Wivona et l'Observatoire Virtuel

Un Projet PRO/AM soutenu par OBSPM

Basé sur une présentation de
Renaud Savalle - PADC/Observatoire de Paris-PSL

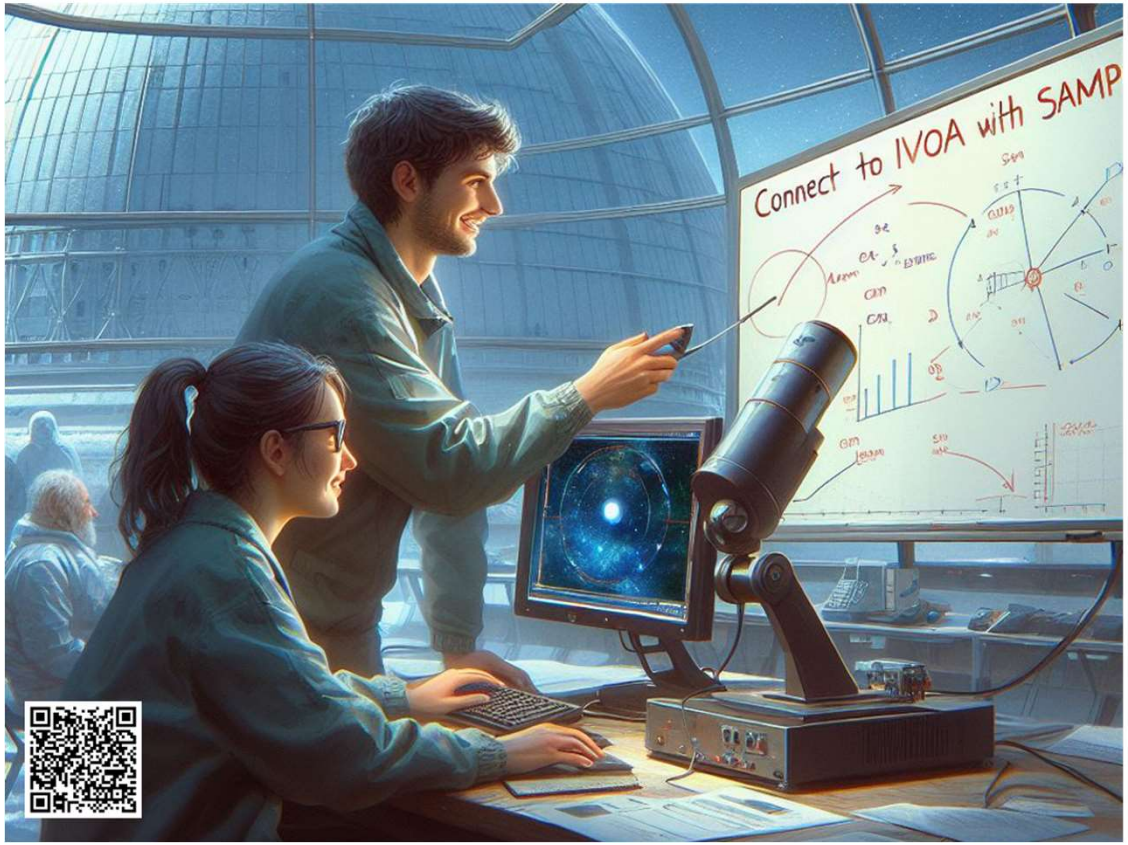
Plan

- Le projet et l'équipe WIVONA
- L'Observatoire Virtuel (OV)
- Télécharger un catalogue entier de VizieR avec TOPCAT
- Les protocoles Simples d'accès aux données de l'OV
- Accéder à des images avec Aladin
- Tutoriel IVOA
- Tutoriel Python: **t.ly/ugxOR**

WIVONA

We Implement
Virtual Observatory
Needs of Astrams

*A **Pro/Am** collaboration for the Observers Community*



- PI: **Jean-Paul GODARD**, Astronome amateur (Dev PRISM: SAMP, Astro-Colibri)
- **Renaud SAVALLE**, PADC/Observatoire de Paris, Ingénieur de recherche CNRS, (Dev SharpCap: SAMP, Scripts Python)
- **Cyril CAVADORE**, ALCOR SYSTEM, PhD (Dev PRISM)
- **David VALLS-GABAUD**, LERMA/Observatoire de Paris, Directeur de Recherche CNRS

L'Observatoire Virtuel

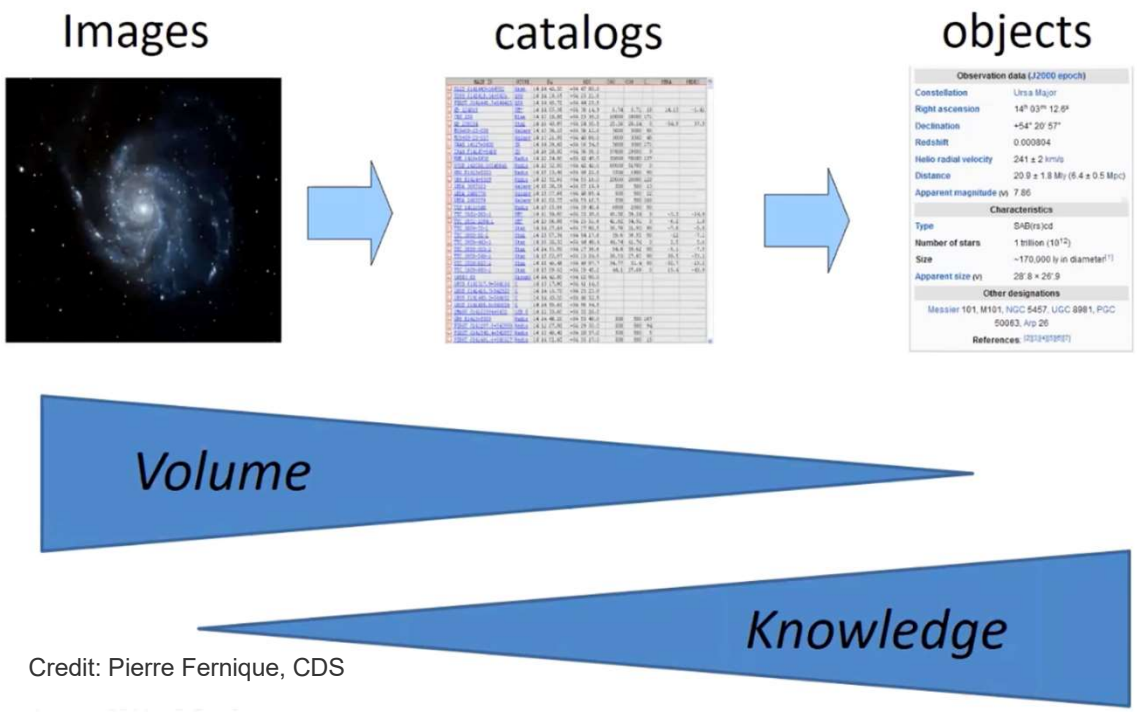
- Ce n'est pas:
  - un site web, ni un ensemble de sites
  - un programme

- Mais plutôt:
  - des protocoles standards de l'IVOA pour trouver, accéder, utiliser les données
  - ~50 centres de données (CDS, ESA, ESO, NASA…) dans ~20 pays
  - des opérateurs pour les services et l'infrastructure centrale (le Registre)
  - des développeurs de clients (TOPCAT, Aladin…)

"Un **observatoire virtuel** (OV) est une collection d'archives de données interactives et d'outils logiciels qui utilisent l'Internet pour bâtir un environnement de recherche scientifique dans lequel les programmes de recherche en astronomie pourront être conduits. De la même façon qu'un observatoire astronomique réel est un ensemble de télescopes, chacun avec une collection unique d'instruments astronomiques, l'observatoire virtuel consiste en un ensemble de centres de données, chacun avec une collection unique de données astronomiques, logiciels et capacités de calcul." [Wikipedia]

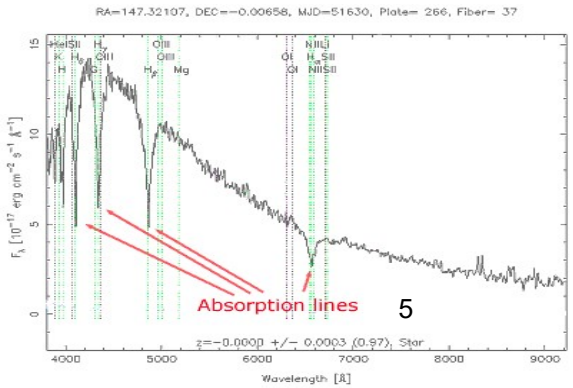
Les données de l'OV

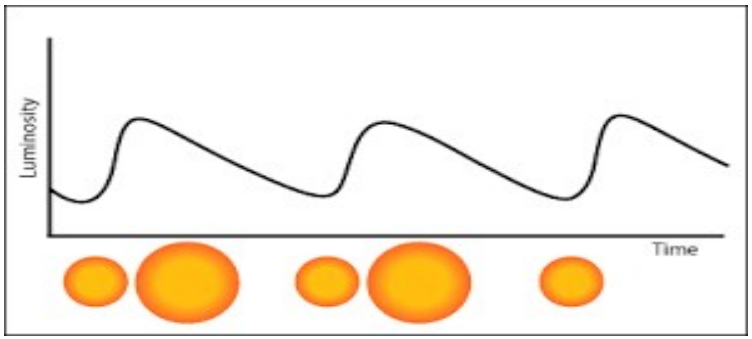
- Images
- Catalogues
- Données physiques
- Séries temporelles



Credit: Pierre Fernique, CDS

- Spectres
- Séries temporelles
- Cubes spectraux
- …





L'Alliance Internationale de l'Observatoire Virtuel (IVOA)

- https://www.ivoa.net/
- Membres: centres de diffusion de données, développeurs, auteurs de standards, utilisateurs…
- Regroupe plusieurs organismes nationaux dans ~20 pays:

- Argentine Virtual Observatory
- Armenian Virtual Observatory
- AstroGrid, United Kingdom
- Australian All-Sky Virtual Observatory
- Brazilian Virtual Observatory
- Chinese Virtual Observatory
- Canadian Virtual Observatory
- Chilean Virtual Observatory
- European Space Agency
- European Virtual Observatory
- German Astrophysical Virtual Observatory
- Hungarian Virtual Observatory
- Japanese Virtual Observatory
- Netherlands Virtual Observatory
- Observatoire Virtuel France
- Russian Virtual Observatory
- South African Astroinformatics Alliance
- Spanish Virtual Observatory
- Italian Virtual Observatory
- Ukrainian Virtual Observatory
- US Virtual Observatory Alliance
- Virtual Observatory India

IVOA Contacts (1/2)

IVOA Working Group Links

Working Group Page	Previous Messages	Subscribe	Send Mail	Chair	Vice Chair
Applications	archive	options	apps@ivoa.net	TBD	Adrian Damian
Data Access Layer	archive	options	dal@ivoa.net	James Dempsey	Grégory Mantelet
Data Model	archive	options	dm@ivoa.net	Laurent Michel	Jesus Salgado
Grid & Web Services	archive	options	grid@ivoa.net	Giuliano Taffoni	Dave Morris
Registry	archive	options	registry@ivoa.net	Renaud Savalle	Tess Jaffe
Semantics	archive	options	semantics@ivoa.net	Markus Demleitner	Carlo Maria Zwölf

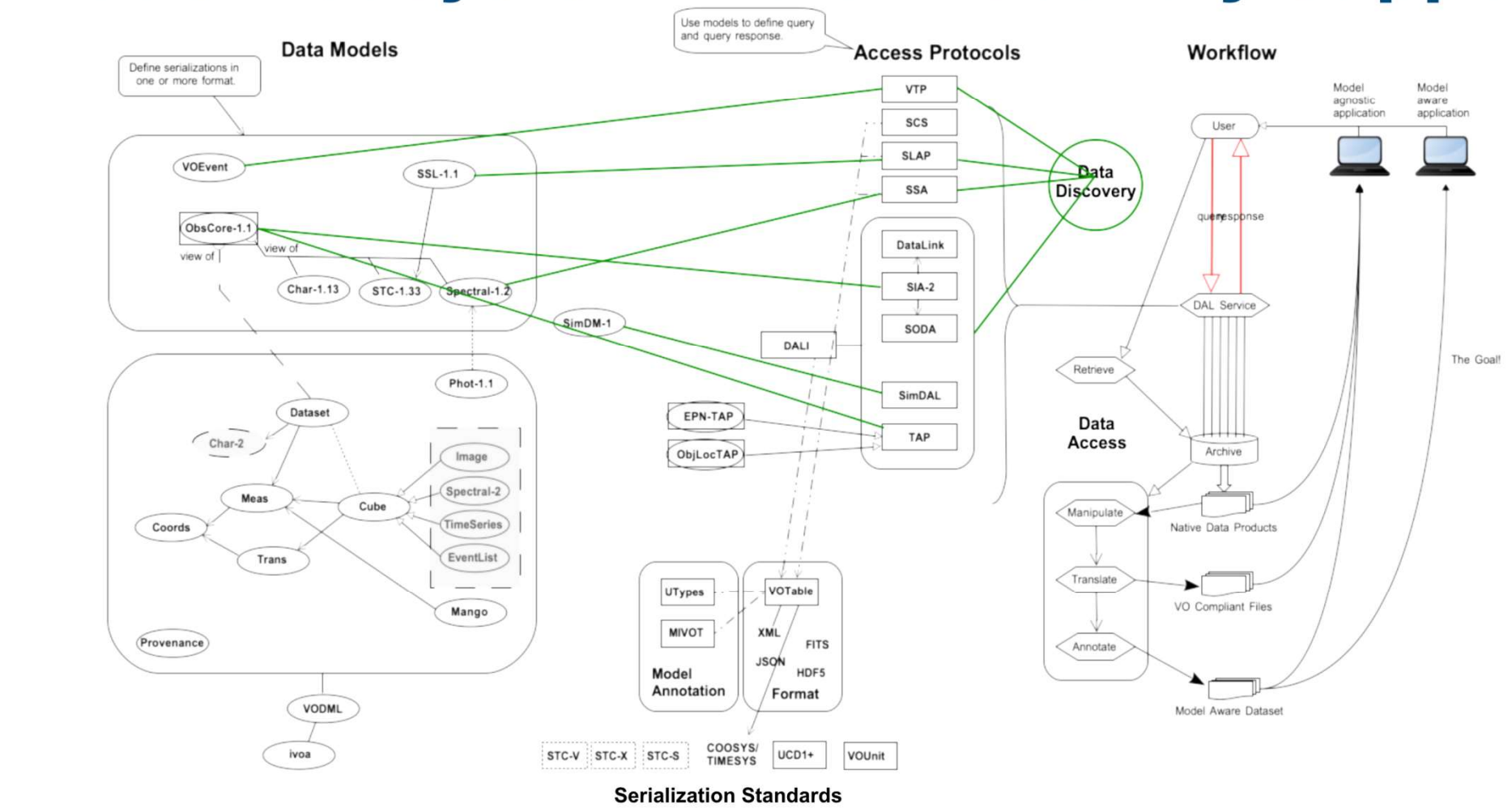
Interest Groups

Interest Group Page	Previous Messages	Subscribe	Mailing List	Chair	Vice Chair
Data Curation & Preservation	archives	options	datacp@ivoa.net	Gilles Landais	Tim Jenness
Education	archives	options	edu@ivoa.net	Hendrik Heinl	Shanshan Li
Knowledge Discovery in Databases	archives	options	kdd@ivoa.net	Raffaele d'Abrusco	Yihan Tao
Operations	archives	options	ops@ivoa.net	Mark Taylor	Steve Groom
Solar System	archives	options	ssig@ivoa.net	Anne Raugh	Baptiste Cecconi
Theory	archives	options	theory@ivoa.net	Gerard Lemson	Simon O'Toole
Time Domain	archives	options	voevent@ivoa.net	Brent Miszalski	Mark Cresitello-Dittmar
Radio	archives	options	radioig@ivoa.net	Mark Lacy	François Bonnarel

Les Standards de l'IVOA

- **VOTable** the format for tabular data for allowing interoperability (coosys, timesys, ucd, utype, VOunits, datalink) - used by many other standards
- **HiPS** more than a format for images - tailored for large data volumes
- Standards describing *web services to s*earch and transport data*:*
  - **Simple Cone search** — spatial + temporal search for catalogs
  - **Simple Image Access**
  - **Simple Spectral Access**
  - **MOC** - spatial and temporal indexing for large data volumes in complex areas of the sky
  - **TAP + ADQL** — Table Access Protocol & astronomical data query language
  - **ObsCore & ObsTAP** — description of observations
- Planning of observations: (under dev.)
  - **ObjVisSAP** — visibility of objects
  - **ObsLocTAP** — facilitate coordination of observations from different facilities
  - Alerts: **VOEvent**

Les Standards de l'IVOA



Les protocoles simples de l'OV
(accès aux données)

Protocoles "Simple"

- **Simple Cone Search** (SCS) pour les tables
  BUT: Récuperer des données de l'OV autour d'une position: (RA, Dec […]) => **VOTable**

- **Simple Image Access** (SIA) pour les images

- **Simple Spectral Access** (SSA) pour les spectres

Les accès utilisateurs aux données

Accès via…	interop	

• **Web**
  • Sesame
  • Vizier
  • Simbad
		https://cds.unistra.fr/

• **Outils IVOA**
  • TopCat
  • Aladin
  • Cassis
		https://www.ivoa.net/astronomers/applications.html

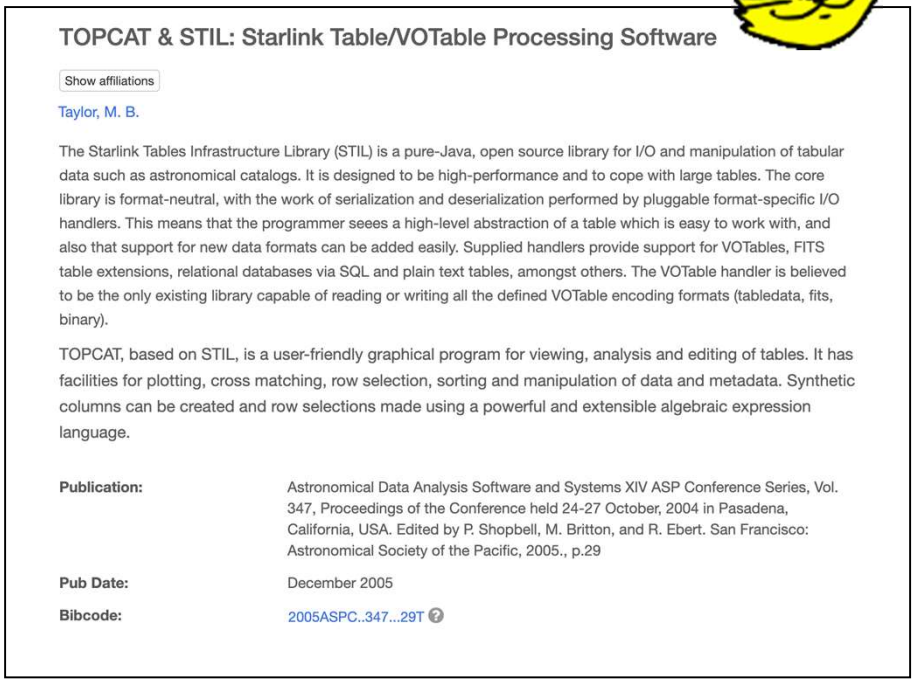
• **Modules Python**
  • AstroPy
  • PyVo
  • AstroQueries
		https://docs.python.org/3/py-modindex.html

Démo: Télécharger un catalogue avec TOPCAT

- Utilisons TOPCAT (https://www.star.bris.ac.uk/~mbt/topcat/) pour récuperer un catalogue depuis le CDS (service VizieR)

- VO / VizieR / Catalogue Selection / All rows / by Keyword: **planetary nebula** / Search Catalog

- Chargement des tables de V/84:
  - main : NP connues
  - pospn : candidats **à confirmer**
  - notpn : candidats rejetés



TOPCAT & STIL: Starlink Table/VOTable Processing Software

Show affiliations

Taylor, M. B.

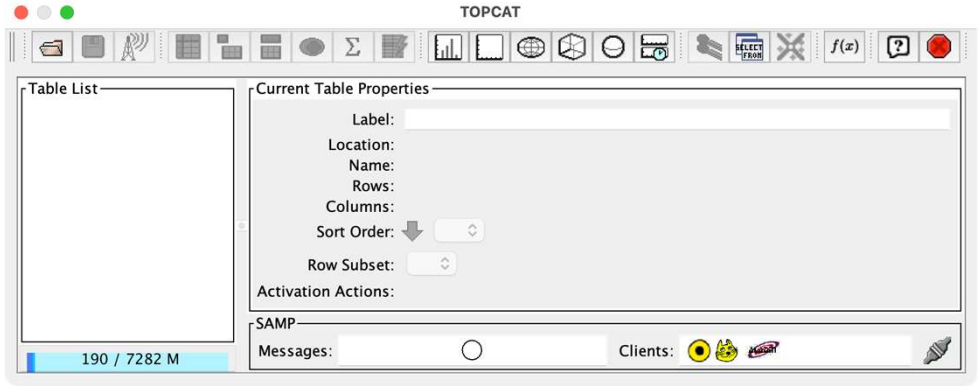
The Starlink Tables Infrastructure Library (STIL) is a pure-Java, open source library for I/O and manipulation of tabular data such as astronomical catalogs. It is designed to be high-performance and to cope with large tables. The core library is format-neutral, with the work of serialization and deserialization performed by pluggable format-specific I/O handlers. This means that the programmer seees a high-level abstraction of a table which is easy to work with, and also that support for new data formats can be added easily. Supplied handlers provide support for VOTables, FITS table extensions, relational databases via SQL and plain text tables, amongst others. The VOTable handler is believed to be the only existing library capable of reading or writing all the defined VOTable encoding formats (tabledata, fits, binary).

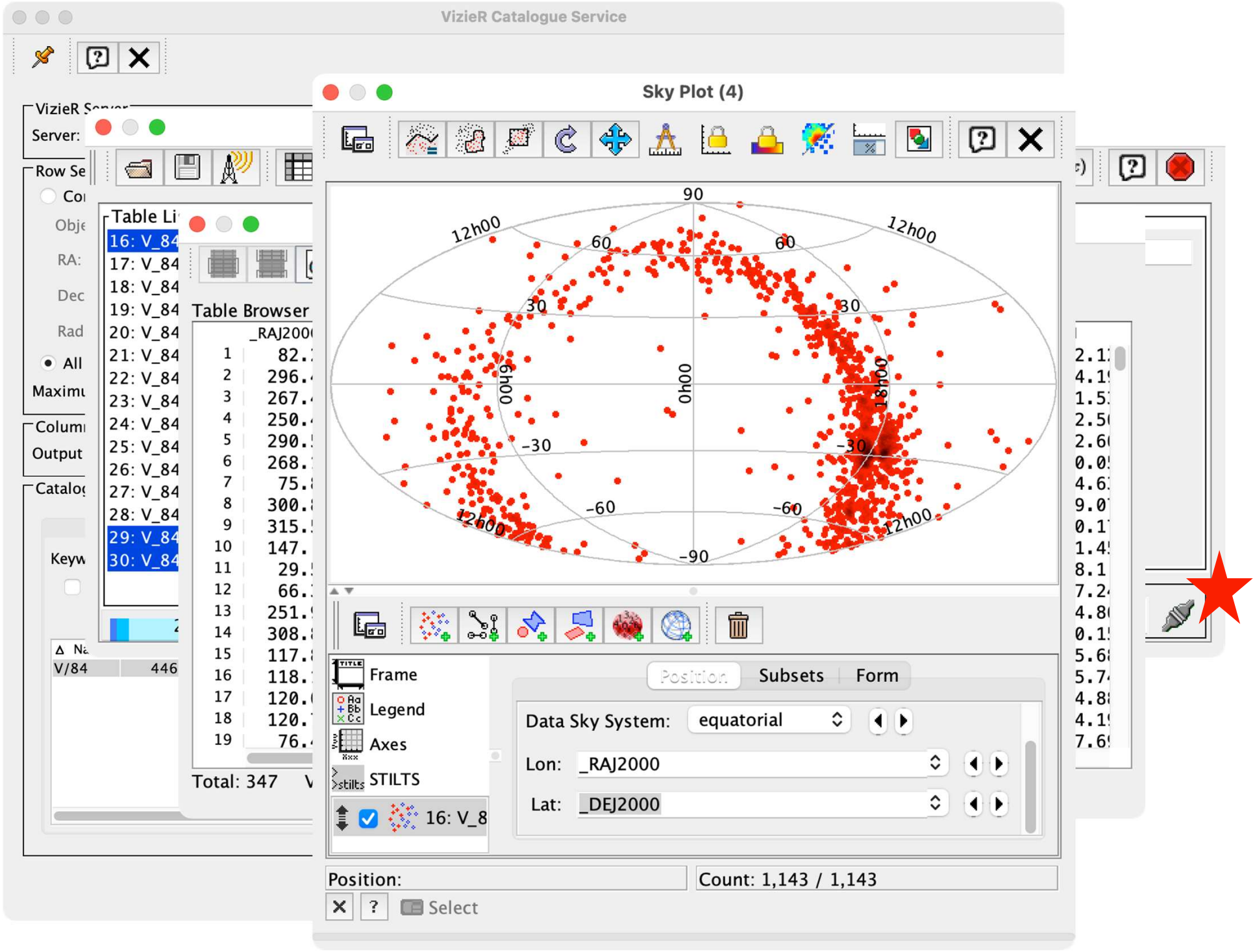
TOPCAT, based on STIL, is a user-friendly graphical program for viewing, analysis and editing of tables. It has facilities for plotting, cross matching, row selection, sorting and manipulation of data and metadata. Synthetic columns can be created and row selections made using a powerful and extensible algebraic expression language.

Publication: Astronomical Data Analysis Software and Systems XIV ASP Conference Series, Vol. 347, Proceedings of the Conference held 24-27 October, 2004 in Pasadena, California, USA. Edited by P. Shopbell, M. Britton, and R. Ebert. San Francisco: Astronomical Society of the Pacific, 2005., p.29

Pub Date: December 2005

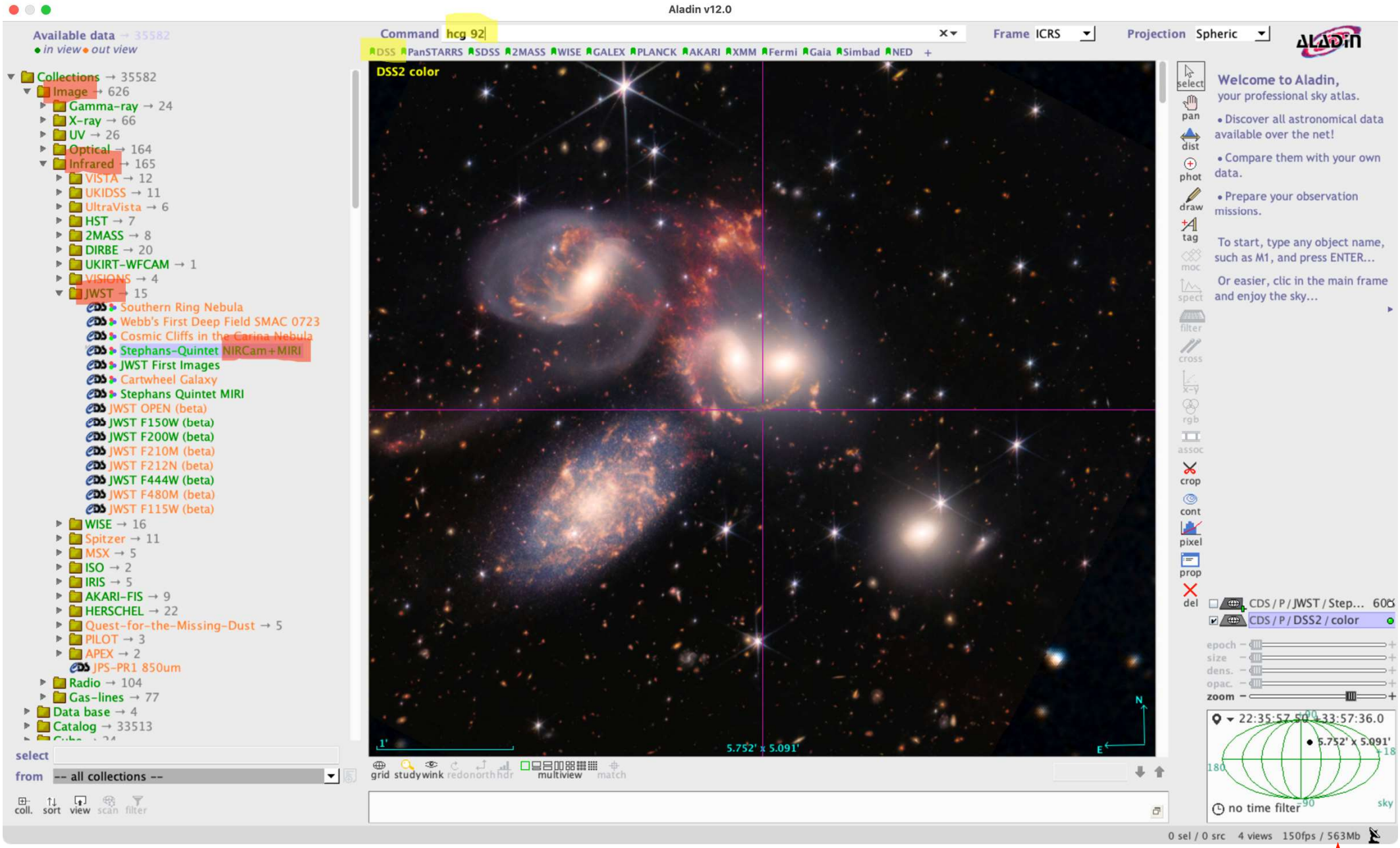
Bibcode: 2005ASPC..347...29T




VizieR Catalogue Service
Sky Plot (4)
Table Browser
Frame
Legend
Axes
STILTS
Position
Subsets
Form
Data Sky System:
equatorial
Lon:
_RAJ2000
Lat:
_DEJ2000
Position:
Count: 1,143 / 1,143
Select
Total: 347

Accès aux images avec Aladin

- Command: HCG 92 => DSS2
- OV=Arbre des collections => Image/Infrared/JWST
  - NIRCam+MIRI / MIRI
- L'arbre est mis a jour en fonction du FOV de l'image affichée (via la couverture spatiale)
- Réalisation d'une composition d'image (transparence)


Aladin v12.0
Available data → 35582
in view out view
Collections → 35582
Image → 626
Gamma-ray → 24
X-ray → 66
UV → 26
Optical → 164
Infrared → 165
VISTA → 12
UKIDSS → 11
UltraVista → 6
HST → 7
2MASS → 8
DIRBE → 20
UKIRT-WFCAM → 1
VISIONS → 4
JWST → 15
Southern Ring Nebula
Webb's First Deep Field SMAC 0723
Cosmic Cliffs in the Carina Nebula
Stephans-Quintet NIRCam+MIRI
JWST First Images
Cartwheel Galaxy
Stephans Quintet MIRI
JWST OPEN (beta)
JWST F150W (beta)
JWST F200W (beta)
JWST F210M (beta)
JWST F212N (beta)
JWST F444W (beta)
JWST F480M (beta)
JWST F115W (beta)
WISE → 16
Spitzer → 11
MSX → 5
ISO → 2
IRIS → 5
AKARI-FIS → 9
HERSCHEL → 22
Quest-for-the-Missing-Dust → 5
PILOT → 3
APEX → 2
JPS-PR1 850um
Radio → 104
Gas-lines → 77
Data base → 4
Catalog → 33513
select
from -- all collections --
coll. sort view scan filter
Command hcg 92
Frame ICRS
Projection Spheric
DSS PanSTARRS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED
DSS2 color
1'
5.752' x 5.091'
N
E
grid study wink redo north hdr multiview match
select pan dist phot draw tag moc spect filter cross rgb assoc crop cont pixel prop del
Welcome to Aladin,
your professional sky atlas.
• Discover all astronomical data available over the net!
• Compare them with your own data.
• Prepare your observation missions.
To start, type any object name, such as M1, and press ENTER...
Or easier, clic in the main frame and enjoy the sky...
CDS / P / JWST / Step...
CDS / P / DSS2 / color
epoch
size
dens.
opac.
zoom
22:35:57.500 -33:57:36.0
5.752' x 5.091'
no time filter
sky
0 sel / 0 src 4 views 150fps / 563Mb

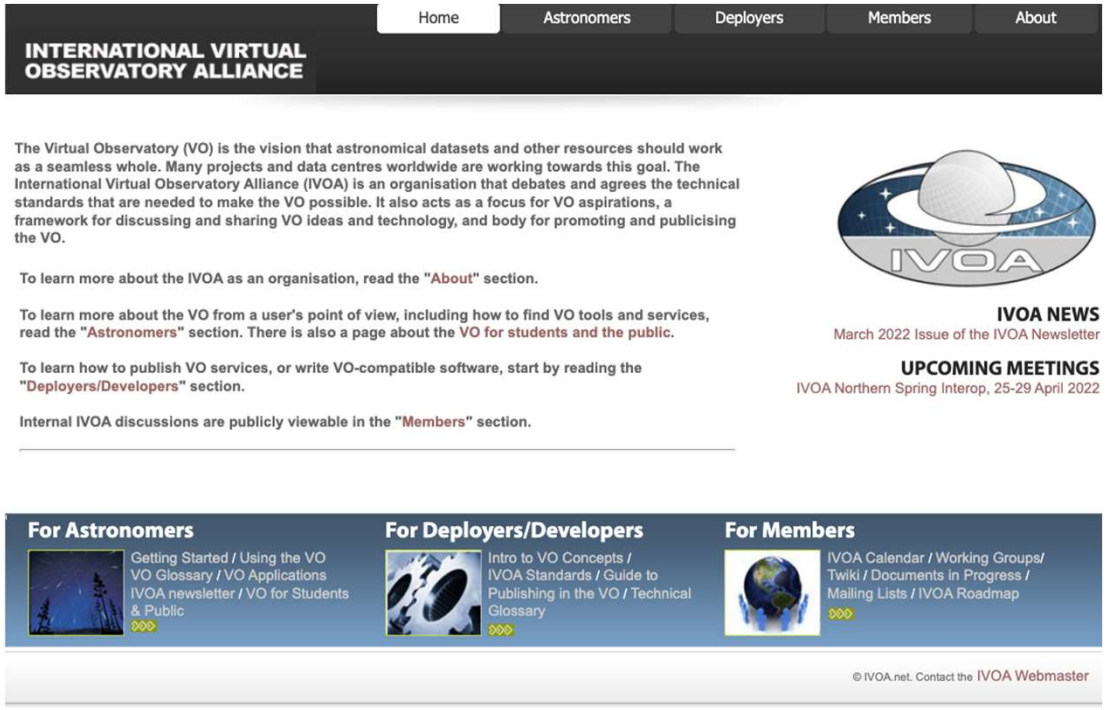
PRISM et l'OV: Démo Lundi

- Interopérabilité avec les outils IVOA et plus
  (Aladin, Topcat, Carte du ciel, Cassis, Sharpcap 😇)
- Affichage des alertes
  (Transients)
- Console Python
  (Accès algorithmique)

WIVONA
We Implement
Virtual Observatory
Needs of Astrams

Tutoriel IVOA

- Web site
  - **https://ivoa.net/**
- Wiki
  - https://wiki.ivoa.net/
- Newsletter
  - https://ivoa.net/newsletter
- Social Media
  - Twitter: https://twitter.com/IVOAastro
  - Facebook: https://www.facebook.com/IVOAastro
- Education Interest Group
  - https://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaEducation



Tutoriel Python

- Langage Python : nombreux tutoriel via Google
- Notebook OV : **t.ly/ugxOR**
- Fichier/Sauver dans votre Google Drive (gratuit)
- Utiliser Google Colab
  - Exécution du code pas a pas

BACKUP SLIDES

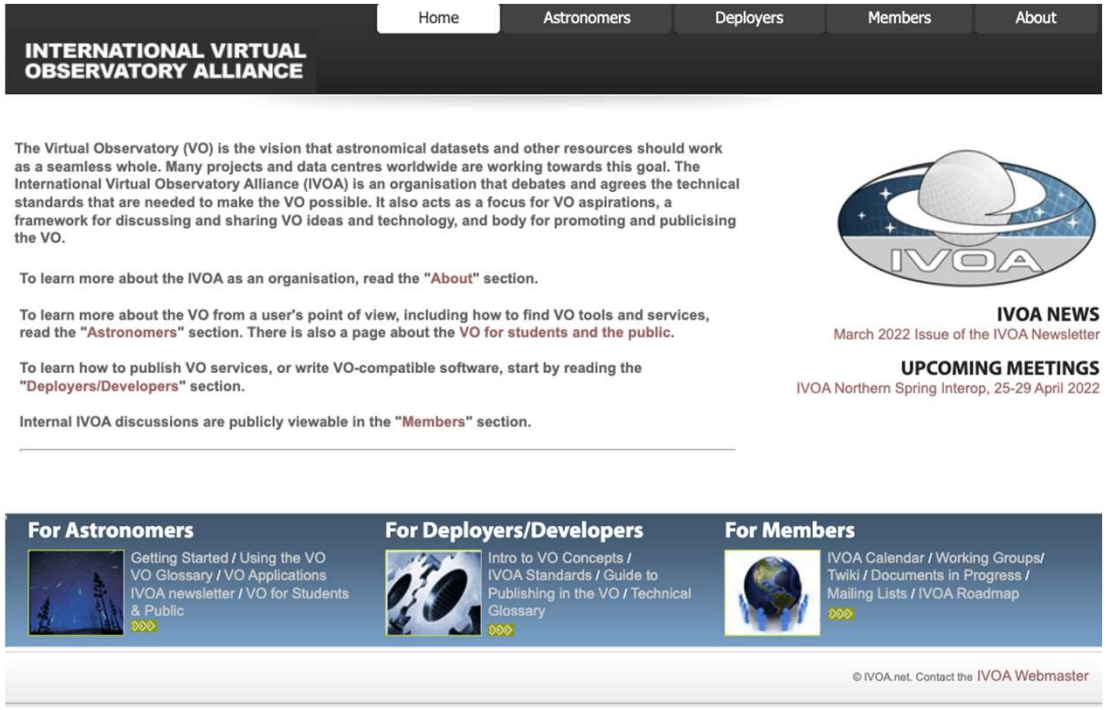
Who is the IVOA ?

A structured organization

- **5 Committees**
  - Executive
  - Technical Coordination Group
  - Standards and Processes
  - Media
  - Science Priorities
- **6 Working Groups (WGs)**
  - Data Models
  - Semantics
  - Data Access
  - Grids and Web Services
  - Registry
  - Applications
- **8 Interest Groups (IGs)**
  - Time-domain
  - Radio
  - Solar System
  - Education
  - Data Curation
  - Knowledge and Discovery
  - Theory
  - Operations

Where to start with the IVOA ?

- Web site
  - **https://ivoa.net/**
- Wiki
  - https://wiki.ivoa.net/
- Newsletter
  - https://ivoa.net/newsletter
- Social Media
  - Twitter: https://twitter.com/IVOAastro
  - Facebook: https://www.facebook.com/IVOAastro
- Education Interest Group
  - https://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaEducation



IVOA Contacts (1/2)

IVOA Working Group Links

Working Group Page	Previous Messages	Subscribe	Send Mail	Chair	Vice Chair
Applications	archive	options	apps@ivoa.net	TBD	Adrian Damian
Data Access Layer	archive	options	dal@ivoa.net	James Dempsey	Grégory Mantelet
Data Model	archive	options	dm@ivoa.net	Laurent Michel	Jesus Salgado
Grid & Web Services	archive	options	grid@ivoa.net	Giuliano Taffoni	Dave Morris
Registry	archive	options	registry@ivoa.net	Renaud Savalle	Tess Jaffe
Semantics	archive	options	semantics@ivoa.net	Markus Demleitner	Carlo Maria Zwölf

Interest Groups

Interest Group Page	Previous Messages	Subscribe	Mailing List	Chair	Vice Chair
Data Curation & Preservation	archives	options	datacp@ivoa.net	Gilles Landais	Tim Jenness
Education	archives	options	edu@ivoa.net	Hendrik Heinl	Shanshan Li
Knowledge Discovery in Databases	archives	options	kdd@ivoa.net	Raffaele d'Abrusco	Yihan Tao
Operations	archives	options	ops@ivoa.net	Mark Taylor	Steve Groom
Solar System	archives	options	ssig@ivoa.net	Anne Raugh	Baptiste Cecconi
Theory	archives	options	theory@ivoa.net	Gerard Lemson	Simon O'Toole
Time Domain	archives	options	voevent@ivoa.net	Brent Miszalski	Mark Cresitello-Dittmar
Radio	archives	options	radioig@ivoa.net	Mark Lacy	François Bonnarel

IVOA Contacts (2/2)

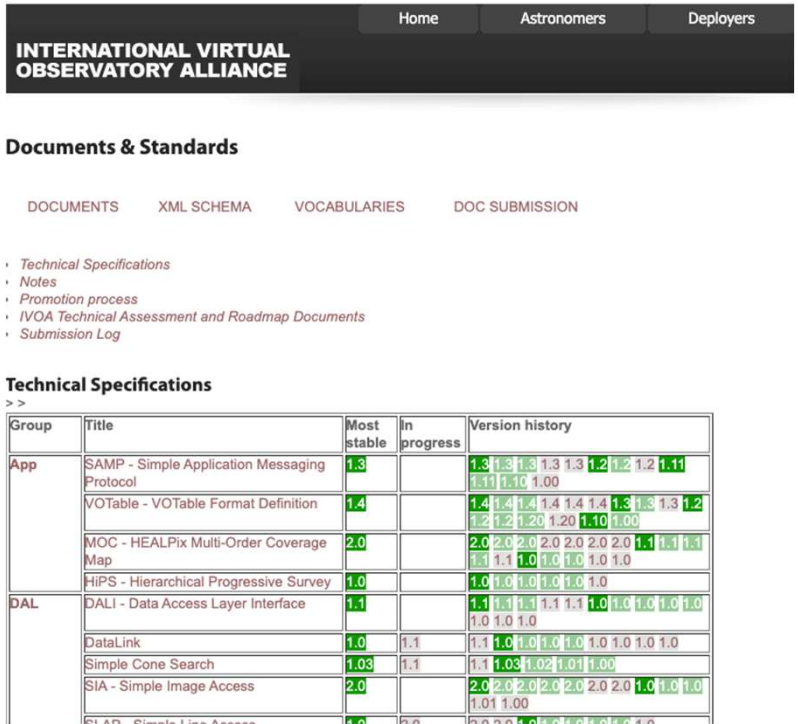
Other Groups/Committees/Activities

Group/Committee Page	Previous Messages	Subscribe	Mailing List	Chair	Vice Chair
Interop	archives	options	interop@ivoa.net	N/A	N/A
Exec			exec@ivoa.net	Bruce Berriman	Severin Gaudet
Technical Coordination Group			tcg@ivoa.net	Janet Evans	Marco Molinaro
Liaison Committee				Masatoshi Ohishi	
Standing Committee on Science Priorities				Ada Nebot	Francesca Civano
Standing Committee on Standards & Processes	archives	options	stdproc@ivoa.net	Patricia Dowler	N/A
IVOA Document Coordinator			ivoadoc@ivoa.net	Giulia Iafrate	N/A

From https://www.ivoa.net/members/index.html

The IVOA Standard Process

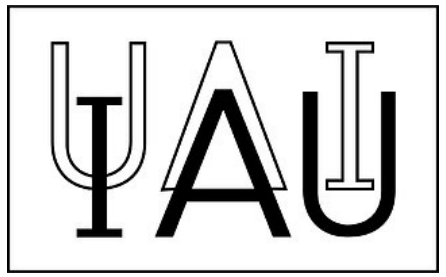
- The Recommendation Process
- Standards in progress are on Github: https://github.com/ivoa-std
- All published standards: https://www.ivoa.net/documents/



VOTable: exemple

```
▼<VOTABLE xmlns="http://www.ivoa.net/xml/VOTable/v1.3" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.4"
 xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.3 http://www.ivoa.net/xml/VOTable/votable-1.4.xsd">
 ▼<RESOURCE type="results">
    <INFO name="QUERY_STATUS" value="OK"/>
   ▼<INFO name="QUERY" value=" SELECT * FROM gaiadr3.gaia_source WHERE CONTAINS(POINT('ICRS',gaiadr3.gaia_source.ra,gaiadr3.gaia_source.dec),BOX('ICRS',
    11.255999999999998, 41.45926388888889 , 0.019444444444444445, 0.019444444444444445))=1 ">
      <![CDATA[ SELECT * FROM gaiadr3.gaia_source WHERE CONTAINS(POINT('ICRS',gaiadr3.gaia_source.ra,gaiadr3.gaia_source.dec),BOX('ICRS', 11.255999999999998,
      41.45926388888889 , 0.019444444444444445, 0.019444444444444445))=1 ]]>
    </INFO>
   ▼<INFO name="CAPTION" value="How to cite and acknowledge Gaia: https://gea.esac.esa.int/archive/documentation/credits.html">
      <![CDATA[ How to cite and acknowledge Gaia: https://gea.esac.esa.int/archive/documentation/credits.html ]]>
    </INFO>
    <INFO name="PAGE" value=""/>
    <INFO name="PAGE_SIZE" value=""/>
   ▼<INFO name="JOBID" value="16560935450590">
      <![CDATA[ 16560935450590 ]]>
    </INFO>
    <INFO name="JOBNAME" value=""/>
    <COOSYS ID="GAIADR3" epoch="J2016.0" system="ICRS"/>
   ▼<RESOURCE>
      <COOSYS ID="t232771-coosys-1" epoch="J2016.0" system="ICRS"/>
    </RESOURCE>
   ▼<TABLE>
     ▼<FIELD datatype="long" name="solution_id" ucd="meta.version">
        <DESCRIPTION>Solution Identifier</DESCRIPTION>
      </FIELD>
     ▼<FIELD ID="DESIGNATION" arraysize="*" datatype="char" name="designation" ucd="meta.id;meta.main">
        <DESCRIPTION>Unique source designation (unique across all Data Releases)</DESCRIPTION>
      </FIELD>
     ▼<FIELD datatype="long" name="source_id" ucd="meta.id">
        <DESCRIPTION>Unique source identifier (unique within a particular Data Release)</DESCRIPTION>
      </FIELD>
     ▼<FIELD datatype="long" name="random_index" ucd="meta.code">
        <DESCRIPTION>Random index for use when selecting subsets</DESCRIPTION>
      </FIELD>
     ▼<FIELD datatype="double" name="ref_epoch" ucd="meta.ref;time.epoch" unit="yr" utype="stc:AstroCoords.Time.TimeInstant">
        <DESCRIPTION>Reference epoch</DESCRIPTION>
      </FIELD>
     ▼<FIELD datatype="double" name="ra" ref="t232771-coosys-1" ucd="pos.eq.ra;meta.main" unit="deg" utype="stc:AstroCoords.Position3D.Value3.C1">
        <DESCRIPTION>Right ascension</DESCRIPTION>
      </FIELD>
     ▼<FIELD datatype="float" name="ra_error" ucd="stat.error;pos.eq.ra" unit="mas" utype="stc:AstroCoords.Position3D.Error3.C1">
        <DESCRIPTION>Standard error of right ascension</DESCRIPTION>
      </FIELD>
     ▼<FIELD datatype="double" name="dec" ref="t232771-coosys-1" ucd="pos.eq.dec;meta.main" unit="deg" utype="stc:AstroCoords.Position3D.Value3.C2">
        <DESCRIPTION>Declination</DESCRIPTION>
```

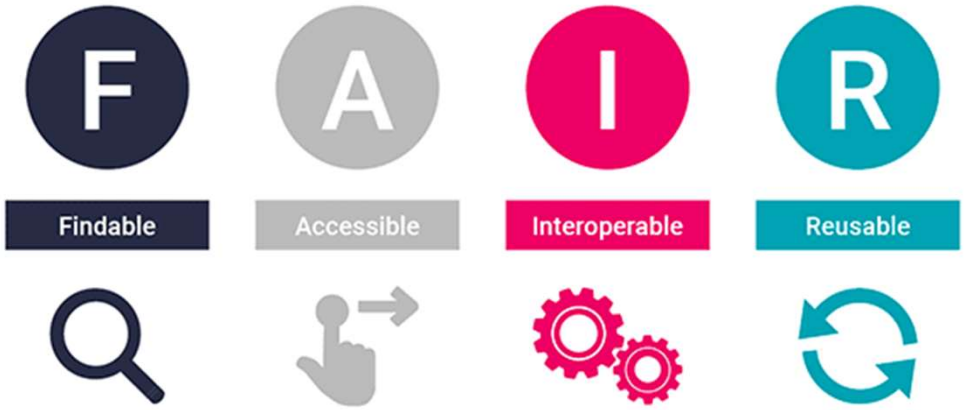
The IVOA and the IAU



- IVOA
  - IVOA standards can be endorsed by the IAU (Commission 5)
- IAU
  - A IAU A Working Group “Virtual Astronomy and Data Centres“ has been formed in Commission B2 of the International Astronomical Union.

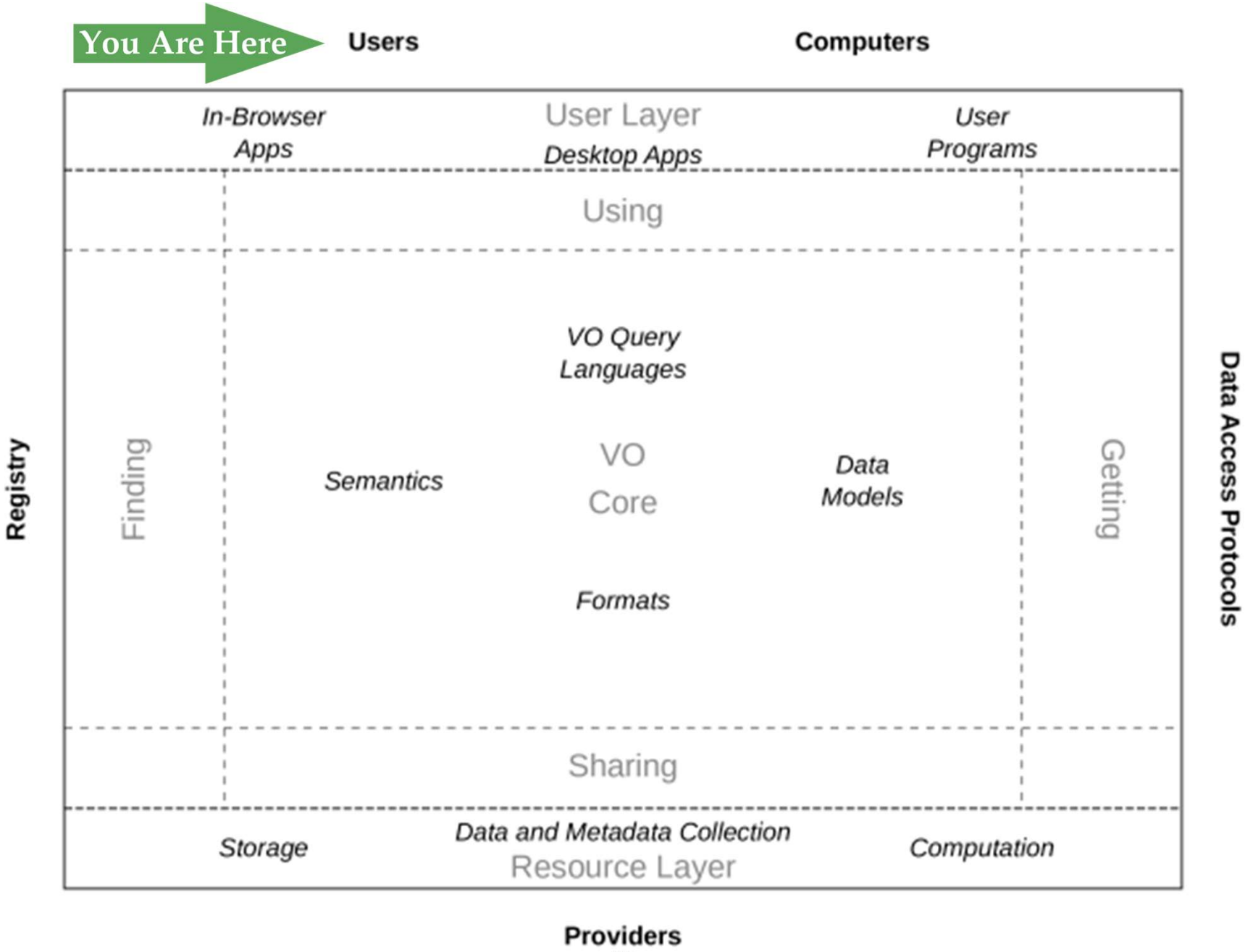
Open Science and the FAIR Principles

- Data should be:
  - Findable
  - Accessible
  - Interoperable
  - Reusable

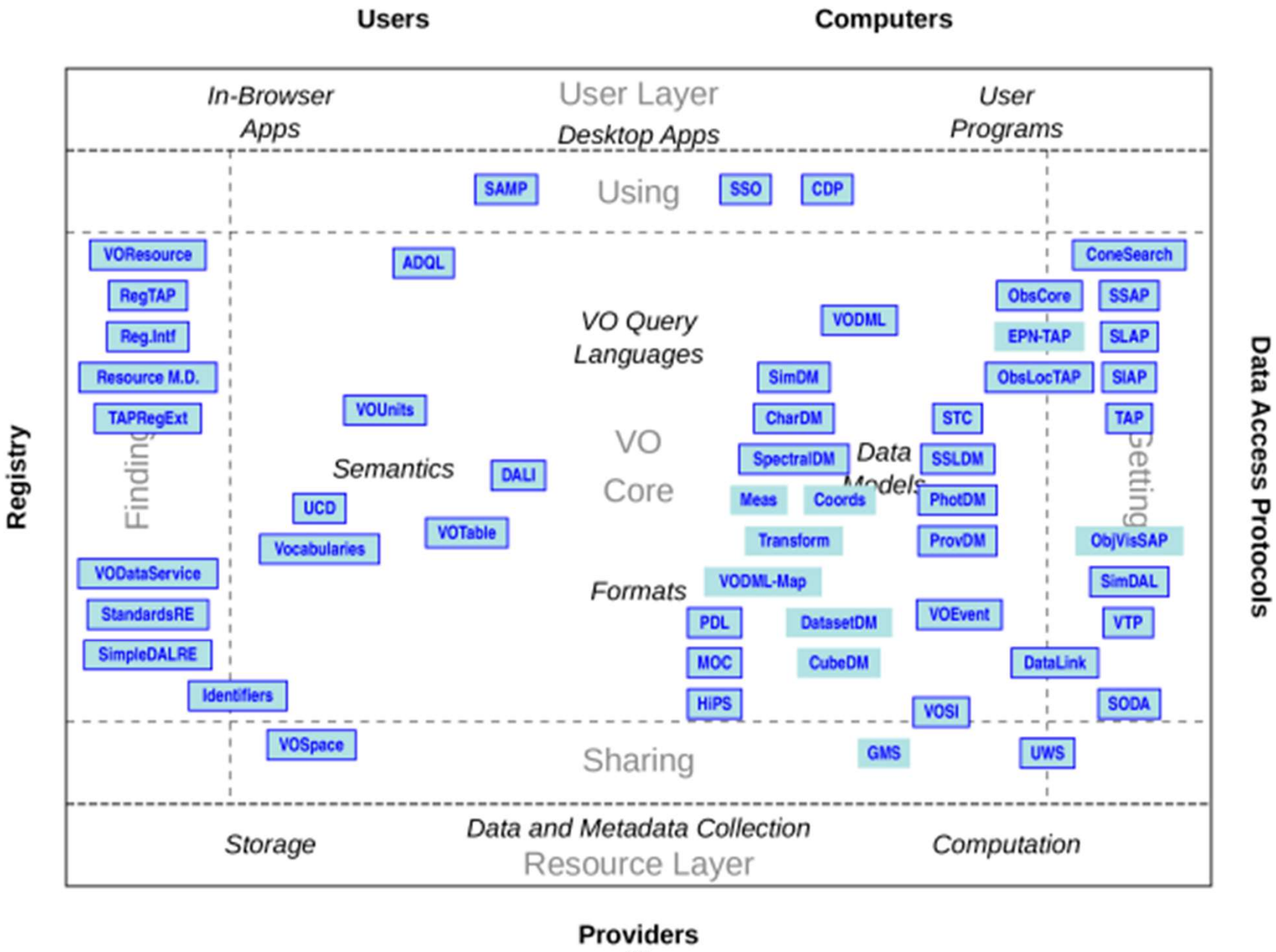


- https://www.go-fair.org/fair-principles/
- Where do we stand ?
  - FAIR standards for astronomical data by Simon O'Toole, James Tocknell https://arxiv.org/abs/2203.10710

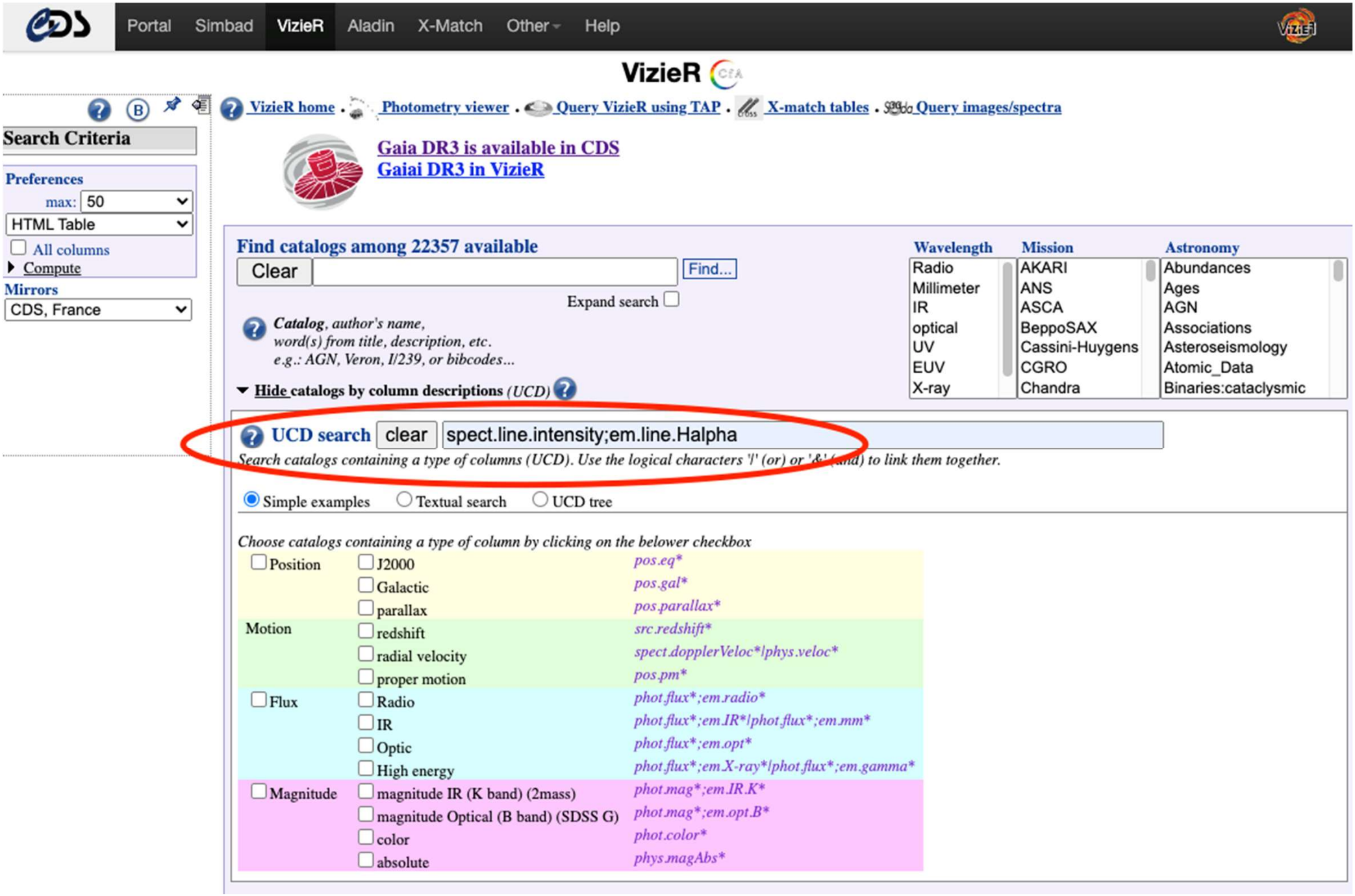
The IVOA Architecture (1/2)



The IVOA Architecture (2/2)



UCD Example (1/2)



UCD Example (2/2)

Portal | Simbad | VizieR | Aladin | X-Match | Other | Help

Catalog

Search Criteria
Keywords
- spect.line.inten...

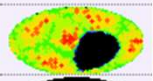
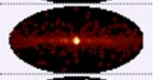
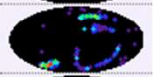
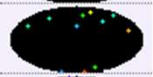
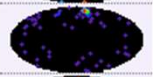
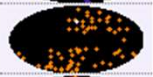
Preferences
max: 50
HTML Table
All columns
Compute

Mirrors
CDS, France

Gaia DR3 is available in CDS
Gaiai DR3 in VizieR

17 catalogs found

ALL | Reset All | Show table details | *or* | Query selected Catalogs

II/249	(c) WHAM Northern Sky Survey, V-1.1 (Haffner+, 2003) 37k		2003ApJS..149..405H	ReadMe+ftp	
III/177	(c) H-alpha emission stars in the Orion region (Wiramihardja+ 1993) 1k		1989PASJ...41..155W	ReadMe+ftp	
V/84	(c) Strasbourg-ESO Catalogue of Galactic Planetary Nebulae (Acker+, 1992) 14k		1992ESOPN...1....1A	ReadMe+ftp	
J/ApJ/858/90	(c) Radial profiles of 5 nearby galaxies (Gallagher+, 2018) 102		2018ApJ...858...90G	ReadMe+ftp	
J/A+A/453/493	53 Line-strength indices in IC 4200 (Serra+, 2006)	Objects	2006A&A...453..493S	ReadMe+ftp	
J/A+A/513/A65	(c) Rotation measures in the fourth Galactic quadrant (Nota+, 2010) 372		2010A&A...513A..65N	ReadMe+ftp	
J/A+A/534/A53	(c) Equivalent widths of 18 subgiant of ω Cen (Pancino+, 2011) 607		2011A&A...534A..53P	ReadMe+ftp	
J/A+A/560/A30	286 Hα spectra of π Aqr (Zharikov+, 2013)	timeSerie spectrum/fits Objects	2013A&A...560A..30Z	ReadMe+ftp	
J/A+A/570/A30	(c) Hα emission-line stars in M42 (Pettersson+, 2014) 1k		2014A&A...570A..30P	ReadMe+ftp	
J/A+A/591/A74	(c) Nebular emission lines towards NGC3372 center (Damiani+, 2016) 866		2016A&A...591A..74D	ReadMe+ftp	
J/A+AS/91/285	(c) HII galaxies spectrophotometric catalogue (Terlevich+, 1991) 1k		1991A&AS...91..285T	ReadMe+ftp	
J/A+AS/104/233	(c) Emission-line stars in Vela Molecular Ridge (Pettersson+ 1994) 278		1994A&AS..104..233P	ReadMe+ftp	
J/AJ/130/1324	(c) Faint emission-line galaxies at z≤1.6 (Drozdovsky+, 2005) 601		2005AJ....130.1324D	ReadMe+ftp	
J/AJ/131/716	(c) Hα scale length in Virgo and field spirals (Koopmann+, 2006) 103		2006AJ....131..716K	ReadMe+ftp	
J/MNRAS/460/1758	(c) Optical emission lines in galaxy cluster cores 1 (Hamer+, 2016) 292		2016MNRAS.460.1758H	ReadMe+ftp	

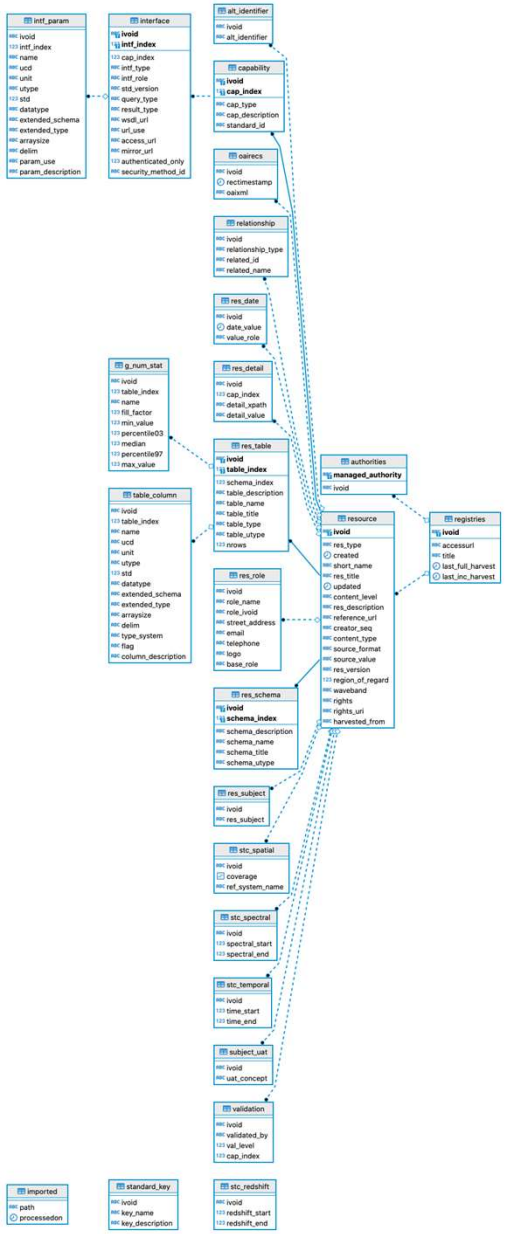
A few high level IVOA Standards

- **VOTable** the format for tabular data for allowing interoperability (coosys, timesys, ucd, utype, VOunits, datalink) - used by many other standards
- **HiPS** more than a format for images - tailored for large data volumes
- Standards describing *web services to s*earch and transport data*:*
  - **Simple Cone search** — spatial + temporal search for catalogs
  - **Simple Image Access**
  - **Simple Spectral Access**
  - **MOC** — spatial and temporal indexing for large data volumes in complex areas of the sky
  - **TAP + ADQL** — Table Access Protocol & astronomical data query language
  - **ObsCore & ObsTAP** — description of observations
- Planning of observations: (under dev.)
  - **ObjVisSAP** — visibility of objects
  - **ObsLocTAP** — facilitate coordination of observations from different facilities
  - Alerts: **VOEvent**

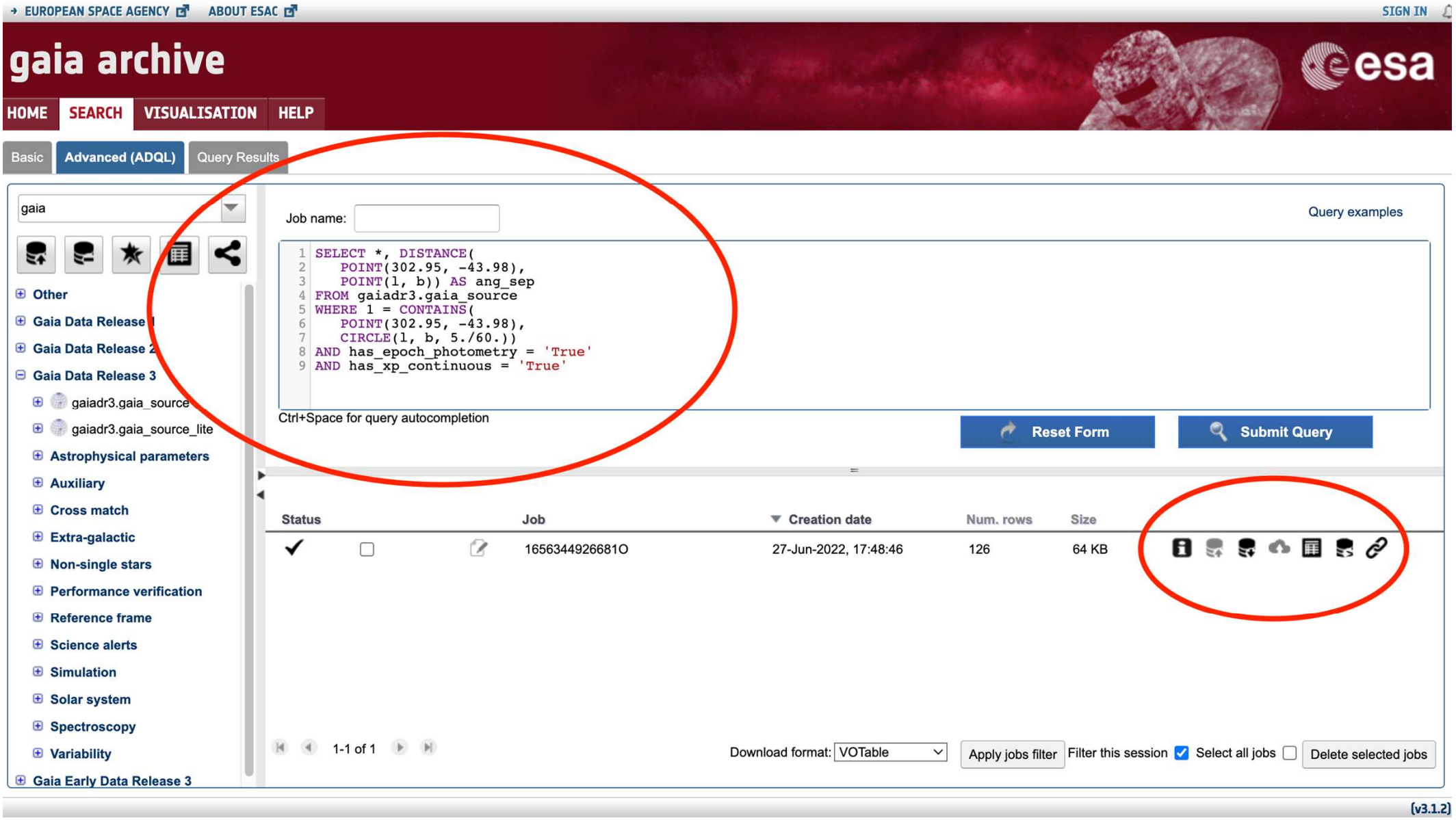
The IVOA Registry

The “yellow pages” of the VO

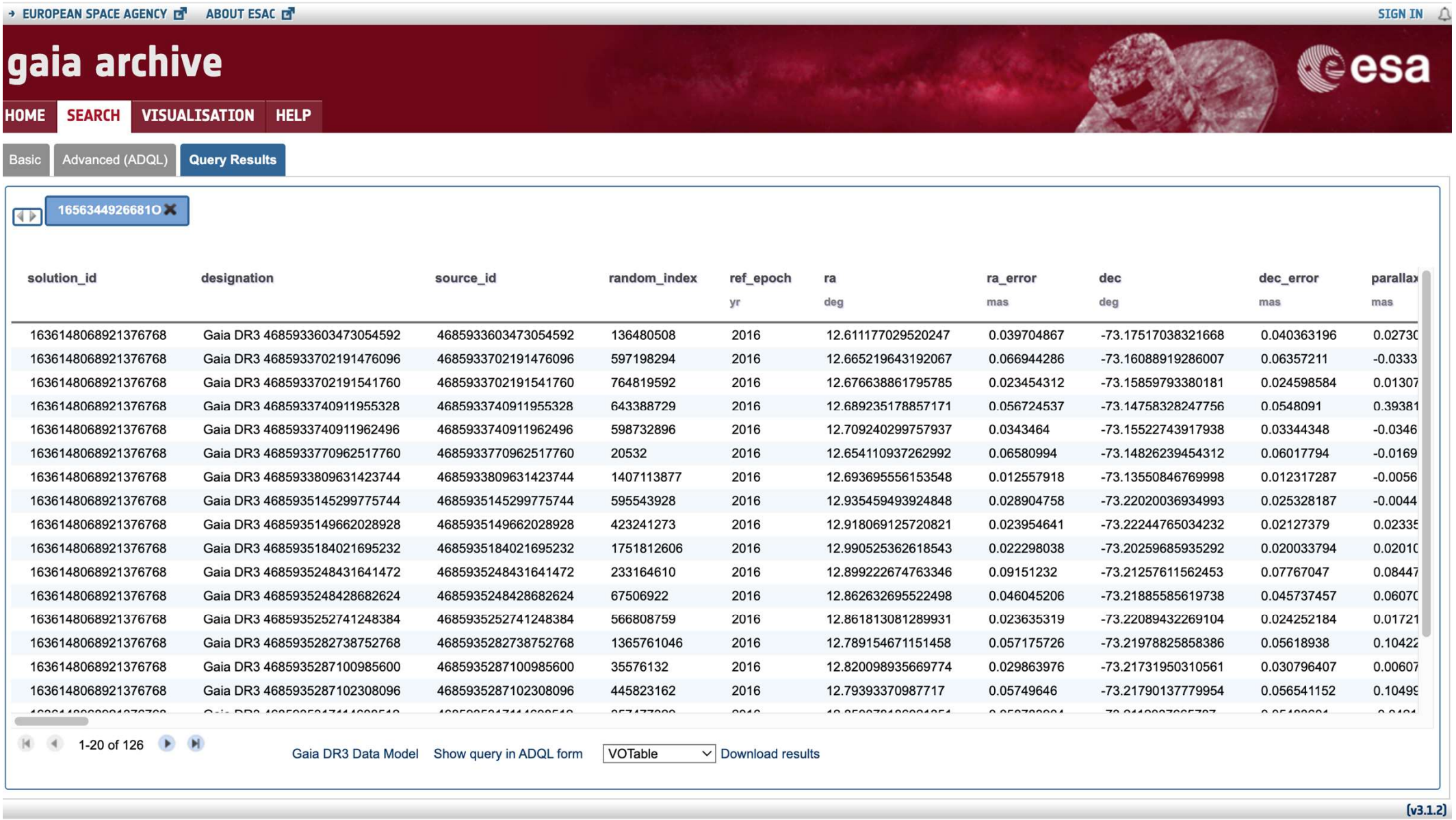
- **F**AIR: Data must be F**I**NDABLE
- A decentralized database for the VO resources
- The Registry of Registries lists all publishing registries
- Publishing Registries are harvested using the OAI protocols into Full Searchable Registries (FSR)
- FSR data is consolidated into a SQL database: the RegTAP
- Client applications query the RegTAP using TAP+ADQL
  - By service type
  - By keyword
  - By position, coverage…



ADQL+TAP: Gaia DR3 Example (1/3)

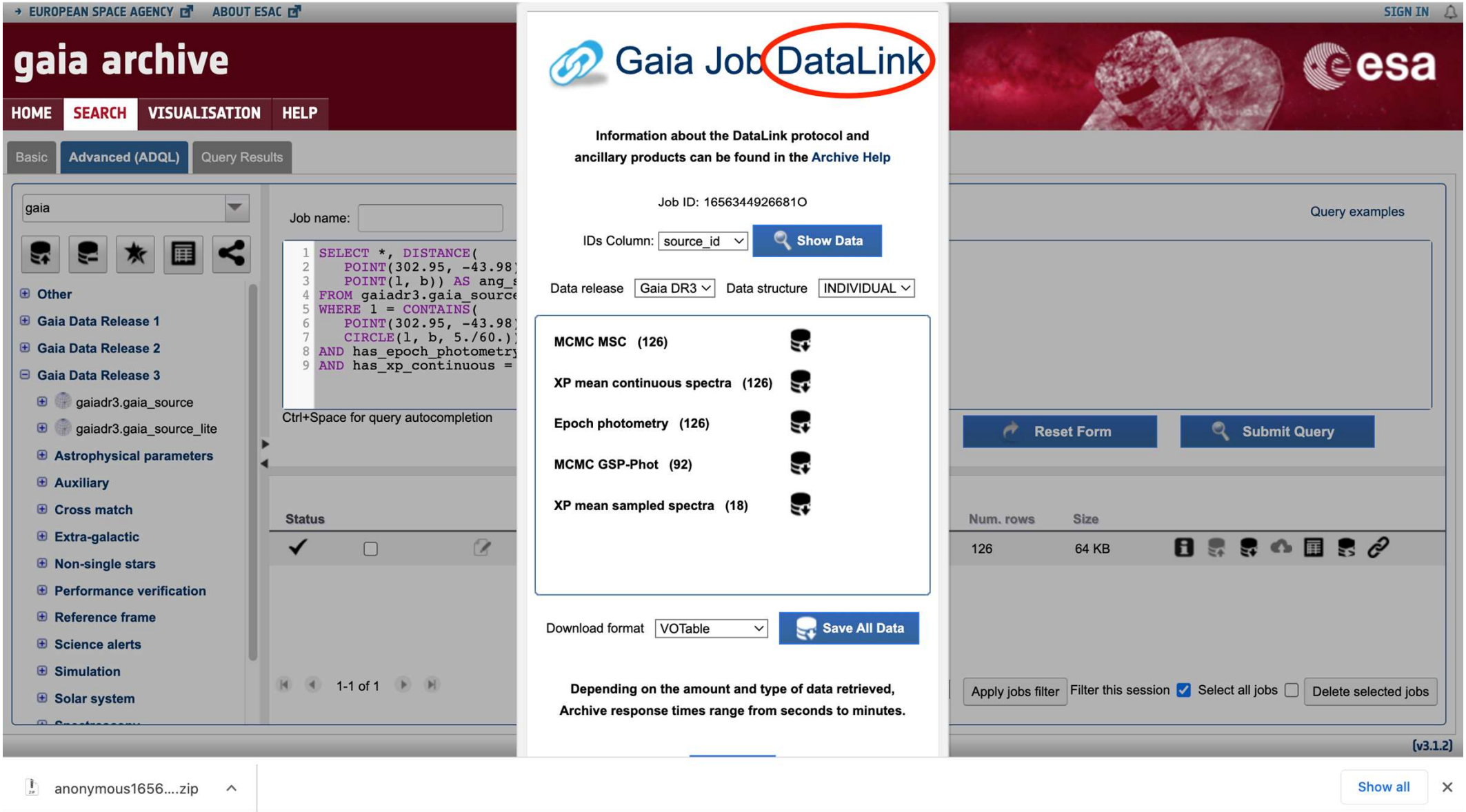


ADQL+TAP: Gaia DR3 Example (2/3)



solution_id	designation	source_id	random_index	ref_epoch yr	ra deg	ra_error mas	dec deg	dec_error mas	parallax mas
1636148068921376768	Gaia DR3 4685933603473054592	4685933603473054592	136480508	2016	12.611177029520247	0.039704867	-73.17517038321668	0.040363196	0.0273(
1636148068921376768	Gaia DR3 4685933702191476096	4685933702191476096	597198294	2016	12.665219643192067	0.066944286	-73.16088919286007	0.06357211	-0.0333
1636148068921376768	Gaia DR3 4685933702191541760	4685933702191541760	764819592	2016	12.676638861795785	0.023454312	-73.15859793380181	0.024598584	0.01307
1636148068921376768	Gaia DR3 4685933740911955328	4685933740911955328	643388729	2016	12.689235178857171	0.056724537	-73.14758328247756	0.0548091	0.39381
1636148068921376768	Gaia DR3 4685933740911962496	4685933740911962496	598732896	2016	12.709240299757937	0.0343464	-73.15522743917938	0.03344348	-0.0346
1636148068921376768	Gaia DR3 4685933770962517760	4685933770962517760	20532	2016	12.654110937262992	0.06580994	-73.14826239454312	0.06017794	-0.0169
1636148068921376768	Gaia DR3 4685933809631423744	4685933809631423744	1407113877	2016	12.693695556153548	0.012557918	-73.13550846769998	0.012317287	-0.0056
1636148068921376768	Gaia DR3 4685935145299775744	4685935145299775744	595543928	2016	12.935459493924848	0.028904758	-73.22020036934993	0.025328187	-0.0044
1636148068921376768	Gaia DR3 4685935149662028928	4685935149662028928	423241273	2016	12.918069125720821	0.023954641	-73.22244765034232	0.02127379	0.02335
1636148068921376768	Gaia DR3 4685935184021695232	4685935184021695232	1751812606	2016	12.990525362618543	0.022298038	-73.20259685935292	0.020033794	0.0201(
1636148068921376768	Gaia DR3 4685935248431641472	4685935248431641472	233164610	2016	12.899222674763346	0.09151232	-73.21257611562453	0.07767047	0.08447
1636148068921376768	Gaia DR3 4685935248428682624	4685935248428682624	67506922	2016	12.862632695522498	0.046045206	-73.21885585619738	0.045737457	0.0607(
1636148068921376768	Gaia DR3 4685935252741248384	4685935252741248384	566808759	2016	12.861813081289931	0.023635319	-73.22089432269104	0.024252184	0.01721
1636148068921376768	Gaia DR3 4685935282738752768	4685935282738752768	1365761046	2016	12.789154671151458	0.057175726	-73.21978825858386	0.05618938	0.10422
1636148068921376768	Gaia DR3 4685935287100985600	4685935287100985600	35576132	2016	12.820098935669774	0.029863976	-73.21731950310561	0.030796407	0.00607
1636148068921376768	Gaia DR3 4685935287102308096	4685935287102308096	445823162	2016	12.79393370987717	0.05749646	-73.21790137779954	0.056541152	0.10499

ADQL+TAP: Gaia DR3 Example (3/3)



Publishing in the VO

- https://wiki.ivoa.net/twiki/bin/view/IVOA/PublishingInTheVO
- Prepare metadata
- Organize data (DB)
- Publish data: DIY or use a toolkit ?
  - Reading the specs and implementing the standards
  - Re-using server software (ex: for TAP/ADQL: GAVO dachs, CDS VOLLT…)
- Register your services so they appear in client applications
  - Create a Publishing Registry
  - Register your service in public Registries: EURO-VO, NAVO

IVOA Education Interest Group

- https://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaEducation
- Tutorials
  - https://wiki.ivoa.net/twiki/bin/view/IVOA/EduResourcesTutorials
  - https://www.euro-vo.org/scientific-tutorials/
  - http://vo-for-education.oats.inaf.it/
  - http://cdsweb.u-strasbg.fr/tutorials/
  - https://svo.cab.inta-csic.es/main/index.php *in spanish !*

LOGICIELS

- **Aladin** https://aladin.cds.unistra.fr/
- **TOPCAT** http://www.star.bris.ac.uk/~mbt/topcat/

Les principes « FAIR »

***F**indable, **A**ccessible, **I**nteroperable, **R**eusable*

- **F :** Les données doivent être ***findable*** (faciles à trouver) et identifiables par les humains et les machines :
  - → **catalogues, métadonnées**, mots clés issus de **thésaurus** disciplinaires,
  - → identifiants uniques et pérennes (DOI)

- **A :** Les données doivent être **accessibles** facilement, avec des conditions connues :
  - → des licences claires, des protocoles « ouverts »,
  - → données présentes dans des entrepôt certifiés … et accessibles

- **I :** Les données doivent êtres **interopérables** à plusieurs niveaux :
  - **Sémantique** : **vocabulaires contrôlés, métadonnées disciplinaires** précises
  - **Syntaxique** : **protocoles d'échanges** ouverts et standards *(CSW, WMS, SOS, DAP …)*
  - **Contenus** : **formats** de fichiers aux **standards** internationaux disciplinaires (ex : NetCDF, ODV, etc.)

- **R : Réutilisables** : l'objectif final des principes FAIR : la pérennité et réutilisation des données :
  - Pas de « R » sans « FAI »
    - Identifiants uniques et pérennes (DOI) pour l'identification et la citation des données
    - Licences claires d'utilisation des données
    - Standards communs : protocoles d'échanges et formats standards des données qui répondent à des normes communautaires pertinentes pour le domaine
  - Authentification d'accès, si nécessaire