



VOV. Aladin



NOTE: This tutorial is based on Aladin v10. The content here described should be compatible with Aladin v11.

All VOV video and pdf tutorials are available [here](#).

I) Science case: **Discovery of Brown Dwarfs mining the 2MASS and databases with Aladin.**

- **Scientific background:** Brown dwarfs are objects occupying the gap between the least massive stars and the most massive planets. They are intrinsically faint objects so their detection is not straightforward and, in fact, was almost impossible until the advent of global surveys at deep optical and near-infrared bands. We propose here to mine the 2MASS-PSC and SDSS-DR12 databases to identify T-type brown dwarfs through an appropriate combination of colours in the optical and the infrared, an approach that perfectly fits into the Virtual Observatory.
- **Workflow:** In this tutorial we will explore how to perform the download of data, cross-match of catalogs, sources selection and filtering with Aladin Sky Atlas.
 - Launch Aladin: Open a terminal and type: `java -jar Aladin.jar &`
 - **Discovery:** Search 2MASS-PSC and SDSS-DR12 sources around RA:08h 30m DEC:01d 30m with a 14 arcmin radius.
 - On top of the central panel, click “2MASS” just below the **Command** box. This will load all the sky observed by 2MASS.
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type “2MASS”. The discovery tree will open and show the available catalogs.
 - Click in the “2MASS All-Sky Catalog of Point Sources” photometric catalog. A new window will pop up.
 - Write 08:30:00 +01:30:00 14' in the empty box next to the **Load** button and click on **Load**. Aladin will load in the main window the 2MASS plane with 683 sources (you can see the number of sources by placing the cursor on the name of the plane in the right panel).
 - Repeat the same steps for the SDSS-DR12 catalog. Select the SDSS-DR12 catalog in the *V – Combined data* folder. A new plane will be loaded with 12404 sources.

- **Crossmatching:** Find common sources in 2MASS-PSC and SDSS-DR12 catalogs.
 - In the Aladin main window: *Catalog* → *Cross match objects*.
 - First catalog: 2MASS-PSC (CDS/II/246/out). Second catalog: SDSS-DR12 (CDS/V/147/sdss12). Default threshold (4 arcsec) and bestmatch option.
 - Click on **Perform cross-match**. A new plane ("XMatch") with 679 sources will be loaded.

- **Filtering:**
 - In this step we will select point sources using the SDSS flag (class=6). "class" is a column of the SDSS- DR12 catalog that provides information on the type of object (3=galaxy, 6=star).
 - Click on the "XMatch" plane. The name of the plane would appear highlighted.
 - In the Aladin main window: *Catalog* → *Create a filter* (or click on the **Filter** button on the right panel of Aladin main window) → *Advanced mode* → *Columns* → *Columns in loaded catalog*. A new window ("Available columns") will pop up. Select the "class_tab2" column from the Xmatch plane. The label of this column will be copied to the "Properties" window.
 - Complete the filter condition. It should be $\{\text{class_tab2}\}=6$ {draw}
 - Click on **Apply**. Then click on **Export** to create a new plane with the filtered sources.
 - A new plane "Filter.src" will be loaded in the Aladin main window. It contains 649 sources.
 - If you wish you can modify the colour and/or the shape of the sources of this new plane by doing the following:
 - Click on the "Filter.src" plane.
 - Click on the **prop** button on the right panel of Aladin main window. A new window ("Properties") will pop up.
 - Select the color and /or shape you wish.
 - Click on **Apply**.
 - Now, let's select sources with no detection in the u,g SDSS bands ($u > 22.0$ & $g > 22.2$, since brown dwarfs are cool objects not detected in the blue SDSS bands) and sources fulfilling the brown dwarf criteria provided by Burgasser et al. (2000, Apj, 531, L57): $((J-H) < 0.3 \ \&\& \ (H- K) < 0.3)$.
 - Click on the icons on the left of the names of the planes to hide them all but "Filter.src".
 - Click on the "Filter.src" plane.

- Repeat the same steps as in the previous filter. The filter condition now should be:
 - $\{\text{umag_tab2}\} > 22.0 \ \&\& \ \{\text{gmag_tab2}\} > 22.2 \ \&\& \ \{\text{Jmag_tab1}\} - \{\text{Hmag_tab1}\} < 0.3 \ \&\& \ \{\text{Hmag_tab1}\} - \{\text{Kmag_tab1}\} < 0.3 \ \{\text{draw}\}$
 - Click on **Apply**. Then click on **Export** to create a new plane with the filtered sources. A new plane “*Filter.src~1*” will be loaded in the Aladin main window. It should contain 1 source (RA_2MASS:127.703265deg; DEC_2MASS:1.475320deg). NOTE: You will get information on the source by clicking on it.
- **Analysis:** We can now use Simbad to confirm the brown dwarf nature of this object:
 - Place the cursor on the source.
 - After a few seconds a small window with basic information of the object will appear. If it does not, click on the right mouse button and select *Astronomical object exploration (Simbad & Vizier)*.
 - By clicking on the object name (in blue) a new tag will open in your browser with the information available in Simbad for this particular object.

NOTE: Before running each of the following examples, it is convenient to remove all loaded catalogs and images by clicking the right mouse button over any of the planes in the panel to the right in the main window and selecting **Delete all panels**.

II) Other functionalities:

- **CDS-X match:** This option is suitable when we want to cross-match a catalog of sources with another VO catalog in different sky regions or when the region to load is too large, for example.
 - We will repeat the exercise described in the *Discovery* section of the science case using this time the CDS-X match option.
 - Load 2MASS-PSC sources around RA:08h 30m DEC:01d 30m with a 14 arcmin radius as described above. For clarity, the steps are repeated here:
 - On top of the central panel, click “2MASS” just below the **Command** box. This will load all the sky observed by 2MASS.
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type “2MASS”. The discovery tree will open and show the available catalogs.
 - Click in the “2MASS All-Sky Catalog of Point Sources” photometric catalog. A new window will pop up.
 - Write 08:30:00 +01:30:00 14’ in the empty box next to the **Load** button and click on **Load**. Aladin will load in the main window the 2MASS plane with 683

sources (you can see the number of sources by placing the cursor on the name of the plane in the right panel).

- Cross-match the 2MASS catalog loaded in the previous step with SDSS-DR12 in an alternative way:
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type "SDSS DR12". The discovery tree will open and show the available catalogs.
 - Select the SDSS-DR12 catalog in the *V – Combined data* folder. A new window will pop up.
 - Select **by CDS-X match** and click **Load**. A new plane will be loaded in the main window with 679 sources resulting from the cross-match between 2MASS and SDSS-DR12. Note: In the pop up window, the previous to the last symbol on the bottom right corner of the SDSS-DR12 window opens a new window where the configuration parameters of the cross-match can be changed.
- **MOC** (Multi-object coverage). Used to describe sky regions (e.g. footprints) and provides a very fast mechanism to perform operations (union, intersection,...) between them.
 - How to obtain the sky coverage of SDSS DR12:
 - On the left panel of the Aladin window, click on the **select** box located in the bottom corner and type "SDSS DR12". The discovery tree will open and show the available catalogs.
 - Select the SDSS-DR12 catalog in the *V – Combined data* folder. A new window will pop up.
 - Select **coverage**, deselect **in view** and then click on **Load**. The footprint of the SDSS-DR12 catalog will be loaded in the main window.
 - Click on the "CDS/V/147/sdss12 MOC" panel. On top will appear the sky coverage: 14520 sq. deg., 35.198% of the sky.
 - How to obtain the region of the sky in common between SDSS DR12 and UKIDSS Large Area Survey9 (LAS9):
 - Repeat the same steps described to obtain the SDSS-DR12 MOC.
 - Repeat the same steps to obtain the UKIDSS LAS9 MOC.
 - **Coverage** → **Logical operations**. A new window will pop up.
 - Select the CDS/V/147/sdss12 MOC and the CDS/III/319/las9 MOC and choose **Intersection**. Click on **Create**. A new plane with the coverage of the intersection of both MOCs will be loaded in the main window with a sky coverage of 3654 sq. deg and 8.585% of the sky.

■ **Arithmetic operations** between images.

- *File* → *Open server selector*. A new window will pop up.
- On the left hand side, select *DSS label* and choose *DSS from ESO*.
- Write LDS 1201 in the **Target (ICRS, name)** box and select *DSS2-red – POSS2UKSTU_Red* in the drop down of **Sky Survey**. Click on **Submit**. The corresponding image will be loaded in the main window.
- In the same Server selector window, select *DSS1 – POSS1_Red and UKSTU_Blue* and click on **Submit**. The corresponding image will be loaded in the main window.
- *Image* → *Arithmetic operation*. A new window will pop up.
- Select the previous loaded images and chose **Subtraction**. Then click on **Create**. A new plane with the subtracted image will be loaded in the main window. In this case, a high proper motion binary system lies in the center of the image and the position of the components of the system at the epochs of the selected images can be clearly seen.

■ **RGB builder**. Compose an RGB image with Aladin.

- Repeat the first four steps in the example above.
- *Image* → *RGB image builder*. A new window will pop up.
- Select the two previous loaded images and click on **Create**. A new image with the resulting composed image will be loaded in the main window. In this case, a high proper motion binary system lies in the center of the image and the position of the components of the binary at the epochs of the selected images can be clearly seen. NOTE: Although the **RGB image builder** is meant to build a three color composed image (red, green and blue), it is also able to build it with only two images, as noted in this example.

■ **Blink/movie** using images with Aladin.

- Repeat the first four steps in the example above.
- *Image* → *Blink/movie generator*. A new window will pop up.
- Select the previous loaded images and click on **Create**. A new plane with the resulting movie will be loaded in the main window. On the top side of the central panel there are control buttons for the movie to stop, play, move forward/backward...

■ **Mosaic builder** using images with Aladin.

- *File* → *Open server selector*. A new window will pop up.
- On the left hand side, select *DSS* label and choose *DSS from ESO*.
- Write 09 55 55.63423 +69 01 55.9684 in the **Target (ICRS, name)** box and select *DSS2-red – POSS2UKSTU_Red* in the drop down of **Sky Survey**. Change **Width** and **Height** to 5 arcmin. Click on **Submit**. The corresponding image will be loaded in the main window.
- Repeat the previous step with the following coordinates and the same width and height:
 - 09 55 32.07698 +69 04 51.2255
 - 09 55 08.96959 +69 02 57.2765
 - 09 54 49.20075 +69 07 25.5246
- *Image* → *Mosaic image builder*. A new window will pop up.
- Select each of the loaded images and click on **Create**. A new plane with the built mosaic will be loaded in the main window.

■ **Sextractor**: extract astrometry and photometry of a loaded image.

- *File* → *Open server selector*. A new window will pop up.
- On the left hand side, select *DSS* label and choose *DSS from ESO*.
- Write 00:10:15.02 -13:38:05.9 in the **Target (ICRS, name)** box and select *DSS2-red – POSS2UKSTU_Red* in the drop down of **Sky Survey**. Click on **Submit**. The corresponding image will be loaded in the main window.
- *File* → *Open server selector*. A new window will pop up.
- Select *Tools* → *S-extractor* on the top labels.
- Select the loaded image in **Image reference** and click on **Submit**. A new plane with the extracted catalog will be loaded in the main window.

■ Display **instruments Field of Views**, useful to check whether one or another instrument's FoV covers the desired region.

- On top of the central panel, click "2MASS" just below the **Command** box. This will load the HIPS 2MASS survey.
- Write SDSS J082322.44+530705.5 in the **Command** box to center the view around that object.
- *File* → *Load instrument FoV*. A new window will pop up.
- Write SDSS J082322.44+530705.5 in the **Target (ICRS, name)** box and select *WFI*. Click on **Submit**. A new plane with the WFI FoV will be loaded in

the main window. Try to change the **Angle** in the FoV window to change the rotation of the displayed FoV.

- Many other functionalities are available, like:
 - Astrometric calibration
 - Visualization of 2, 4, 9 or 16 panels (images) with the possibility of matching views (unifying sizes and orientation)
 - Load a macro script for repetitive tasks
 - Generate a MOC from a loaded catalog
 - ...

NOTE: We refer the user to the [F.A.Q](#) section of Aladin for details on these and other functionalities. A manual on the use of Aladin v10 is available [here](#) (in french).