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An introduction to the CDS services and tools

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updated with a new template for ASTERICS with the new CDS portal, new plots

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1 Introduction

The CDS harbors 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.

Besides these tools, the CDS has been providing 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:

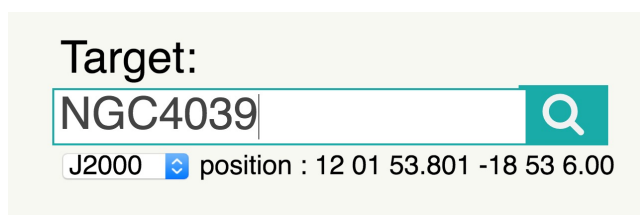


Figure 1: Query for NGC4039 in the CDS Portal

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

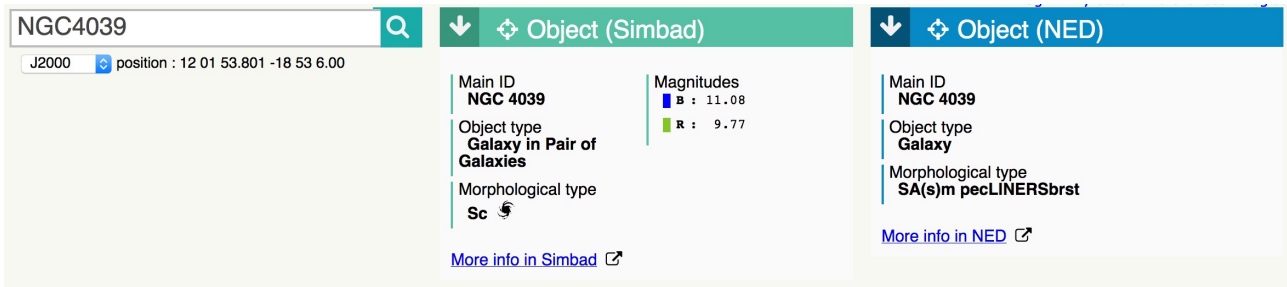


Figure 2: Result of the query for NGC4039 in the CDS Portal

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

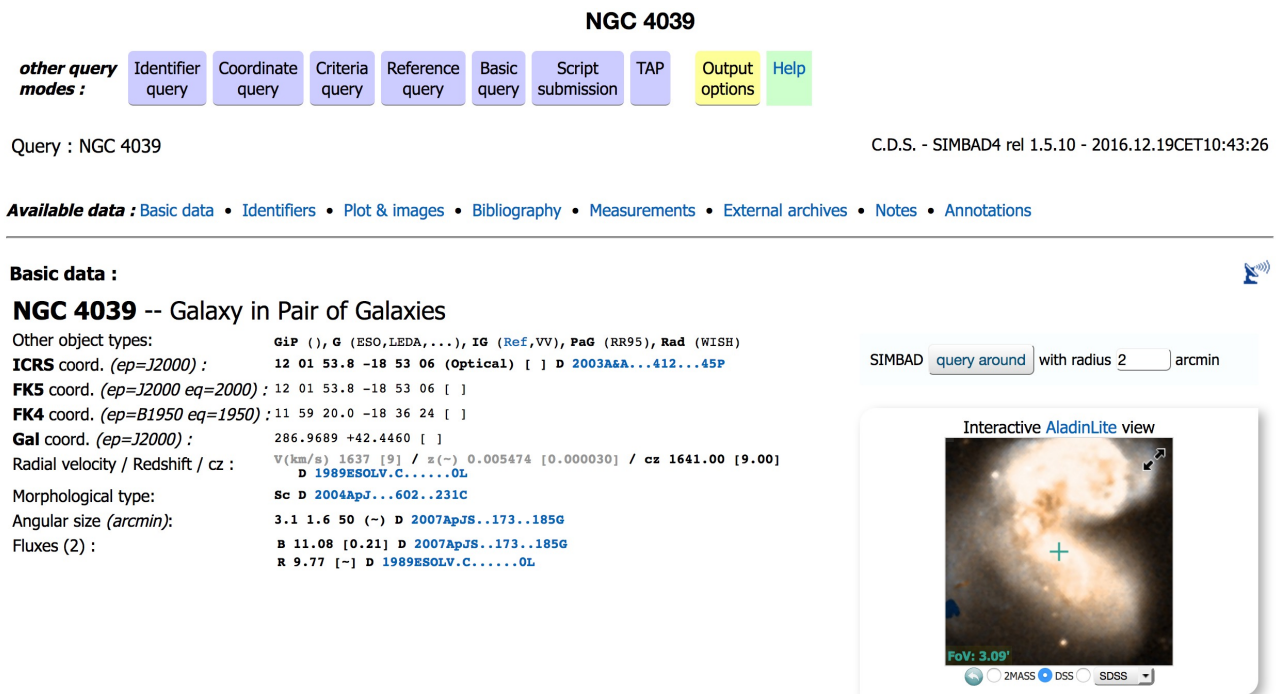




Figure 3: Result of the query for NGC4039 in SIMBAD.

- 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 **siblings** button  to identify the name of the other galaxy in this interacting pair. Sorting by the number of references  can help bring out the most important ones. What is the separation in arcseconds of these two galaxies?
- 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

The screenshot shows the Aladin Lite interface with search filters and a list of images. The filters are: Wavelength (checked: Gamma-ray, X-ray, UV, Optical, Infrared, Radio, Gas-line), Resolution (checked: Low, Medium, High), and Show (radio buttons: All HIIPS, Most popular, My favorites). The filter results show 15 entries (filtered from 204 total records) with a continuous update button. The table below lists the search results:

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 %

The right side of the interface shows a DSS2 optical HEALPix survey image of NGC 4039. The image is a color composite (R=red[-0.6um]/G=average/B=blue[-0.4um]) with a field of view of 11.98. The image shows a bright, irregularly shaped galaxy with a central core and several bright spots. The interface includes a search bar, a zoom-in (+) and zoom-out (-) button, and a share button.

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

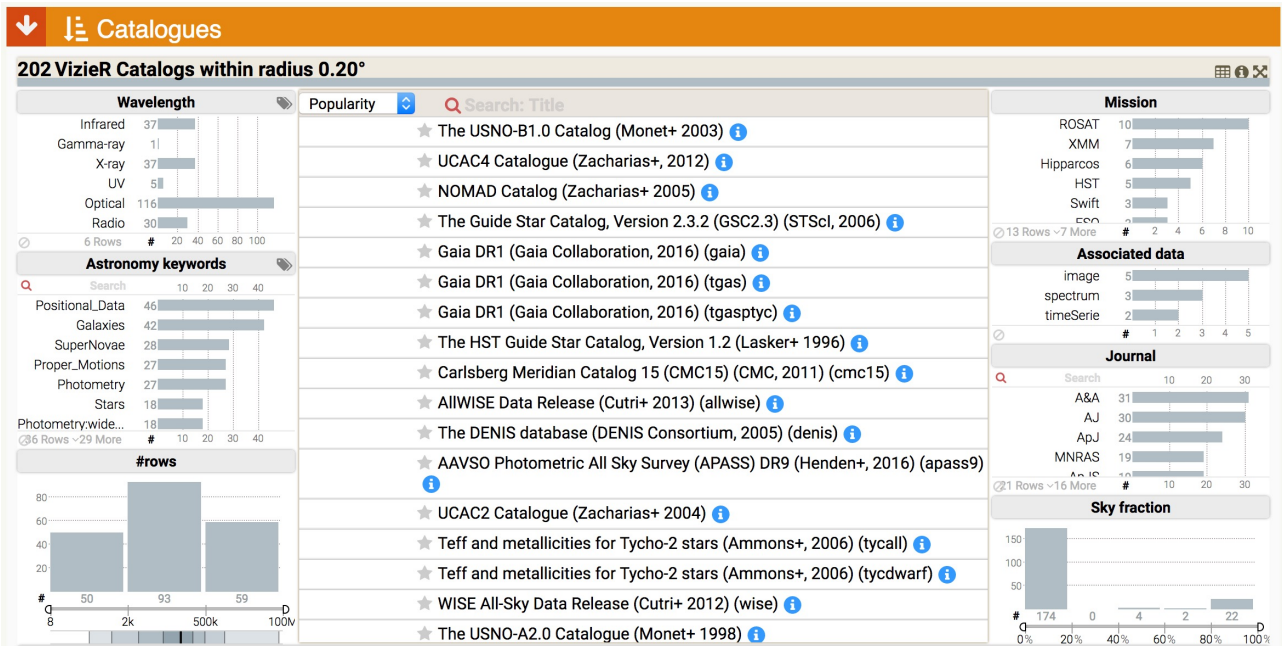


Figure 6: Result of the query for NGC4039 in the CDS Portal

- 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.

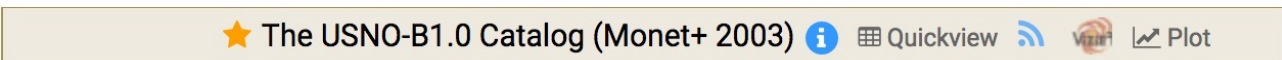


Figure 7: Selection of a VizieR Catalog on the CDS Portal.

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

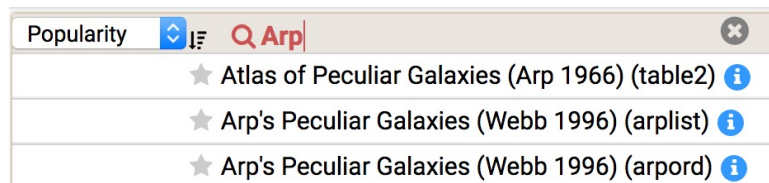



Figure 8: Looking for 'Arp' in the vizier catalogs.

- 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.

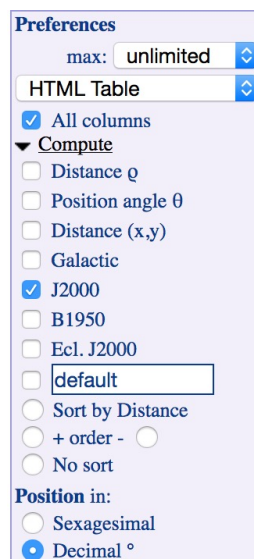


Figure 9: Preferences panel.


- 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	Set metadata	20/12/2016 at 15:43:44	VOTable csv tsv fits

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 '

Open the SERVER SELECTOR window via **File** → **Open** or by clicking the **File** icon  at the top left corner of the Aladin window or **CTRL+i**. The SERVER SELECTOR provides access to **Images**

servers on the left, **Catalog servers** on the right and to a range of services including **all VO** at the top.

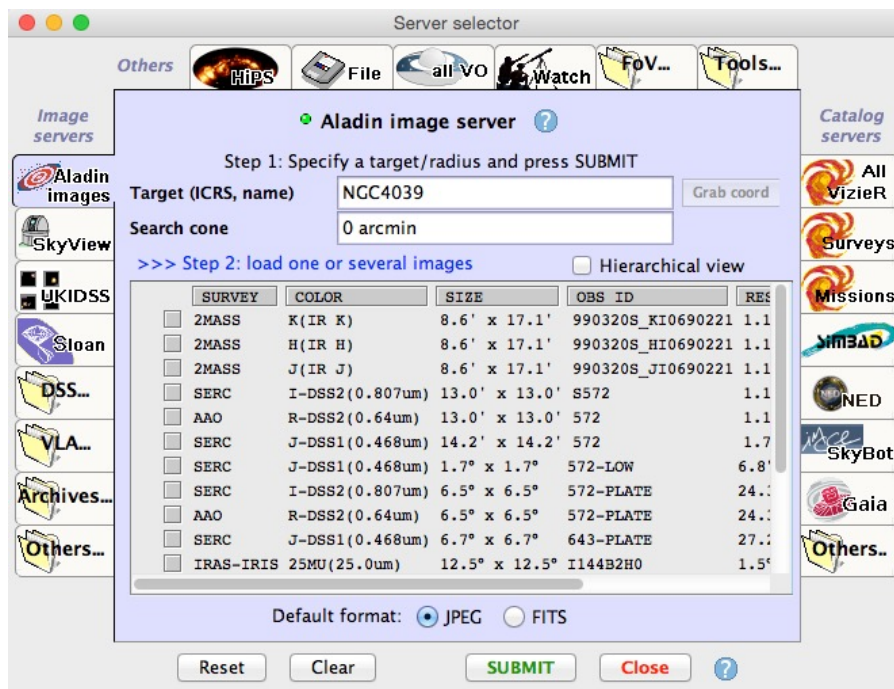












Figure 11: SERVER SELECTOR of the Aladin tool, **Aladin images** has been selected for a query on NGC4039

- Insert in the **Target** box, 'NGC4039' in the **Aladin images** tab of the **Image server** and click on **submit**.
- Select a 13'x13' DSS image from the list and load it (tick the box and **submit** again). Note that it loads as a plane into the stack on the right panel of the Aladin window.
- Make a contour map of the image using the **cont** button  next to the stack. Increase the number of contours to better represent the image.
- Overlay a SIMBAD plane showing only the galaxies by selecting the  tab of the **Catalog servers** in the SERVER SELECTOR and choosing **Galaxy** as the **Display filter**.
- Change the color 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. Note that this window can be detached with the icon .
- Select **2MASS J, H and K** bands images from the **Aladin images** tab in the SERVER SELECTOR window and construct a color image with the **rgb** tool .
- Select an image from the **Hubble Press Release images**:
 - **File** → **Load Astronomical Image** → **Others** → **Hubble Press Release Images**
 - or via the **Others** in the **Image servers** in the SERVER SELECTOR window.
- 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 below each plane . Note that you can move the location of the planes in the stack.
- Search the VO for data on NGC4039:
 - Use the **All VO** tab  in the SERVER SELECTOR to search for more images, catalogs and spectra.
 - Make a general query for data from all the VO services accessible via Aladin by clicking on **Submit**. When a number of results have returned, click on **Stop**.
 - Expand some of the nodes of the tree. Note how the Field of View from some services is displayed over the images in the Aladin image window.

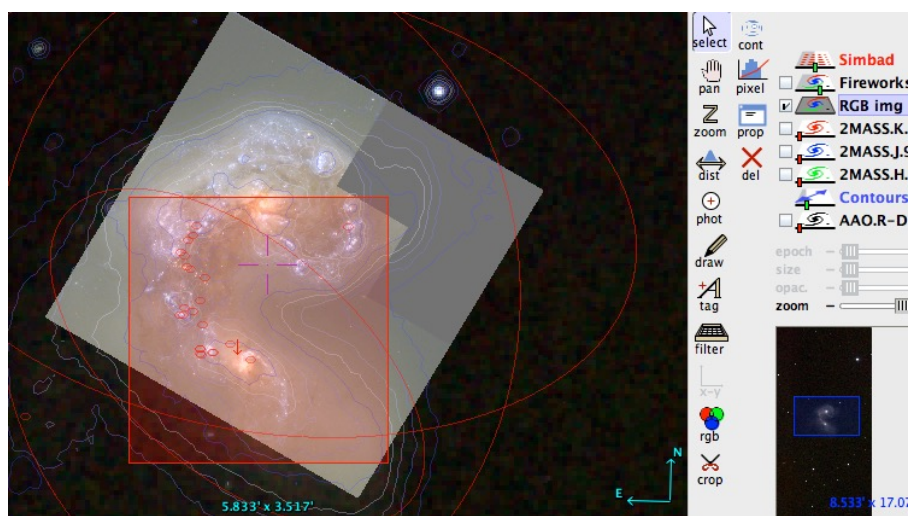


Figure 12: Results of all the above mentioned steps.

- To make a restricted search use the **Detailed List**. To do so, first **unselect all**, then choose the services you want to query (note that the **Filter** text box can be used to search the list), e.g.: 'Hubble Legacy Archive', 'Skyview Virtual Observatory', 'Chandra X-Ray Observatory Data Archive'.
 - **Submit** (bottom of the SERVER LIST) to load selected images.
 - Display the images in **multiview** mode and note that you can align all the images to the same orientation and scale using the **match** icon.
- 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.

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

- Browse the available surveys by clicking the **HiPS** (Hierarchical Progressive Survey, see <http://aladin.u-strasbg.fr/hips/> for more information) tab in the SERVER SELECTOR window.
- Select the **SDSS 9 colored (Image → Optical → SDSS)** and **GALEX All Sky Imaging Survey colored (Image → UV → GALEX)** surveys and **submit**.

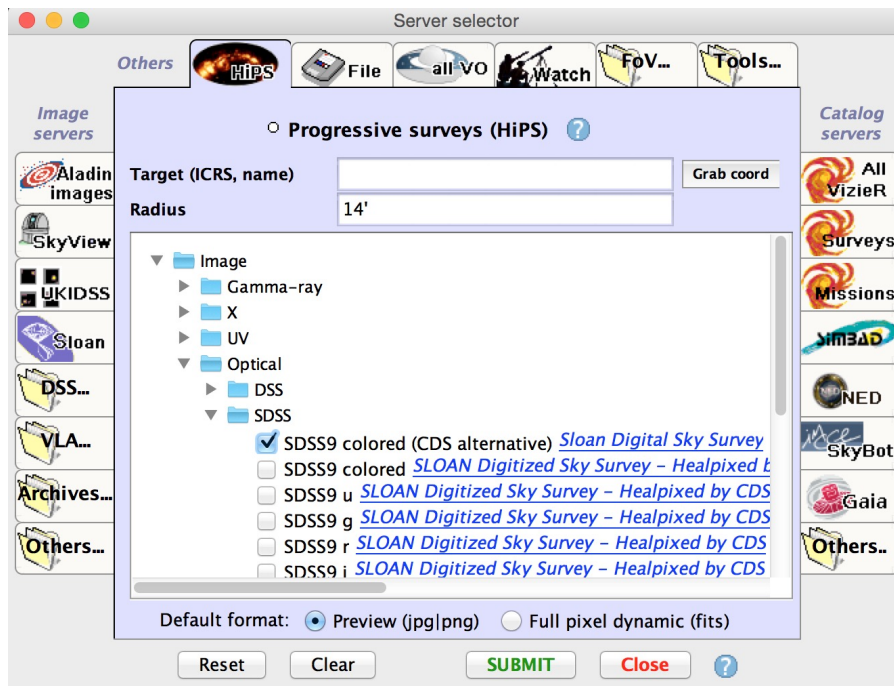




Figure 13: Selecting the SDSS 9 colored survey

- Turn on the coordinate **grid** , zoom out and use the **pan** tool  to explore the whole sky.
- Go into **multiview** mode and match the views so that they can be panned and zoomed together.
- Load the coverage map (MOC - Multi-Order Coverage map) of both the SDSS and GALEX surveys from the **properties** panel for each plane and click on **Coverage**. Zoom onto the edges of the surveys and note the way the MOC represents the coverage of the surveys.

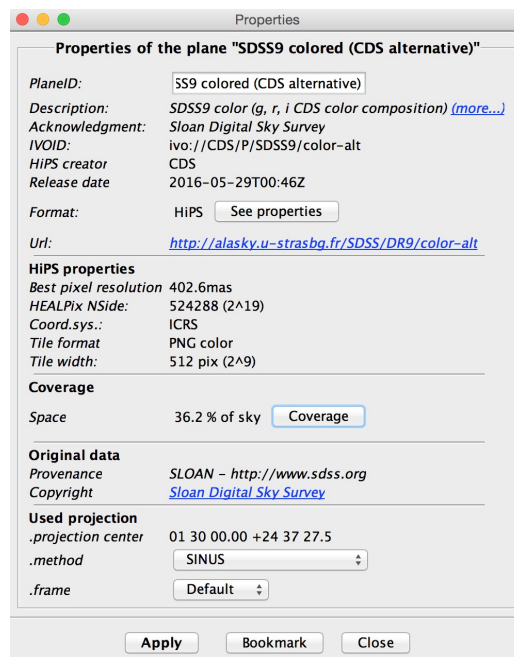


Figure 14: Displaying the coverage map

- Calculate the intersection of the coverage maps of the SDSS and GALEX surveys using in the menu the item **Coverage** → **Logical operations**.

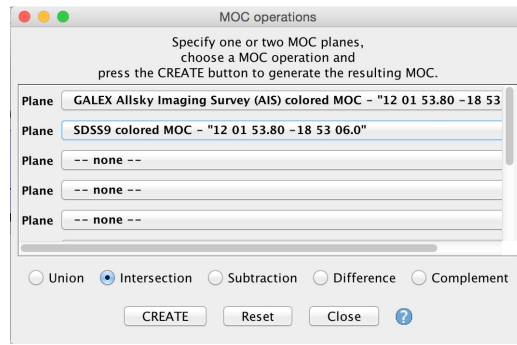


Figure 15: Building the intersection of the coverage maps

- Load the full Webb 1996 Arp catalog that you saved earlier. You can do this in one of the two ways:
 - **file** → **load**
 - drag and drop on the images
 Alternatively you can download again the catalog via the Vizier interface in the **Catalogue Servers** in Aladin.
- 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.

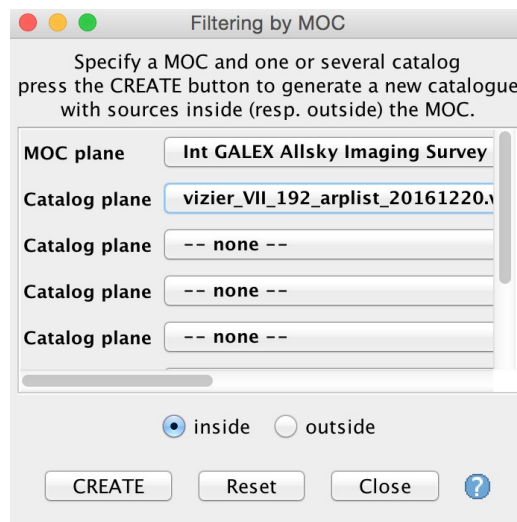

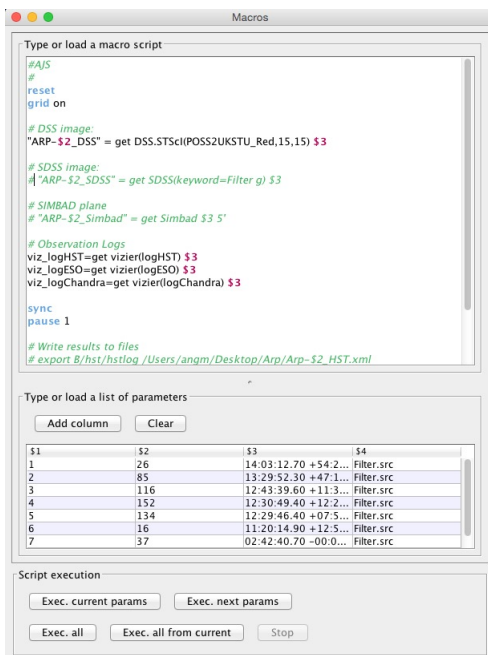


Figure 16: Filtering a catalog by a MOC

- 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 MOC filtered catalog is active in the stack (or other sources may also be filtered). An easy way to ensure that is to delete every catalog not useful anymore.
 - 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.

- 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.



```
#AJS
#
reset
grid on

# DSS image:
"ARP-$2_DSS" = get DSS.STScI(POSS2UKSTU_Red,15,15) $3

# SDSS image:
# "ARP-$2_SDSS" = get SDSS(keyword=Filter g) $3

# SIMBAD plane
# "ARP-$2_Simbad" = get Simbad $3 5'

# Observation Logs
viz_logHST=get vizier(logHST) $3
viz_logESO=get vizier(logESO) $3
viz_logChandra=get vizier(logChandra) $3

sync
pause 1

# Write results to files
# export B/hst/hstlog /Users/angm/Desktop/Arp/Arp-$2_HST.xml
save /Users/angm/Desktop/Arp/Arp-$2_chart.png
backup /Users/angm/Desktop/Arp/Arp-$2_stack.aj
#adapt ~~~~~ to your own path
```

Figure 19: MACROS window & Arp_script.ajs