

Intro to the IVOA

Interop meeting 25-29 April 2022

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The VO and the IVOA: what?

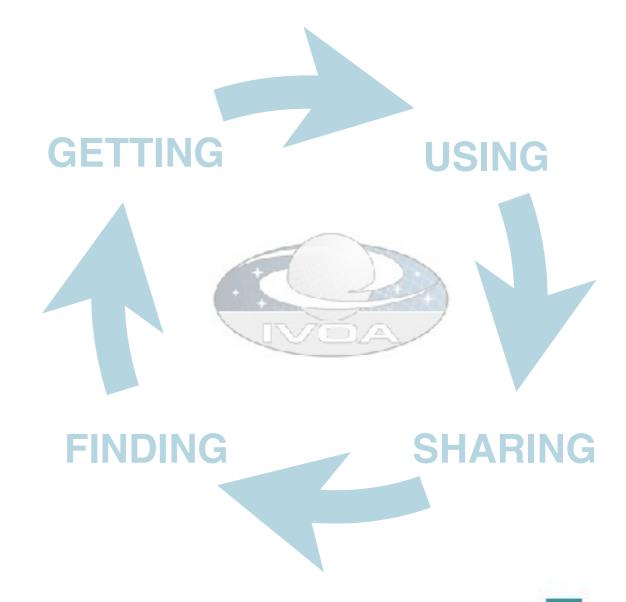
"A multi-wavelength digital sky that can be searched, visualised and analysed in new and innovative ways" P. Fabianno

What is the Virtual Observatory?

 Framework for astronomical datasets, tools, services to work together in a seamless way

What is the International Virtual Observatory Alliance?

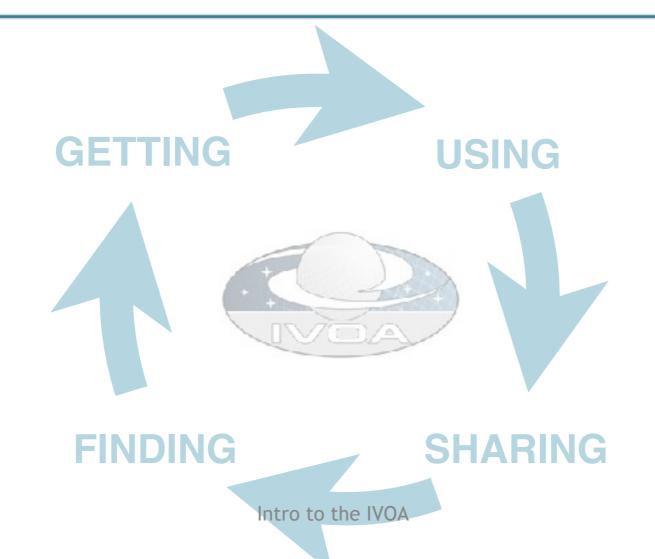
- A science driven organisation that builds the technical standards
- A place for discussing and sharing VO ideas and technology to enable science
- Promoting and publicising the VO



The VO and the IVOA: why?

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: who?

Who is the IVOA?

http://ivoa.net/

- 5 Committees: Exec, Tech Coordination, Standards & processes, Media, Science priorities
- 6 Working Groups (WG): Applications, access, models, grid & web services, registry, semantics
- 8 Interest Groups (IG): Time-domain, radio, solar system, education, data curation, knowledge & discovery, theory, operations

Want to get involved?

- Meetings: 2 interoperability meetings per year
- Don't know where to start? Email any chair/vice-chair of a IG/WG, CSP



□ 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)

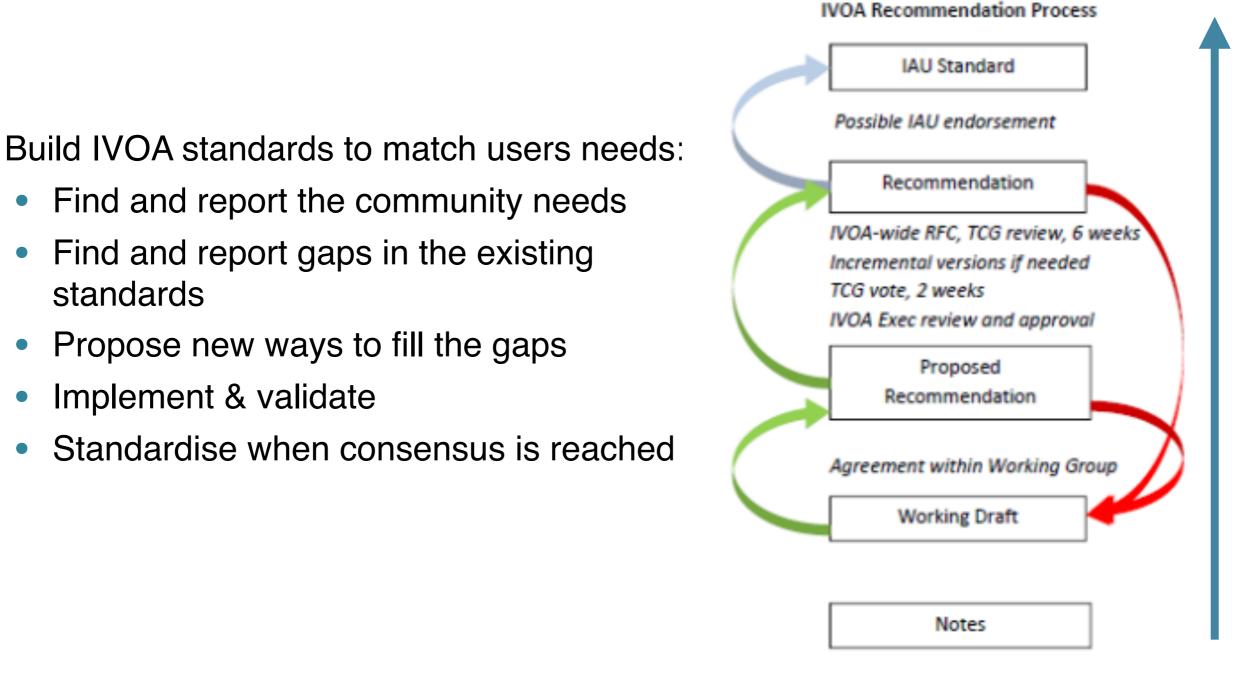


The VO and the IVOA: how?

Through the **development and adoption** of common standards scientifically driven, as an international community effort where astronomers, software engineers and documentalists are involved



IVOA development process of standards



https://www.ivoa.net/documents/DocStd/index.html

OK, but where do I start?

 A good starting point to newcomers to the IVOA: the architecture document (more on slide 22)

https://www.ivoa.net/documents/IVOAArchitecture/20211101/index.html

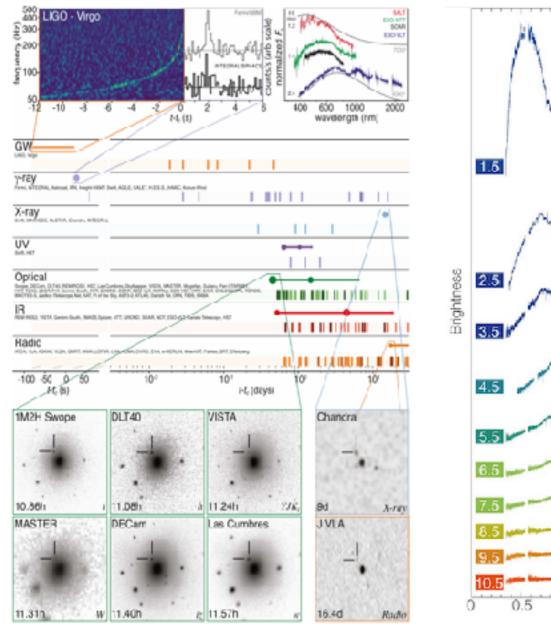
Things to keep in mind:

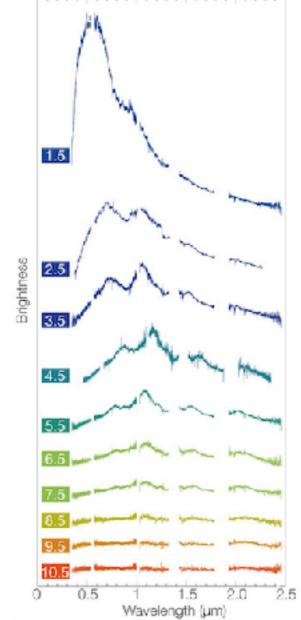
- The IVOA will not answer your scientific questions nor will it ask the questions for you
- The IVOA provides you with common formats and common ways of describing and accessing the data which when adopted will ease your work

Let's see it with an example

VO in the multi-messenger landscape

HE ASTROPHYSICAL JOURNAL LETTERS, 848:L12 (59pp), 2017 October 20





- Multi-wavelength / messenger approach is needed - different data types
- Follow-up observations and reaction time for that can be crucial - alerts
- Analysis, Visualisation & navigation through the data
- Coordination & transmission of information

The IVOA should match user's needs

Some selected standards

- 1. **VOTable** the format for tabular data for allowing interoperability (coosys, timesys, ucd, utype, VOunits, datalink).
- 2. HiPS more than a format for images tailored for large data volumes
- **3**. Search for data:
 - **Cone search** spatial + temporal search
 - MOC spatial and temporal indexing for large data volumes and more complex areas in the sky
 - TAP + ADQL Table Access Protocol & astronomical data query language
 - **ObsCore & ObsTAP** description of observations
- 4. Planning of observations:
 - ObjVisSAP visibility of object to plan observations
 - **ObsLocTAP** facilitate coordination of observations
 - Facilities / observatory list (under dev.)
- 5. Alerts: VOEvents

6. ... many more! SLAP, SIAP, SSA, Provenance, SAMP... each tailored to specific use cases

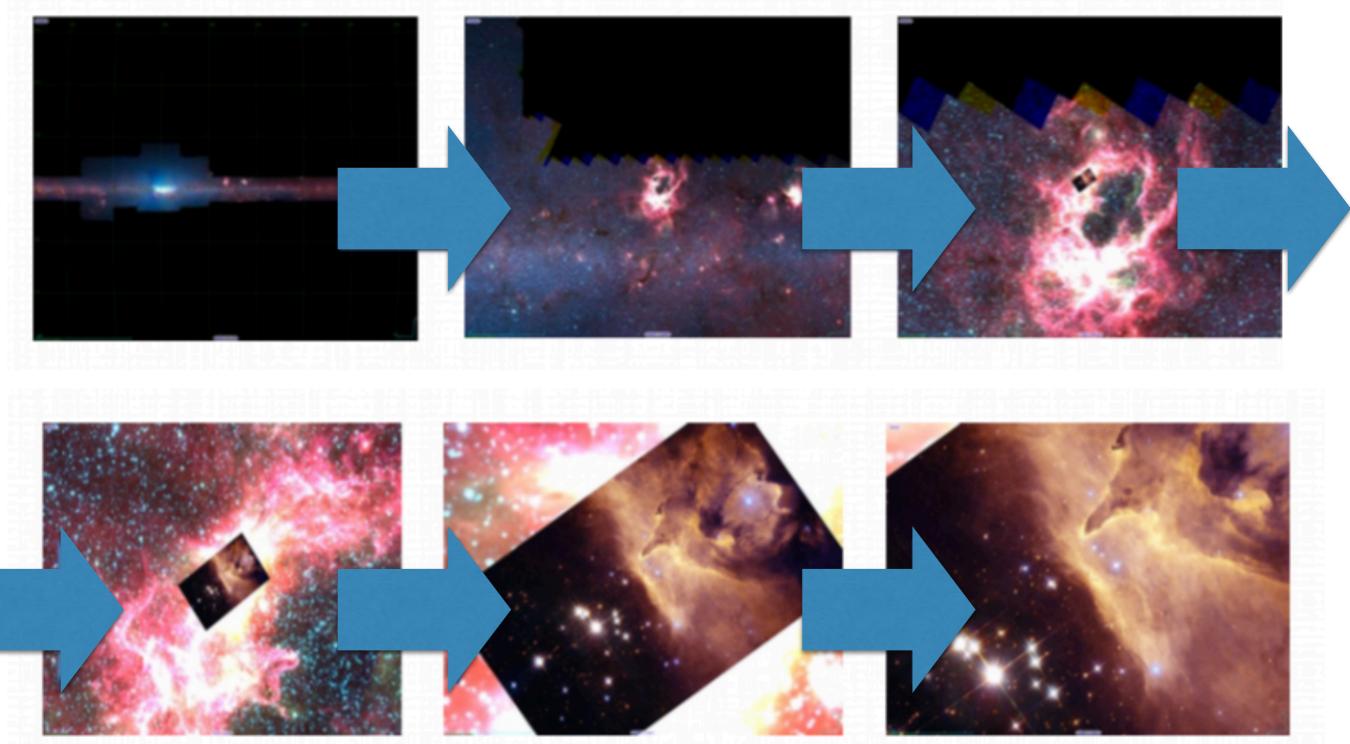
VOTable: format for tabular data

Standardisation of coordinate system annotation (time and space), UCD, utypes, VOUnits, datalink

- **COOSYS** ("ICRS", "eq_FK5",...)
- **TIMESYS** (scale: TT, TAI, ..., refposition: barycenter,... timeorigin: JD, MJD,...)
- Unified Content Descriptor (UCD): controlled vocabulary for describing astronomical data quantities - related to the nature of the values
- UTypes: relationship between the columns and the data model components
- VOUnits: units expressed as a simplified text label (e.g. m.s-2 instead of m s⁻²)
- **Datalink**: links to other associated data

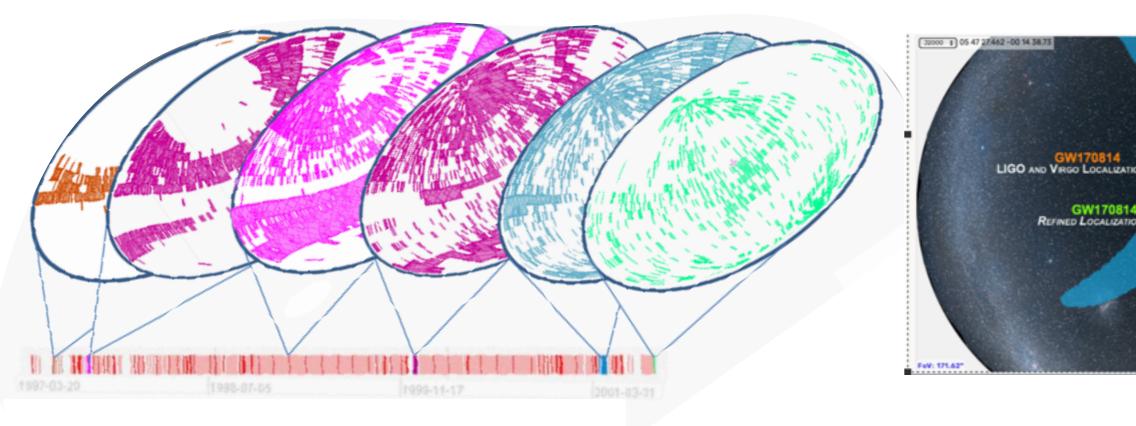
HiPS: Hierarchical image Progressive Survey

• A hierarchical scheme for the description, storage and access of sky survey data (the more you zoom-in the more the details)



Search: know where & when

Cone search extension to add a time interval for search in catalogs
MOC : Search by temporal+spatial coverage of surveys for the more complicated areas



TAP & ADQL

- Table Access Protocol (TAP) defines a service protocol for accessing general table data, including astronomical catalogs as well as general database tables. Access is provided for both database and table metadata as well as for actual table data.
- Astronomical Data Query Language (ADQL) Based on Structured Query Language (SQL) with special restrictions and extensions in order to support generic and astronomy specific operations

ObsCore & ObsTAP

- Goal: "to give data providers a set of metadata attributes that they can easily map to their database system in order to support queries of the sort listed below."
- Science cases:
 - Support multi-wavelength as well as positional and temporal searches.
 - Support any type of science data product (image, cube, spectrum, time series, instrumental data, etc.).
 - Directly support the sorts of file content typically found in archives (FITS, VOTable, compressed files, instrumental data, etc.).

ObsCore & ObsTAP are Key IVOA standards for searching, finding and combining all sorts of data and allow for interoperability

ObsCore & ObsTAP

- Map the METADATA of your project data into ObsCore Keywords
- Set a TAP Service
- Register it! —> "The yellow pages of the IVOA"

Search, find, and combine the data coming from multiple missions

Visibility of an object

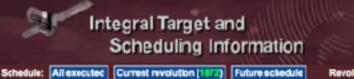
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Different services have different inputs / outputs

Facilitate the work by having some level of standardised input / output

Object Visibility Simple Access Protocol, Aitor Ibarra, Richard Saxton, Jesús Salgado et al. 2020 http://www.ivoa.net/documents/ObjVisSAP/index.html

Coordination of observations



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Schedule for revolution 1872

(this list is also available in cav-formar, click pere to download)

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Observing schedules

Short Range Observatory Schedule I service

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1	7.939 01.27.19 01.56.24	1492198	Biley	\$8-031	BTP.8	87T1/CC5	ACCUSC.	P263501.P	NERVER	0.01	DC:	81	DS	÷.,
1	7.259 01:27:12 01:56:24	1462130	Biley	50-031	DIAS	5715/CED	ACCUR	P25050LP	MIRVIS	0.01	50	01	03	1
Ċ	7.289 01+27+12 01+56+24	1482190	Biley	50-031	DTR.5	6715/CCD	ACCUM	728390LP	NTRATE	0.01	507	\$1	64	٨.
n	7.239 01+27+12 01+56+24	1482198	Biley	50-011	BIAS	RPTR/CCD	ACCUM	P28X50TP	NTRATE	0.01	90	01	09	٤.,
9	7.239 01:27:12 01:56:24	1402190	Piley	50-031	DIAS	9915/CCD	recire	P20050LP	MIRVIS	0.01	90	01	00	÷
4	7.239 01:27:12 01:56:24	1402190	Paley	50-031	DEAG	SAIR/CGD	ACCOR	1/2 6015 0147	MIRVIE	0.01	90	91	UC.	2
	7.249 01/27/12 01/56/24	1482190	Balley	90-031	BLAS	STILLED	ACCOM	PZERSOLP	NIRV12	0.01	50	21	100	2
1	7 946 01.27.19 01.56.24	1402190	witter	50-032	BLC.3	SPIE/CCD	ACCOR	222005012	NIR/15	0.01	100		100	1
ĩ	7.939 01.27.19 01.56.24	1402190	Miller	\$0-031	010.0	STEE (CCC)	ACCORD	12003020	MINUTE	0.01	22	11	22	1
1	2.229 011916 0 11211 0	1451870	Colinouski	¥0-011	BINS	ACS/MPC	ACCUR	MPC	F102N	0.01	FO	01	DI	i.
	Carlo Britando Berginaz	145-674		PU-042		H. C. H. L	-		P502M	1000-50	P0	81	62	*
	7.289 02:09:22 02:58:56								P502H P663M	0.51				
)1	7.289 02:09:22 02:20:56	1451891	Golizouski	\$1-032	DAKE	ACS/MPC	ACCUR		P5028 P5639	1000.58	11	01	02	1

19-Det-2017 18:48:29 --- Preliminary HST Observing Timeline Report for SME: 17:88884 --- F SME Swaves 2017.28:422:00:00 (15-021-2017 22:10:00), Red: 2017.234:00:00:00 (33-029-2017 00:00:00)

	Schedulin			Frincipal	-		Science			Spectral	Esposure			
	Boşîn VE	STA ST	81 30	Investigat	209 1	201.902	10013/080	2046	Apertures	Eleneaus	Time(seal	44	die	8
2017.289	02:38:56	03:00:18	1451802	Golizowski	32-031	DIA.S	acs/wro	ACCUR	NEC	F5023	0.01	72	01	D
3017-289	02:38:56	03+08+18	1451872	Colinouski	F2-012	DARX	NCS/MPC	ACCUR	MEC	F102N	1000.51	F3	81	03
2017.289	03+10+31	03+40+05	1451893	Colimouski	F3-031	DALK	ACC/MEC	VOCIN:	MEG	P502N P563N	0.51	69	01	0
2017.239	03:10:31	03:40:05	1451003	Golimowski	F3-032	DARI	acs/wro	аесик		P502H P563N	1000.58	F3	01	03
	03116100		1493522	Lockwood	22-031				\$12 Box 5 OLLP	N1RV12	1000.00	22		
2017.239	03:49:34	05:01:49	145-4639	Shapahan	39-031	201032100	HPC1/EV1	Yean war	W191-8512-9	10439	60.01	22	01	D
2017.239	03:19:30	25:01:05	1454635	Sharahan	29-032	TUNCETER	RFC3/UVI	ACCUR:	UV1E	F810M	2.01	33	21	0.
3017.239	03.19.35	35.51.49	1454639	Shanahan	39-013	70.18/0.6/T RM	RPC1/EVE	ACCUR.	19/18	P138H	360.08	39	31	0
2017.289	01:19:34	95:01:49	1454619	Shanahan	39-034	TEROSTEN	KPC1/EVT	ACCIN	INTS	F1386	340.01	39	01	D
D Neple														

What object has been (or will be) observed when and in which wavelength?

Observation Locator Table Access Protocol, Aitor Ibarra, Jesús Salgado et al. 2021 http://www.ivoa.net/documents/ObsLocTAP/^{VOA}

VOEvent: Sky Event Reporting Metadata

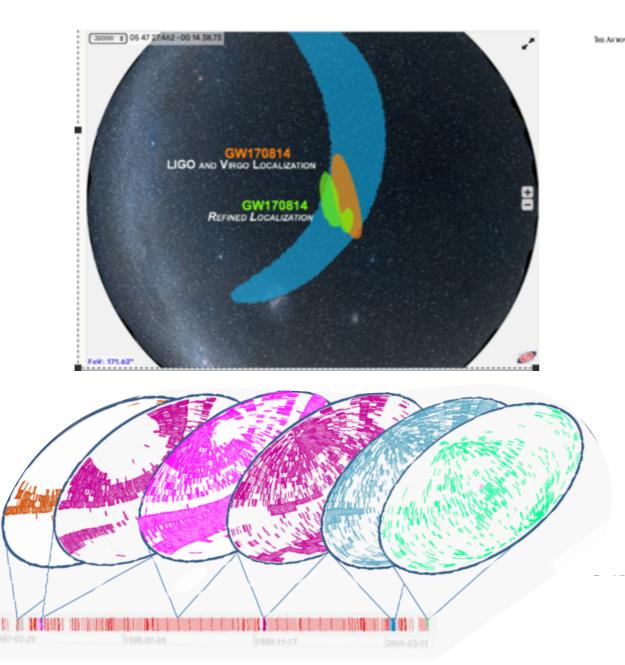
- "Defines the content and meaning of a standard information packet for representing, transmitting, publishing and archiving information about a transient celestial event, with the implication that timely follow-up is of interest"
 - Who: Identification of scientifically responsible Author
 - What: Event Characterization modeled by the Author
 - WhereWhen: Space-Time Coordinates of the event
 - How: Instrument Configuration
 - Why: Initial Scientific Assessment
 - **Citations**: Follow-up Observations
 - **Description**: Human Oriented Content
 - **Reference**: External Content

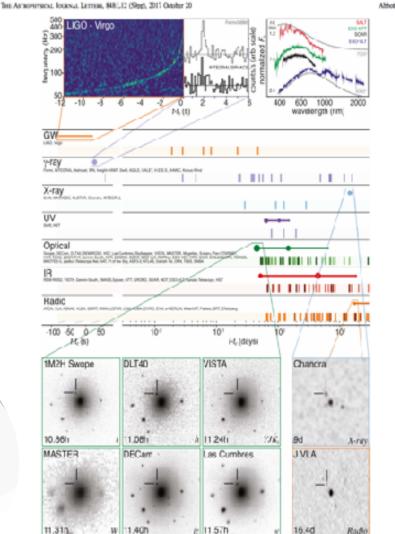
Register your services

 Describe what data and computational facilities are available where, and once identified, how to use them.

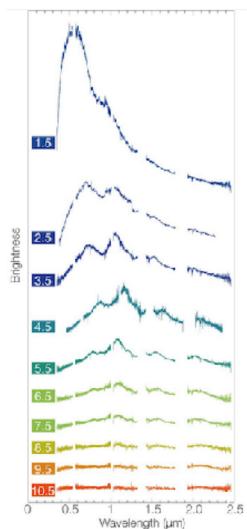


In a multi-messenger landscape









What else?

- Many more standards!
- Want to know more? Don't know what an acronym means?
- Have a look at the architecture document!
 - A summary of each standard plus a table with acronyms
- https://www.ivoa.net/documents/IVOAArchitecture/20211101/index.html

9.9 SODA

The Server-side Operations for Data Access (SODA) (Bonnarel and Dowler et al., 2017) is an API for low-level data access or server side data processing. The initial version describes operations for extracting a subsection of a data file using astronomical coordinates; Future evolution is expected to include performing various kinds of operations: transformations, pixel operations, and applying functions to the data.

Acronym	Expansion
ADQL	Astronomical Data Query Language - standard
API	Application programming Interface
CDP	Credential Delegation Protocol - standard
CharDM	Characterisation Data Model - standard
ConeSearch	Cone Search - simple positional search service standard

Want to publish your data in the VO?

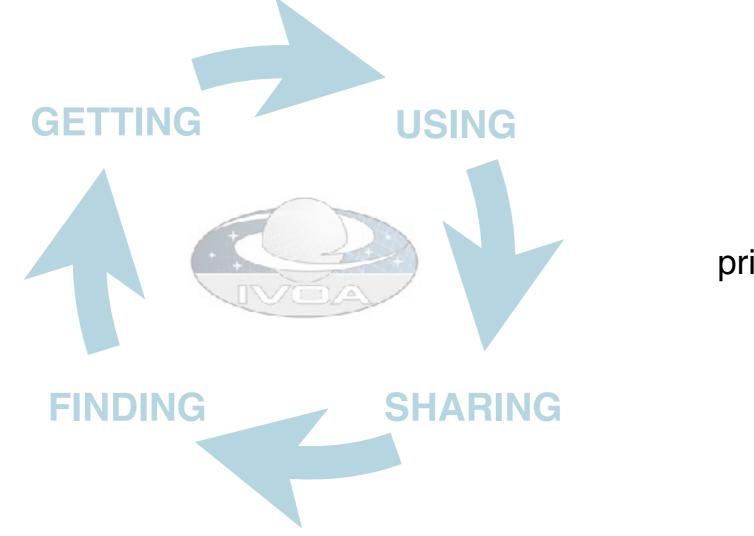
- Have a look here:
- https://wiki.ivoa.net/twiki/bin/view/IVOA/PublishingInTheVO
 - Check the Q&A section! (How do I publish images? spectra? catalogues or generic data tables?...)
- And come to the dedicated panel session

Tuesday April 26 - 15:00 UTC

Speaker	Title	Time	Materials
Ada Nebot	Summary of the Project Survey + Intro to the panel	12'	pdf
Dongwei Fan	LAMOST and the China Virtual Observatory	12'	pdf
Tamara Civera	Observatorio Astrofísico de Javalambre: VO Services	1 2 '	pdf
Alberto Micol	European Southern Observatory	12'	
Yan Grange	ASTRON - Netherlands Institute for Radio Astronomy	1 2 '	
All	Open discussion	30'	

Summary

The IVOA standards are built to enable access, discovery and ultimately interoperability



Meeting **FAIR** principles by design

The IVOA needs the community to participate!

Intro to the IVOA

Some useful links

- https://www.ivoa.net
- Docs : <u>https://www.ivoa.net/documents/</u>
- GitHub : <u>https://github.com/ivoa</u>
- Mailing list : <u>https://www.ivoa.net/members/index.html</u>
- Architecture: <u>https://www.ivoa.net/documents/IVOAArchitecture/</u> 20211101/index.html
- Slack: <u>https://join.slack.com/t/ivoa/shared_invite/zt-17kd0v93b-b32~KReWd1T96gDyYFDLPQ</u>