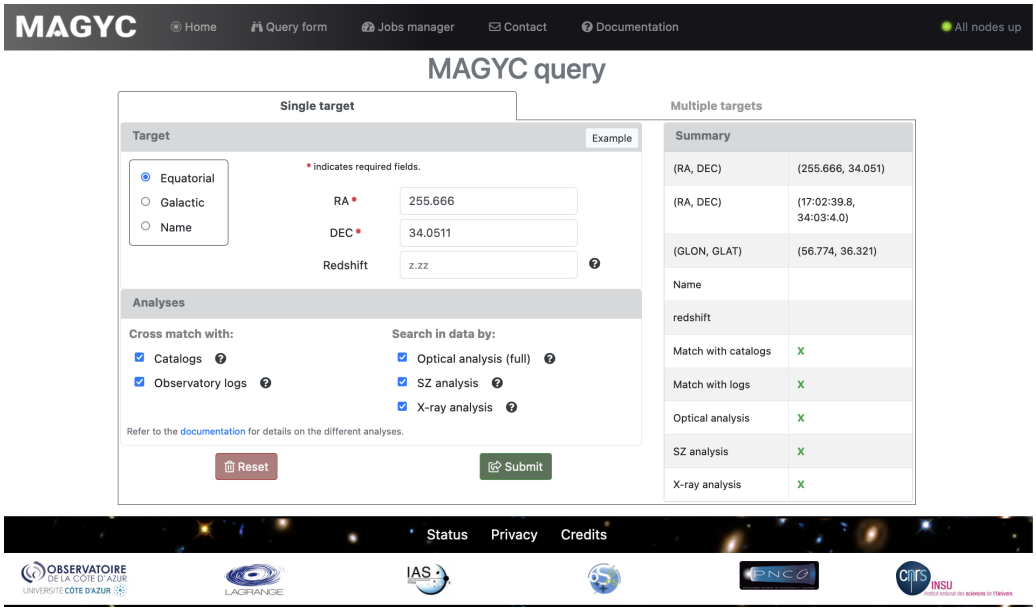


**Fig. 1.** The MAGYC interface that can be used in single target mode (displayed here) or in multiple targets mode.

### *2.2 Survey and observations availability*

A cone search is performed in the following observatories databases with a 1arcmin radius:

- XMM [`https://nxsa.esac.esa.int/`]
- Chandra [`https://cxcfps.cfa.harvard.edu`]
- HST [`MASTbyastroquery`]

If an observation is found, typical properties are shown (observation time, total observational time if more than one observation, name of the observation, wavelength). If no match is found, the table will show "-". If the query has failed (database not available) the table will show "-1".

### *2.3 SZ analysis*

Cutout in the Planck SZ map (from Planck Collaboration et al. (2016) and private communication of Hurier, 7arcmin resolution) is performed and returned. If the target position falls in the SPT footprint, the cutout is performed on the Planck+SPT SZ map (Bleem et al. 2022). The cutouts are 128x128 pixel of 1 arcmin$^2$. In the available archive, an SZ profile computed from the center is also returned (figure and data) as well as an estimated flux (aperture photometry). New SZ maps combining Planck and SPT and/or ACT, like the PACT one (Aghanim et al. 2019), are being built to improve the resolution and noise.

### *2.4 X-ray analysis*

Cutout in the ROSAT* [1.5-2.2keV band] emission map is performed and returned. The cutouts are 128x128 pixel of 0.5 arcmin$^2$. In the available archive, a count-profile computed from the center is also returned (figure and data) as well as an estimated flux (aperture photometry).

### *2.5 Optical analysis*

The optical analysis works in two different modes. If the target's redshift is unknown, the optical analysis aims at proposing one or several optically selected clusters in a radius around the target position (30 arcmin is the

*https://heasarc.gsfc.nasa.gov/docs/rosat/rhp_geninfo.html

current default value). This is achieved by running the wavelet based WaZP optical cluster finder and a suite of analysis tools to provide a galaxy based characterisation of all detections.

The advantage of running a cluster finder in real time over a pre-defined catalogue cross-match is the possibility to update some of the cluster finder parameters (e.g. detection SNR), or to force the optical centering or radius to estimate the cluster richness.

Delivered products include, for each optical component, a redshift estimate, membership probabilities, overdensity radius, richness, and various maps and diagrams as listed below. Note that the explored redshift range is conditioned by the depth and wavelength coverage of the available local galaxy surveys. In the case the user specifies a target redshift, the optical analysis is forced to that redshift and also provides a characterisation of neighbouring structures in a radius of 10 Mpc around the target.

The optical analysis is based on publicly available large photometric and spectroscopic surveys. The photometric information currently includes the Sloan Digital Sky Survey[†] and the CFHT Legacy Survey[‡]. Pan-STARRS and DES are currently being included. When several surveys are available, the analysis is performed on the deepest local available surveys. Cluster detection and probability membership assignment are based on the WaZP algorithm presented in Aguena et al. (2021) and in Castignani & Benoist (2016).

The optical analysis returns first information on the selected input galaxy data (png images, scatter plots and visibility maps of the field) to assess the quality and coverage of the input data. If coverage and quality are sufficient, the following information related to the identified clusters is provided:

- A list of all detected clusters. In the case of a target without redshift this is the list of the 3 richest detected clusters within the search radius. In the case of a target with known redshift, this is the list of all clusters with richness $N_{200} \geq 20$ within a radius of 10 Mpc.
- A list of cluster members with their membership probability for each detected cluster.
- A (gri) color image of the central 5 arcmin around each detected cluster (PNG).
- A galaxy density map based on wavelet decomposition at the redshift of each detected cluster.
- (RA, DEC) scatter plot of galaxies in the whole field of analysis with all detected clusters overlayed.
- The distribution of available spectroscopic redshifts around each detected cluster.

## 3 Technical description

MAGYC is a Java web application that uses the Spring Boot framework. The MAGYC architecture is based on two kinds of components: a frontal server and two node servers, hosted at Observatoire de la Côte d'Azur (OCA) and Institut d'Astrophysique Spatiale (IAS). Only the frontal server is publicly accessible by the users of the service (see Fig. 2).

The frontal server is is charge of all interactions with users. It communicates requests to both node servers using the UWS protocol through the powerful UWS library from CDS (`http://cdsportal.u-strasbg.fr/uwstuto/`). The nodes are in charge of jobs management. These jobs run on laboratory clusters.

When a MAGYC request, is submitted several jobs need to be launched. The frontal server transmits the list of jobs with their associated parameters to the nodes. Then, the nodes launch the types of jobs that they support. When you are on the status page for a request, the nodes are regularly queried for job statuses, which are reported back to you. When the jobs are all finished and you request the results, the data are downloaded from the nodes to the frontal server and packed into a single zip archive that you can download.

Multitarget MAGYC requests are treated in the same way as single target requests: they usually just consist of more jobs to launch with different parameters.

## 4 Conclusions and perspectives

MAGYC is a webservice dedicated to galaxy clusters that offers a user-friendly interface of the UWS protocol to execute several codes and do the analyses of the results. MAGYC offers the possibility to investigate one target

[†]http://sdss.org
[‡]https://www.cfht.hawaii.edu/Science/CFHLS/

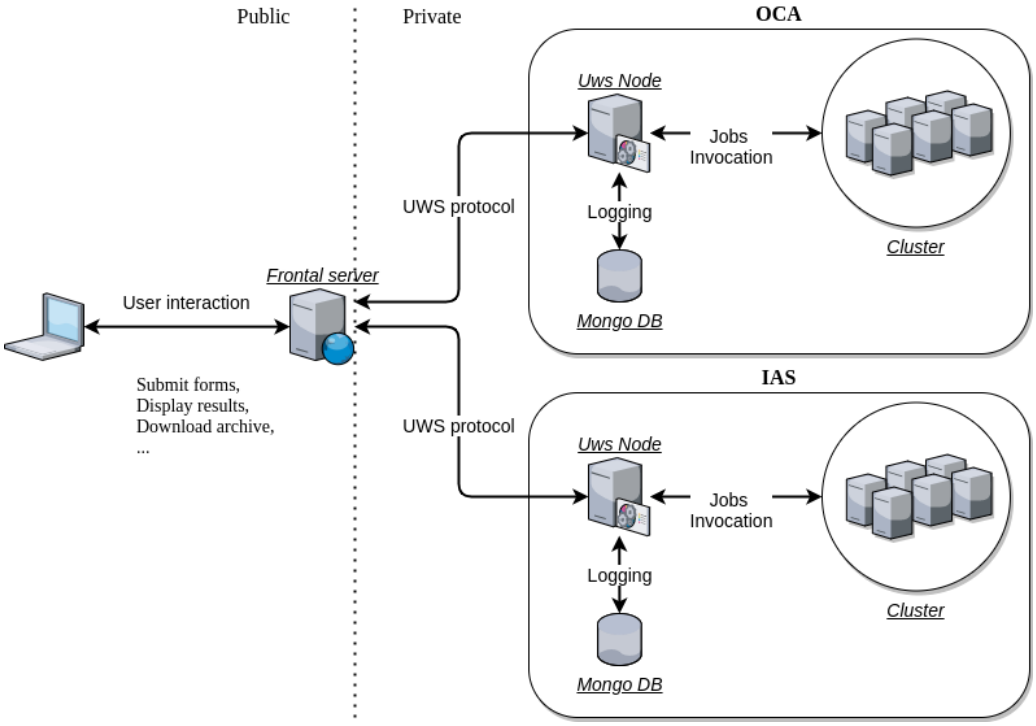


**Fig. 2.** General architecture

(interactive interface) or a list of positions (30 at max now) in an asynchronous mode. After a first release in 2021, the service is expected to be upgraded with news survey data (DES, Pannstars, Planck+SPT SZ maps) and new detection and characterisation techniques (SZ Multi matched filter and machine learning based quality assessment). More importantly, next release will include the computation of properties obtained from coherent multi-wavelength analyses of given clusters (ex. mass proxy from SZ and optical).

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