CDS Tutorial

The Antennae and other Interacting Galaxies

Search for information on NGC 4039 in the CDS Portal

- Open the CDS Portal http://cdsportal.u-strasbg.fr/ and make a query for NGC 4039.

▼ The result provides an overview of the information and data available for this object in the 3 CDS services.
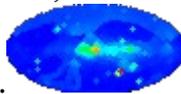
- SIMBAD - Identifiers, Basic Measurements and links to the Bibliography

- Aladin - Images. A DSS (Digitized Sky Survey) image is shown, click below the image to obtain a colour version.

- Vizier - Catalogues. The list of catalogues is sorted by Local Density, but can also be sorted by Name, Wavelength or Popularity. Note the sky coverage maps for each catalogue on the right.

▼ Click on "More SIMBAD data" to see the full SIMBAD information on this object. Note the list of object type codes. These classifications are drawn from the literature, and are stored in SIMBAD using an 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 NGC 4039 is 'Galaxy in Pair of Galaxies' (GiP). Use the 'siblings' button : 83 (in the Hierarchy section) to identify the name of the other galaxy in this interacting pair. Sorting by the number of references (#ref) can help bring out the most important ones. What is the separation in arcminutes?

- Use the References section to find the earliest listed reference in the literature to this object

▼ Return to the CDS Portal page, and go to the Vizier catalogues section

- The Antennae is listed in the Arp Atlas of Peculiar Galaxies.

- Filter the Vizier catalogues returned for NGC 4039, by typing 'Arp' into the Filter box in the Vizier part of the CDS Portal.

- Click on 'Query' of the Webb 1996 catalogue to take you to the Vizier detailed query page

- Note that this catalogue contains two tables.
  Select the VII/192/arplist table by clicking on it.

- Make a first query on this table by clicking 'submit', and examine the output as html

▼ Modify the query to add extra coordinate columns in decimal degrees, and to obtain the

whole catalogue

- remove the restriction on searching only around NGC 4039 by clearing the target name at the top of the form (click on "show the target form", if hidden)
- add extra coordinate columns in decimal degrees by checking the J2000 and decimal boxes in the Preferences window on the left (expand the "compute" section)
- change the maximum number of rows returned to 'Unlimited' in order to get the whole catalogue
- then 'submit' again
- When you are satisfied with the changes, select save to 'CDS Portal' in the Preferences window and submit again.
- The saved file is now shown in your personal user space on the CDS Portal.
- Save a copy from the portal to your desktop in VOTable format, it will be used later in the tutorial.

▼ Search for data on NGC 4039 in Aladin
  - Open Aladin with 1GB of memory allocated to the java virtual machine java -Xmx1024m -jar Aladin.jar
  - ▼ Open the Server Selector window via File>Open, or by clicking the File icon 📂 in the top left of the Aladin window
    - The Server Selector provides access to Image servers on the left, catalogue servers on the right, and to a range of services including 'all VO' along the top
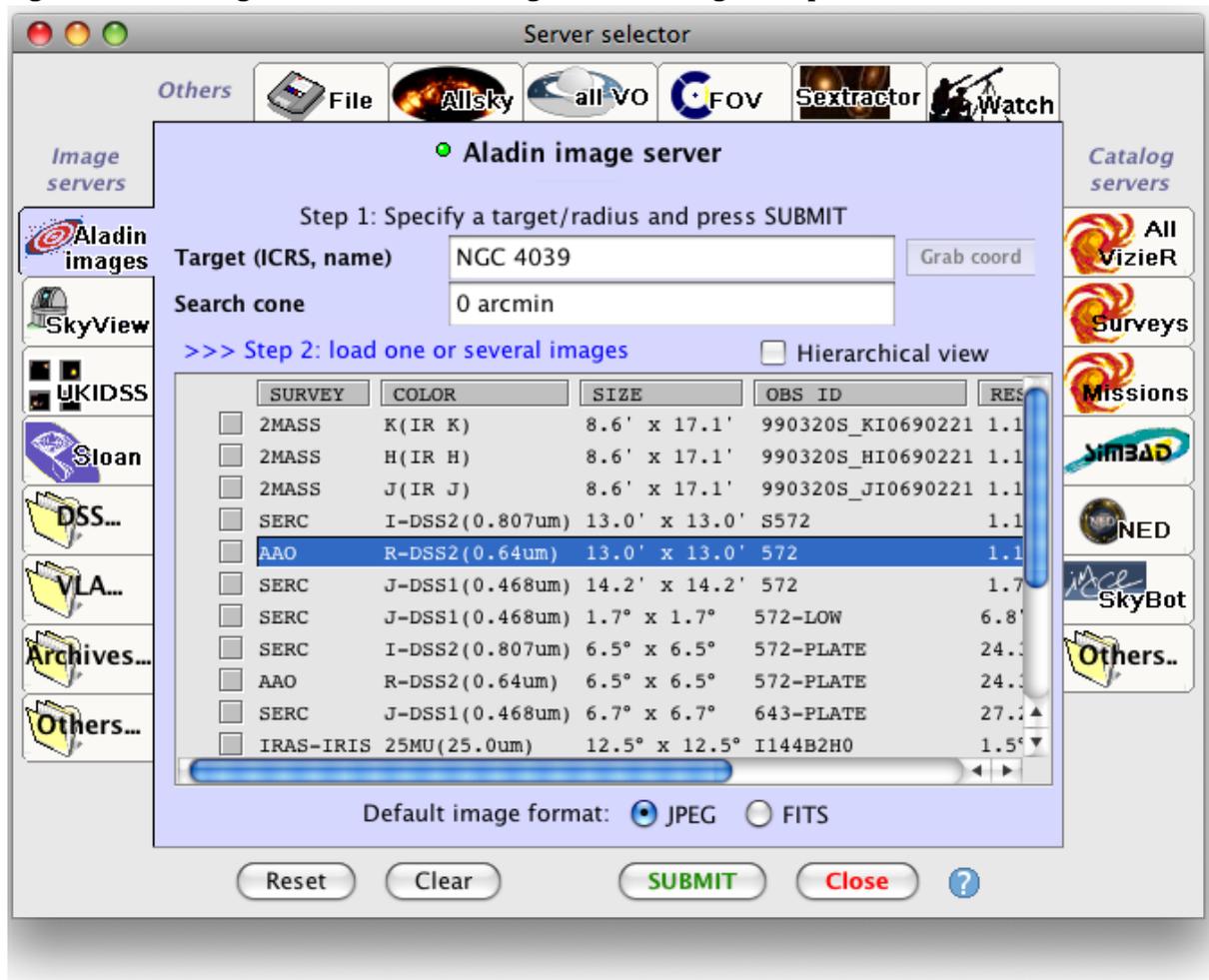
  - Insert the target name NGC 4039 in the 'Aladin images' server tab and press submit
  - Select a 13'x13' DSS image from the list and load it. Note that it loads as a plane into 'stack' on the right panel of the Aladin window.

- Make a contour map of the image using the 'cont' icon 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 'SIMBAD Catalogue' server tab and choosing the 'Galaxy' as the Display filter.
- Change the colour of the SIMBAD plane using the plane Properties (be sure to have selected the correct plane before changing its proprieties)
- 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 band images from the Aladin images tab in the server selector window, and construct a colour image with the 'rgb' tool (red -> J band, green -> H band, blue -> K band).
- Select an image from the Hubble Press Release images (File>Load Astronomical Image>Others>Hubble Press Release Images, or via the 'Other' 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 icons 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 opacity slider at the bottom of the stack. Try moving the location of planes in the stack.

▼ Search the VO for data on NGC 4039
- Use the 'All VO' tab in the server selector to search for more images, catalogues and spectra

▼ Select a number of services to query from the 'Detailed List'. To do this, first 'unselect all', then choose the following services (note that the 'Filter' text box can be used to search the list).
- Multimission Archive at STScI (MAST)
- Chandra X-ray Observatory Data Archive
- The XMM-Newton Science Archive Interoperability System
- ST-ECF Hubble Legacy Archive Images
- Submit to send the query to the selected services. When the selected services have returned results, press 'stop'.
- Expand some of the nodes of the tree. Note how the Field of View outlines of the data from some services is displayed over the images in the Aladin image window
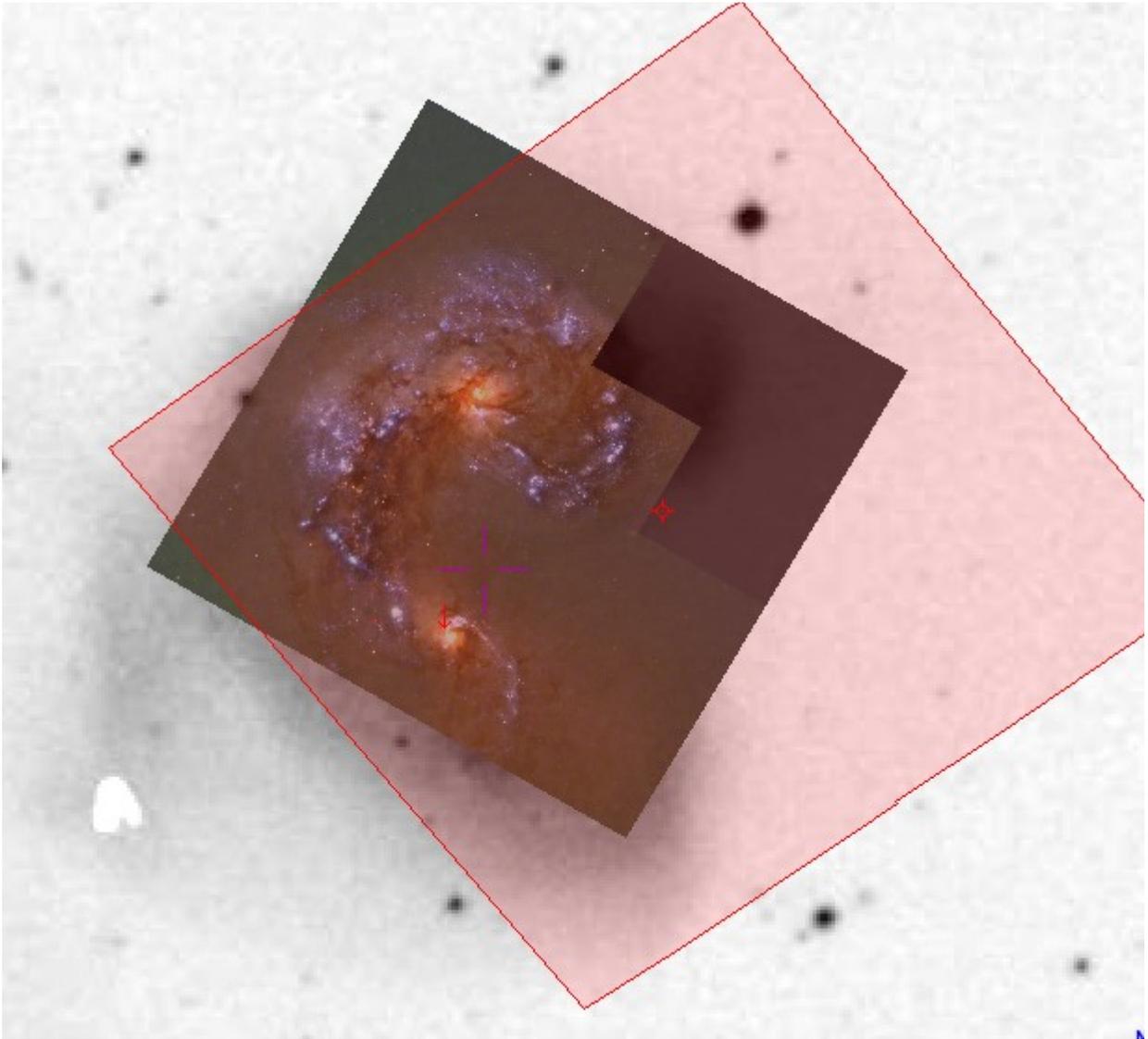
- ▼ Select a few images:
  - * one of the 7.8'x7.8' GALEX NUV or FUV images from MAST
  - * one of the 8.4'x8.4' Chandra images
  - * one of the XMM EPIC images
  - * one of the HST images from the ST-ECF Hubble Legacy Archive Images
  - * Submit to load the selected images
  - * Display the images in multiview mode, and align all the images to the same orientation and scale using the match icon below the image window
- * Back up the complete stack (File -> Backup the stack) and delete all planes, in order to save memory.

- ▼ Go to All Sky mode by clicking 'All Sky' in the Server Selector window, and selecting Image>Optical>DSS> DSS coloured
  - * Switch to a single view mode , and turn on the coordinate grid
  - * Zoom out to see the full sky, and use the pan tool to explore the whole sky
  - * Load and the full Webb 1996 Arp catalogue that you saved earlier (by file>load, or by drag and drop, or download again via the Vizier interface in the Catalogue Servers in Aladin)

- Detach the measurements window, and zoom into one of the sources.
- Select all the sources in the Webb 1996 Arp catalogue (right click on the catalogue in the stack)
- Click on the rows of the table one by one to inspect the selected galaxies at the same zoom level.
- Try the SIMBAD progressive catalogue, available from the AllSky tab in the server selector (Also File>All Sky> Progressive Catalogue)

▼ Collect information on a sample of galaxies using Aladin
  ▼ Select the brightest galaxies in the catalogue by using a filter:
    - Add a filter to the stack using the filter tool
    - Choose the 'Show brightest stars' pre-defined filter, and edit it by going into 'Advanced mode' and modify it to select objects with magnitude < 9 (Note that the VT column is automatically identified with the Unified Content Descriptor 'phot.mag*') and apply the filter.
    - Make sure that only the Arp catalogue is active (otherwise sources in other planes may also be filtered)
    - In the filter Properties (click on the 'prop' icon next to the stack), create a new plane with consisting only of the sources selected by the filter by clicking the 'export' button
    -
    - Also save the selected subset of the Arp catalogue as a VOTable by using File>Export Planes
   ▼ Optional - Alternative ways to select objects from the catalogue using constraints
      - Alternative 1: Select all the sources in the catalogue, and sort them based on the VT column by clicking on the column name at the top of the table in the measurements window. Tag the brightest sources by checking the boxes, and save the tagged sources as a new plane
      - Alternative 2: Open TOPCAT and send the catalogue plane to TOPCAT by right-clicking the catalogue plane and selecting 'Broadcat selected tables to > TOPCAT'. Use TOPCAT to make a subset of the brightest sources and send the result back to Aladin
      - Alternative 3: From the Vizier web pages, extract only the brightest sources using a constraint on the VT column. Save the resulting file and then load it into Aladin (or send it directly from the Vizier web page to Aladin via SAMP [on Mac this only works for OS X > 10.6] – "send to VO tools" in the upper right corner of the page)
  - Are any of these bright galaxies observed in the Sloan Digital Sky survey? Try comparing the catalogue subset with the SDSS density map, or the SDSS all sky image
  - Delete all the planes except the bright galaxy subset

▼ Use the Aladin script to obtain DSS and SDSS images with HST, Chandra, ESO observation log overlays for each of the selected bright galaxies
  - Open the Aladin macro controller Tool>Macro controller
  - Load the script (Arp_script.ajs) into the macro controller (Tools>Macro Controller then File>Load script, or cut and paste the script into the top panel of the Macros window)
  - Create a folder called 'Arp' and edit the script to insert a sensible path for saving the output files, e.g. ~/Desktop/Arp
  - Select all the sources in the bright galaxies catalogue (right click on the plane, and 'Select all objects in selected planes')
  - In the Macros window, File>Use selected plane sources as params. Note how the catalogue columns are shown as parameters

which can be referred to as $1, $2, etc. within the script
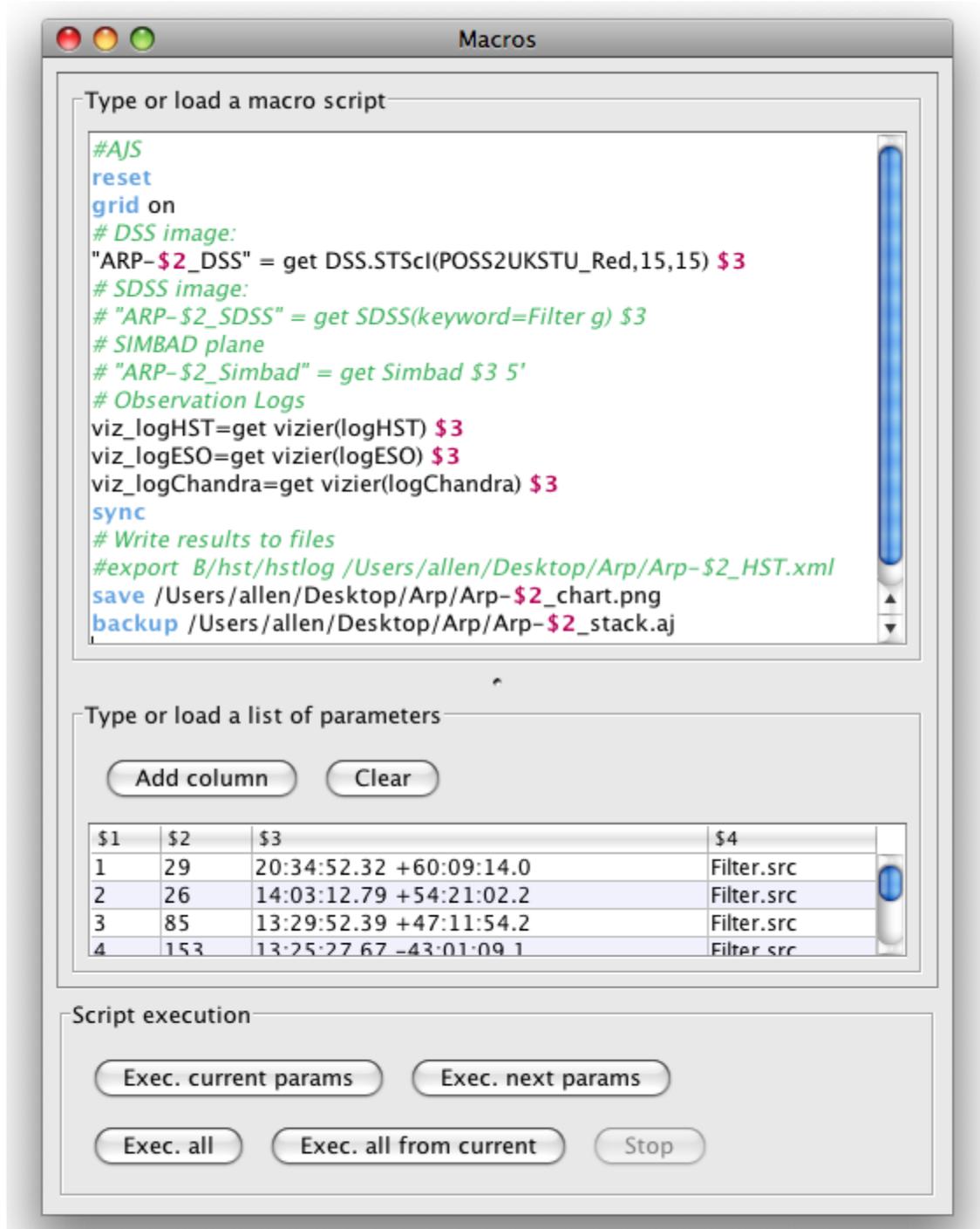
- Click on the first row of the parameters table and execute the script for this row 'Exec current params'
- Optional - add SDSS image: remove the # to enable download of a SDSS g-band image for each source. Note that this results in an 'Data not available' message for objects not covered by SDSS
- Inspect the output in the Aladin window, and also the files written in the Arp folder
- Execute the script for all sources by 'Exec all from current'
- Note that the saved 'stack' files, can simply be dragged and dropped into Aladin for inspection