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An introduction to the CDS services and tools

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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:

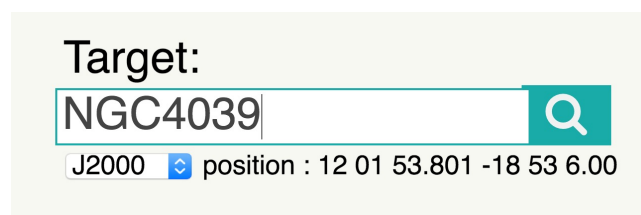


Figure 1: Query for NGC4039 in the CDS Portal

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

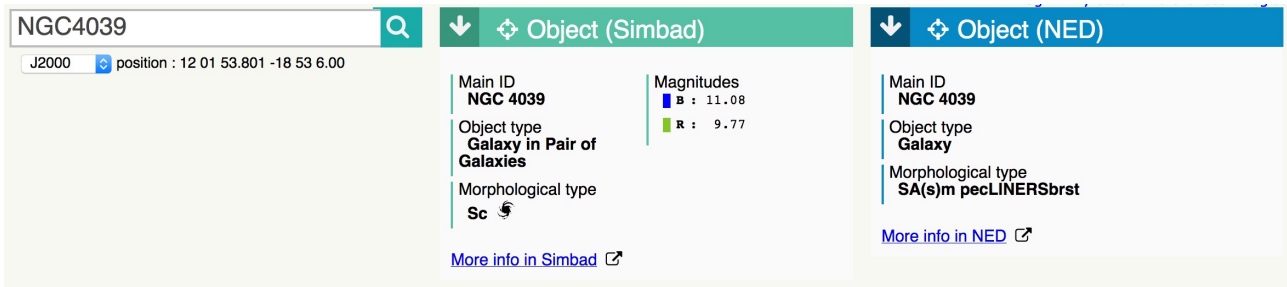


Figure 2: Result of the query for NGC4039 in the CDS Portal

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

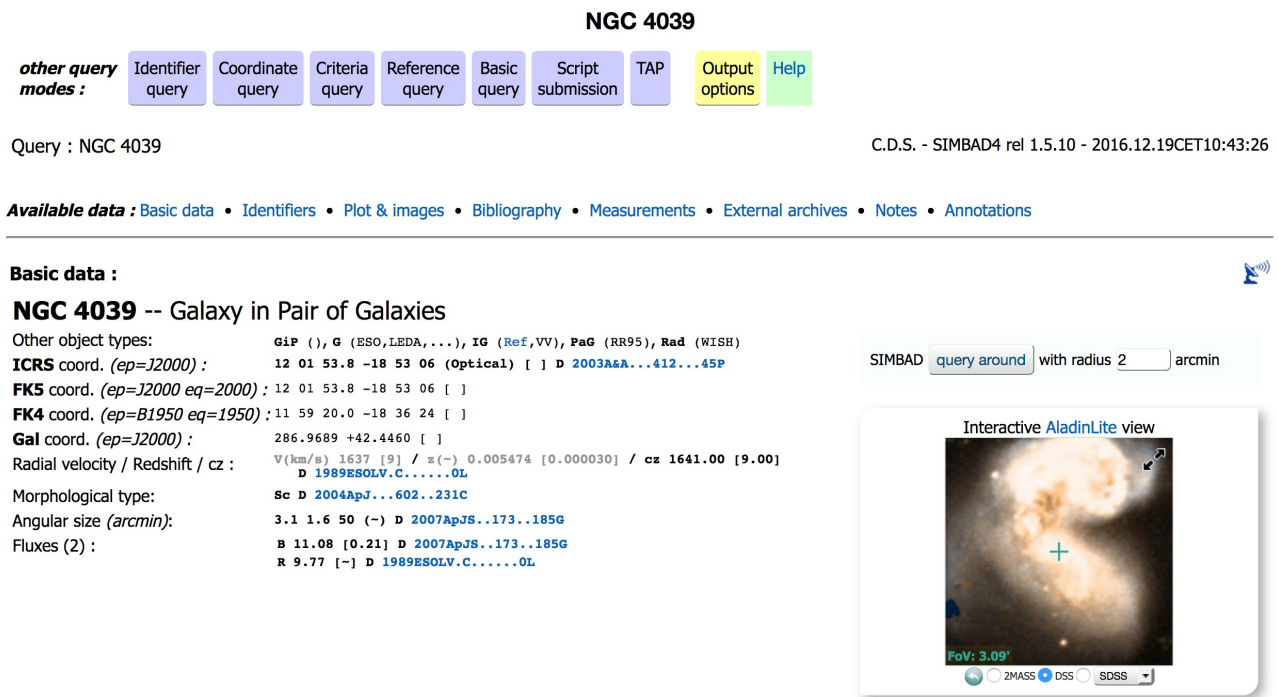




Figure 3: Result of the query for NGC4039 in SIMBAD.

- 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 include Wavelength (Gamma-ray, X-ray, UV, Optical, Infrared, Radio, Gas-line) and Resolution (Low, Medium, High). The search results table is as follows:

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 %

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

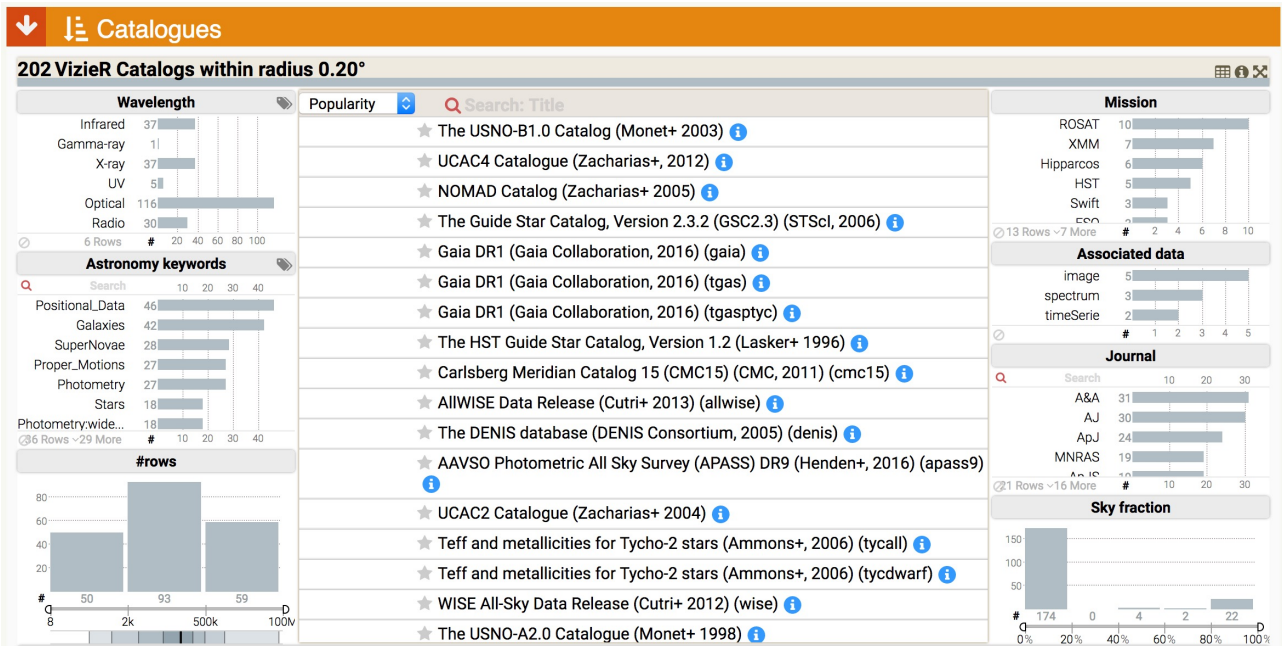


Figure 6: Result of the query for NGC4039 in the CDS Portal

- 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 catalogue, it is then possible to visualize it (either quickly or in vizier), to plot it and/or to send it to the Aladin tool.

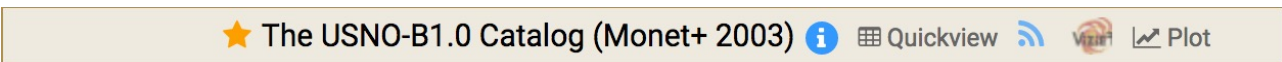


Figure 7: Selection of a VizieR Catalog on the CDS Portal.

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

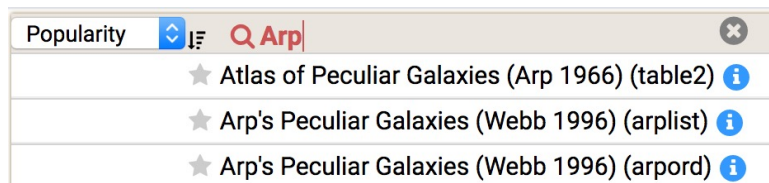



Figure 8: Looking for 'Arp' in the vizier catalogs.

- 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.

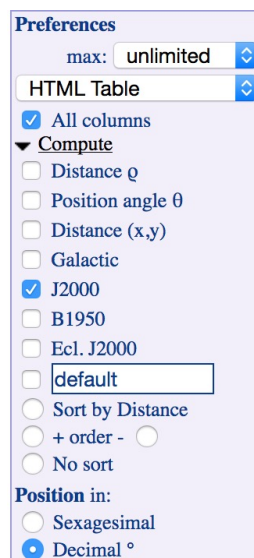


Figure 9: **Preferences** panel.

- 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 Server Selector**. The SERVER SELECTOR provides access to **Images servers** on the left, **Catalog servers** on the right, and to a range of services at the top.

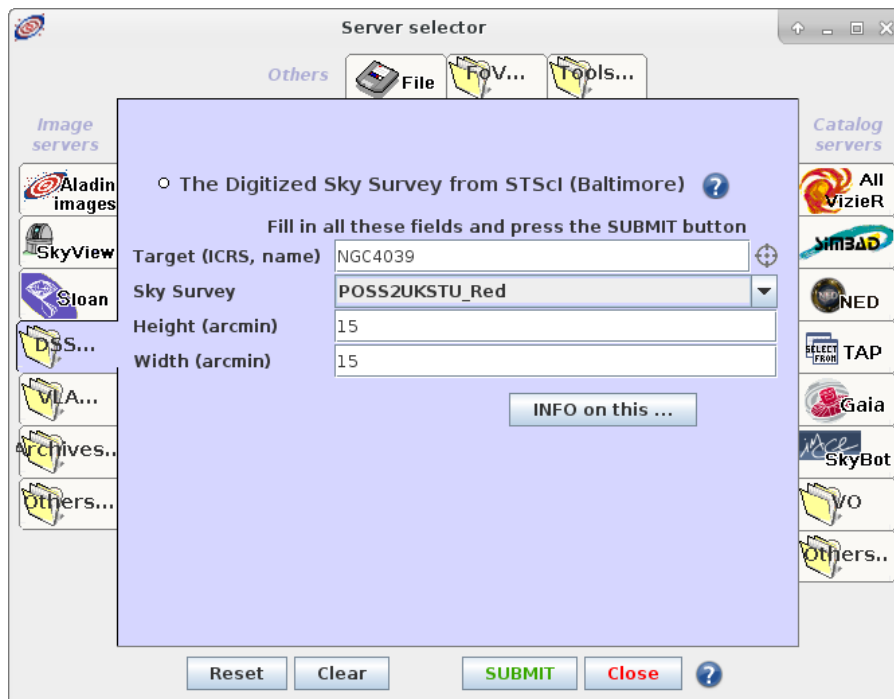










Figure 11: SERVER SELECTOR of the Aladin tool, **Digitized Sky Survey from STScI** has been selected for a query on NGC4039

- Insert in the **Target** box, 'NGC4039' in the **DSS from STScI** tab of the **Image server**, leave the rest at it is and click on **submit**. Note that it loads as a plane into the stack on the right panel of the Aladin window, which includes a 15'x15' POSS2UKSTU_Red image and a catalogue plane. Move the location of the image plane to the top of the stack by dragging it. Remove the others.
- 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 an image from the **Hubble Press Release images**:
 - 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 .
- Search the VO for data on NGC4039:
 - Use the **Data discovery tree** panel at the left of the main window. Use this panel to browse, to filter, and to select data collection that you want to load, to display, and to process in Aladin.

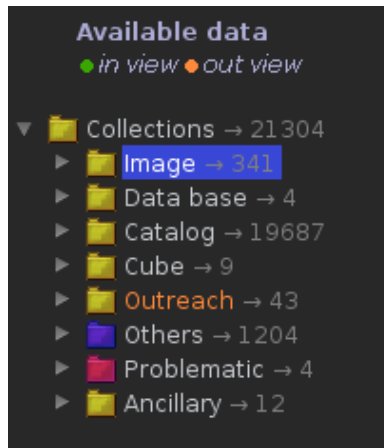



Figure 12: Data discovery tree

- Expand some of the nodes of the tree. It appears in green when there are available data in the field of view, in orange when there are not available data in the field of view, and in white when there are data in same services but there are not in others.
- To make a restricted search use the **select** box or the **from** menu. You can also use the **Data discovery tree filter** .

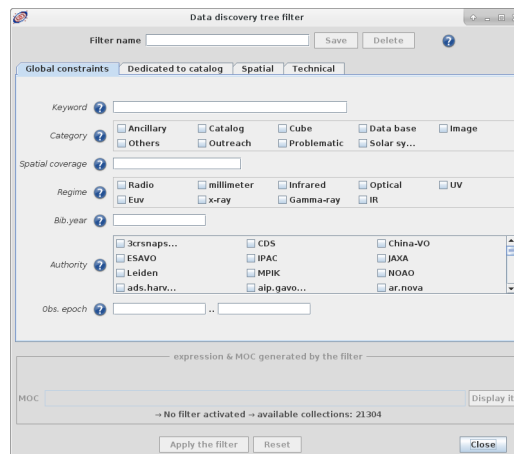


Figure 13: Data discovery tree filter


- Choose the services you want to query. Note that the **Data discovery tree filter** box can be used to search the list. For example, introduce ‘Hubble Legacy Archive’ in the **Global constrain** → **Keyword**, or ‘Skyview Virtual Observatory’, ‘Chandra X-Ray Observatory Data Archive’, etc.

- 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

- Select the **SDSS 9 colored** and **GALEX All Sky Imaging Survey colored** from the top bottom menu.

Figure 14: Selecting the colored surveys

- Turn on the coordinate **grid (Overlay → 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.

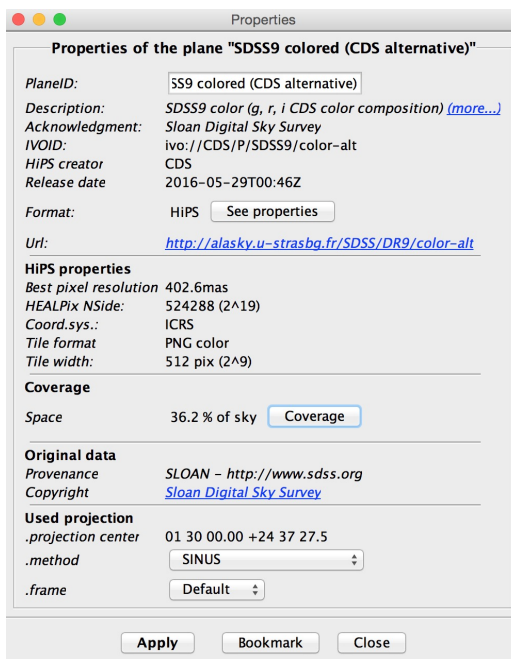


Figure 15: Displaying the coverage map

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

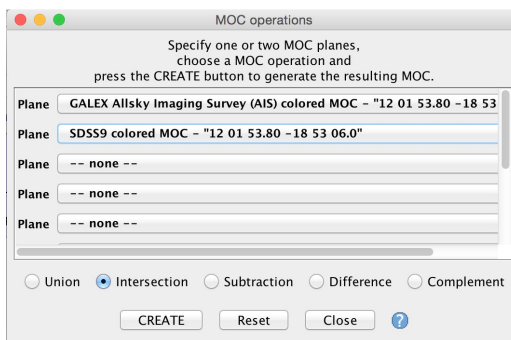


Figure 16: Building the intersection of the coverage maps

- 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 again the catalog via the Vizier interface in the **Catalogue Servers** in the SERVER SELECTOR window.

- 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.

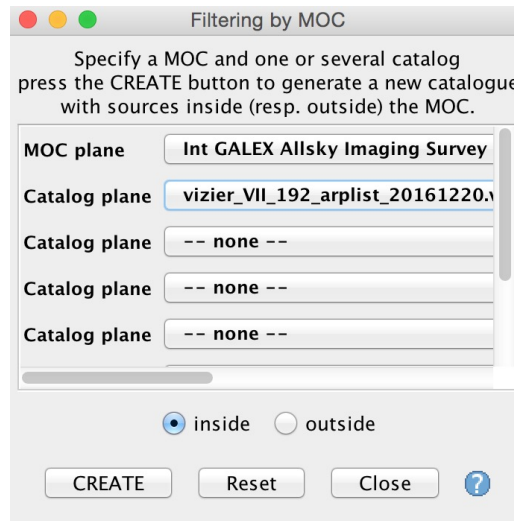


Figure 17: Filtering a catalog by a MOC


- 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.



Figure 18: Filtering a catalog by magnitude

- Make thumbnails of the selected brightest sources: **Tools** → **Thumbnail view generator**

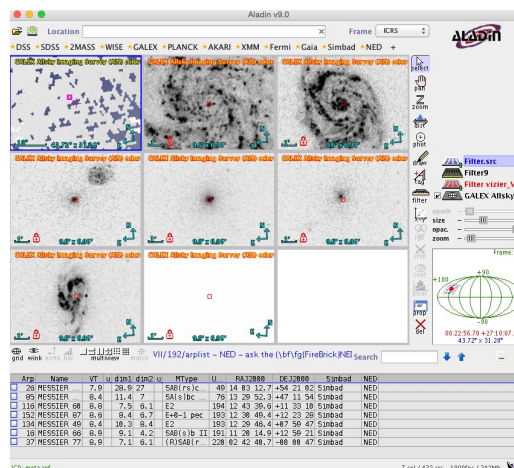


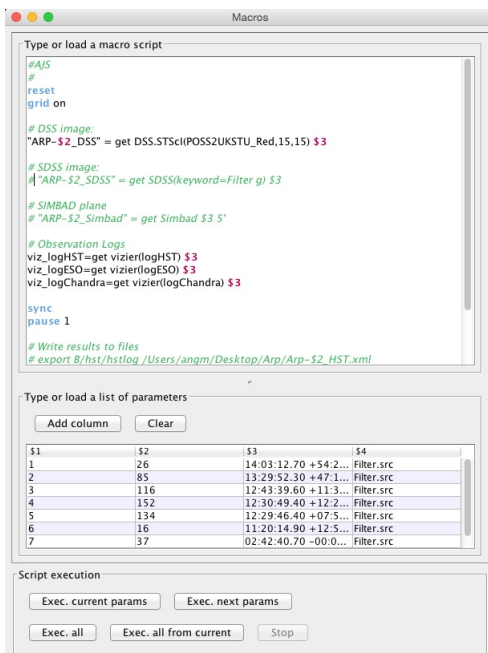
Figure 19: Thumbnails

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 to your computer. The content of the script is shown in Figure 20
- 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.



The screenshot shows the MACROS window with a script editor and a parameters table. The script contains commands for setting parameters, downloading images, and saving results. The parameters table has columns \$1 through \$4 and contains 7 rows of data.

```

#AJ$
#
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

```

\$1	\$2	\$3	\$4
1	26	14:03:12.70 +54:2...	Filter.src
2	85	13:29:52.30 +47:1...	Filter.src
3	116	12:43:39.60 +11:3...	Filter.src
4	152	12:30:49.40 +12:2...	Filter.src
5	134	12:29:46.40 +07:5...	Filter.src
6	16	11:20:14.90 +12:5...	Filter.src
7	37	02:42:40.70 -00:0...	Filter.src

```

#AJ$
#
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 20: MACROS window & Arp_script.ajs