

# Les Houches PNP School- Online tools

## Online tools for planetary sciences

### Objectives

The objective of this hands-on session is to introduce some of the most common Virtual Observatory (VO) tools, such as **aladin** (Bonnarel et al., 2000) and TOPCAT (Taylor, 2005), and a widely used protocol, **cone-search**, to query data from archives.

We will start with a graphical user interface and then move to using **python** scripts to query Application Programming Interfaces (API) and automatize the repetitive tasks.

### 1 Finding moving objects in an image (field of view)

This exercise introduces the Sky Body Tracker (SkyBoT) tool (Berthier et al., 2006). SkyBoT is a specialized **cone-search**: it lists all Solar System Objects (SSOs) present within a given field of view **at a given epoch**. Alike all the services hosted at IMCCE on the VO Solar System Portal (VOSSP<sup>1</sup>), SkyBoT requests can be submitted in different ways (**aladin**, HTTP, SOAP), and results can be provided in different formats (VOTable, text, html).

We will use SkyBoT to illustrate calls to VO services first with a graphical user interface (GUI), **aladin** (Fig. 1), then with a **python** script (in the `../03-Query_APIs/3.1-How_to_query_an_API.ipynb` notebook).

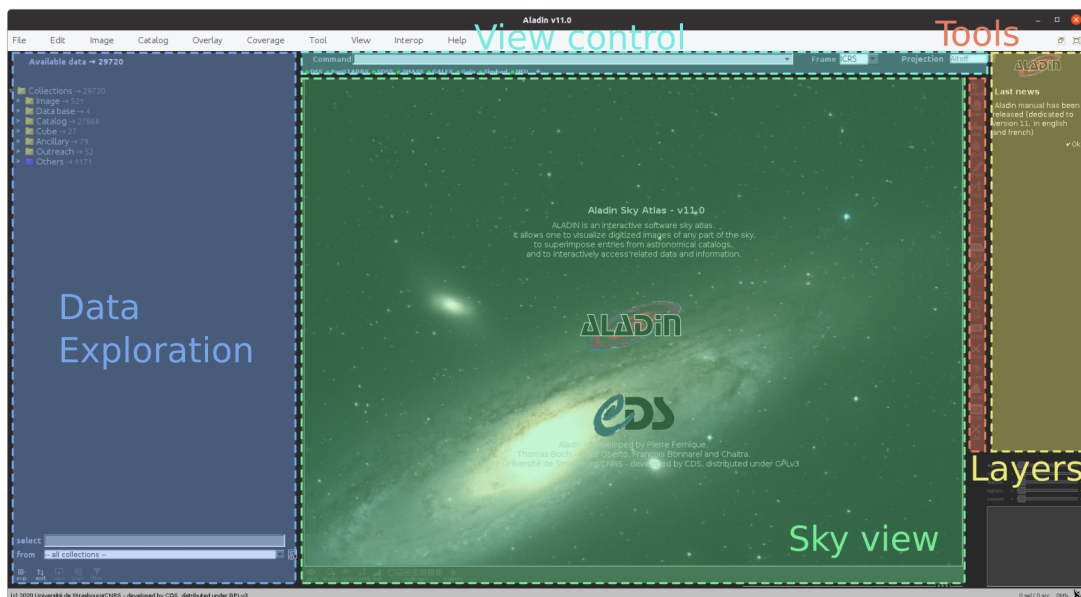


Fig. 1: The **aladin** client. Loaded data from the **data exploration** panel are listed as **layers** and displayed in the **sky view**. Coordinates can be entered in the **view control** panel, and many **tools** are available.

<sup>1</sup>Forms: <https://ssp.imcce.fr/forms>  
APIs: <https://ssp.imcce.fr/webservices>

1. Launch **aladin**.
2. Using the **view control**, center de view on (RA,Dec) of (07h 08m, +26d 34m).
3. Open the **Serveur selector**. Keystroke **ctrl-l** or **File → Open server selector**.

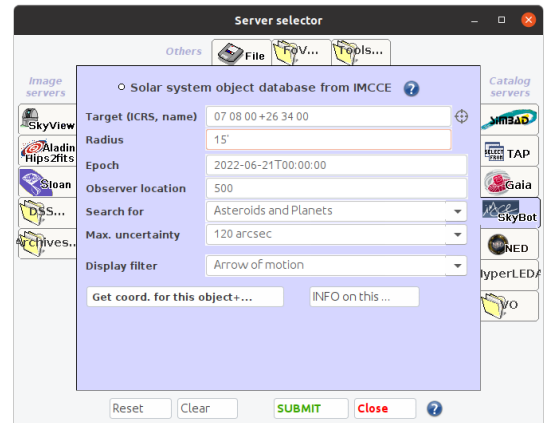
There are seven fields in the pop-up window: **Target**, **Radius**, **Epoch**, **Observer location**, **Search For**, **Max. uncertainty**, and **Display filter**. By default, **aladin** fills the **Target** and **Radius** fields to correspond to current display.

4. Check that the coordinates in **Target** correspond to the value above.
5. Set the **Radius** to 15'.
6. Set the **Epoch** to 2022-06-21T00:00:00.
7. Let everything else by default and click on **SUBMIT**.

A new layer has appeared, showing the SSOs with their arrow of motion. Like for any other catalog loaded in **aladin**, you can select objects and see their properties in the bottom panel.

8. Select all SSOs. **Ctrl-a** or **Edit → Select all objects**.
9. Click on any of the column in the bottom panel. The histogram of values for all objects will appear at the bottom right.

We just used a **tiny** fraction of what **aladin** can do. With it, you can retrieve catalogs, images, cross-match them, select intersections, unions, etc etc. It is an extremely powerful tool to explore the sky.



## 2 In a script

We often process many images. Clicking on a GUI is not the most productive method. We thus often write scripts to perform many automated steps. Most VO services can be called through APIs and be scripted.

Generally, the service has a base **url** to which queries are to be sent. The user choices are submitted through a list of **parameter=value** arguments. Of course, we cannot guess which **parameter** is available, nor what **value** are allowed. So read the documentation!

For instance, we can repeat the query above in **python**:

```
1 import requests
2 import json
3 import pandas as pd
4 from astropy.coordinates import Angle
5
6 # User choices
7 ep = '2022-06-21T00:00:00'
8 ra = '07h08m00'
9 dec = '+26d34m00'
10 sr = 15/60
11 observer = '500'
12
13 # Service URL
14 url = 'http://vo.imcce.fr/webservices/skybot/skybotconesearch_query.php?'
15
16 # Query parameters
17 params = {
18     '-ep': ep,
19     '-ra': Angle(ra).degree,
20     '-dec': Angle(dec).degree,
21     '-sr': sr,
22     '-mime': 'text',
23     '-output': 'all',
```

```
24     '-loc': observer,
25     '-tscale': 'UTC'
26 }
27
28 # Query the service
29 r = requests.post(url, params=params, timeout=2000)
30
31 # Write results to disc
32 with open("response.txt", "w") as f:
33     f.write(r.text)
34
35 # Load results in a pandas.DataFrame
36 data = pd.read_csv( 'response.txt', sep='|', skiprows=2 )
```

So long story short, we first define the parameters (coordinates, radius, epoch) then query the SkyBoT service thanks to the `request` package. The results are written in a file, and read as a `pandas DataFrame`. Performing this query for each image acquired by a telescope is very easy (the parameters are contained in the image).

The script above is a simple example, let's move to the notebook `3.1-How_to_query_an_API.ipynb` in the directory `03-Query_APIs` to get some practice.

## References

Berthier, J., Vachier, F., Thuillot, W., et al. 2006, in Astronomical Society of the Pacific Conference Series, Vol. 351, Astronomical Data Analysis Software and Systems XV, ed. C. Gabriel, C. Arviset, D. Ponz, & S. Enrique, 367

Bonnarel, F., Fernique, P., Bienaymé, O., et al. 2000, A&AS, 143, 33

Taylor, M. B. 2005, in Astronomical Society of the Pacific Conference Series, Vol. 347, Astronomical Data Analysis Software and Systems XIV, ed. P. Shopbell, M. Britton, & R. Ebert, 29