



**ASTERICS - H2020 - 653477**

## An introduction to the CDS services and tools

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# 1 Introduction

The CDS harbours three major programs, accessible through the CDS portal:

-  **SIMBAD**: The astronomical database SIMBAD contains more than 8 million objects. For each object it provides basic measurements (type, coordinates, proper motion, radial velocity, spectral type, distance, magnitude), cross-correlations and bibliography.
-  **VizieR**: The VizieR catalog service provides access to about 15,000 catalogs, being the most complete library of published astronomical data tables available online.
-  **Aladin**: The interactive sky atlas Aladin allows to visualize astronomical images and to superimpose entries from different catalogs and databases. It allows to visualize SIMBAD and VizieR information and distributed archives and databases as well as to upload own tables or images. There are two versions of Aladin: Aladin desktop and Aladin lite which runs in the browser.

In addition, the CDS has been offering a cross-match service (X-match  ) since November 2011.

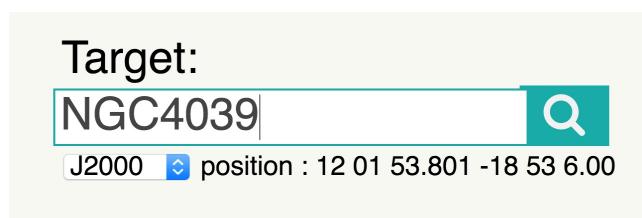
## 2 Goal of this tutorial

This tutorial shows how to use the CDS tools to gather information on specific astronomical objects. We will:

- Search for information on NGC4039 in the CDS portal
- Search for data on NGC4039 in Aladin
- Compare the coverage of Sky Surveys and select interacting galaxies that have SDSS and GALEX data

## 3 Search for information on NGC4039 in the CDS Portal

Open the CDS Portal <http://cdsportal.u-strasbg.fr/> and make a query for ‘NGC4039’. The result provides an overview of the information and data available for this object in the 3 CDS services: SIMBAD, Aladin and VizieR:



The screenshot shows a search interface with a light gray background. At the top left, the word "Target:" is followed by a text input field containing "NGC4039". To the right of the input field is a teal-colored search button with a white magnifying glass icon. Below the input field, there is a smaller text input field containing "J2000" followed by a dropdown arrow and the coordinates "position : 12 01 53.801 -18 53 6.00".

Figure 1: Query for NGC4039 in the CDS Portal

### 3.1 SIMBAD - Identifiers, Basic Measurements and links to the Bibliography

The screenshot shows the CDS Portal interface for object NGC4039. At the top, there are two tabs: "Object (Simbad)" and "Object (NED)". The "Object (Simbad)" tab is active. Below the tabs, the object's name "NGC4039" is displayed, along with its position "J2000: 12 01 53.801 -18 53 6.00". On the left, there are sections for "Main ID" (NGC 4039), "Object type" (Galaxy in Pair of Galaxies), and "Morphological type" (Sc). On the right, there are sections for "Magnitudes" (B: 11.08, R: 9.77) and "Morphological type" (SA(s)m pecLINERSbrst). Below these sections are "More info in Simbad" and "More info in NED" links.

Figure 2: Result of the query for NGC4039 in the CDS Portal

- Click on **More info in Simbad** to see the full SIMBAD information on this object in a new tab.

The screenshot shows the SIMBAD database results for NGC4039. At the top, there is a navigation bar with tabs for "other query modes", "Identifier query", "Coordinate query", "Criteria query", "Reference query", "Basic query", "Script submission", "TAP", "Output options", and "Help". The "Basic query" tab is selected. Below the navigation bar, the query "Query : NGC 4039" is shown, along with the timestamp "C.D.S. - SIMBAD4 rel 1.5.10 - 2016.12.19 CET 10:43:26". A link "Available data" leads to "Basic data", "Identifiers", "Plot & images", "Bibliography", "Measurements", "External archives", "Notes", and "Annotations".

**Basic data :**

**NGC 4039 -- Galaxy in Pair of Galaxies**

Other object types: GIP(), G (ESO, LEDA,...), IG (Ref,VV), PaG (RR95), Rad (WISH)

ICRS coord. (ep=J2000) : 12 01 53.8 -18 53 06 (Optical) [ ] D 2003A&A...412...45P

FK5 coord. (ep=J2000 eq=2000) : 12 01 53.8 -18 53 06 [ ]

FK4 coord. (ep=B1950 eq=1950) : 11 59 20.0 -18 36 24 [ ]

Gal coord. (ep=J2000) : 286.9689 +42.4460 [ ]

Radial velocity / Redshift / cz : V(km/s) 1637 [9] / z(-) 0.005474 [0.000030] / cz 1641.00 [9.00] D 1989ESOLV.C.....OL

Morphological type: Sc D 2004ApJ...602..231C

Angular size (arcmin): 3.1 1.6 50 (-) D 2007ApJS..173..185G

Fluxes (2) : B 11.08 [0.21] D 2007ApJS..173..185G  
R 9.77 [-] D 1989ESOLV.C.....OL

SIMBAD [query around](#) with radius 2 arcmin

Interactive AladinLite view

FoV: 3.09' 2MASS DSS SDSS

Figure 3: Result of the query for NGC4039 in SIMBAD.

- Note the list of **Other object types**. These types are drawn for the literature and are stored in SIMBAD using a hierarchical classification scheme. The full list of Object Types can be found here: <http://simbad.u-strasbg.fr/simbad/sim-display?data=otypes>. The main Object Type of NGC4039 is **Galaxy in Pairs of Galaxies (GIP)**.
- Use the **parents** button to identify the name of the galaxy pair. Sorting by the number of references can help bring out the most important ones.
- Follow the link to the SIMBAD entry of the Antennae galaxies . There click on the **children** button to identify the name of the two galaxies making up the galaxy pair.
- Visit the SIMBAD entry of the interaction partner of NGC 4039 and use the **References** section to find the earliest listed reference in the literature to this object.

## References (1086 between 1850 and 2017)

Simbad bibliographic survey began in 1950 for stars (at least bright stars) and in 1983 for all other objects (outside the solar system).

 Follow new references on this object

[sort references](#)

display reference summary ▾  
from: 1850 to: \$currentYear

Sort reference summaries by : (not exhaustive, [explanation here](#))

[Date](#) [Title](#)|[Abstract](#)|[Keyword](#) [In table](#) [Score](#)

Figure 4: References section

- Return to the CDS portal.

## 3.2 Aladin - Images

  **Images**

204 HiPS images optical 0.20° around 12 01 53.801 -18 53 6.00 :

**Wavelength :**  Gamma-ray  X-ray  UV  Optical  Infrared  
 Radio  Gas-line

**Resolution :**  Low  Medium  High

**Show :**  All HiPS  Most popular  My favorites

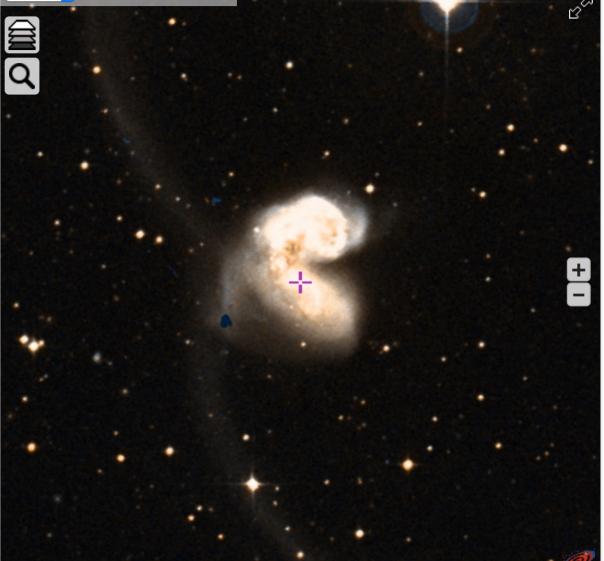
**Filter:**  15 entries (filtered from 204 total records)  continuous update

title	wavelength	Sky fraction	
Fermi Color HEALPix survey	Gamma-ray	100 %	
MAXI SSC all-sky image integrated for 4.5 years	X-ray	100 %	
Swift-BAT 70-month all-sray hard X-ray survey image	X-ray	100 %	
XMM-Newton stacked EPIC images	X-ray	5.06 %	
False color X-ray images (Red=0.5-1 Green=1-2 Blue=2-4.5)Kev	X-ray	6.69 %	
GALEX GR6 AIS (until March 2014)- Color composition	UV	79.79 %	
DSS2-XJ North and DSS2-S South merged survey (Blue)	Optical	99.56 %	
DSS2 optical HEALPix survey, color (R=red[-0.6um]/G=average/B=blue[-0.4um])	Optical	100 %	
DSS2-F North and DSS2-R South merged survey (Red)	Optical	100 %	
Finkbeiner Halpha composite survey	Optical	100 %	
Mellinger optical survey, color	Optical	100 %	

15 entries (filtered from 204 total records)

  **Aladin Lite**

DSS2 optical HEALPix survey, color (R=red[-0.6um]/G=average/B=blue[-0.4um])  
J2000 12 01 53.801 -18 53 6.00



FoV: 11.98' | Digitized Sky Survey - STScI/NASA, Colored & Healpixed by CDS

 Share  Thumbnails  Update

Figure 5: Result of the query for NGC4039 in the CDS Portal

- A DSS (Digitized Sky Survey) image of NGC4039 is shown.
- Note that you can zoom on the image by scrolling your mouse.
- Other images can be displayed by selecting them in the left column.
- Restricted searches on wavelength and resolution are possible by ticking/unticking the boxes in that same column.

### 3.3 VizieR - Catalogs

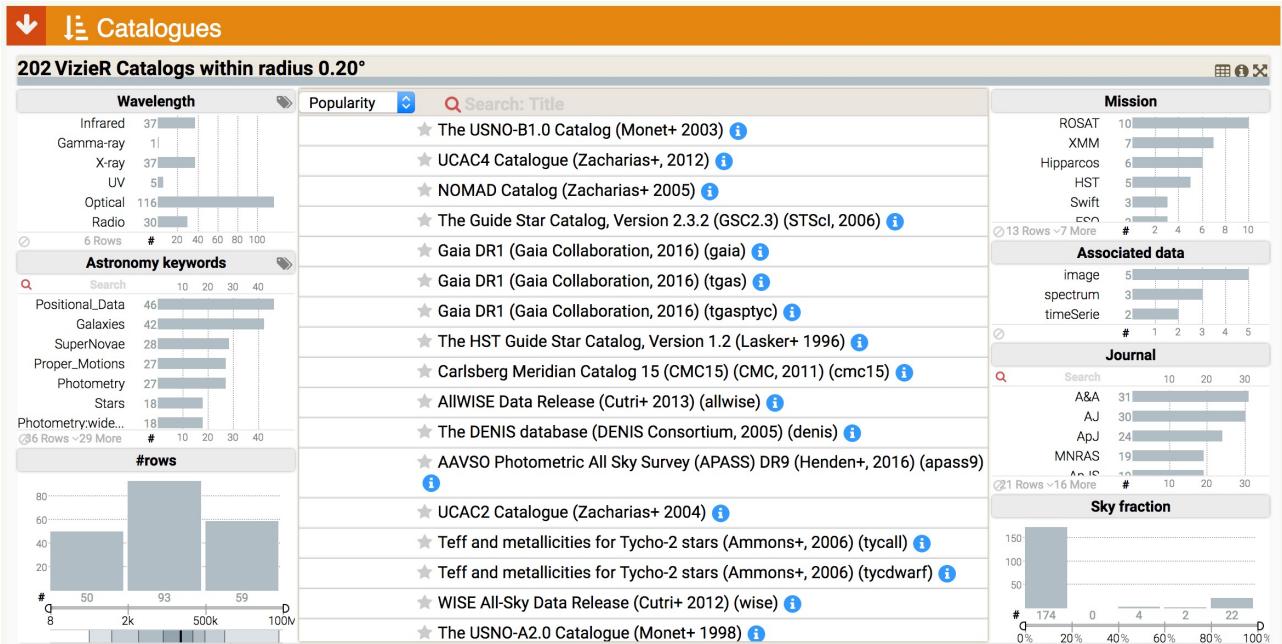


Figure 6: Result of the query for NGC4039 in the CDS Portal

- The list of catalogs is sorted by **Popularity** but can also be sorted by number of rows (**#rows**), **sky fraction** or **year**.
- Note that restrictions and filtering can be applied by clicking on the left or right columns according to your wills.
- Selecting a catalog, it is then possible to visualize it (either quickly or in vizieR), to plot it and/or to send it to the Aladin tool.



Figure 7: Selection of a VizieR Catalog on the CDS Portal.

- Actually the Antennae is listed in the Arp Atlas of Peculiar Galaxies, make a search for ‘Arp’ into the **Search** box.



Figure 8: Looking for ‘Arp’ in the VizieR catalogs.

- Note that there are two tables for Webb 1996. Select the **arplist** table by clicking on it and then on . This sends to the VizieR detailed query page.
- Make a first query on this table by clicking on **submit**. Examine the output as html. Go back to the previous page

- Modify the query preferences to add extra coordinate columns in J2000 decimal degrees and to obtain the whole catalog:
  - Remove the restriction on searching only around ‘NGC4039’ by clicking on the **Clear** button below **Target Name (resolved by Sesame) or Position** at the top of the page.
  - In **Preferences** on the left side of the page, add extra coordinate columns in decimal degrees by ticking **J2000** and **decimal** boxes.
  - Change the maximum (**max**) number of rows to **unlimited** and tick **All columns** to get the whole catalog.

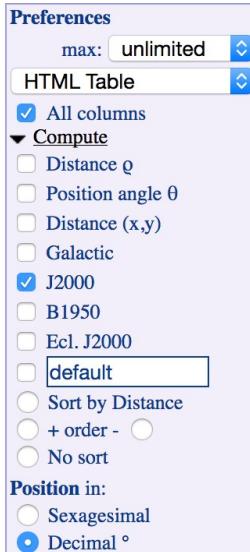


Figure 9: **Preferences** panel.

- Submit again.
- When satisfied, click on **Save in CDSportal**, then click on the **Save** button. The file is now saved in your personal user space on the CDS portal.
- Click on **Go to MyData** and download a copy in **VOTable** format on your desktop. This file will be used later in the tutorial.

Filename	Nb. rows	Size	Comment	Metadata	Upload date	Download
vizier_VII_192_arplist_20161220	592	176.5 KB	Your comment	<a href="#">Set metadata</a>	20/12/2016 at 15:43:44	<a href="#">VOTable</a> <a href="#">csv</a> <a href="#">tsv</a> <a href="#">fits</a>

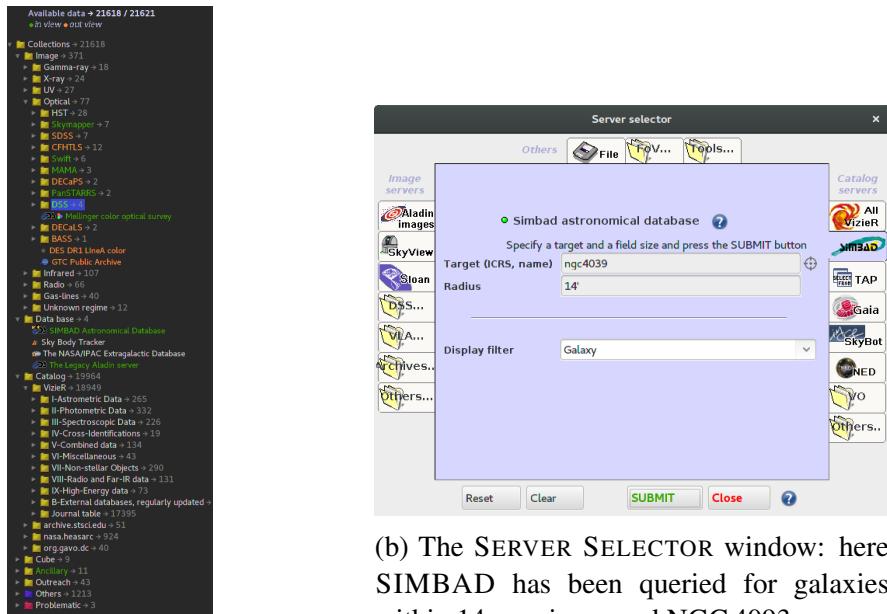
Figure 10: Personal User Space on the CDS Portal.

## 4 Search for data on NGC4039 in Aladin

Open Aladin with at least 1GB memory allocated to the save virtual machine. To do so use the following command line: ‘ java -Xmx1024m -jar Aladin.jar ’

Aladin offers two ways to retrieve data: through the DATA TREE on the left hand side of the Aladin window and through the SERVER SELECTOR window, which can be opened via **File → Open server selector...** or with **CTRL + I**.

Data sets in the DATA TREE are colour coded in green or orange depending on whether or not they are available in the region currently visible in the main viewing window.



(a) The DATA TREE: green entries are available for the sky region currently visible in the main viewing window (not shown).

(b) The SERVER SELECTOR window: here SIMBAD has been queried for galaxies within 14 arcmin around NGC 4093.

Figure 11: The two entry points to retrieving data in Aladin: The DATA TREE (left) and the SERVER SELECTOR (right).

- Start by typing "NGC4039" in the **Command** line  and press **Enter**. In the main viewing window the coloured DSS image of the Antennae galaxies appears. As for the Aladin lite window in the CDS portal you can zoom in and out by scrolling your mouse.
- Make a contour map of the image using the **cont** button next to main viewing window. Increase the number of contours to better represent the image.
- Overlay a SIMBAD plane showing only the galaxies by selecting the tab in the SERVER SELECTOR and choosing **Galaxy** as the **Display filter** (see Figure 11b).
- Change the colour of the SIMBAD plane using the button **Properties**
- Using the **Select** tool , select some of the SIMBAD points and note that these are displayed as a table below the image. This window can be detached with the icon . Note that the data point belonging to a row in the table blinks in the main viewing window when hovering over the table row with the mouse.
- In the DATA TREE, go to **Images** → **Infrared** → **2MASS** and load the 2MASS colour image. Use the opacity slider next to the 2MASS plane in the image stack to change the opacity of the 2MASS image and to compare it to the DSS image.

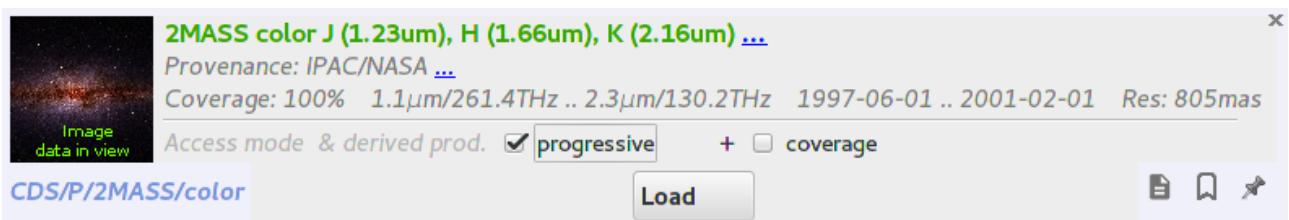


Figure 12: Loading the 2MASS colour image from the DATA TREE.

- Now add more colour images from the DATA TREE, for example the allWISE (infrared) and the XMM Newton (X-rays) colour images. Compare the images in a number of different ways:

- Multiview: **View → Create one view per image**, or via the **multiview** icon at the bottom left of the Aladin image window 
- Align and scale all images by using the **match** icon below the image window 
- Transparency overlays: return to single view mode. Change the transparency of planes in the stack with the opacity sliders  as before. Note that you can move the location of the planes in the stack and thus change the order in which the images are shown.

- Search for more data from the VO on NGC4039:

- To restrict the collections that the DATA TREE is showing, use the **Select** line below the DATA TREE . For example when searching for transients within the Antennae galaxies you might restrict the search to "transient" and find that the Palomar Transient Factory photometric catalogue has data for transient events in the area. Load the catalogue and find the data points in the main viewing window.
- More elaborate filters can be created using the **Data Discovery Tree Filter** window, accessed through  next to the **Select** line.
- As before, entries in the DATA TREE, which are coloured in green, have data available in the region currently visible in the main viewing window.

- Now delete all the planes in your stack before continuing. This is not mandatory but it will free some useful memory space and allow you to proceed more easily with the next steps.

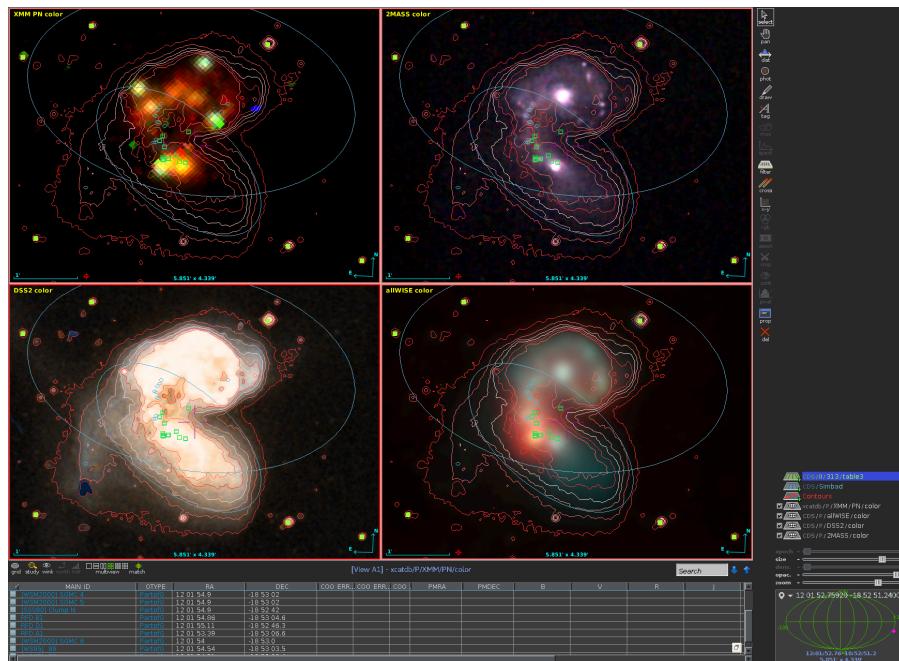


Figure 13: Results of all the above mentioned steps.

## 5 Compare the coverage of Sky Surveys and select interacting galaxies that have SDSS and GALEX data

Many large sky surveys in Aladin are stored in the **HiPS** format (Hierarchical Progressive Survey, see <http://aladin.u-strasbg.fr/hips/>), which allows for easy access, browsing and visualisation of image and catalogue data. To describe (non-trivially shaped) regions on the sky **MOC** (Multi-Order Coverage) maps are used. In the following, we will make use of the advantages of these two data structures to easily assess which galaxies in the Arp catalogue of peculiar galaxies have been observed by SDSS and GALEX. If you would like to have an overview of the HiPS exist have a look at <https://aladin.u-strasbg.fr/hips/list>

- Select the **SDSS 9 colored (Image → Optical → SDSS)** and **GALEX All Sky Imaging Survey colored (Image → UV → GALEX)** surveys in the DATA TREE and load both the imaging data (tick progressive  **progressive**) and the MOC of the survey (tick coverage  **coverage**). For the moment make the two MOC planes invisible by clicking on their opacity slider .



Figure 14: Selecting the SDSS 9 coloured survey and MOC

- Turn on the coordinate **grid** , zoom out and use the **pan** tool  to explore the whole sky.
- Now turn the MOC planes back on (click again on the opacity slider). Zoom onto the edges of the surveys and note the way the MOC represents the coverage of the surveys.
- Calculate the intersection of the coverage maps of the SDSS and GALEX surveys using in the menu the item **Coverage → Logical operations** or the MOC button  right of the main viewing window.

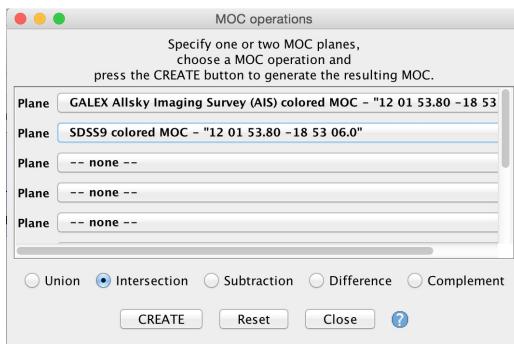


Figure 15: Building the intersection of the coverage maps

- Load the full Webb 1996 Arp catalog that you saved earlier. You can do this in one of the two ways:
  - **File → Load local file...**
  - drag and drop on the images

Alternatively you can download the catalogue from VizieR through the DATA TREE, enter "Arp Webb" in the **Select** line below the DATA TREE, select the "arplist" table and **Load the Whole data**.

- Filter the catalog to select only the sources that fall within the SDSS+GALEX MOC: **Coverage → Filter a table by MOC...**: 425 sources are selected. Note that you can also filter a table by MOC when loading the table initially (instead of loading the entire table).

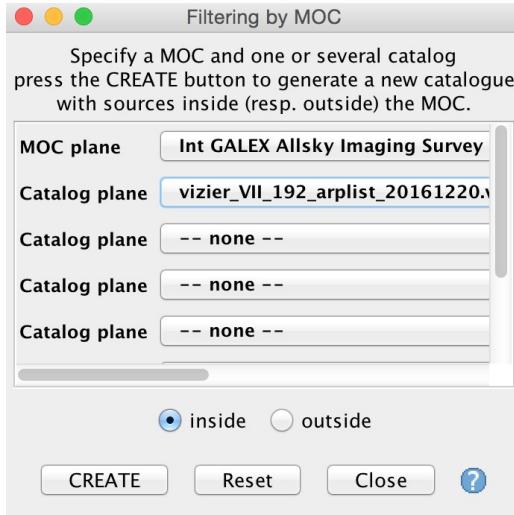


Figure 16: Filtering a catalog by a MOC

- Visualize the brightest (<9 mag) galaxies of the selected sources by extracting small images from the SDSS survey:

- Select the brightest galaxies using the **filter** tool **grid**: select the **Show brightest stars** predefined filter and edit it with the **Advanced mode** to select object with magnitude below 9. Note that the column is automatically identified with the Unified Content Descriptor ' phot.mag\*' .
- Make sure that only the MOC filtered catalogue is active in the stack and visible in the main viewing window (or other sources may also be filtered). An easy way to ensure that is to delete every catalogue not useful any more.
- Click on **Apply** and then **Export** to create a new plane consisting only of sources selected by the filter. There are 7 sources with magnitudes below 9.



Figure 17: Filtering a catalog by magnitude

- Make thumbnails of the selected brightest sources: **Tool → Thumbnail view generator...**, set the thumbnail size to 11 arcmin.

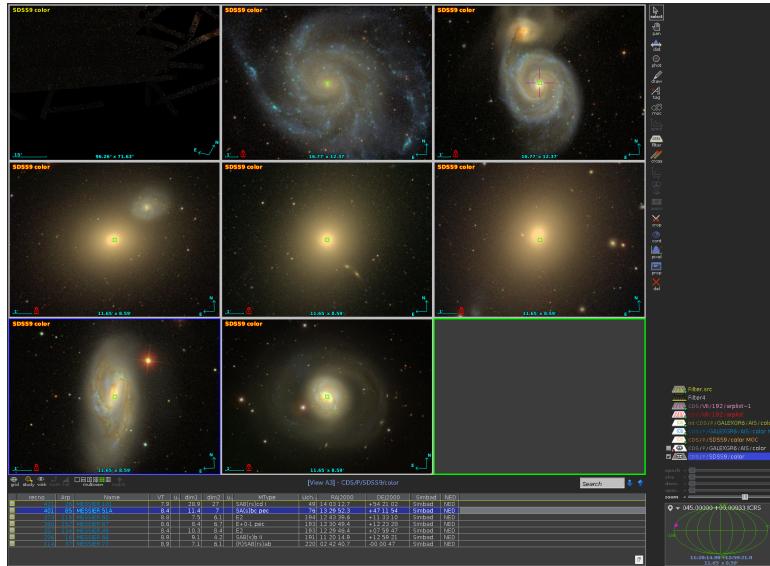


Figure 18: Thumbnails

## 6 Collect information on a sample of galaxies using Aladin [Optional]

Use an Aladin script to obtain DSS and SDSS image with HST, Chandra, ESO observation log overlays for each of the selected bright galaxies.

- Copy the script Arp\_script.ajs from the url [http://cds.unistra.fr/tutorials/CDS-tutorial/Arp\\_script.ajs](http://cds.unistra.fr/tutorials/CDS-tutorial/Arp_script.ajs) to your computer. The content of the script is shown in Figure 19
- Create a folder called ‘Arp’ and edit the script Arp\_script.ajs to insert a path in order to save the output files, e.g. `~/Desktop/Arp`.

- Open the Aladin macro controller and load the script:
  - **Tools → Macro Controller** then **File → Load script**
  - or cut and paste the script into the top panel of the MACROS window.
- Select all the sources in the bright galaxy catalog:
  - Right click on the plane and **Select all objects in the selected planes**
  - In the MACROS window: **File → Use selected plane sources as params.**
  - Note how the catalog columns are shown as parameters which can be referred to as \$1, \$2, etc within the script.
- Click on the first row of the parameters table and execute the script for this row: **Exec current params.**
- Optional: add an SDSS image: remove the '#' to enable download of a SDSS g-band image for each source. Note that this results in an **Could not find any data corresponding to your request** message for objects not covered by SDSS.
- Inspect the output in the Aladin window and also the files written in the Arp folder.
- Execute the script for all sources: **Exec all from current.**
- Note that the saved stack files can simply be dragged and dropped into Aladin for inspection.

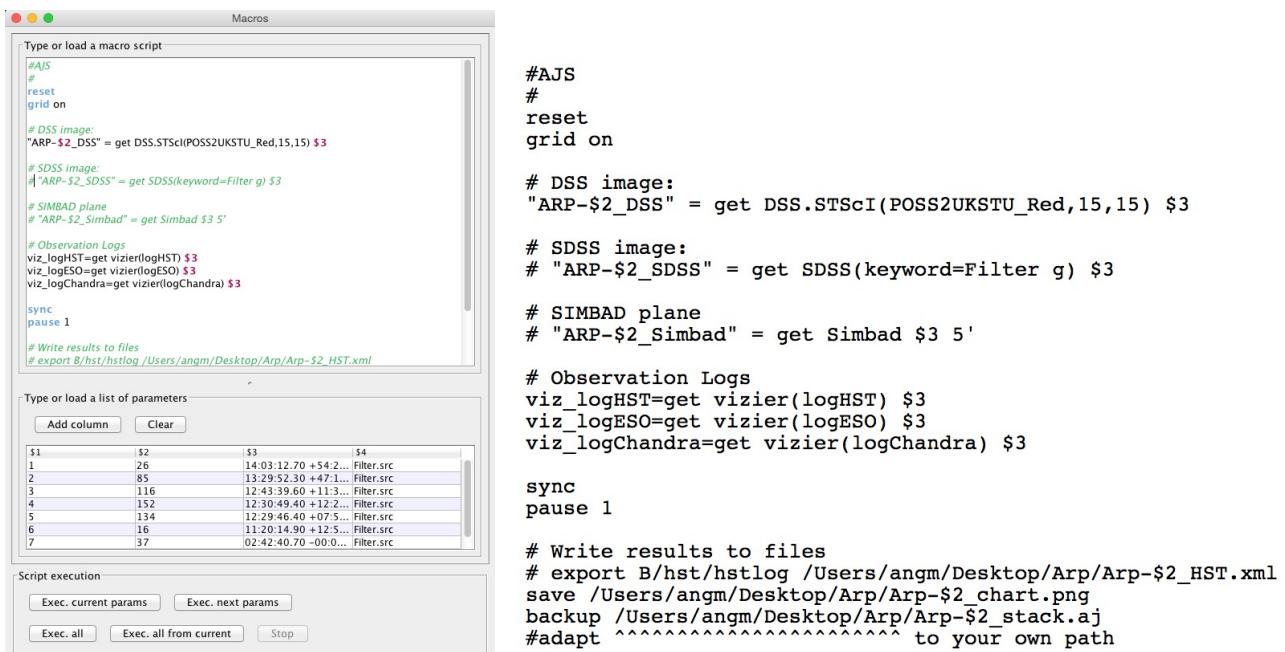


Figure 19: MACROS window & Arp\_script.ajs