OAJ Web Portals: From Observations Scheduling to Data Access and Visualization

Tamara Civera and Javier Hernández

Centro de Estudios de Física del Cosmos de Aragón (CEFCA), Teruel, Aragón, Spain; `tcivera@cefca.es`

Abstract. The Observatorio Astrofísico de Javalambre (OAJ, Teruel, Spain) has two main telescopes: JST/T250, a 2.5m 3 deg FoV and JAST/T80 with 2 deg FoV. From OAJ two large area multiband photometric sky surveys of 8500 square degrees are being carried out. J-PAS using 54 narrow and 5 broad band filters and J-PLUS using 12 filters. The OAJ also offers 20% of observing time to the community.

This contribution presents different web applications designed and implemented at the Centro de Estudios de Física del Cosmos de Aragón (CEFCA) used for a variety of purposes: scheduling and tracking of the different observations, management and data quality review of the products of the reduction pipeline, external access to the data products of the Open Observing Time, and external access and visualization of the images and catalogues of the J-PLUS and J-PAS surveys using services such as images search, cone search, object list search, object visualization, sky navigation and asynchronous queries (ADQL). All web applications have been developed with Python language and PostgreSQL database.

1. Introduction

The Centro de Estudios de Física del Cosmos de Aragón (CEFCA[1]) is a center for research in Astrophysics and Cosmology whose activities focus on the technological development and operation of the Observatorio Astrofísico de Javalambre (OAJ[2]) and on its scientific exploitation.

The observatory has been particularly conceived for carrying out large sky surveys with two large field telescopes: JST/T250, a 2.5m 3 deg FoV and JAST/T80 an 80cm 2 deg FoV. The most immediate objective of the two telescopes for the next years is carrying out two unique multiband photometric sky surveys of 8500 square degrees: Javalambre Physics of the Accelerating Universe Astrophysical Survey (J-PAS; Dupke et al. 2019) (using 54 narrow plus 5 broad band filters) and Javalambre Photometric Local Universe Survey (J-PLUS; Cenarro et al. 2019) (using 12 filters).

The OAJ as Spanish ICTS (singular scientific and technical infrastructure) also offers 20% of observing time to the astronomical community through periodical calls.

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[1] http://www.cefca.es
[2] http://oaj.cefca.es/

2.   Scheduling and tracking the observations: Tracking portals

The observatory has to deal with the complexity of carrying out two large area surveys, J-PLUS and J-PAS, with thousands of pointings in different filters, and different open time projects with different requirements and types of observations (queue and target of opportunity (ToO)). To schedule and track all these observations two different web portals have been implemented: J-PLUS Tracking portal (for J-PLUS survey) and TAC Tracking portal (for open time projects).

These portals include tools to plan the best observations during the night depending on object visibility, the priority and the moon distance; to track the observations to easily know if they are already observed, not observed or they must be repeated; to know the status of the survey; and to create the command files for the telescope.
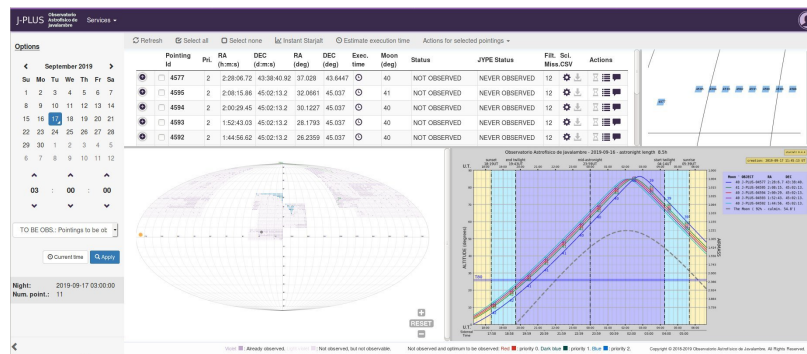

Figure 1.   J-PLUS Tracking Tool.

3.   Reduction pipelines management and review: The reduction portal

Right after the data acquisition, the images are archived in the Unit for Processing and Data Archiving (UPAD) and they are pipeline processed (Cristóbal-Hornillos et al. 2014). During this pipeline processing different data, images and products are generated and saved in the pipeline database and in the UPAD main storage.

A web portal, the reduction portal, has been created to easily access to all these information. This web interface uses the administrative database to provide an agile access to the status, processing history, metadata, measurements and statistics of the images and plots that allows the validation of the image quality and the data treatment.

4.   Data publication: The catalogues portal

J-PAS and J-PLUS include images, dual and single catalogue data which include parameters measured from images and photo-redshift computations. In single mode catalogues, objects detection is performed independently on each filter using SExtractor while in dual mode catalogues object detection and aperture definition is performed in a reference band ('rSDSS') and the measurements are done in each filter using SExtractor (Dual Mode) having as result a photo-spectra of each object.
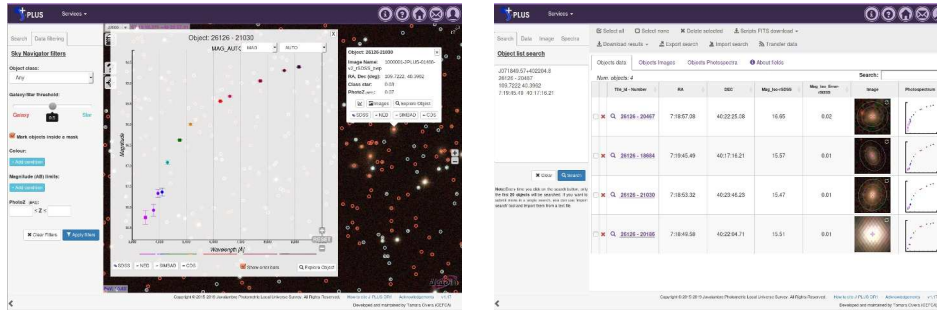
Figure 2.   Catalogues portal. *Left:* Sky navigator *Right:* Object list service

A powerful web portal, the catalogues portal[3], has been implemented to publish all this survey data offering advanced tools, each suited to a particular need, for data search, visualization and download.

The portal includes a sky navigator service where users can navigate through the sky and click on the different objects which allows them to visualize a summary of the object properties and its photo-spectra and explore it using the Object Visualization tool. The Object Visualization tool displays all the parameters of the object and the image thumbnail in each filter as well as provides tools to download reports and custom object fits cut-outs and to perform cross matches in other catalogues.

The portal also provides an object list search tool which lets the user upload a list of sky positions, object names or objects identifiers and then returns a list of objects near those positions displaying a customizable summary, photo-spectra and thumbnail images for all of them. An asynchronous queries interface based on Virtual Observatory (VO)[4] Table Access Protocol (TAP) has been also implemented in the portal where users can perform Astronomical Data Query Language (ADQL) queries to the database to search for all objects that meet any criteria they can think of.

Other services supplied are a cone search service (which lets the user search the database for objects near a certain sky position and with certain brightnesses and photo-redshift), an image search service (where the user can search and download the survey images) and a Multi-Order Coverage Map (MOC) service (where the MOC file which describes the area covered can be downloaded).

All of these services support Simple Application Messaging Protocol (SAMP) that enables the catalogues portal interoperate and communicate with VO-compatible applications. Moreover, catalogue data are also accessible through VO protocols as SIAP (Simple Image Access Protocol), SCS (Simple Cone Search), SSAP (Simple Spectral Access Protocol) or TAP (Hernandez & Civera 2020).

5.   Data publication: The TACData portal

External access to the data collected as part of an Open Time proposal is provided to its PIs and CoIs once the observations are concluded and validated. The data provided include raw scientific data, calibration frames and scientific data reduced and calibrated

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[3]http://archive.cefca.es/catalogues
[4]http://www.ivoa.net/

with the specific OAJ pipelines. After a proprietary time of one year, the data are made public for all the astronomical community.

To offer all this data, a web portal, the TACData portal[5], has been implemented. This portal deals with the complexity of offering private (only accessible for the proposal PIs and CoIs) and public data and allows users to perform searches and download the data and files. To make downloading easier, the portal also includes functionality to create scripts to download a set of files using command line tools.

6. Technical Aspects

J-PLUS and J-PAS catalogue data are expected to occupy several Terabytes of data so to store it the relational database PostgreSQL has been chosen. This database is well known to manage terabyte sized databases and to support array datatypes necessary to store the fluxes and errors measured in 16 different apertures in the different filters. PostgreSQL has been also selected for storing TACData portal and Tracking Tools data. Adequate indexing is a key point to achieve to provide 'web response time' as many of portal services query sky areas. To achieve it HEALPix pixelization schema[6] is used.

All the web portals have been implemented using the Python programming language and the framework Pyramid. Python language has been chosen because it is widely used in astronomy and there are a lot of scientific open libraries with very useful functionalities to manage astronomy images, coordinates, etc. On the other hand, to implement the sky navigator the Aladin lite library[7] is used and RGB images have been generated following the Hierarchical Progressive Survey (HiPS) system.

7. Conclusion

Different web applications designed and implemented at CEFCA used for a variety of purposes, from observations scheduling to data access and visualization, have been presented with their main functionalities and the technologies used to implement them.

References

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[5]`https://tacdata.cefca.es`
[6]`https://healpix.jpl.nasa.gov`
[7]`https://aladin.u-strasbg.fr/AladinLite/`