



Data sharing and visualisation

AtLAST-fr-days 12-14 May 2025 Paris

Ada Nebot with the CDS team





Outline

- Data Sharing:
 - The VO and the IVOA: what, how, why, where, who?
 - Publishing data in the VO
 - Using data in the VO
- Data visualisation
 - HiPS
 - HiPS3D prototype

The VO and the IVOA: what?

The Virtual Observatory

"A multi-wavelength digital sky that can be searched, visualised and analysed in new and innovative ways" - P. Fabianno

The VO and the IVOA: how?

The Virtual Observatory

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International Virtual Observatory Alliance

A science driven organisation that debates and agrees the technical standards that are needed to make the VO possible

The VO and the IVOA: why?

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A science driven organisation that debates and agrees the technical standards that are needed to make the VO possible

Clear benefits

- Growth in the scientific return of data
- Capability to discover and fuse multiple data sets
- Application of the VO in planning new observations and observing strategies

The VO and the IVOA: why?



The VO and the IVOA: where?

Existing global framework: populated by major data providers (space and ground based) that is heavily used by the community (e.g. Gaia data access is fully VO, Rubin will be too)



The VO and the IVOA: who?

- 5 Committees: Exec, Tech Coordination, Standards & processes, Media, Science priorities
- 6 Working Groups (WG): Applications, data access, models, grid & web services, registry, semantics
- 8 Interest Groups (IG): radio, high energy, time-domain, solar system, operations, data curation, knowledge & discovery, education
- 2 IVOA interoperability meetings per year
 - June 1-6 2025 Maryland, USA https://indico.ict.inaf.it/event/3121/
 - November 14-16 Goerlitz, Germany

http://ivoa.net/



Publishing data in the VO

Several ways to publish your data into the VO (depending on needs):

- Very little technical expertise —> Contact your national VO projects
- Some technical expertise —> off the shelf VO Publishing toolkits
- Technical expertise & prefer to build VO interfaces to your data:
 - There are useful ready to use VO software tools and libraries.
 - Determine what type of data you want to publish (images, catalogues, spectra, time-series, ...)?
 - Have a look at the <u>Architecture Document</u> to find out which IVOA standards you might need to use

https://wiki.ivoa.net/twiki/bin/view/IVOA/PublishingInTheVO

Publishing data in the VO

Example: ObsCore

Goal: give data providers a set of <u>metadata</u> attributes that they can easily map to their database system in order <u>to support the following science</u> <u>cases</u>:

- Support multi-wavelength, positional and temporal searches
- Support any type of data product (image, cube, spectrum, time series,...)
- Support file formats / content typically found in archives (FITS, VOTable, compressed files, instrumental data, etc.)

It allows users to search, find and combine all sorts of data enabling interoperability

Publishing data in the VO

- Map the METADATA of your project data into the IVOA standards
- Set a service
- Register the service

Allows users to search, find, and combine the data coming from multiple missions

Makes your data VO-compliant Makes your data FAIR

Using the VO

- Different ways to find, access, interoperate and reuse data in the VO
 - e.g. via dedicated tools such as Aladin & Topcat,... programmatic access using python, ...
- Lots of tutorials are available





grating observations (see: Monster Blackhole Spin Revealed)

Data visualisation

The Virtual Observatory

"A multi-wavelength digital sky that can be searched, visualised and analysed in new and innovative ways"

• **HiPS**: A hierarchical scheme for the description, storage and access of sky survey data (Images, catalogues, 3-dimensional data cubes,...)

"The more you zoom in on a particular area, the more details show up"



- Conserves scientific data properties alongside visualisation considerations.
- No databases or dedicated servers are required, just HTTP
- A response to big data: Makes a sky survey accessible, visualisable, and even interactive, regardless of the survey size, network quality, or the computing power available to the astronomer.

 Implemented by different visualisation tools: Aladin, AladinLite, hips2fits, ESAsky, ESO portal, prototype in the SRCNet Science Gateway



ALMA science portal







HiPS in action



Aladin v12.6 *** PROTOTYPE VERSION (based on v12.619) ***



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Data visualisation: HiPS in action (long version)

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Screen Recording Screen Recording 2025-0...3.50.mov 2025-0...8.45.mov





Screenshot Screen Recording 2025-0...10.08.53 2025-0...4.00.mov



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Screenshot Screen Recording



- P. Fernique et al.
- Soon, a flood of cube-shaped data (SKA = 300 PB of data per year in the form of cubes of several hundred GB, or even much more).
- We must invent solutions to extend our tools and standards to keep up with this evolution.
- 3 years of discussions, testing, studies, and development led by the CDS as part of its contribution to the SKA visualisation team and SKA SRCnet FR



- A HiPS3D is a generalisation of HiPS that allows you to walk around in a "cubic" mosaic of observations.
- Instruments like MUSE, Alma, MeerKAT, ASKAP or SKA produce data cubes, not images.
- HiPS3D takes this third dimension into account, allowing you to pan and zoom both spatially (as with conventional HiPS) and in frequency (a new feature).

- The client loads the HiPS3D:
 - Tiles covering the spatial view
 - Tiles covering the frequency view
 - At the appropriate resolution



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Screenshot Screen Recording 2025-0...10.59.20 2025-0...3.18.mov

Take away messages

- The VO is an ecosystem formed by archives and tools which efficiently communicate so that users can find, access, interoperate and reuse data for carrying out their science.
- It is not a unique tool, but rather a way of doing things (as it is the web)
- The IVOA sets the standards for enabling that interoperability
- New fast and efficient ways of exploring and visualising data cubes are under development <u>https://aladin.cds.unistra.fr/</u> java/TutoHiPS3Den.pdf





Some useful links

- IVOA: <u>https://www.ivoa.net</u>
 - Docs : <u>https://www.ivoa.net/documents/</u>
 - Mailing lists : <u>https://www.ivoa.net/members/index.html</u>
 - Architecture: <u>https://www.ivoa.net/documents/IVOAArchitecture/</u> 20211101/index.html
 - GitHub : https://github.com/ivoa
- **OV-France**: <u>https://asov.obspm.fr/</u>
 - Mailing lists:
 - https://listes.services.cnrs.fr/wws/info/ov-france
 - https://listes.services.cnrs.fr/wws/info/ov-france-dev (more tech)