

# International Virtual Observatory Alliance

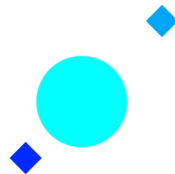
## organisation & processes

S. Bertocco, H. Heintz, M. Molinaro

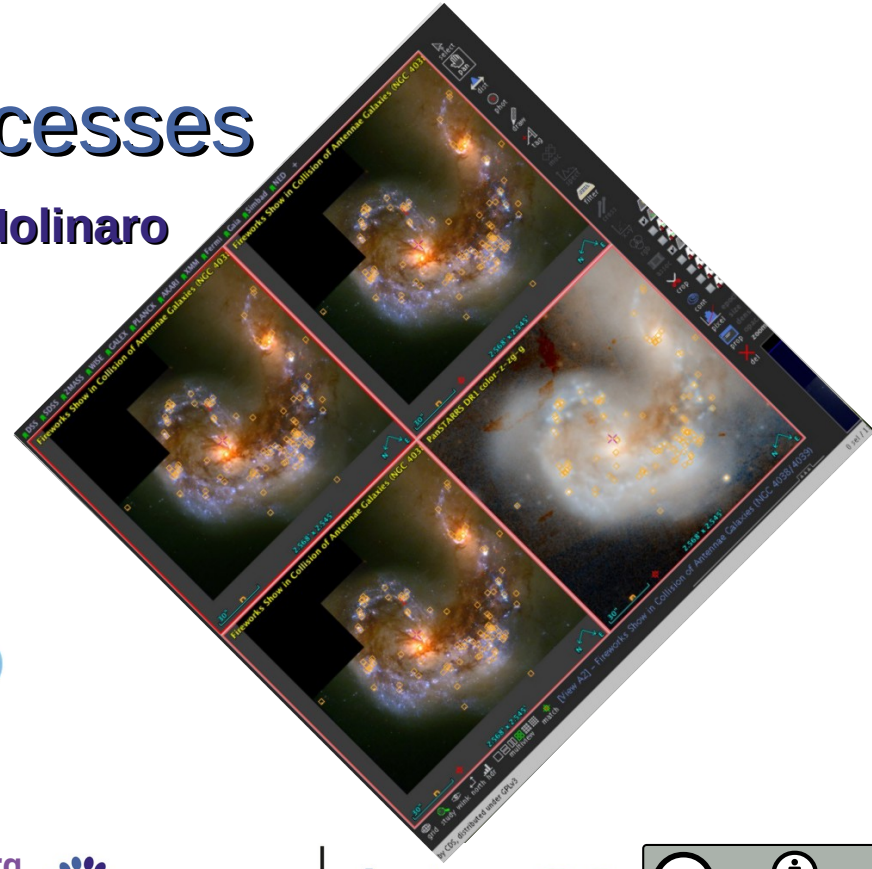
[INAF - OATs]

D. Morris

[UK-SRC SKAO]



**INAF**  
ISTITUTO NAZIONALE  
DI ASTROFISICA



Introduction to the VO

Wednesday 25 March 2026 – Internationales Wissenschaftsforum Heidelberg  
Astro-CC European Data Provider Forum



**Astro-CC**





# Summary: IVOA why and how

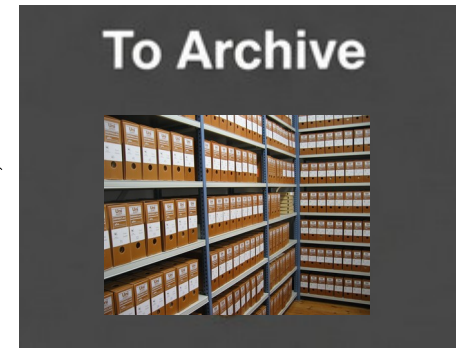
- Archive concept

- IVOA:

- Vision
- Interoperability
- Standards
- Organization
- Architecture
- How to participate



# Store vs. Archive



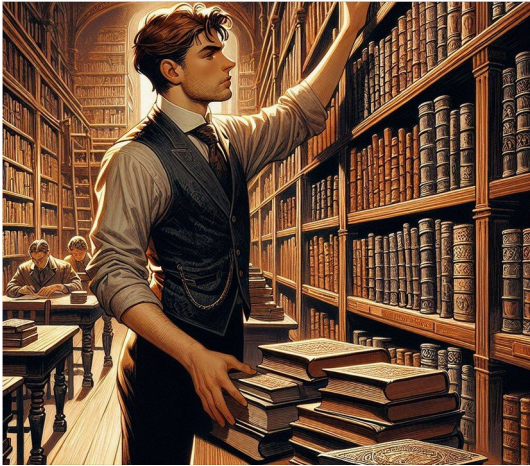
## To store:

placing something in a specific location for future use, whether immediate or distant.

## To archive:

to catalogue, sort, and preserve documents or data in an archive

# To archive



"The librarian organized the **collection** of books."



"The librarian meticulously **classifies** all the books."



"The librarian **organized** an **exhibition** of books."

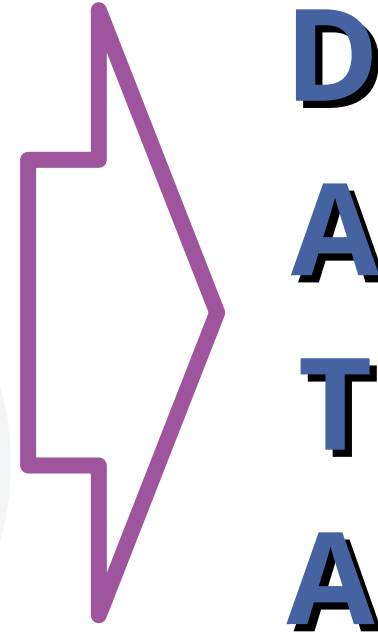


"The reader **found** the book he were looking for."

“ To archive means  
to catalogue, sort, and preserve  
documents or data in an archive

# Why archives?

- **Preservation**
  - *"forever"*
- **Sharing**
  - **Open/Public** accessibility
- **Interoperability**
  - Technical & **Semantic**





# VIRTUAL OBSERVATORY

The Virtual Observatory (VO) is the vision that astronomical datasets and other resources should work as a seamless whole.



# IVOA

**“ The International Virtual Observatory Alliance (IVOA) is an organisation that debates and agrees the technical standards that are needed to make the VO possible. ”**

# Interoperability

“ Interoperability is the ability of two or more systems to exchange information and to use the information that has been exchanged ”

# IVOA Standards

## The Language of Astronomy

Just like human beings need a **shared language** to communicate, telescopes and archives need a shared framework to exchange data. This is what the IVOA provides.

**Vocabulary** (The 'What'): "In a language, we agree on what words mean. In the Virtual Observatory, we use Unified Content Descriptors (UCDs). They ensure that when two different archives talk about 'brightness', they are using the exact same 'word' or tag, avoiding a Tower of Babel scenario."

**Grammar** (The 'How'): "Grammar gives **structure** to words. Data Models like ObsCore act as our grammar; they define the mandatory relationship between a metadata field and its observation context."

**Syntax**: The formal structure and format used to write and read the data. VOTable (XML) is how to describe data to exchange

**Dialogue** (The 'Action'):

"Finally, we need a way to ask questions. Protocols like TAP (Table Access Protocol) are the formal rules of **conversation** that allow a scientist to query any compliant archive worldwide using the same syntax: ADQL."

# Interoperability through Common Rules

<u>Linguistic Element</u>	<u>IVOA Equivalent</u>	<u>Technical Role</u>
Vocabulary	UCDs & Semantics	Assigns unambiguous names to physical concepts (e.g., flux, velocity)
Grammar	Data Models (DM)	Defines how to describe pieces of information
Syntax	VOTable (XML)	The formal structure and format used to write and read the data
Dialogue	Protocols (TAP, SIA)	How a client (you) "talks" to a server to request specific data

# FITS: a first (technical?) solution



[https://fits.gsfc.nasa.gov/fits\\_home.html](https://fits.gsfc.nasa.gov/fits_home.html)

- Discussion started end of '70s
- First formal document in 1981
  - focus: archive & share
- Today it's FITS v.4.0 (2018)
- Maintained by an IAU Working Group
  - Challenged by a growing number of other formats

# What is the IVOA?

IVOA founded in 2002.

23 Member Organizations/Projects

A **group of people** that agrees on **standards** on which to build applications that **interoperate** across data providers

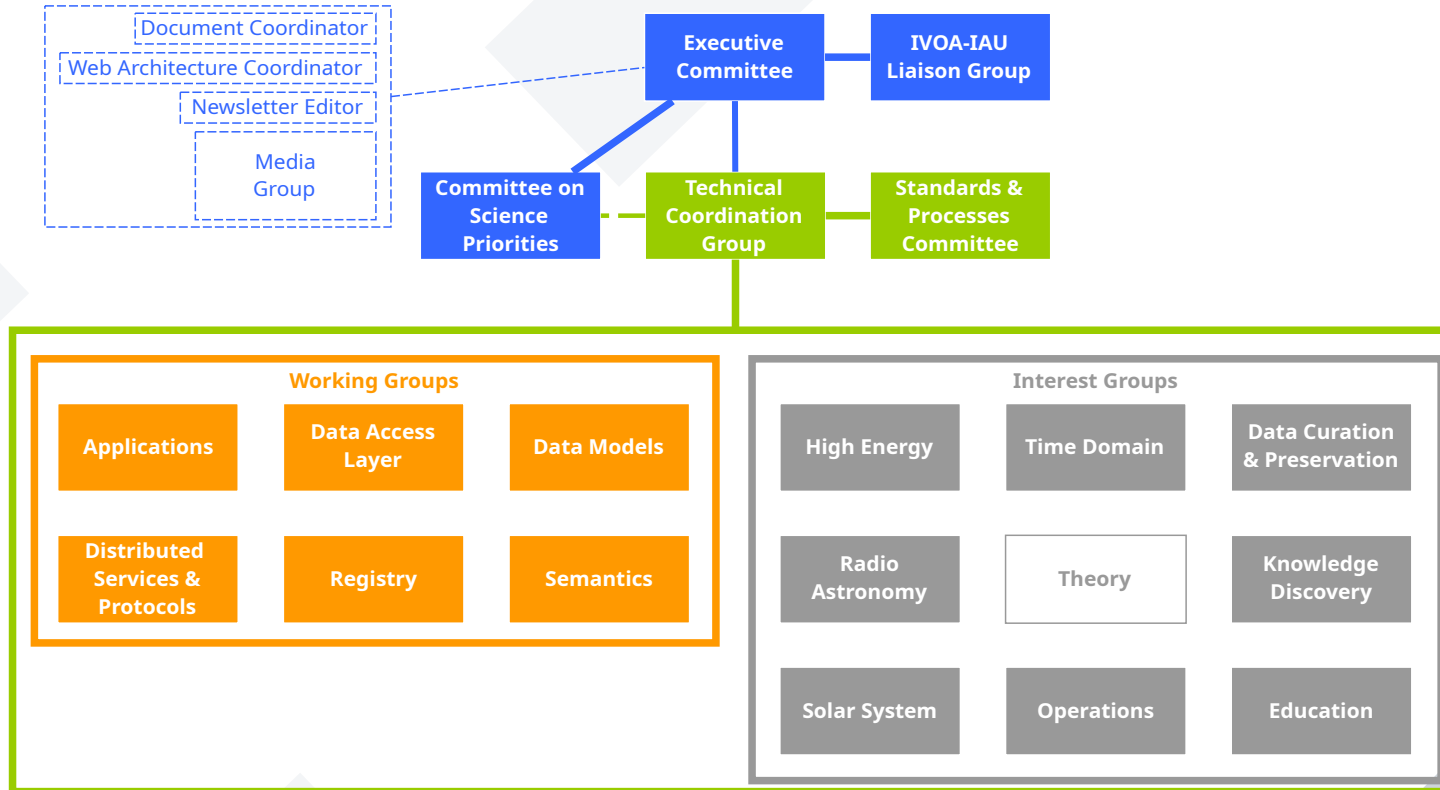
Two **interoperability** meetings per year:

- “Northern Spring”
- “Southern Spring” (typically after ADASS)



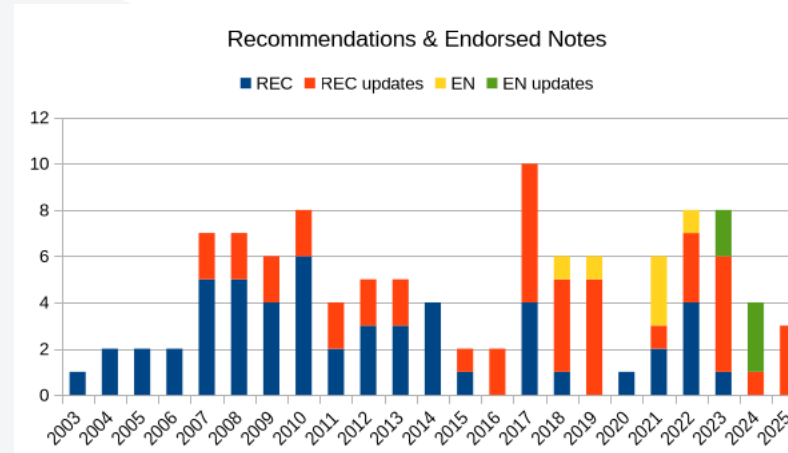
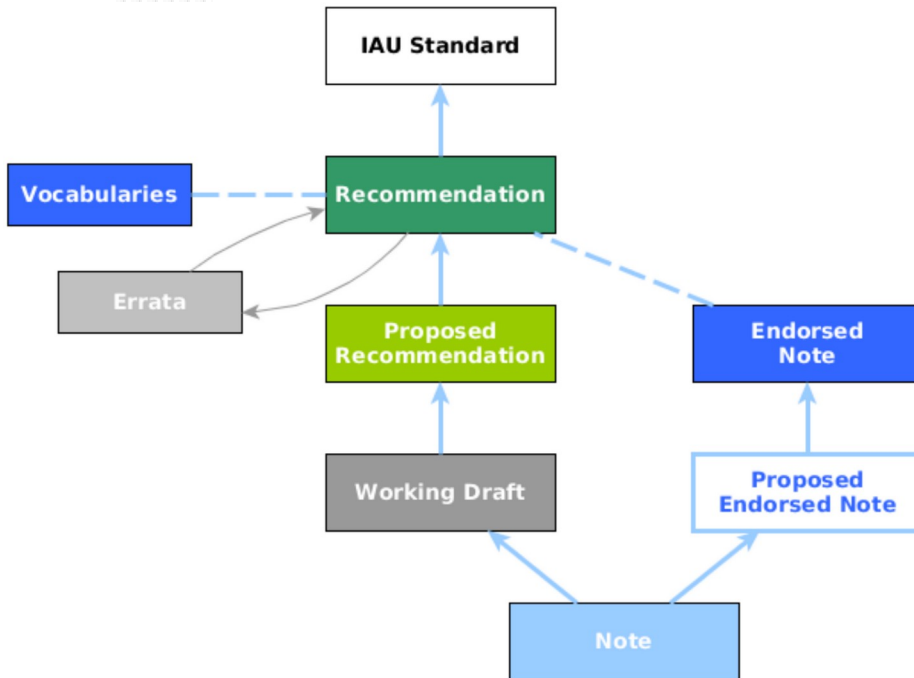


# IVOA organisation



# IVOA processes

- **IVOA Document Standards 2.0**
  - 10.5479/ADS/bib/2017ivoa.spec.0517G
- **Vocabularies in the VO 2.1**
  - 10.5479/ADS/bib/

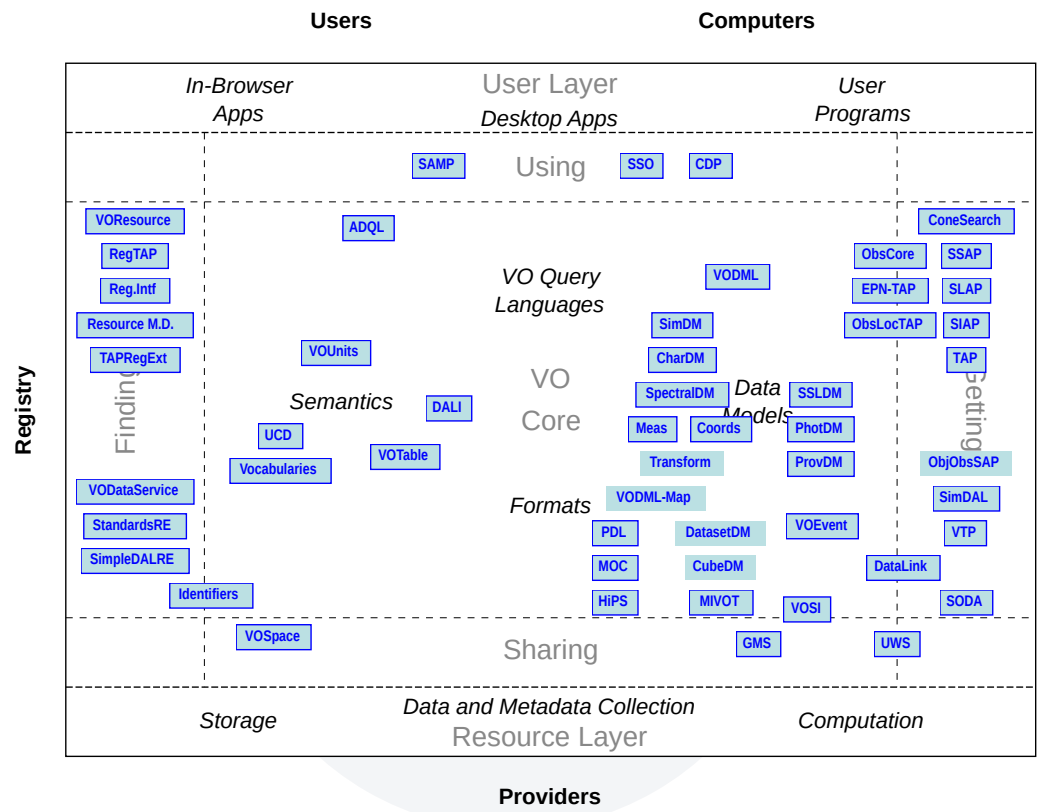


recommendations (standards) are **agreed on consensus**

# IVOA architecture

IVOA Architecture 2.1

<https://ui.adsabs.harvard.edu/abs/2024ivoa.spec.1114E>

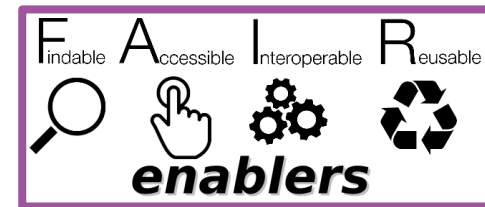
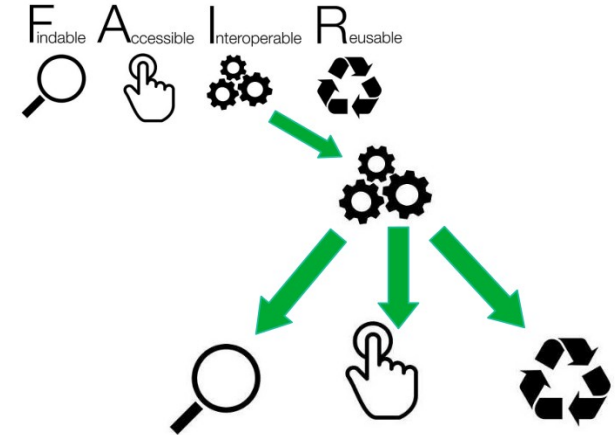
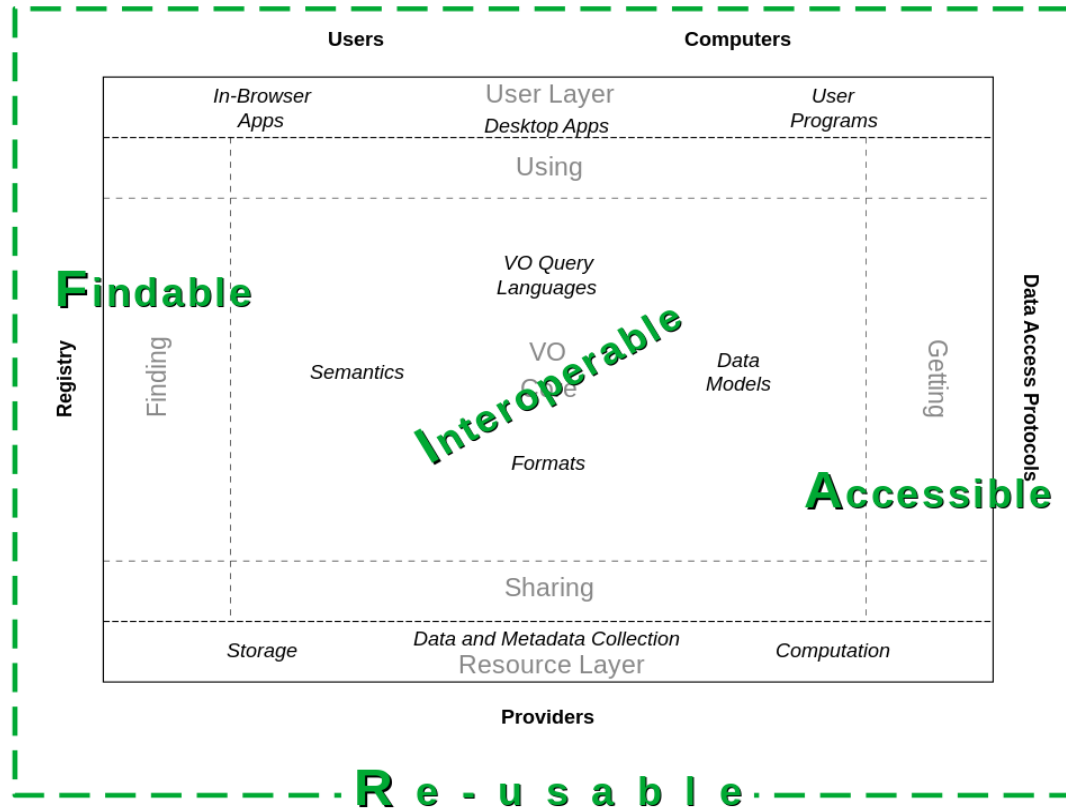


level 2

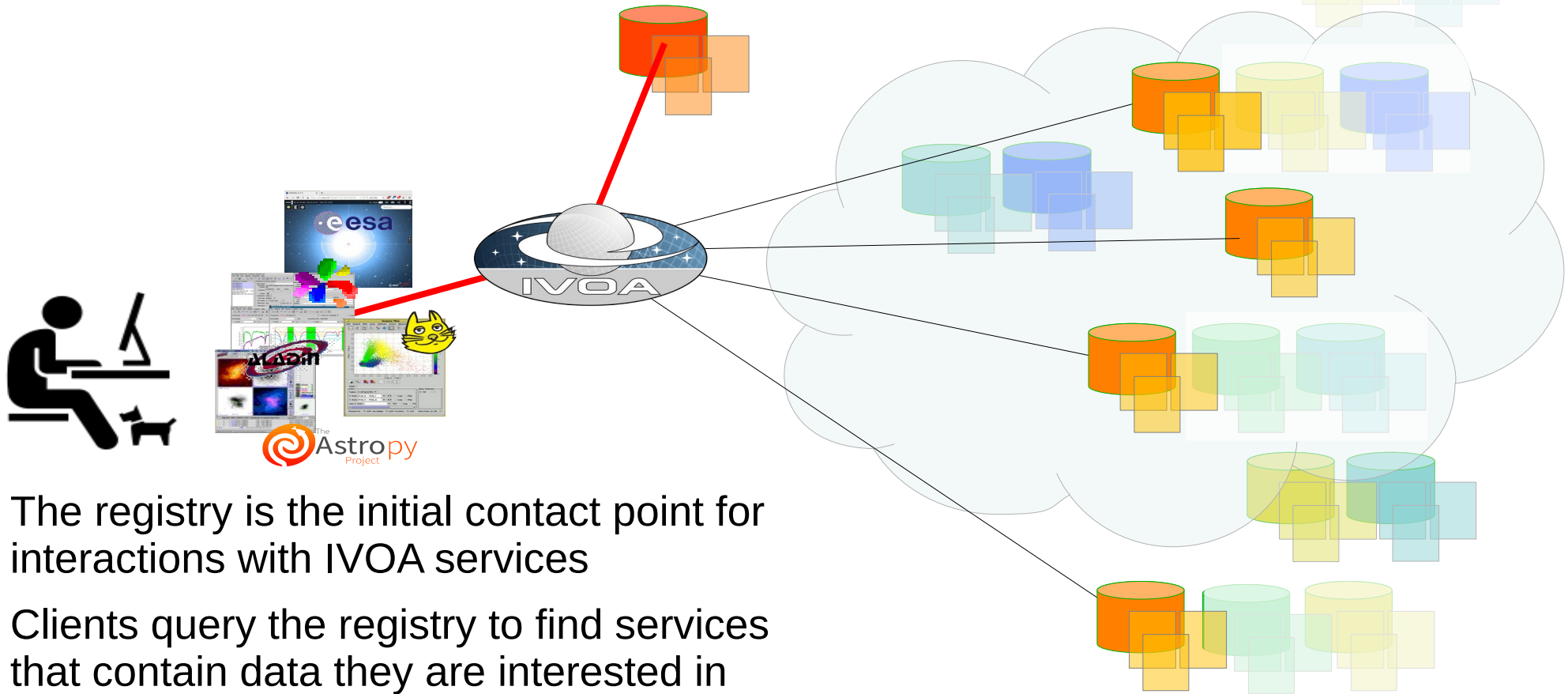
Data Access Protocols

Providers

# IVOA - FAIR mapping



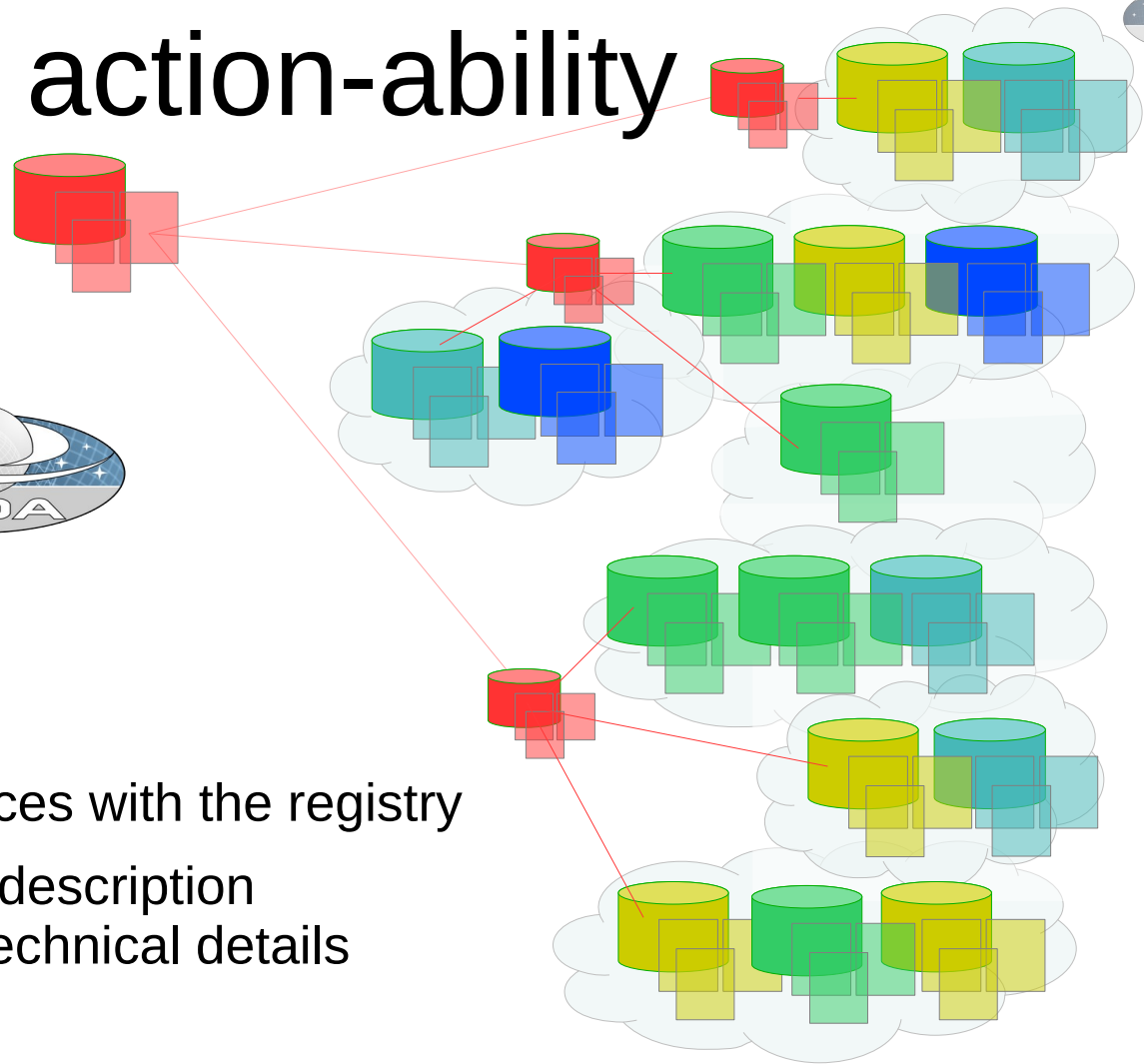
# The IVOA Registry



The registry is the initial contact point for interactions with IVOA services

Clients query the registry to find services that contain data they are interested in

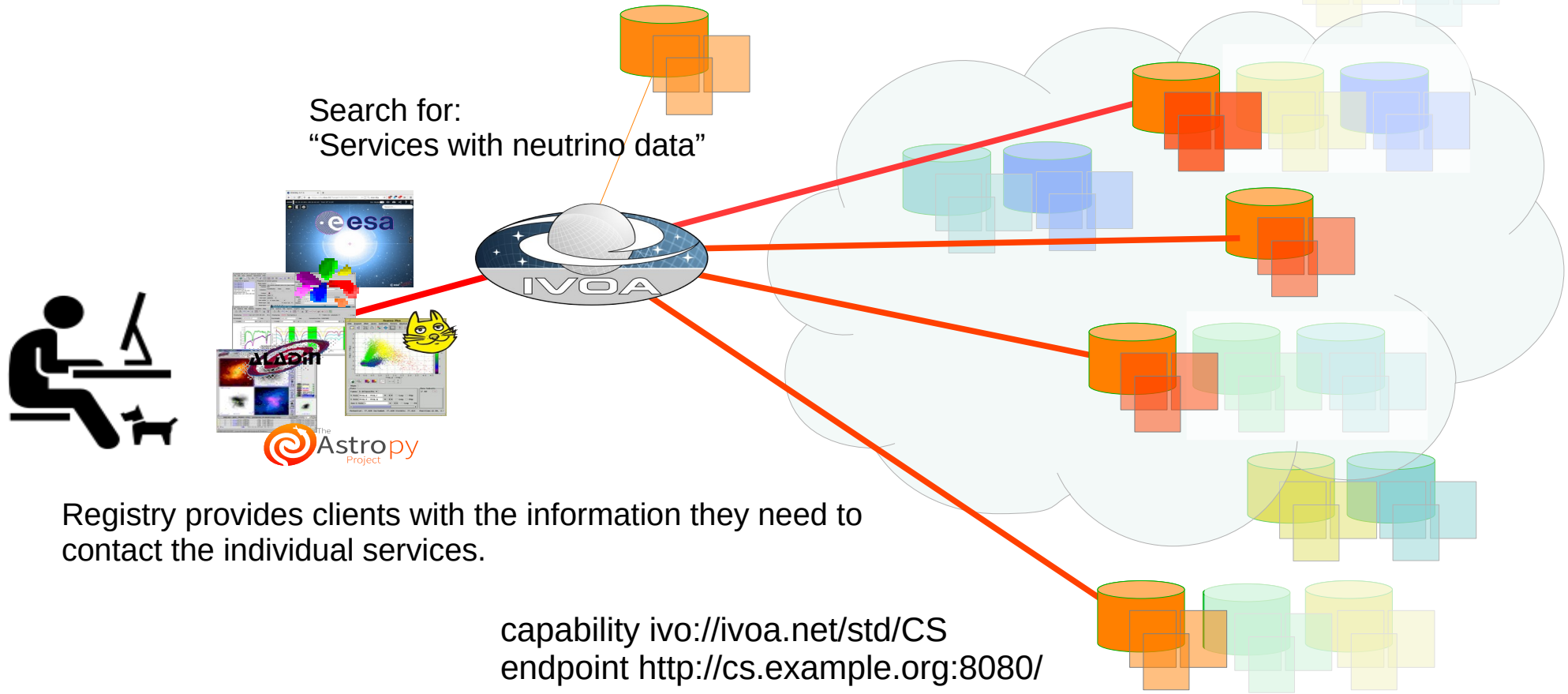
# Access action-ability



Data providers register their services with the registry

Registration metadata includes a description of the data they provide and the technical details of how to connect

# Client perspective



# (archives)

Select a collection... and enter target:

Home Page | MASE: andromeda

30347 Total Rows

M 31, radius: 1.60279

Filters

Keyword/Text Filter

Observation Type

Mission

Provenience Name

Instrument

Actions	Observation T.	Mission	Provenience Name	Instrument	Project	Filters	Wavelength	Target Name	Target Classification
1	***	science	WUPPE	ASTRO-2 W...	UV	EG-AND			
2	***	science	WUPPE	ASTRO-2 W...	UV	EG-AND			
3	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	TESS FFI
4	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	TESS FFI
5	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	TESS FFI
6	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	1005000001
7	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	1005000001
8	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	1005000001
9	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	43825804
10	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	25900680
11	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	25900680
12	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	47899072
13	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	42400672
14	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	42400672
15	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	115745971
16	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	115745971
17	***	science	TESS	SPOC	Photometer	TESS	TESS	Optical	115745971

<https://archive.eso.org/>



<https://archive.stsci.edu/>

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180.87° × 104.1°

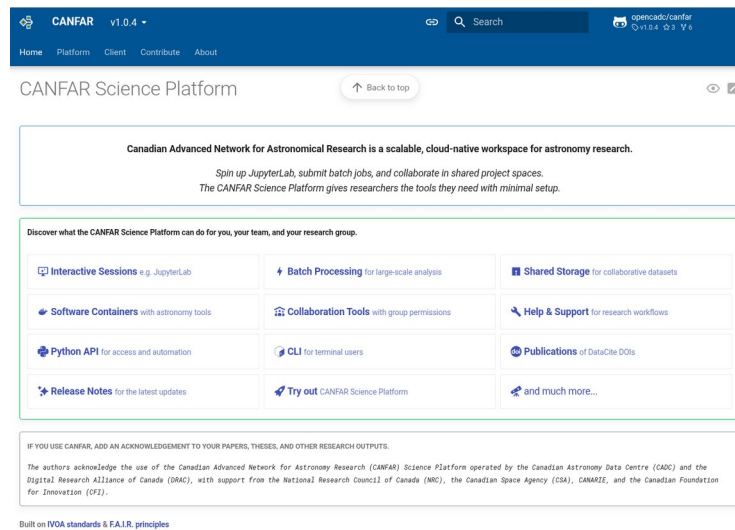
Observatory:  La Silla Paranal APEX  ALMA

Data Type:  SPECTRUM  IMAGE  CATALOG  CUBE  VISIBILITY

Spectral Range:  UV  opt  NIR  MIR  mm

Actions	Data Type	Spec. Range	Spec. Res.	SMR	Obs. Date	Collection	Instrum.	T. Exp. T.	#Obs	P.A.	Program Id	Object	Data Prev.
	SPECTRUM	378.3-491.3 nm	150000	176.4	2025-11-03 07:30:55	HARPS	HARPS	136.7 s	single		60.A-9709	H81966	ESO_PHASE3
	SPECTRUM	378.3-491.3 nm	80000	344.8	2025-11-03 07:29:50	HARPS	HARPS	93 s	single		60.A-9709	H81966	ESO_PHASE3
	SPECTRUM	378.3-491.3 nm	150000	127.3	2025-11-03 08:17:59	HARPS	HARPS	100 s	single		60.A-9709	H81970	ESO_PHASE3
	SPECTRUM	378.3-491.3 nm	150000	132.3	2025-11-03 06:16:47	HARPS	HARPS	100 s	single		60.A-9709	H81970	ESO_PHASE3
	SPECTRUM	378.3-491.3 nm	150000	134.4	2025-11-03 06:13:35	HARPS	HARPS	100 s	single		60.A-9709	H81970	ESO_PHASE3
	SPECTRUM	378.3-491.3 nm	80000	313.2	2025-11-03 06:08:34	HARPS	HARPS	65 s	single		60.A-9709	H81970	ESO_PHASE3
	SPECTRUM	378.3-491.3 nm	80000	310.1	2025-11-03 06:07:06	HARPS	HARPS	65 s	single		60.A-9709	H81970	ESO_PHASE3

# (platforms)



**CANFAR v1.0.4** | Search | opencado/canfar v1.0.4 03 Y5  
 Home Platform Client Contribute About

**CANFAR Science Platform** | Back to top

**Canadian Advanced Network for Astronomical Research is a scalable, cloud-native workspace for astronomy research.**  
 Spin up JupyterLab, submit batch jobs, and collaborate in shared project spaces.  
 The CANFAR Science Platform gives researchers the tools they need with minimal setup.

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IF YOU USE CANFAR, ADD AN ACKNOWLEDGEMENT TO YOUR PAPERS, THESE, AND OTHER RESEARCH OUTPUTS.  
 The authors acknowledge the use of the Canadian Advanced Network for Astronomy Research (CANFAR) Science Platform operated by the Canadian Astronomy Data Centre (CADeC) and the Digital Research Alliance of Canada (DRAC), with support from the National Research Council of Canada (NRC), the Canadian Space Agency (CSA), CANARISE, and the Canadian Foundation for Innovation (CFI).

Built on IVOA standards & FAIR principles

<https://www.canfar.net/>




**esa** | THE EUROPEAN SPACE AGENCY | ESA Datalabs (0.16.0 BETA) | Log in

**«YOU CAN EITHER MOVE YOUR QUESTIONS OR THE DATA. [...] OFTEN IT TURNS OUT TO BE MORE EFFICIENT TO MOVE THE QUESTIONS THAN TO MOVE THE DATA.»**  
 Jim Gray, eScience: A Transformed Scientific Method

**BRING YOUR QUESTIONS TO THE DATA**

There is a new paradigm, opening completely new opportunities for discovery – a data-intensive approach to science. In many domains, we have entered what could be called the golden age of surveys, with several large-scale projects, spanning decades, between finished, ongoing, and planned activities. ESA is responsible, or is a major partner, in several of these initiatives.



There is, however, a new profound change: data has become a major technological challenge. Increases by multiple orders of magnitude in dataset size means that transferring data to a scientist is often unfeasible.

<https://datalabs.esa.int/>

## VizieR

**Search Criteria**

**Preferences**

max:

HTML Table ▾

All columns

▶ [Compute](#)

**Mirrors**

CDS, France ▾

[VizieR home](#) · 
 [Photometry viewer](#) · 
 [Query VizieR using TAP](#) · 
 [X-match tables](#) · 
 [Query images/spectra](#)

The VizieR service is now hosted by CDS domain (cds.unistra.fr). Please, modify your configuration for the new domain.

### Find catalogs among 26799 available

Expand search

? **Catalog**, author's name,  
 word(s) from title, description, etc.  
 e.g.: AGN, Veron, I/239, or bibcodes...

- ▶ [Search for catalogs by column descriptions \(UCD\)](#) ?
- ▶ [Search for catalogs containing additional data](#)

### Search by Position across 30413 tables

Target Name (resolved by [Sesame](#)) or Position:

Target dimension:

NB: The epoch used for the query is the original epoch of the table(s)
  Radius
  Box size

[More about VizieR](#)

Wavelength	Mission	Astronomy
Radio	AKARI	Abundances
Millimeter	ANS	Ages
IR	ASCA	AGN
optical	BeppoSAX	Associations
UV	Cassini-Huygens	Asteroseismology
EUV	CGRO	Atomic_Data
X-ray	Chandra	Binaries:cataclysmic



sort by : popularity  date   [↻](#)

### Tools related to VizieR

- [Catalogue collection](#) : Search VizieR catalogues available via various services (FTP, VizieR, TAP, ...)
- [CDS Portal](#) : Access CDS data including VizieR, Simbad and Aladin using the CDS portal
- [Spectra, images in VizieR](#) : Search Spectra, images in VizieR
- [Photometry viewer](#) : Plot photometry (sed) including all VizieR
- [TAP VizieR](#) : query VizieR using ADQL (a SQL extension dedicated for astronomy)
- [CDS cross-match service](#) : fast cross-identification between any 2 tables, including VizieR catalogues, SIMBAD

J2000 00 41 06.557 +41 01 37.02 FoV: 3.3° X 1.9° SIN DSS2 color Counting Available Data Sci. Mode En Feedback

Search...

**Catalogues**

Gaia DR3 (Optical)	AllWise (Near-IR to Mid-IR)	HSC v3.1 (UV to Near-IR)	AKARI IRC (Near-IR to Far-IR)		
2MASS (Near-IR)	XMM-SUSS 6.2 (UV to Optical)	PLATO asPIC1.1 (Optical)	EPIC Stacked (Soft X-ray)	HSPSC-250 (Far-IR)	CSC2.1.1 (Soft X-ray)
	Tycho-2 (Optical)	EPIC (Soft X-ray)	HPPSC-160 (Far-IR)	HSPSC-500 (Submm)	PCCS2E-HFI (Far-IR to Radio)
	HPPSC-100 (Far-IR)	HPPSC-070 (Far-IR)	Hipparcos-2 (Optical)	2SXPS (Soft X-ray)	PGCC (Far-IR to Submm)
				Icecube (Neutrino)	

Gamma-ray      Optical      Radio

+42 00 00.000  
+41 30 00.000  
+41 00 00.000  
+40 30 00.000

00 54 00.000 00 48 00.000 00 42 00.000 00 42 00.000

cesA ALADIN

# What to do?

“ As a data providers, manager, describe your resources, add them to the Registry, and let the applications connect. ”



EUROVO

*If you want to go fast, go alone.  
If you want to go far, go together.*



## Introduction to the IVOA

*Thank you for your attention!*

**Bertocco, Heinl,  
Morris, Molinaro**