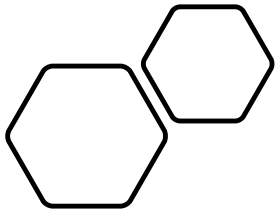
State of the IVOA:
Virtual IVOA Interoperability Meeting.

October, 2022

https://www.ivoa.net/

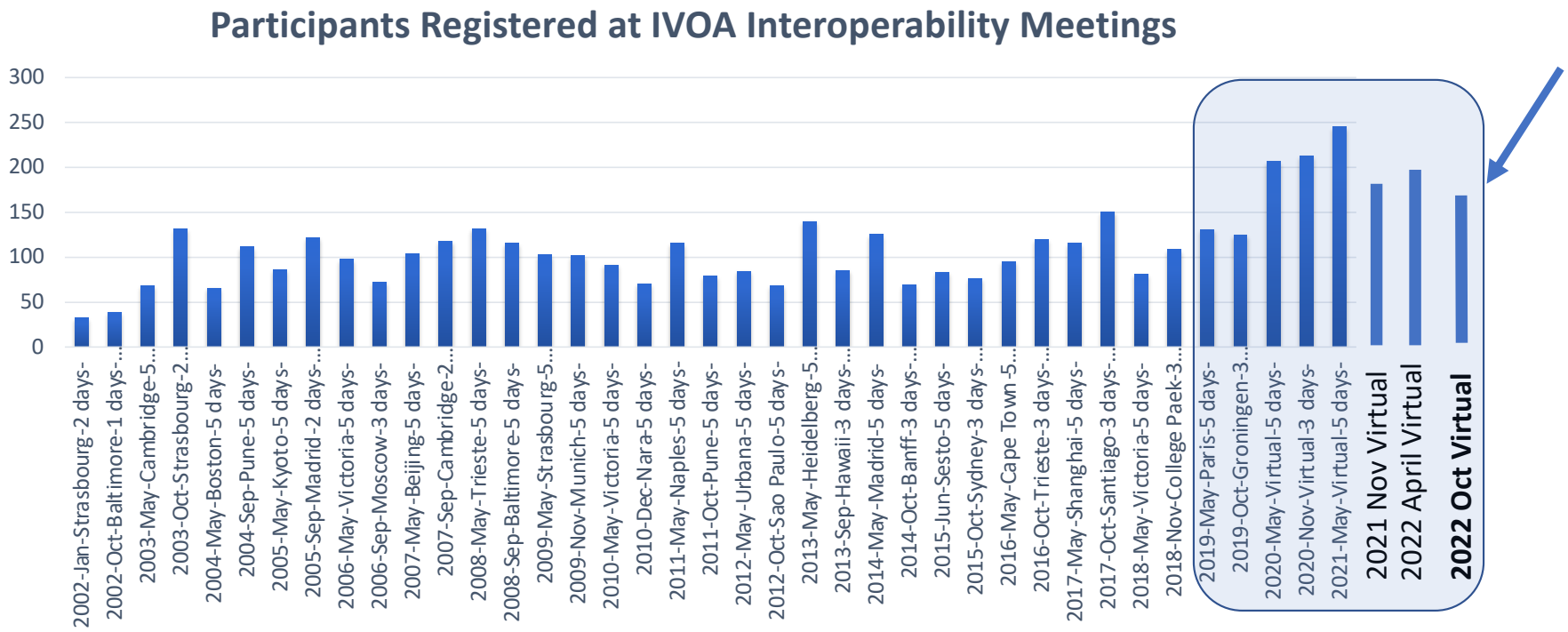


G. Bruce Berriman

Chair, IVOA Executive Committee

(USVOA/NAVO)

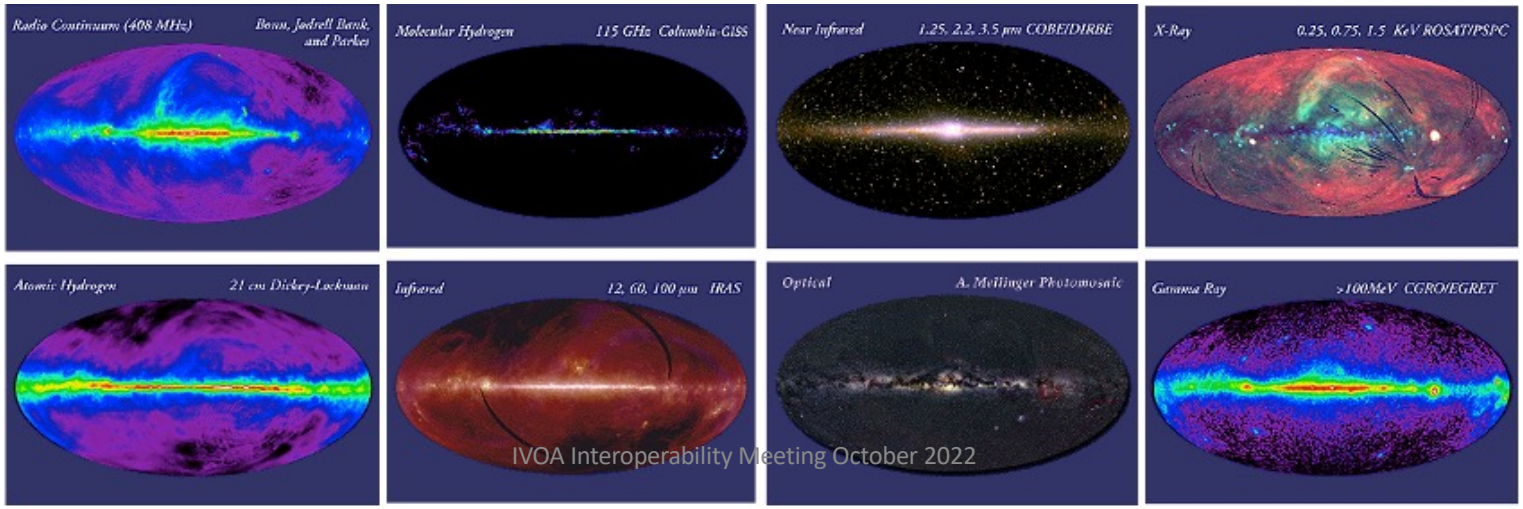
Participation –165 registered (10/17)



The Idea of the Virtual Observatory

"A multi-wavelength digital sky that can be searched, visualized, and analyzed in new and innovative ways."

- The VO enables queries to multiple data centers in a seamless and transparent way, provides new powerful analysis and visualization tools within that system, and gives data centers a standard framework for publishing and delivering services using their data.
- Like the World Wide Web, the VO is not a fixed system, but rather a *way of doing things.*



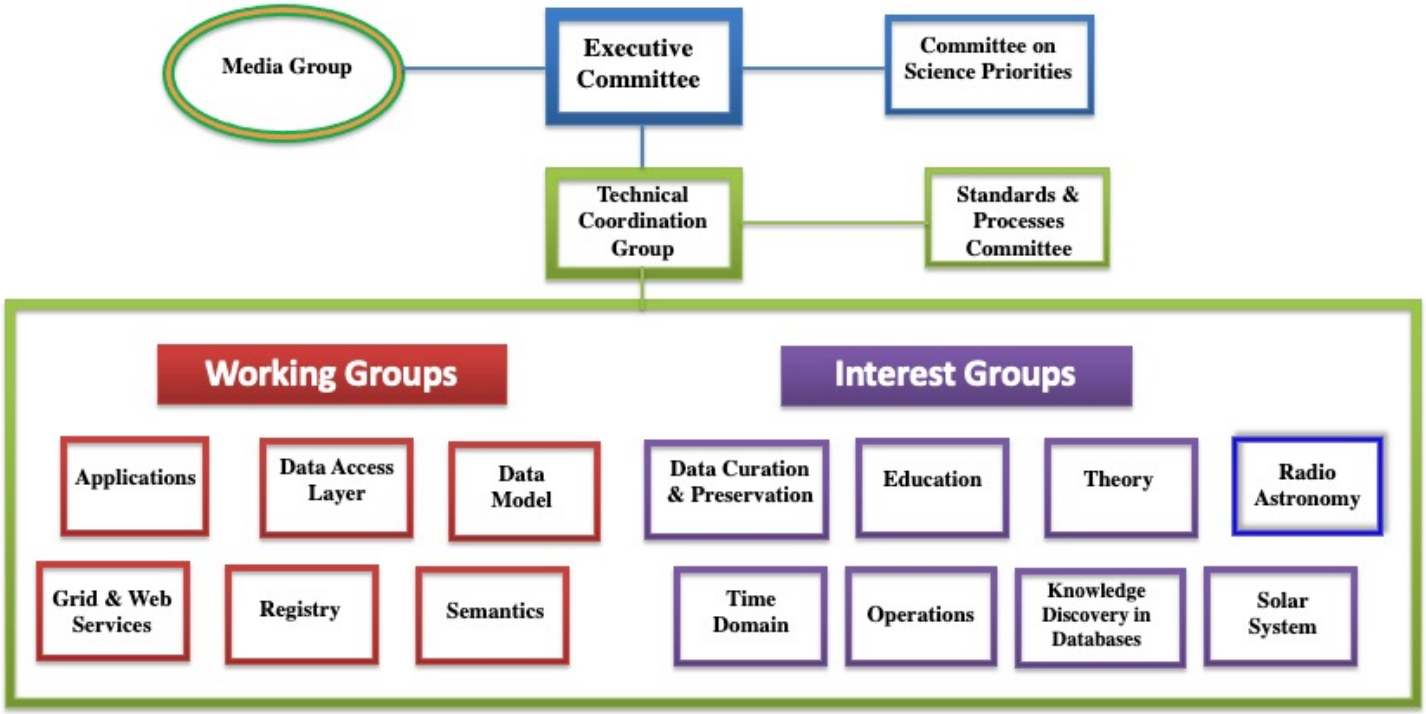
Welcome To Two New Members!

- We welcome two new members
- Square Kilometer Array Observatory (SKAO)
- VO Kazakhstan

The International Virtual Observatory Alliance

- The IVOA develops the technical standards needed to make the VO possible.
- Created in 2002
- 24 member VO projects
- 6 Working Groups, 8 Interest Groups
- 2 Interoperability meetings per year
  - May
  - Oct/Nov, consecutive with ADASS
- *~ 50 interoperability standards*

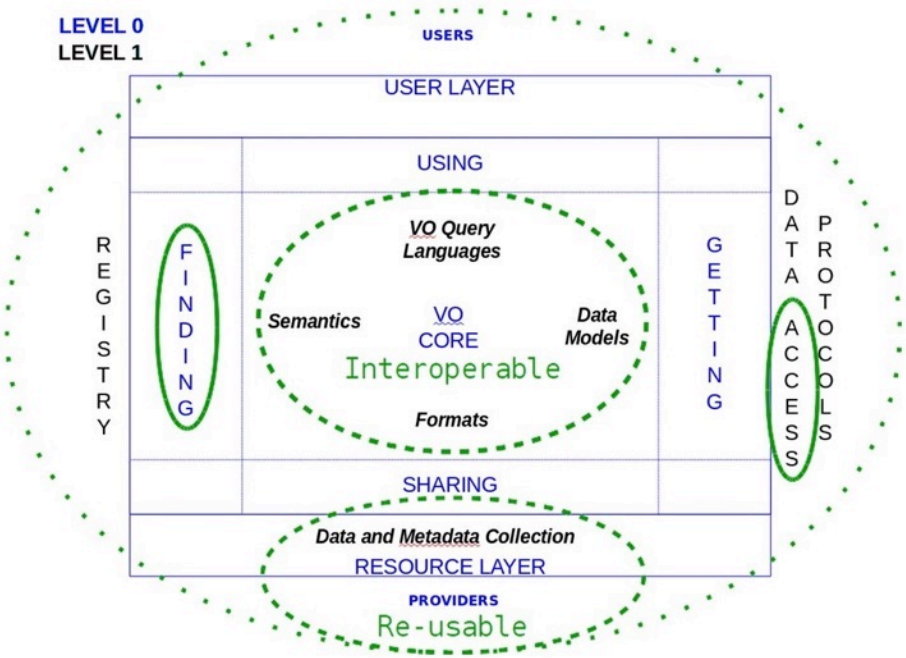
IVOA Organization Chart



The VO Is FAIR!

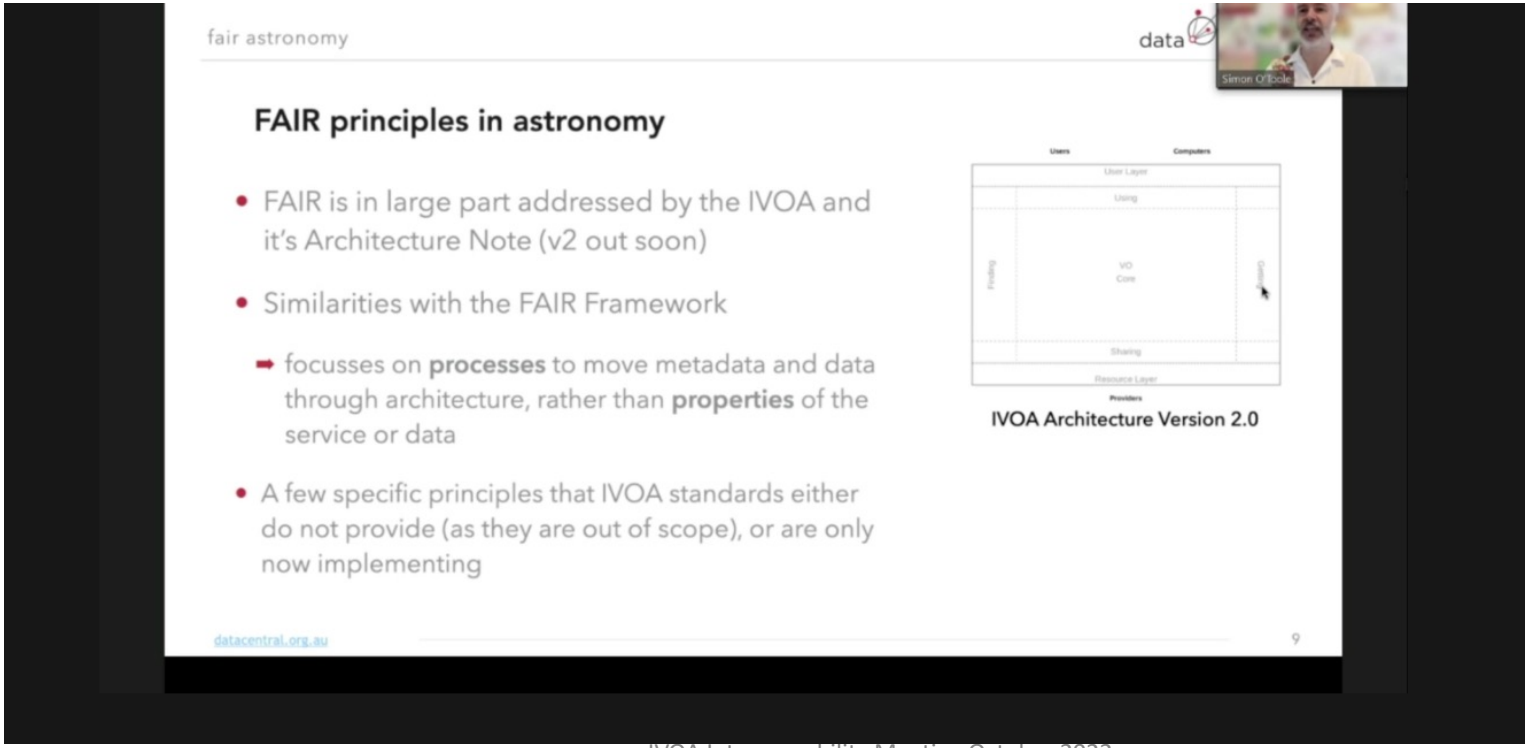
- FAIR Principles make data:

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



*Wilkinson et al 2016 "*The FAIR Guiding Principles for scientific data management and stewardship. doi: 10.1038/sdata.2016.18."

The VO IS FAIR!



See invited talk by Simon O'Toole at ADASS XXXI.

"Make your data VO compliant and you are nearly there."

O'Toole and Tocknell. 2022 https://arxiv.org/abs/2203.10710

It takes more than a pandemic to stop us!

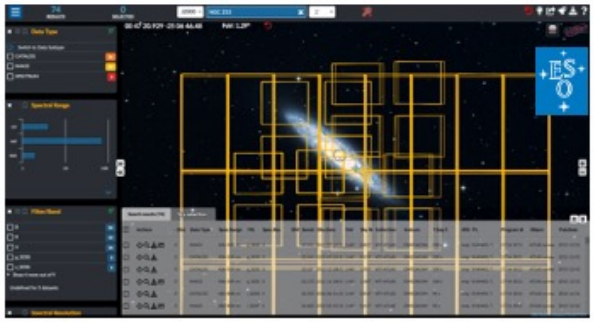
- We have now run five successful virtual meetings …
- … and I am sure we are about to have the sixth.
- Very full program for this meeting
- Full suite of Working Group and Interest Groups
- **Special Plenary Session on VO In The Cloud: Oct 18 1330 UTC**

Session	Time (UTC)	Elapse time	Session	Notes
Tuesday Oct 18 2022 @ 06:00 UTC				
ZOOM LINK for Tuesday:				
1	06:00 UTC	10 min	Welcome and Logistics	Marco Molinaro
		20 min	State of the IVOA	Bruce Berriman
		10 min	Committee on Science Priorities (CSP) report	Ada Nebot
		20 min	State of the Technical Coordination Group (TCG)	Janet Evans
	07:00 UTC	Break - 10 min		
2		50 min	Charge to WG/IGs	WG/IG Chairs
	08:00	*Break - 5.5 hours*		
3	13:30	60 min	VO in the Cloud Plenary	S Groom/D Morris/G Taffoni/R D'Abrusco/Y Tao
	14:30	*Break - 30 min*		
4	15:00	60 min	DM	L Michel/J Salgado
	16:00	*Break - 4.5 hours*		
5	20:30	60 min	DAL 1	J Dempsey/G Mantelet
	21:30	*Break - 30 min*		
6	22:00	60 min	GWS	G Taffoni/D Morris
	23:00	*End of Session*		

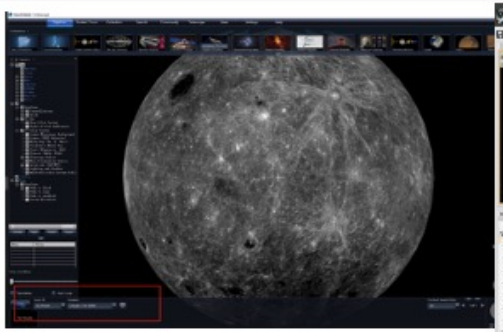
The IVOA and the IAU

- Bruce Berriman gave three talks at the IAU General Assembly in August 2022:
  - "Division B Days (Facilities, Technologies and Data Science)
    - "Science With The VO"
    - "FAIR Standards And The IVOA."
  - Working Group (WG) of Global Coordination of Ground and Space Astrophysics Session on Future Role of Archives "The IVOA Perspective." (invited)
- We will submit a proposal to hold a Focus Session at the UAU GA in 2023 (South Africa)
  - "Community Engagement and Open Science in the Virtual Observatory"
  - Proposal due December 1

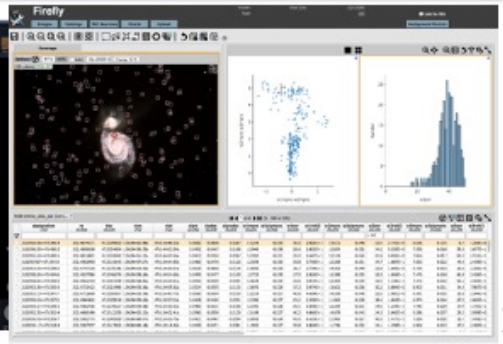
VO embedded in astronomy services



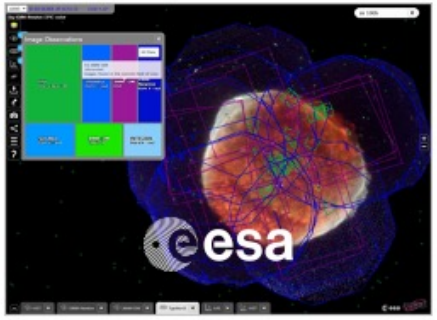
ESO Science Portal



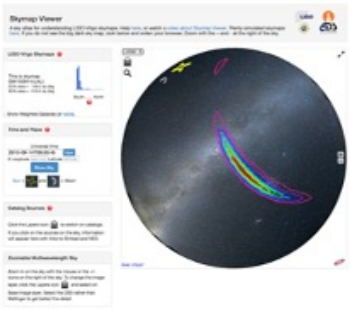
WWT



Firefly
Caltech-IPAC



ESA Sky

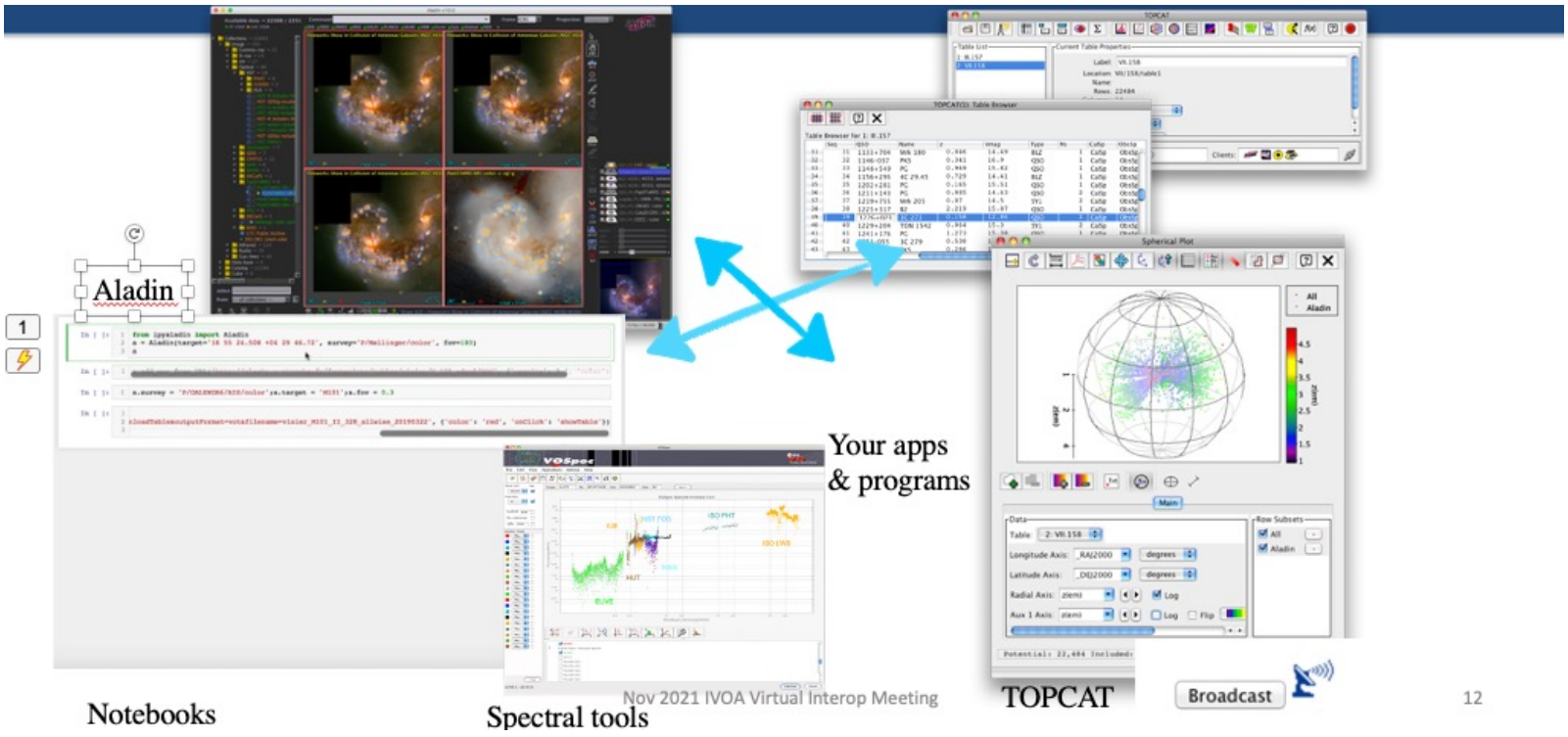


Grav. waves

CDS reference data service

SVO Filter Profile service

Interoperable applications and services

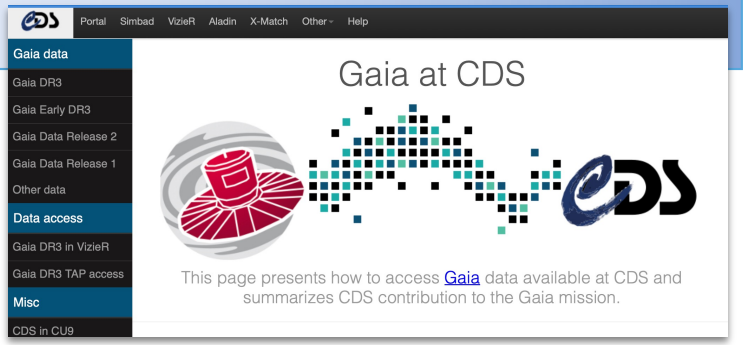


OV FRANCE

Gaia DR3 made available in the CDS services

Include : TAP, HiPS, X-Match, services

Link : https://cds.unistra.fr/gaia



Aladin Lite Version 3 has been released

new capabilities using WebGL

Link : https://aladin.cds.unistra.fr/AladinLite/v3-beta/news/

Workshops :

Publication of models and simulations

Montpellier - 6 & 7th October 2022

~45 french participants

Link : https://indico.in2p3.fr/event/28071/

High Energy Astrophysics & VO

Strasbourg - 11th October 2022

Participants : CTA, XMM, SVOM, Gravitational waves, neutrinos

Link : https://indico.obspm.fr/event/1489/

Also, many activities concerning :

- Interoperability in **heliophysics** (IHDEA)
- **Planetology** - link between IVOA standards & OGC (Earth Science)

VObs.it

Recognised by INAF as a multi-institution "programme" (long-term project), to support Italian participation in IVOA and Euro-VO, included in INAF Medium-Term (3 yr) Plan. INAF funding for development of standards and provision of services has been fairly constant over time.

- Vice-Chair of TCG
- Chair of GWS WG
- IVOA documents coordination
- Activity in IVOA within WGs and IGs
- Support to the IVOA Newsletter

Person-power: ~ 3 FTE/year

(half for development + half for service)

Additional efforts to develop data access / retrieval and applications compliant to IVOA standards at the two main Italian centers:

- IA2, the INAF center for Astronomical Archives
- SSDC, the ASI Space Science Data Center

Each data centre has its own budget

VObs.it

VObs.it supports (on INAF-provided servers and resources) the following IVOA services:

- web pages (www.ivoa.net)
- wiki (wiki.ivoa.net)
- mail and lists (mail.ivoa.net)
- documents repository (www.ivoa.net/documents)
- vocabulary maintenance (www.ivoa.net/rdf)

It also manages the

- registration of IVOA domains (ivoa.net and ivoa.info)
- the related DNS service
- resolving the other IVOA provided services:
  - rofr.ivoa.net (currently hosted at CADC)
  - mail.ivoa.net/search (provided by CNRS/CDS)

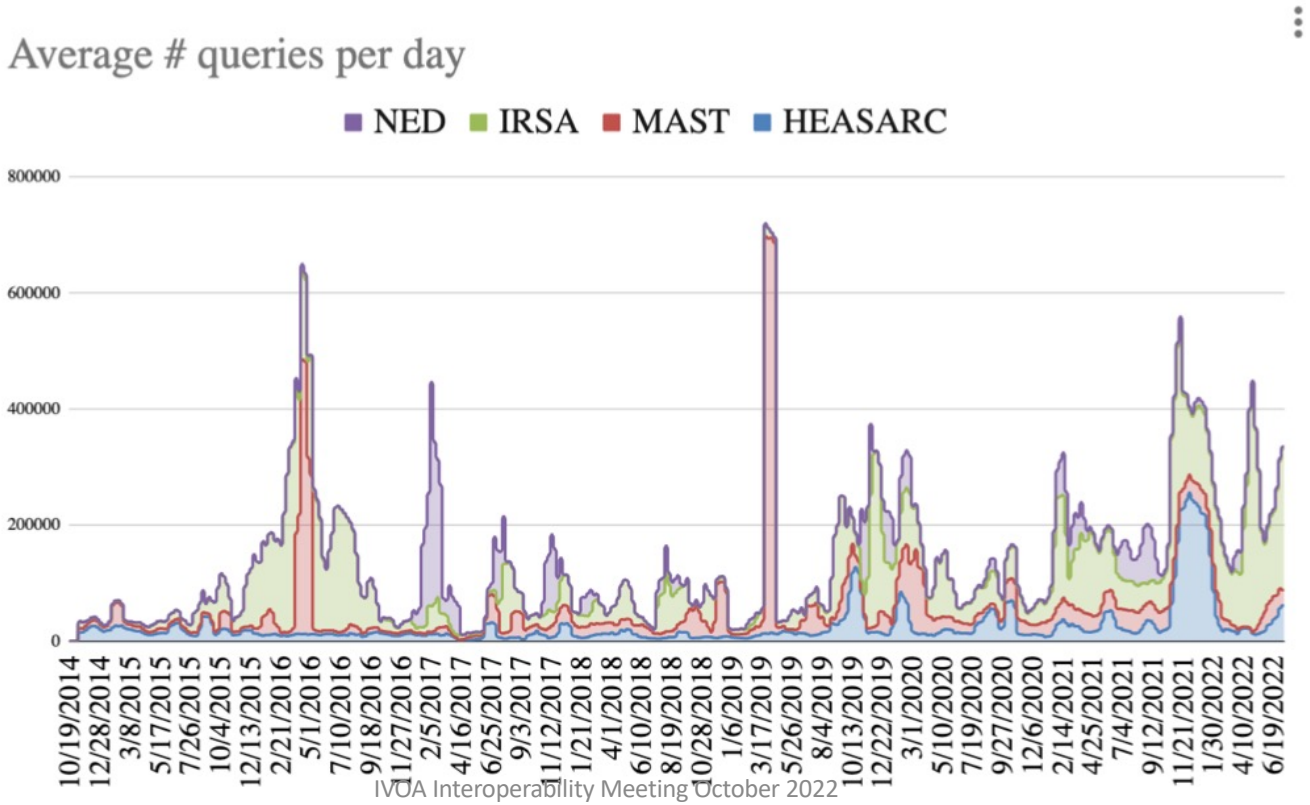
Current efforts/activities include:

- Within EuroVO, active participation in the EU-funded ESCAPE project.
- Work is in progress to explore and implement the ability to run containerized VO services exploiting EGI computing resources through ESAP (ESCAPE's ESFRIs Science Analysis Platform).
- INAF IA2 has developed a VOSpace service connected to a Tape Library and is now working on adding on-request DOI minting leaning on the VOSpace platform for Long Term Preservation of published datasets.
- Developments for the Radio domain.
- Organizing Northern Spring 2023 Interop.

NAVO In 2022

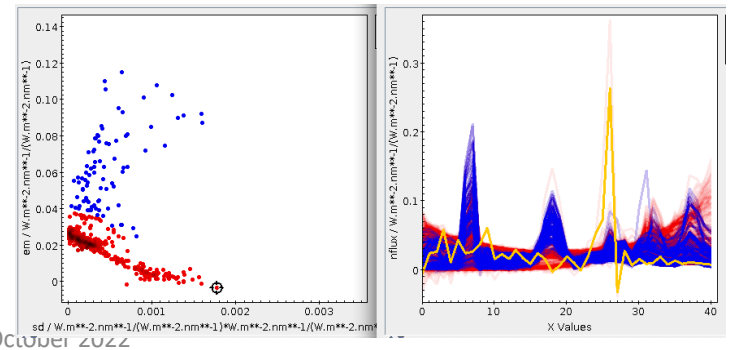
- Milestones:
  - Contributed to PyVO releases (all)
  - Prototype to demonstrate cloud data access through VO services (all)
  - Additional SSA services for two missions with DataLinks to response matrices (HEASARC) used by 3rd party web client for quick-look spectral analysis
  - CAOM tables for Spitzer (IRSA)
  - New Python SIA service at MAST
- Ongoing development:
  - Continuing to improve cross-archive data discovery with ObsTAP (all)
  - NED working on database restructuring to support TAP services serving SEDs following Spectrum Data Model.
  - AAS workshops using PyVO continue (all)
  - Exploring cloud data access with VO services (all)

Average # queries per day



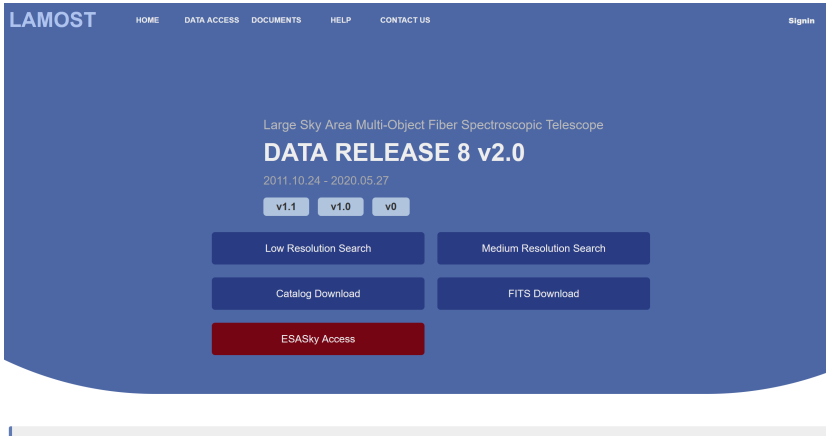
GAVO

- Server suite DaCHS in version 2.6 (e.g., LineTAP support)
- Epoch propagation in pgsphere in PR #8 (please review!) for ivo_epoch_prop ADQL user defined function
  *
- Proposal for a vector extension to ADQL – extra nifty for our sampled Gaia XP spectra! See our blog at https://blog.g-vo.org.

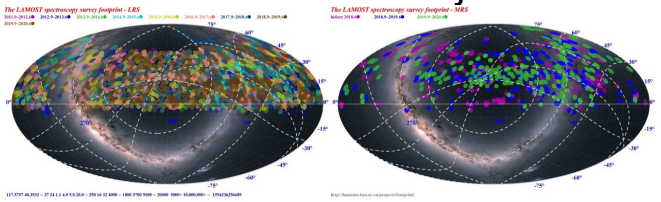


LAMOST DR8 Released by China-VO and ESASky

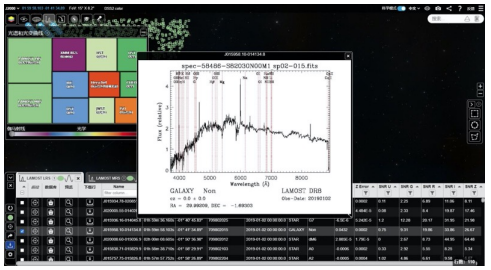
- On Sep. 30th, 2022, LAMOST published its Eighth Data Release (DR8 v2.0) worldwide through the China-VO, which includes the spectra obtained from October 2011 to June 2020. The DR8 dataset includes 16.6 million spectra and 7.91 million sets of stellar spectral parameters. The total number of spectra and stellar parameters released is still the largest in the world.
- For the first time, the China-VO jointly published the LAMOST DR8 dataset in conjunction with the ESASky.



Data release portal at http://www.lamost.org/dr8/

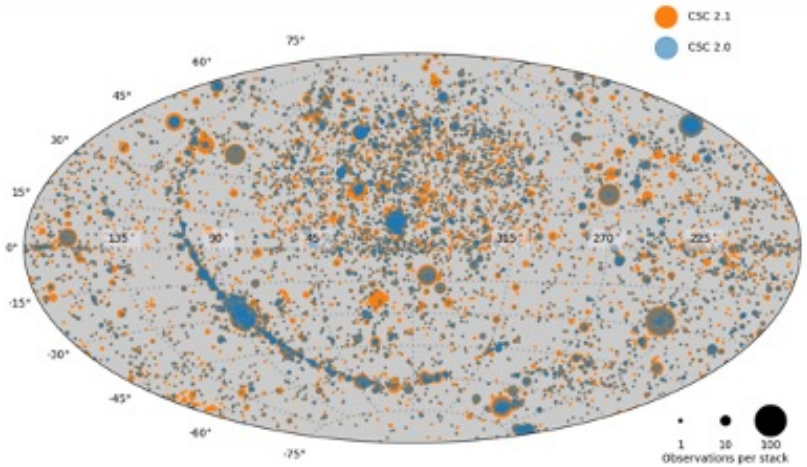


Left: Low-resolution survey footprint; Right: Medium-resolution survey footprint.



LAMOST DR8 at the ESASky

Chandra Source Catalog version 2.1



- Added public observations 2015–2021 inclusive
- Number of observations increased from 10K–15K
- Total sky coverage 40% larger

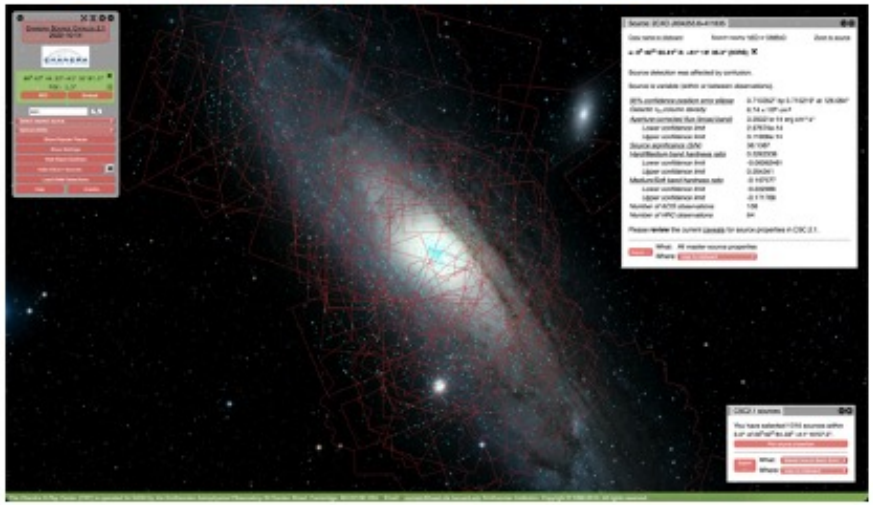
In production

Processed datasets can be accessed *now*

Algorithmic updates

- Catalog astrometry tied to the *Gaia* reference frame
- Improved photometry in the low-counts regime
- Overlapping sources fit simultaneously for position/extent

WWT provides visual interface to CSC 2.1 production data
See https://cxc.cfa.harvard.edu/csc/wwt21.html



For more information see https://cxc.cfa.harvard.edu/csc/

ESA VO activities

JWST:

- Early Release Observations (EROs) became available in the European JWST archive (eJWST) on 13th July 2022, 1 day after NASA presented the observations and began transferring the data to ESA.
- JWST Early Release Science data and any public product, such as Commissioning data also available in the eJWST. Daily ingestion continues along with science operations.
- HiPS and MOCs generated for EROs
- Automatic HiPS generation from public JWST imaging data on-going
- TAP 1.1 compliant. ESA JWST astroquery module and ObsCore table now available

HST: SIAP upgraded to 2.0, SSAP updated to 1.1, ObsCore table added to TAP

ESA VO activities

Gaia:

- Successful Data Release (DR3) on 13th June 2022. See movie: accesses to archive
- Datalink giving access to six different products (epoch photometry, medium- and low-res spectra, and probability density distributions for the different astrophysical parameters).
- DOI assigned to the whole Gaia DR3
- Planning on deploying ADQL 2.1 for the next archive release

Euro-VO Registry: Latest release v3.0.1 (Feb 2022). New contract started this summer, status and plans will be reported in Registry session.

ObsCore tables, **astroquery modules** and **DOIs** being created for all missions. All non-legacy mission archives are **TAP 1.1** compliant & plan to update to ADQL 2.1

ESA VO activities

ESASky:

- Users can load HiPS from a URL, locally or any of the 900+ HiPS in the HiPS Registry
- More External Data Centres added: ASTRON (ObsCore table) and HEASARC (TAP)
- Multi-messenger GW events (GraceDB) and IceCube Neutrino events (NASA GCN) added
- ESA Virtual Assistant in ESASky: uses natural language processing, allows users to interact using simple sentences that trigger commanding of ESASky via its API.
- Includes PR images from both HST and JWST
- Working on providing access to all TAPs in the TAP registry

Euclid: Datalink access to Spectra data source_id related. SIAP v2 and ObsCore are available. TAP 1.1 compliant.

CADC/CVO 2021 data holding and usage

- CADC Archive Activities:
- 219 telescope/instruments
- 1.6Pb/310 million files
- 4.9Pb/100 million downloads/year
- 220 archive data refereed papers in 2021
- Machine Learning consulting: led to 53 refereed papers in 2021

CANFAR Science Platform

- Uses IVOA-Inside
- User Storage 1.3 Pb (VOSpace on File System and Object Store)
- Processing on 2500 cores: managed by 'skaha' on kubernetes
- 350 active users – Dramatic increase during 2021
- User Databases 'YouCat' based on TAP service layer.

CADC/CVO IVOA Activities in 2022

- CADC new storage infrastructure, called Storage Inventory (SI), now operational:
  - Uses IVOA Registry, CDP, SSO and VOSpace transfer negotiation
  - Implements SODA for data access.
  - Now holds and manages delivery of over **1 billion files** across three storage sites.
  - Exploring use of SI for data transfers with TAOS-II telescopes on SPM in Mexico.
- **Demonstrating use of** GMS, SSO and CADC-SI to SKA Regional Centre consortium.
- Development of VO Services for ALMA Science Archive.
  - New Simple Cone Search (SCS) service,
  - Updates to TAP, DataLink, SIAv2 and SODA services and to *astroquery.alma*
- Developing Next Gen SSO concepts in collaboration with Mark Taylor.
- Continued contributions to *pyvo* project.

Euro-VO Activities

- EC funded **ESCAPE** Project – ***concluding in Jan 2023*** https://projectescape.eu
  - Work package: **CEVO "C**onnecting ESFRI to the **E**OSC via **VO".**
  - Final reports and events being prepared now.

- Euro-VO partners with large Astronomy, Astroparticle and Solar physics partners.

  - **Making the connection of VO to the European Open Science Cloud** (EOSC)
    – *final report done!* ➜ Provides feedback to EOSC.

  - **Developing IVOA standards and tools for interoperability**
    – based on the needs of the big Research Infrastructures (ESO, CTA, KM3NeT, EGO-Virgo, SKA, EST).

  - **Interfacing with ESCAPE Software Repository and Science Analysis Platform**

  - **Training and coordination events**
    – *2 VO schools, 3 Technology forums, 1 Data provider forum.*

Funded by the European Union's
Horizon 2020 - Grant N° 824064

Recent Activities:

- *New tools and services – Aladin Lite v3 (beta). Radio, Solar, Neutrino TAP services*
- Presentation of Astronomy VO at the European Open Science Cloud (EOSC) policy event, 3 May 2022 *https://eoscfuture.eu/eventsfuture/eosc-policy-event/*
- *R*e-using tutorials from ESCAPE/Euro-VO schools e.g.:
  - VO workshop at 5th Cosmology School, Krakow 23-25 July 2022.
  - VO Workshop ETH, on-line Zurich 8 September 2022.

Upcoming:

- **ESCAPE to the Future event, 25-26 October 2022**

https://projectescape.eu/events/escape-future

Funded by the European Union's
Horizon 2020 - Grant N° 824064

All-Sky Virtual Observatory News

Data Central and SkyMapper

- Data Central is redesigning their data ingestion system and building a new TAP service, based on CDS/VOLLT.
- Pipelines as a Web Service (PAWS) deployed at archives.datacentral.org.au – currently AAT data using 2dF
- SkyMapper preparing for Data Release 4 (some delays)

Theoretical Astrophysical Observatory

- Maintenance and user support and testing is the main focus of TAO at the moment

All-Sky Virtual Observatory News

MWA

- Major architecture changes of VO services deployed to make it more maintainable
- Looking at a new identity management system

CASDA

- New ASKAP data – check out casda.csiro.au
- A new image cutout tool has recently been released here

Challenges for the IVOA In 2022 And Beyond

- **PB scale missions will be commissioned!**
- **Big new telescopes!**
- **Support "science platforms" with analysis close to data.**
- Support new data-type adoption, driven by the growth in size and complexity of data sets.
  - Columnar storage formats for large datasets, such as Apache Parquet.
- Support time-domain astronomy and multi-messenger astronomy
- New radio projects.
- Machine learning.

Let's get to work!