State of the IVOA

Paris, France
13 May 2019

Mark Allen

Centre de Données astronomiques de Strasbourg
Chair of the IVOA Executive Committee

IVOA Interoperability Meeting
Opening Session

Credit: X-ray: NASA/CXC/CfA/R. Tullmann et al.; Optical: NASA/AURA/STScI

Hosted by Observatoire de Paris

- International Planetary Data Alliance (IPDA) held here last week

IVOA in 2019

- **21** diverse member projects
- 2 well attended Interoperability meetings per year
  - May
  - Oct/Nov with ADASS

- 6 Working Groups, 7 Interest Groups
  - Completely open to participation
- Technical coordination Group (TCG)
- Committee for Science Priorities (CSP)
- Media Group
- Document Coordinator
- Executive committee

Credit: X-ray: NASA/CXC/CfA/R. Tullmann et al.; Optical: NASA/AURA/STScI

All projects in contact

VO and IVOA

Vision of the VO:

- Astronomical datasets, tools, services should work seamlessly together

IVOA:

- An organisation that debates and agrees the technical standards that are needed to make the VO possible
- A focal point for VO aspirations, a framework for discussing and sharing VO ideas and technology
- Promoting and publicising the VO

International Virtual Observatory Alliance

Enabling seamless access to astronomical data and services worldwide

The Virtual Observatory is a framework for interoperable access to astronomical data and services across all areas of astronomy. It provides unique scientific capabilities and is opening up new ways of using the rich data in astronomy archives and services.

Data access from many major astronomical archives is via VO interfaces, and you may use the VO and its tools without knowing it! VO tools and services provide a wide range of scientific capabilities including all-sky visualization, large scale catalogue cross-matching, complex queries and much more. **Try it for your science!**

The **IVOA** is an alliance of worldwide projects that develops standards and coordinates global aspects of the infrastructure. Participation in the ***technical*** and ***scientific*** development of IVOA is completely open.

International Virtual Observatory Alliance

Image credit: X-ray: NASA/CXC/CfA/R. Tullmann et al.; Optical: NASA/AURA/STScI

An alliance for the global vision of the Virtual Observatory

The vision of the Virtual Observatory (VO) is that astronomical datasets and other resources should work as a seamless whole. Many projects and data centres worldwide are working towards this goal. The International Virtual Observatory Alliance (IVOA) is an organisation that debates and agrees the technical standards that are needed to make the VO possible. It also acts as a focus for VO aspirations, a framework for discussing and sharing VO ideas and technology, and a body for promoting and publicising the VO.

Constituted in 2002, the IVOA has now been joined by 21 national and international VO projects.

Open development of the necessary standards

The IVOA work is pursued by Working Groups and Interest Groups who meet at bi-annual ***interoperability meetings***, that are open to participation by the whole community.

WORKING GROUPS
Applications • Data Access Layer • Data Modelling • Grid & Web Services • Semantics • Resource Registry

INTEREST GROUPS
Time Domain Astronomy • Solar System • Theory • Education • Data Curation & Preservation • Knowledge Discovery in Databases • Operations

Using the Virtual Observatory

To find out more about using the VO – connect to the IVOA community via the web site, e-mail forums, collaboration wiki, and slack channels. Try the tools and services!

See the *bi-annual Newsletter* for highlights on the latest science applications, scientific results using VO tools, and a calendar of events.

Find out more

ivoa.net

International Virtual Observatory Alliance

IAU XXX GA Vienna 2018 August 20-31

What is the Virtual Observatory?

- **Operational framework** for interoperable access to astronomical data and services across all areas of astronomy

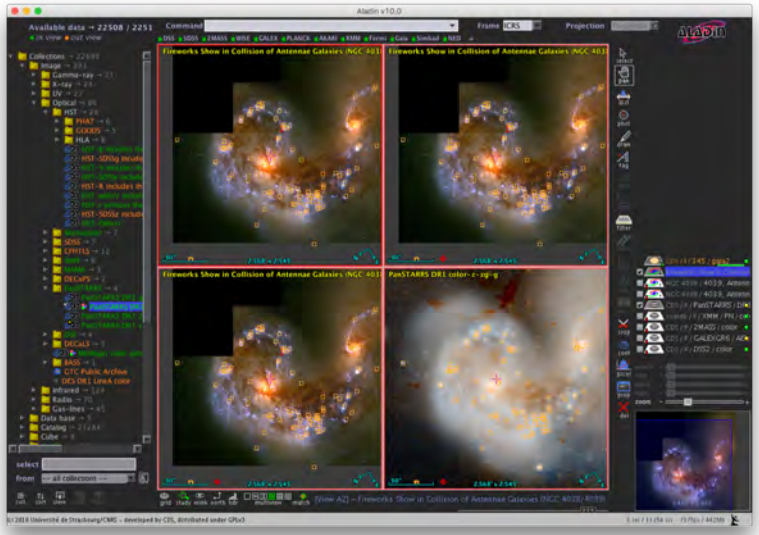
- Provides unique scientific capabilities, opening up new ways of using rich data in astronomy archives and services

- **A pioneer of FAIR data sharing** - **an 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)*

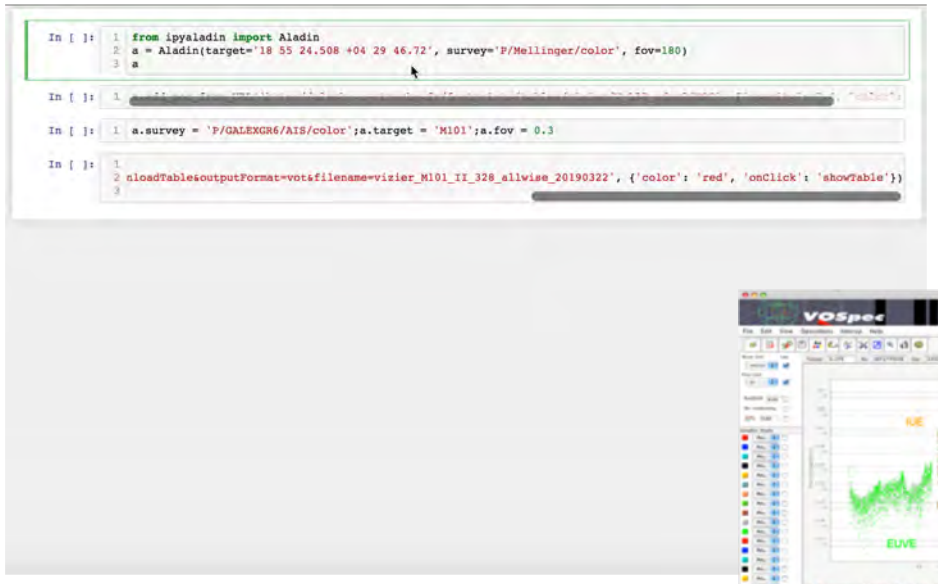
- **Re-used and customized** by planetary science (EuroPLANET), atomic and molecular physics (VAMDC) and materials sciences (via RDA Working Group)

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

Interoperable applications and services

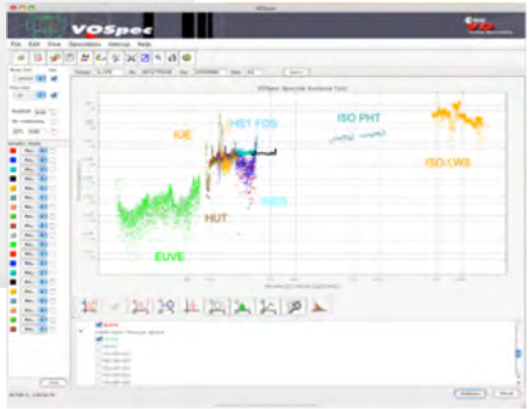


Data exploration and integration tools

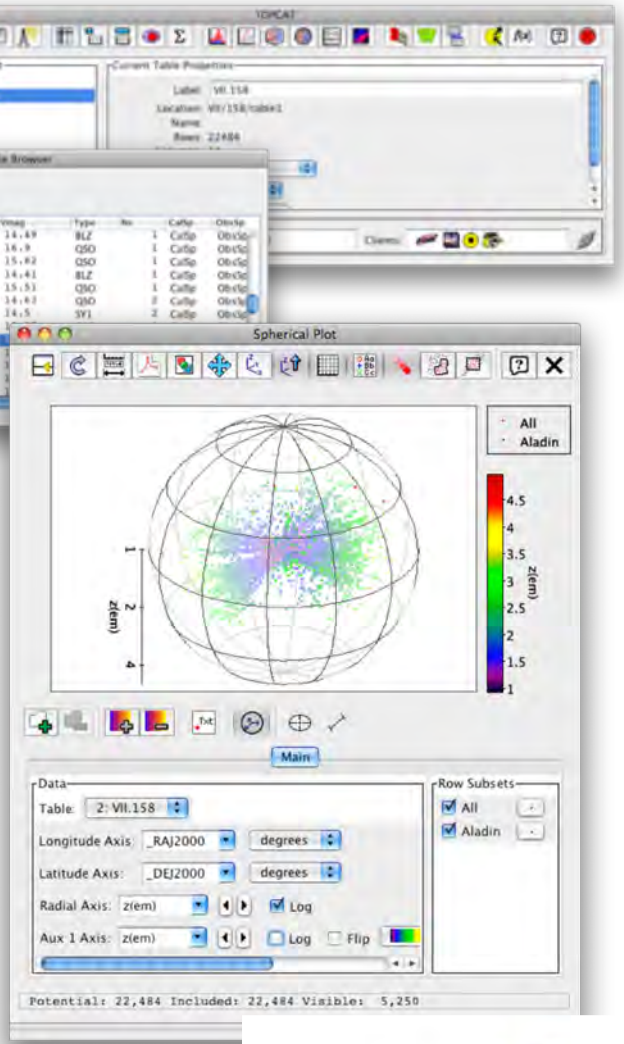


Notebooks

Your apps
& programs



Spectral tools



TOPCAT

Broadcast

IVOA 2018 - 2019

- IVOA is still here because it is a good idea!!
  - *Integrated into planning – e.g. white papers for decadal review*
  - *A major part of new projects for interoperability in astronomy*
- Large data producing projects engaged
  - active participants in the IVOA process
  - *e.g. LSST: VO first approach, e.g. New projects coming – EST*
  - *e.g. Widening scope : Solar, Planetaria – Education, EOSC*
- VO is integrated in many Astronomy data centres and archives
  - Often behind the scenes… *e.g. ESO science portal*
  - Huge benefits from shared software components
- Common challenges: *scalability, code to data, user platforms*

Changing landscape

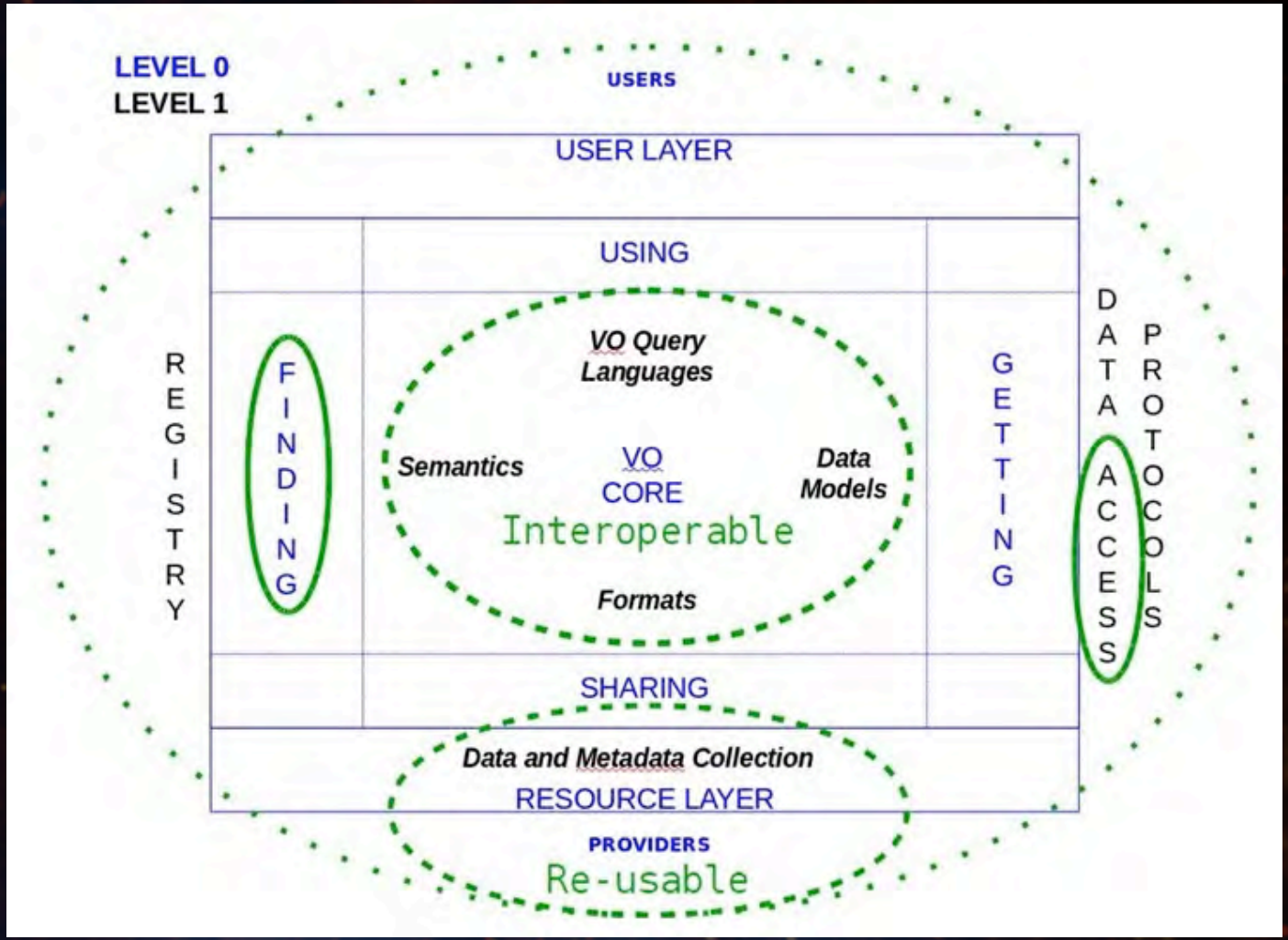
Convergence of principles and language being used:

- **FAIR**
  - **F**indable, **A**ccessible, **I**nteroperable, **R**eusable
- **Open Science**
  - Data sharing with open and seamless services to analyse and reuse research data to improve science
- **Stewardship**
  - Human skills for curation, quality content, data management, services

VO is FAIR

Making data:

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

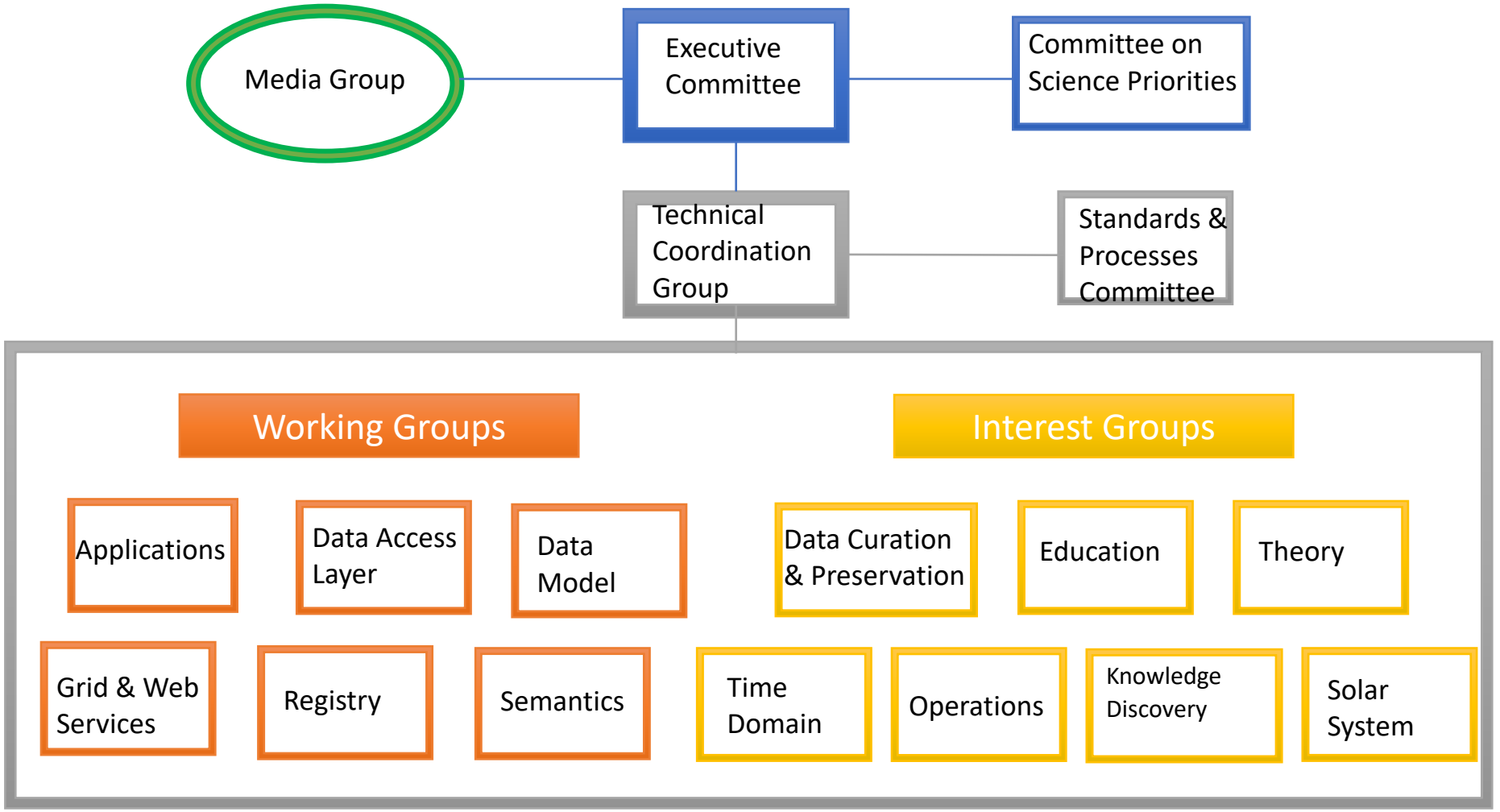


Credit: X-ray: NASA/CXC/CfA/R. Tullmann et al.; Optical: NASA/AURA/STScI

Changing Scientific landscape

- Multi-messenger astrophysics
- Time Domain Astronomy – movie of the sky surveys/projects
- Rise of python – users and data centres
- Science analysis platforms: how will users access and analyse data?
- Prominence of machine learning
- Big Data
  - Scalability of data access mechanisms
  - Code to the data
- **See the CSP presentation!**

IVOA Organization Chart



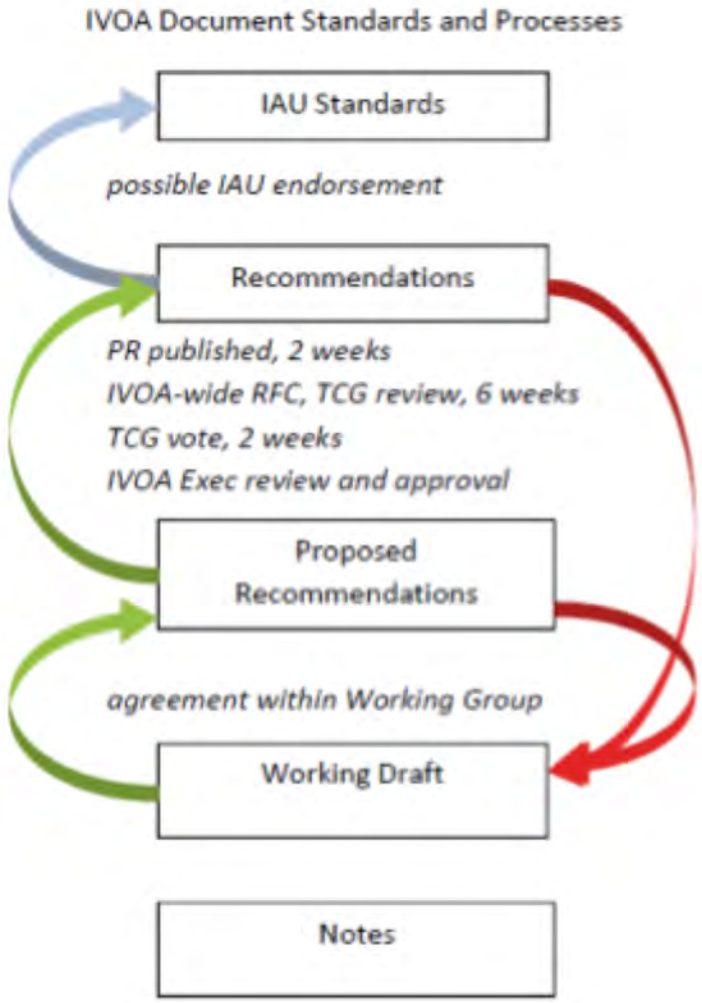
Recent change: New IVOA Secretary

- An enormous thanks to Janet Evans

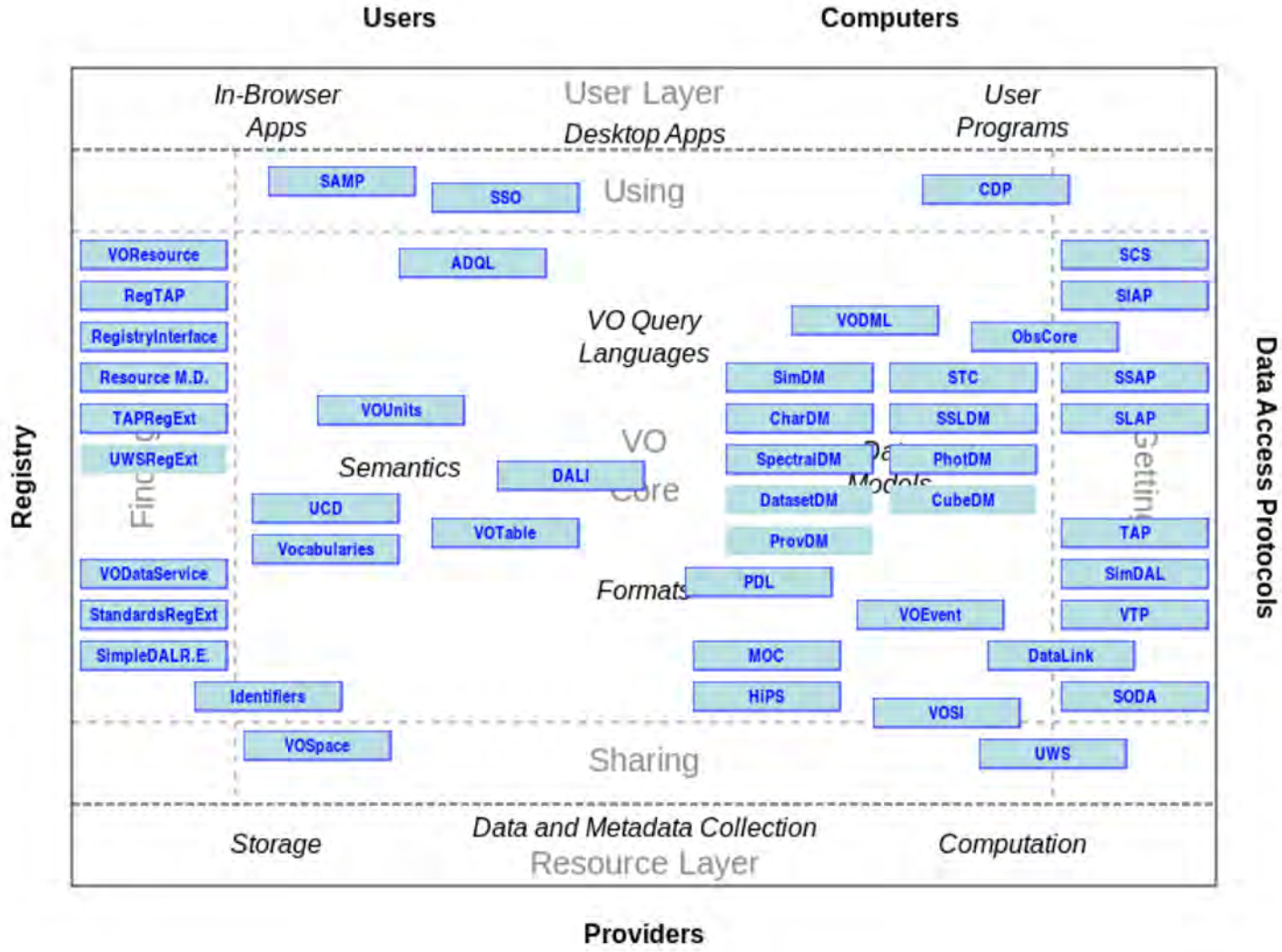
  (IVOA Secretary 9/2013 – 12/2018)

- *Welcome* **Francesca Civano**
  - Astrophysicist – Harvard Smithsonian CfA, Chandra X-ray Center
  - Approved by Exec, December 2018
  - Smooth transition ☺

Process



IVOA Standards



IVOA Media Group

Social media: Follow us and help spread the IVOA word! Interop: #ivoa19fr

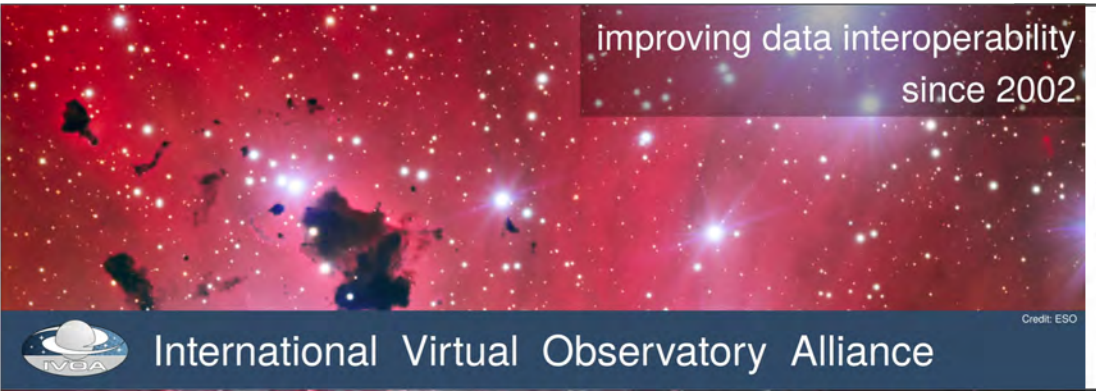
Twitter: https://twitter.com/IVOAastro

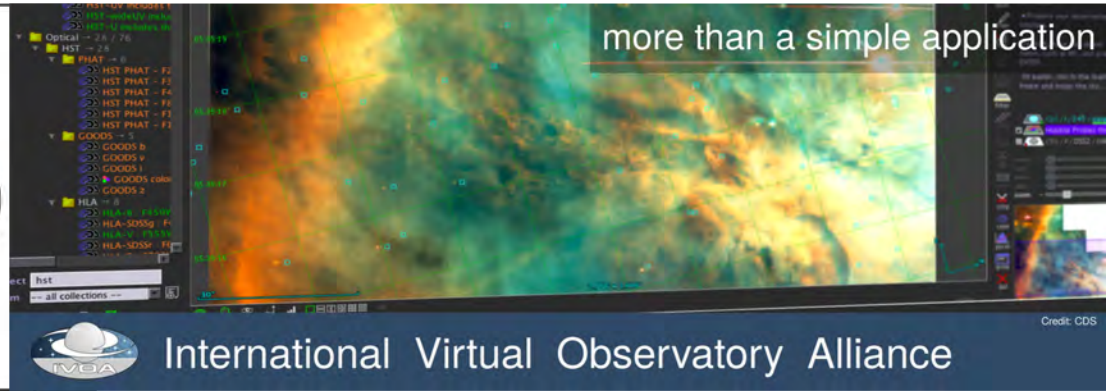
Facebook: https://www.facebook.com/IVOAastro

Weibo (in chinese): https://m.weibo.cn/p/1005056397469427

Outreach: Handout material, templates, slides, stickers, examples, and the Corporate Design Document available at:

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





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Newsletter: Send articles for the next IVOA newsletter, deadline: 5th June 19

Send to: ivoa-news-editors@ivoa.net

Contact us media@ivoa.net ***+ New members welcome!!***

Newsletter – please contribute!

IVOA Newsletter - January 2019

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IVOA Newsletter Editors: Deborah Baines, Bruce Berriman, Jamie Anne Budynkiewicz, Theresa Dower, Giulia Iafrate, Shanshan Li, Simon O'Toole, Yihan Tao.

The International Virtual Observatory Alliance (IVOA) was formed in June 2002 with a mission to facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating virtual observatory. The IVOA now comprises 20 VO programs from Argentina, Armenia, Australia, Brazil, Canada, Chile, China, Europe, France, Germany, Hungary, India, Italy, Japan, Russia, South Africa, Spain, Ukraine, the United Kingdom, and the United States and an inter-governmental organization (ESA). Membership is open to other national and international programs according to the IVOA Guidelines for Participation. You can read more about the IVOA and what we do at http://ivoa.net/about/.

What is the VO?

The Virtual Observatory (VO) aims to provide a research environment that will open up new possibilities for scientific research based on data discovery, efficient data access, and interoperability. The vision is of global astronomy archives connected via the VO to form a multiwavelength digital sky that can be searched, visualized, and analyzed in new and innovative ways. VO projects worldwide working toward this vision are already providing science capabilities with new tools and services. This newsletter, aimed at astronomers, highlights VO tools and technologies for doing astronomy research, recent papers, and upcoming events.

IVOA NEWS

College Park IVOA Interoperability Meeting

The Northern Fall IVOA Interoperability Meeting was held on November 8-10, 2018 in College Park, Maryland, USA, supported by the NASA Astronomical Virtual Observatories (NAVO) and the US Virtual Observatory Alliance (USVOA). There were 109 registered participants who gathered for two and a half days of productive discussions.

The Working Group and Interest Group sessions covered scientific and technological aspects of interoperability of astronomy data and services. Many presentations reported on practical implementations of IVOA standards, showing results and providing feedback. Progress was reported on the 'Time Domain' priority area. A number of contributions focussed on emerging needs of the astronomy community such as standards to support multi-messenger astronomy, and improving the access to VO resources via python language tools. Other topics included the status of operations in 'VO weather reports' and the use of Digital

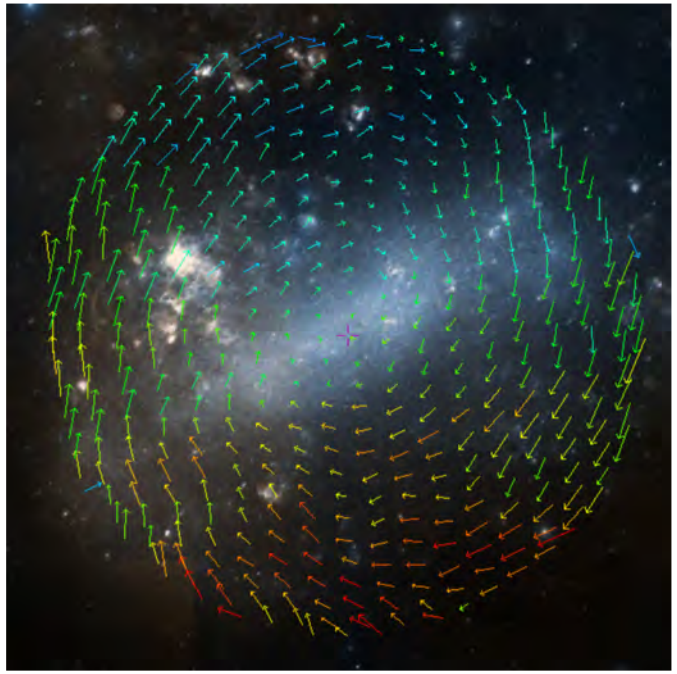
- **IVOA News**
- **Schools and Workshops**
- **VO Applications and Implementation highlights**
- **Recent papers about VO-enabled science**
- **VO Calendar**

IVOA Web and Wiki pages

- Web and wiki to be hosted in Trieste, Italy (Vobs.it)
  - Transfer in the hands of Trieste & IUCAA
- Plans for new web site design have been made by the IVOA Media Group
  - Requirements for home page – to be sent to exec
- Developer resources being arranged in Italy

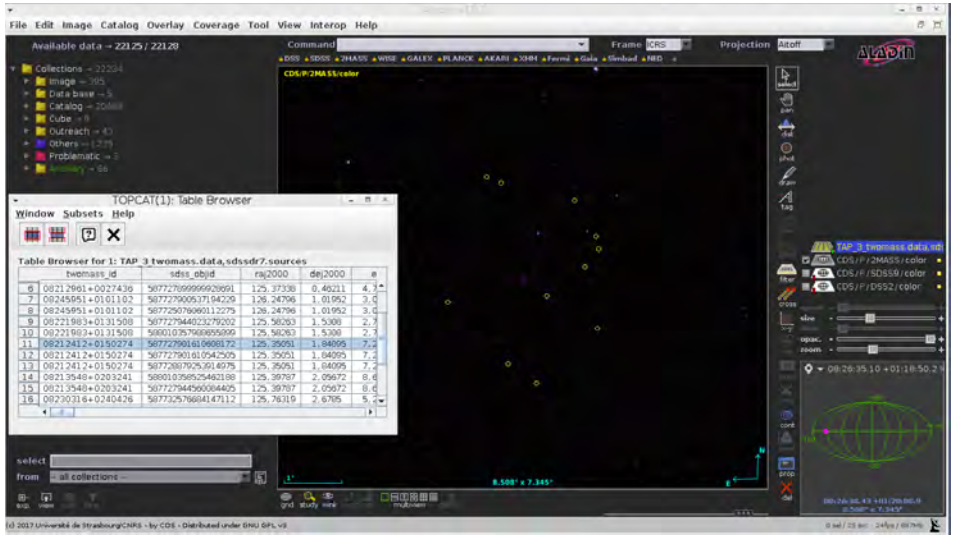
VO tutorials in ADASS

All sky astronomy with HiPS and MOCS



A comprehensive use case scenario of VO standards and protocols

Education IG



- ADASS paper
  - The International Virtual Alliance in 2018 (Allen et al. 2019)
  - http://arxiv.org/abs/1903.06636

- Investigate whether to do on annual basis

The International Virtual Observatory Alliance in 2018

Mark G. Allen,[1] Patrick Dowler,[2] Janet D. Evans,[3] Chenzhou Cui,[4] and Tim Jenness[5] for the IVOA Executive Committee and Technical Coordination Group

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[2]*Canadian Astronomy Data Centre, National Research Council Canada, Victoria, British Columbia, Canada*

[3]*Center for Astrophysics, Harvard & Smithsonian, Cambridge, MA, USA*

[4]*National Astronomical Observatories, CAS, Chaoyang District, 100101 Beijing, China*

[5]*Large Synoptic Survey Telescope, Tucson, AZ, USA*

Abstract. The International Virtual Observatory Alliance (IVOA) held its bi-annual Interoperability Meeting over two and half days prior to the ADASS 2018 conference. We provide a brief report on the status of the IVOA and the activities of the Interoperability Meeting held in College Park.

1. An alliance for the global vision of the Virtual Observatory

The Virtual Observatory (VO) is a collection of interoperating data archives and software tools that facilitate astronomical research. The overall goal is to support innovative research in astronomy by exploiting the full power of growing and emerging datasets and interoperable services. Many projects and data centres worldwide are working to make data and other resources work as a seamless whole. The International Virtual Observatory Alliance[1] (IVOA) is an organisation that debates and agrees on the technical standards that are needed to make the VO possible. Constituted in 2002 (see for example Quinn et al. 2004), the IVOA has now been joined by 21 national and international VO projects that meet bi-annually. Major IVOA accomplishments include standards for data and metadata (Data Models), data exchange methods (Data Access Layer; Query Language), and a registry that lists available services and identifies what can be done with them. Organisations have implemented VO-enabled tools and services that can interface seamlessly with VO-enabled archives worldwide, and some projects have built new data systems with VO services at their core. The IVOA acts as a focus for VO objectives, a framework for discussing and sharing VO ideas and technology, and a body for promoting and publicizing the VO.

[1]http://www.ivoa.net

News from IVOA members

For the set of reports from IVOA members

– see the Exec meeting page: Aiming to be complete!

OV France

See the Plenary presentation by Francoise Genova

US VOA

- Science Policy - white paper effort for the US 2020 Decadal Review
  - Archival exploration – major source of scientific discovery
- Discusses important unanticipated discoveries, and advocatse support for data management, software and archive interoperability. A collation of the white
- Papers can be seen at https://arxiv.org/abs/1903.06634
- Chandra Source catalogue, Chandra HiPS
- Multi-messenger VO services implemented
- DM, RoR, DCP activities

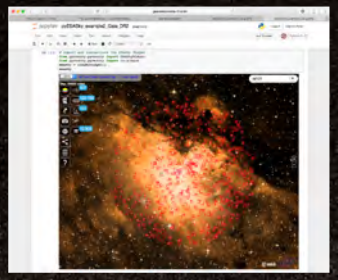
US VOA - NAVO

- Science White Papers
  - Preparing to submit state of the profession white papers, which will advocate for the VO (due July 1).
- "Deep Learning for Multi-Messenger Astrophysics: A Gateway for Discovery in the Big Data Era" - Nature Reviews Physics, advocates the value of the VO in data discovery
- AAS meetings – python workshops, special sessions Astrophysics archives in the 2020s
- Connections to Astropy, initial effort on Registry access
- Data and tools: PanSTARRS, ZTF, NEOWISE, Montage (HiPS)

US VAO - LSST

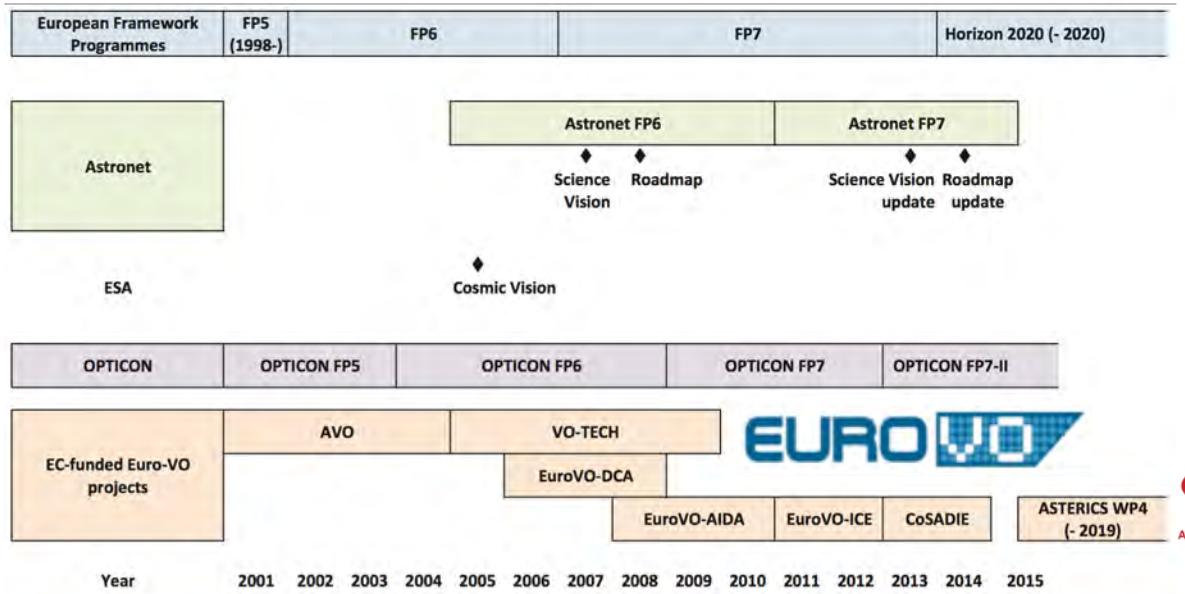
- “VO-first” approach to providing LSST data access Web services.
  * Adapting the OpenCADC TAP server code to work with the LSST Qserv parallel database.
  * Developed a Python SODA service implementation that works with the LSST Python science pipeline code base to perform its image cutout operations.
  * Deploying integrated single-sign-on for all the components of the LSST Science Platform (LSP)
  * Looking at adopting community VOSpace implementations, including CADC’s new POSIX-based server
  * Developed a Firefly-based Web front end to TAP queries.
  * Worked on STC transforms data model to ensure that it's compatible with current implementations.

ESA VO activities since Nov 2018



- pyESASky
  - Integration of ESASky into the Jupyter Notebook
  - Able to handle TAP, VOTable input and HiPS from users
- Gaia Archive
  - Very high use of the TAP module, in particular through astroquery.gaia
  - Discussions on the way to serialise and access Gaia Time Series and Spectra and data models for DR3 -> ESDC promotion of IVOA DMs and protocols
  - Access to other TAPs through new Gaia Archive User Interface
- Euclid Archive
  - Continue of the preparation of the Euclid Archive, applying VO standards
  - TAP+, HiPS, SIAP...
  - Needs of "move code to the data" paradigm (to be discussed this interop)
- Visibility (ObjVisSAP) and planned observations (ObsLocTAP) protocols definition progressing
  - Prototype implementations for visibility protocols from Chandra and Gaia
  - Implementation for INTEGRAL ongoing

Timeline of VO development in European projects



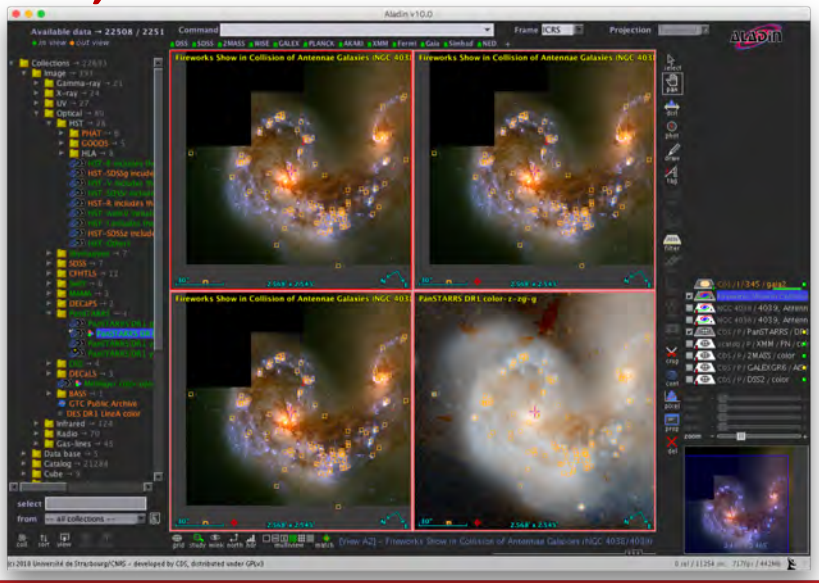
Genova et al. 2015

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

Work Package DADI

Key results:

- **The ESFRIs and pathfinders become consumers AND actors of the VO**
- **High impact on the IVOA standards, tools and topics** *(requirements/feedback/effort/expertise):*
  - **Multi-D data standards, All-sky approach, Time Domain, Provenance**
  - **Reference implementations & prototype interfaces**
- **Impact of the VO school training activities**

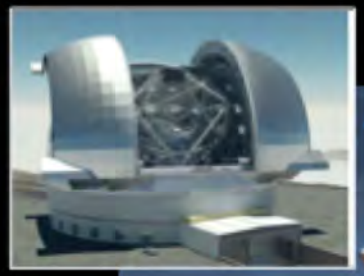


Radio

JIVE-VLBI

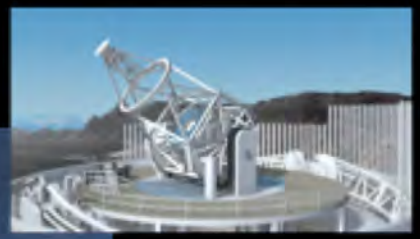
SKA

Visible light



ELT

ESO



EST

Gamma rays

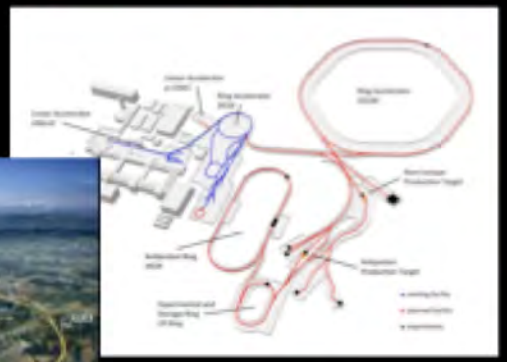
CTA

Accelerator-based
Particle Physics

HL-LHC

CERN

Accelerator-based
Nuclear Physics

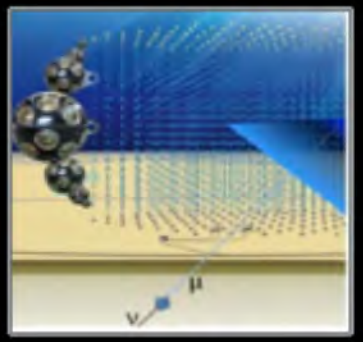


FAIR

Gravitational Waves

EGO-VIRGO

Cosmic-rays
Neutrinos



KM3NeT

ESCAPE goals

1. Implementing **Science Analysis Platforms** for EOSC researchers to stage data collections, analyse them, access ESFRIs' software tools, bring their own custom workflows.

2. Contributing to the **EOSC** global resources federation through a Data-Lake concept implementation to manage extremely large data volumes at the multi-Exabyte level.

3. Supporting **"scientific software"** as a major component of ESFRI data to be preserved and exposed in EOSC through dedicated catalogues.

4. Implementing a community foundation approach for continuous software shared development and training new generation researchers.

5. ***Virtual Observatory standards and methods for FAIR principles to a larger scientific context; demonstrating EOSC capacity to include existing frameworks***.

6. Further involving SMEs and society in knowledge discovery.

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

Vobs.it (I)

- VObs.it staff participated in the EU ASTERICS project, and organised (Jan 19) in Trieste a meeting on Authentication and Authorisation.
- VObs.it staff have started participation in the EU ESCAPE project. Our role in the project is the integration of astronomy VO data and services into the European Open Science Cloud (EOSC).
- Funding for VObs.it has been secured by INAF for the 2019 fiscal year.
- Collaboration on VO-related activities has started between INAF and ASI: this involves the two data centres (IA2 and SSDC respectively) and VObs.it (IVOA-related) activities.
- Initial steps have been taken to migrate to INAF-OATs the part of the IVOA web currently hosted at IUCAA.

Vobs.it (II)

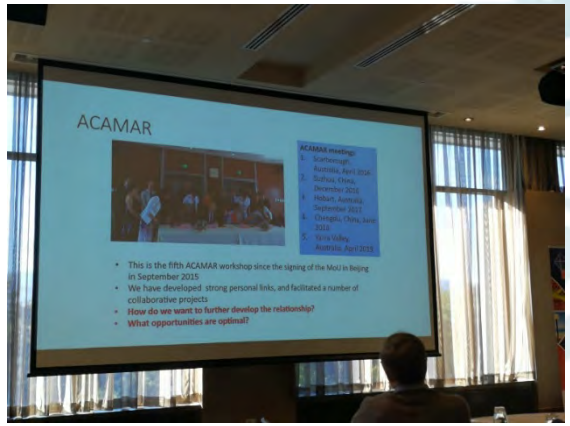
- Marco Molinaro (IVOA DAL Chair) and Giulia Iafrate (IVOA Doc Coordinator) were appointed to permanent INAF positions.
- Two new INAF fixed-term staff were selected to work full-time within VObs.it and have taken up duty at INAF-OATs (Trieste). They are Chaitra (formerly at CDS, Strasbourg) and Kalyani Pedamkar.
- A VO-related presentation (on VO Forum and Training activities for new-generation infrastructures) was made at the Integrating Event of the ASTERICS project.
- A VO related event (presentation of Virtual Reality contents for EPO) was made as conclusion of ASTERICS project

Communities and Involvement

- Nov. 2018, the China-VO and Astroinformatics 2018 was held successfully in Jingdezhen, more than 170 persons attended the event.

- Dec. 2018, the Proposal of Informatization Working Committee (IWCC) of Chinese Astronomical Society was approved.

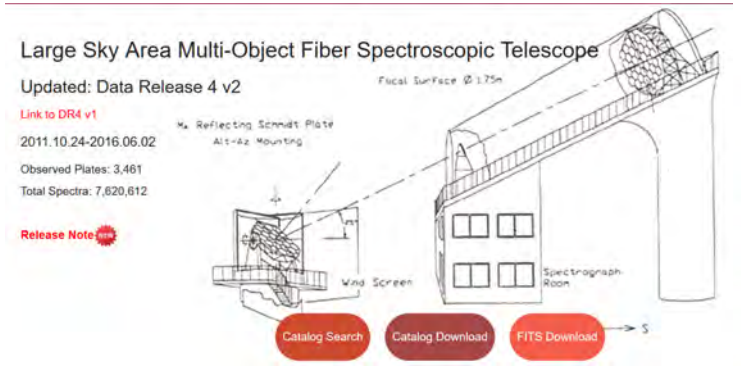
- Apr. 2019, at the ACAMAR 5 (Australia-China Consortium for Astrophysical Research), Chenzhou gave a talk about IVOA.



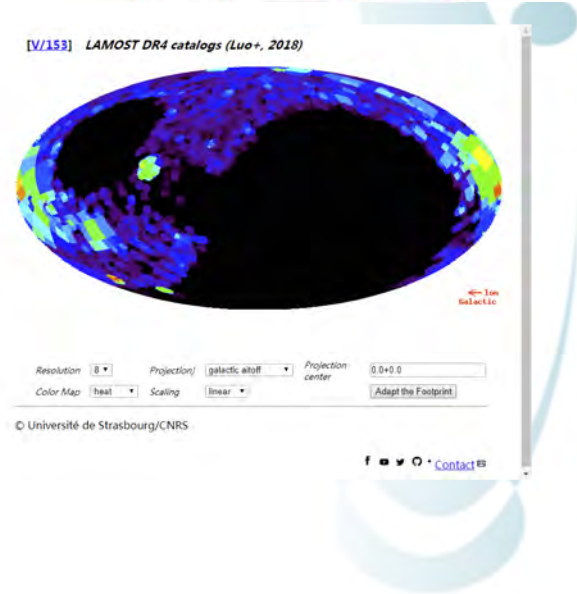
- Under the name of EduIG and IAU DAEPO WG
  - IAU GA30 Vienna
  - WG renew application
  - IAUS 358 Astronomy for Equity, Diversity and Inclusion — a roadmap to action within the framework of the IAU 100th Anniversary
  - Data-driven EPO session @ CODATA Beijing 2019
  - Data-driven EPO session @ Scientific Data Conference 2019

Data Releases and Open Access

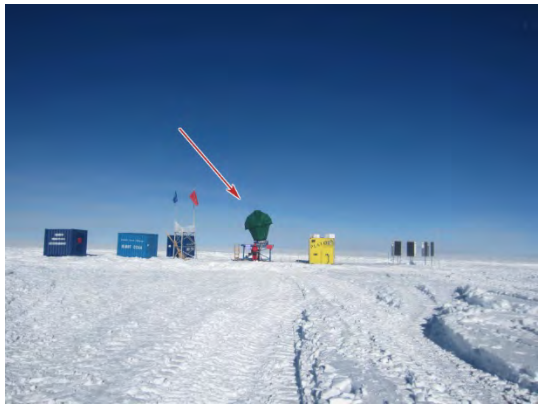
- Jul. 2018, LAMOST DR4 released globally
  - Included by VizieR in Sep. 2019



- May. 2018, AST3 (Three Antarctic Survey Telescopes) DR1 released

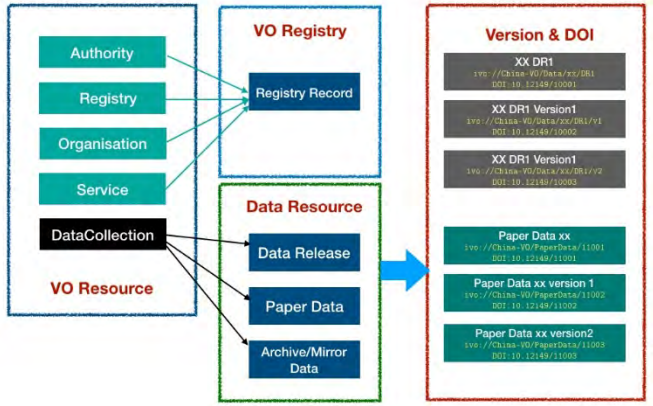


- Apr. 2018, GAIA DR2 was mirrored in China by China-VO



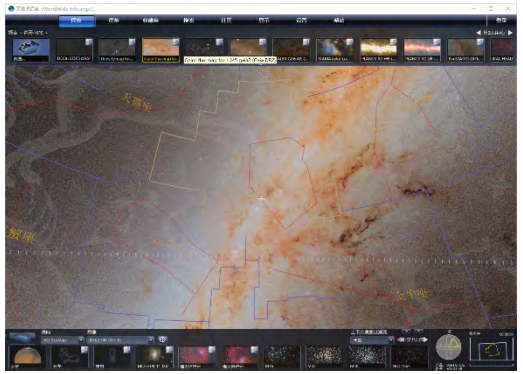
System Development

- May 2019, China-VO Paperdata, a journal paper data repository, upgraded with VOSpace and DOI implementations, and linked with China-VO Registry.
  - http://paperdata.china-vo.org/
  - Dr. Yihan's talk at DCP Session



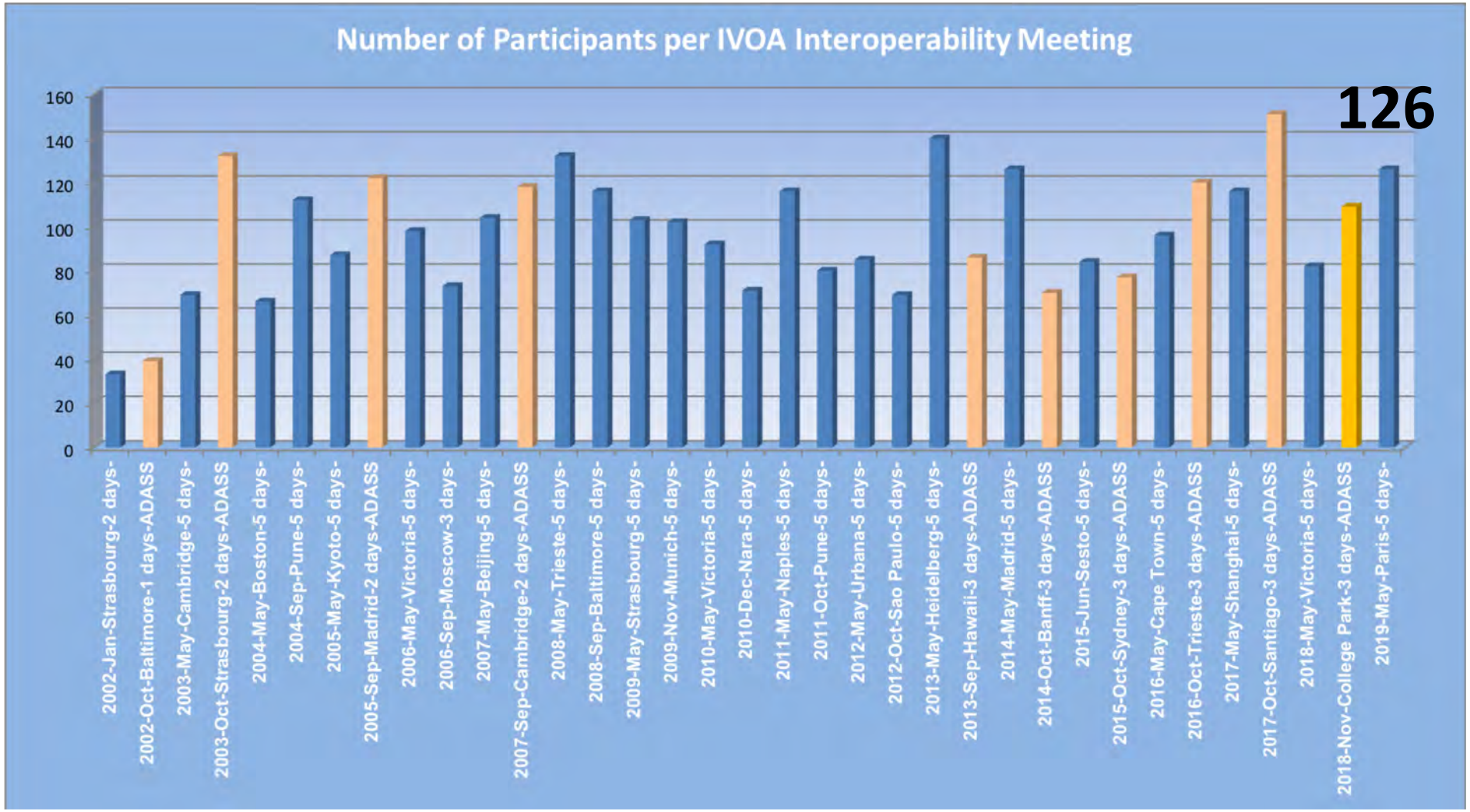
https://registry.china-vo.org/resource/11001

- May 2019, China-VO WWT 2.0 released with HiPS implementation and enhanced VR and Microsoft Kinect support. Dozens of HiPS datasets, including Chang'e-II 7m lunar global data, are accessible from the new version.
  - http://wwt.china-vo.org
  - Chenzhou's talk at App Session



This Meeting
IVOA

Participation



Schedule

- **Plenary Sessions**
- **WG and IG sessions**
  - A working meeting
  - Open discussions
- **Focus Session**
  - See CSP presentation
- ***Astropy hackathon/sprint***
  - Experiment!
  - See CSP presentation

Thanks to the Program Organising Committee!

TWiki > IVOA Web > IvoaEvents > InterOpMay2019 (2019-05-12, KaiLarsPolsterer)

May 2019 IVOA Interop Meeting Schedule

- General Meeting Information (Registration, Hotel, Travel etc.) can be found here

Session	Time	Room	Session	Notes
Sunday May 12 2019				
	10:30–12:00	Salle du Conseil	TCG Meeting	WG/IG Chairs/Vice-chairs
	12:00-13:00	Lunch		
	13:00-15:30	Salle du Conseil	TCG Meeting cont.	WG/IG Chairs/Vice-chairs
	15:30-16:00	Coffee Break		
	16:00–18:00	Salle du Conseil	IVOA Exec Meeting	Exec + WG/IG Chairs/Vice-chairs
Monday May 13 2019				
1	09:00–09:05	Salle Le Verrier	Logistics	Local organizer
	09:05–09:20		Welcome	Local IVOA member
	09:20–10:00		State of the IVOA	Mark Allen
	10:00–10:20		CSP status report	Bruno Merín
	10:20–10:30			
	10:30–11:00	Break		
2	11:00–11:20	Salle Le Verrier	State of the TCG	Pat Dowler
	11:20–12:30		Charge to the WG/IGs	WG/IG Chairs
	12:30–14:00	Lunch		
3	14:00–15:30	Salle Le Verrier	Plenary	
	15:30–16:00	Break		

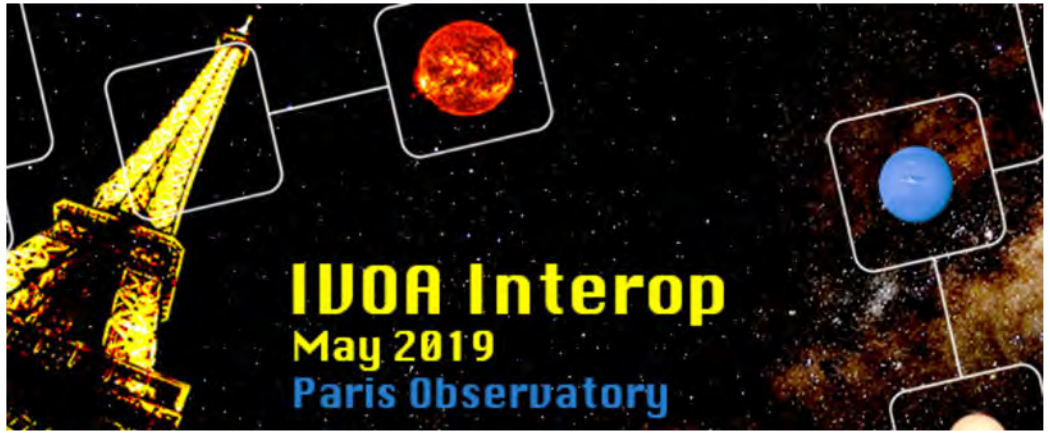
WG Chairs and Vice-Chairs

- ***Applications***:
  Tom Donaldson, Raffaele D'Abrusco
- ***Data Access Layer***:
  Marco Molinaro, James Dempsey
- ***Registry***:
  Theresa Dower, Pierre Le Sidaner
- ***Data Models***:
  Mark Cresitello-Dittmar, Laurent Michel
- ***Grid and Web Services:***
  Brian Major, Giuliano Taffoni
- ***Semantics***:
  Mireille Louys, Markus Demleitner

Open in May 2019

IG Chairs and Vice-Chairs

- ***Data Curation and Preservation*:**
  André Schaaff, Tim Jenness
- ***Knowledge Discovery :***
  Kai Polsterer, Matthew Graham
- ***Operations*:**
  Tom McGlynn, Mark Taylor
- ***Solar System:***
  Baptiste Cecconi, Steve Joy
- **Time Domain:**
  Ada Nebot, Dave Morris

For Open positions – it's not too late !
Please let us know if your interested!

And now – to work!!