State of the IVOA

College Park, MD, USA
8-10 November 2018

Hosted by :

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

IVOA Interoperability Meeting Opening Session

National Aeronautics and Space Administration
NAVO: NASA Astronomical Virtual Observatories

IVOA in 2018


Astro Grid
ArVO
Aus-VO
BRAVO
China-VO
ChiVO
CHILEAN VIRTUAL OBSERVATORY
CVO
esa
European Space Agency
France
EURO VO
IVOA
GAVO
HVO
JVO
NOVA
RVO
NRF
SA
SVO
UKR VO
USVOA
VObs.it
vo-i

An Alliance pursuing the global vision of the Virtual Observatory

VO and IVOA

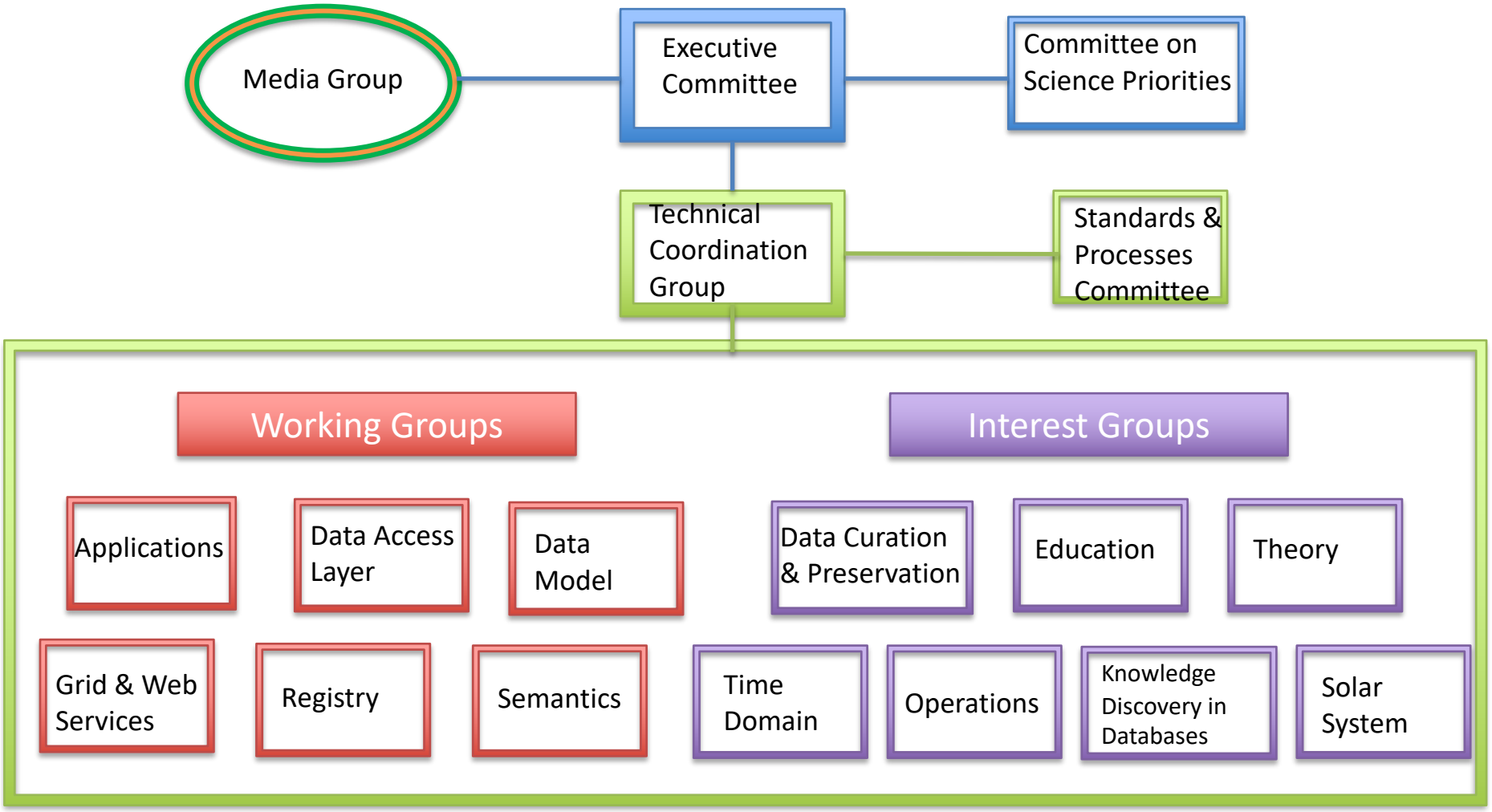
Vision of the VO:

- 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

IVOA Organization Chart



- 21 diverse member projects
- 2 well attended Interoperability meetings per year – Oct/Nov meeting linked with ADASS
- 6 Working Groups, 7 Interest Groups
  - Completely open to participation
- Some members come and gone…
- Pioneering work on development of standards
  - Some hard lessons learned

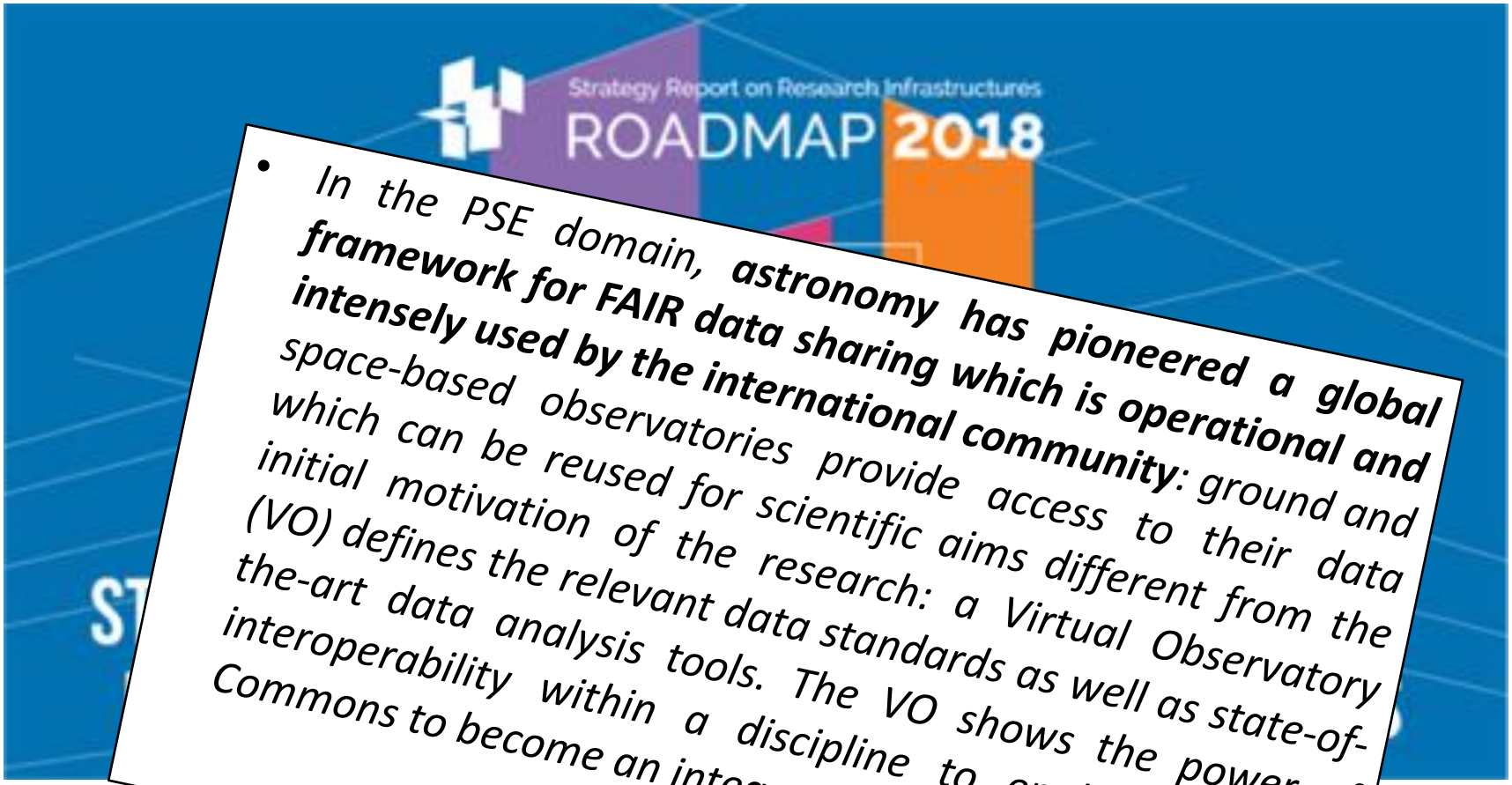
IVOA in 2018

- IVOA is still here because it is a good idea!!
- Large data producing projects engaged
  - active participants in the IVOA process
- VO is integrated in many Astronomy data centres and archives
  - Often behind the scenes…
  - Huge benefits from shared software components
- VO enables many scientific capabilities, just not possible otherwise – All sky astronomy

Pioneering effort recognised

- ESFRI Roadmap 2018

Pioneering effort recognised



- *In the PSE domain,* ***astronomy has pioneered a global framework for FAIR data sharing which is operational and intensely used by the international community****: ground and space-based observatories provide access to their data which can be reused for scientific aims different from the initial motivation of the research: a Virtual Observatory (VO) defines the relevant data standards as well as state-of-the-art data analysis tools. The VO shows the power of interoperability within a discipline to enable data and Commons to become an integrated Research Infrastructure.*

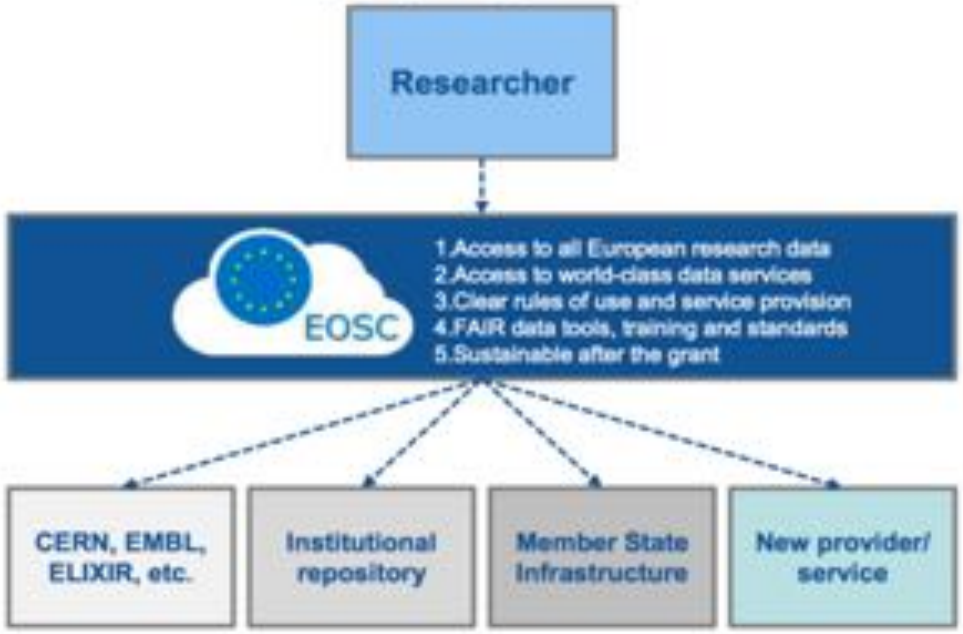
Changing landscape

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

In Europe…
European Open Science Cloud (EOSC)

A. The EOSC will allow for universal access to data and a new level playing field for EU researchers



- Easy access through a universal access point for ALL European researchers
- Cross-disciplinary access to data unleashes potential of interdisciplinary research
- Services and data are interoperable (FAIR data)
- Data funded with public money is in principle open (as open as possible, as closed as necessary)
- EOSC will help increase recognition of data intensive research and data science

Seamless environment, enabling interdisciplinary research

Other aspects of the changing landscape

- **Growth of Astroinformatics and Machine Learning**
- **'Science analysis platforms'**
  - Sharing of services across science platforms
  - Access to cloud computing resources
  - Importance of python / astropy in astronomy
- **Support for interdisciplinary science ramping up strongly**
  - generic framework components expected to be shared on commercial and academic/research clouds
- **Computing and storage on cloud**
  - Strongly growing need to connect VO to computing
  - "Data Lake" concept emerging and being embraced by e.g. CERN
- **Education / Outreach – big push via IAU and others**

All of these are challenges and opportunities for IVOA !!

IVOA and members address various audiences

Research astronomers – how can I get the data and use it?

Data Centres and Archives – how to make data FAIR?

Software developers - how to make software interoperable?

Educators – how can we use research data in Education and Outreach contexts?

Institutions, policy-makers, and funders – how do we make the system work to meet the needs of the community?

IAU / UN / ? – Status of IVOA as an organisation

RDA + – How can the successes of astronomy be translated to other fields/domains?

IVOA at the IAU

- IVOA booth active -- for the full 10 days!
  - Engagement with Astronomy community
    - Astronomers, students, policy makers, IAU, educators
  - Demonstrations of tools and services
    - CDS, ADS, GAVO, CXC, China-VO, Vobs.it, Euro-VO +
  - IVOA flyer for overview of IVOA
  - Virtual Flyers contributed from IVOA members(+)

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.

IVOA

International Virtual Observatory Alliance

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!

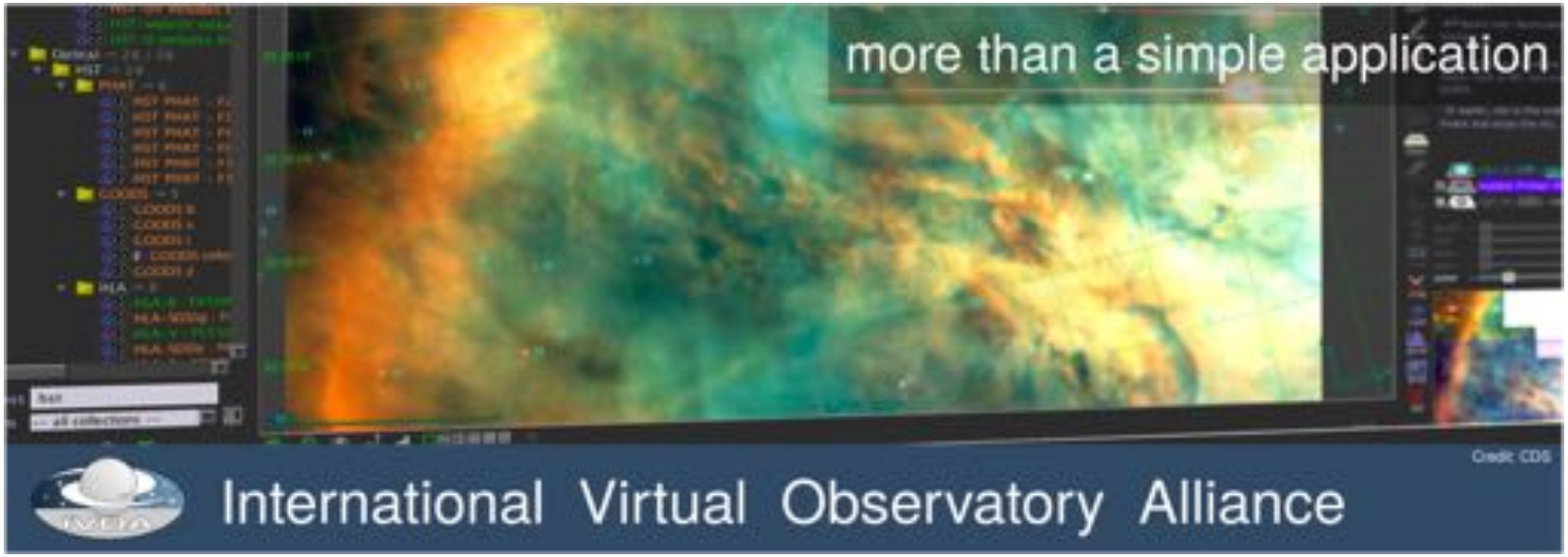
See the bi-annual Newsletter for highlights on the latest science applications, scientific results using VO tools, and a calendar of events.

Find out more

ivoa.net

International Virtual Observatory Alliance


improving data interoperability
since 2002
Credit: ESO
International Virtual Observatory Alliance


more than a simple application
Credit: CDS
International Virtual Observatory Alliance

IVOA Virtual Fliers

A few examples of the Virtual Fliers…

For all of them, + posters, + IVOA flyer

See the IVOA wiki page:

http://wiki.ivoa.net/twiki/bin/view/IVOA/IAUAug2018

Chandra X-Ray data in the Virtual Observatory

The Chandra X-ray Observatory has nearly 20 years of public data in its archive. Chandra data is easily accessible to the scientific community through VO-enabled services and interfaces.

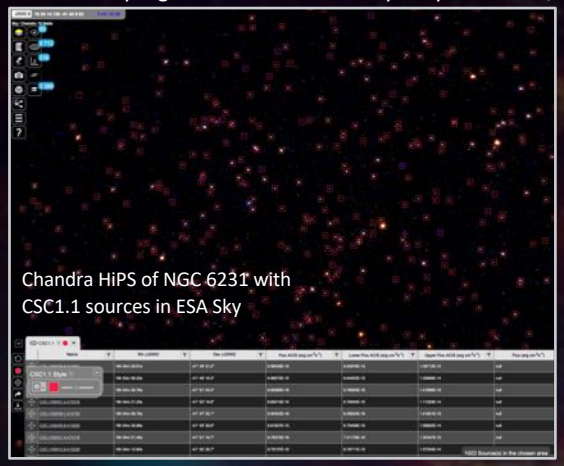
cxc.harvard.edu

Image credit: X-ray: NASA/CXC/UMass/D. Wang et al.; Optical: NASA/ESA/STScI/D.Wang et al.; IR: NASA/JPL-Caltech/SSC/S.Stolovy

Access Chandra X-ray data through Virtual Observatory Services & Interfaces

Chandra Hierarchical Progressive Survey (HiPS)

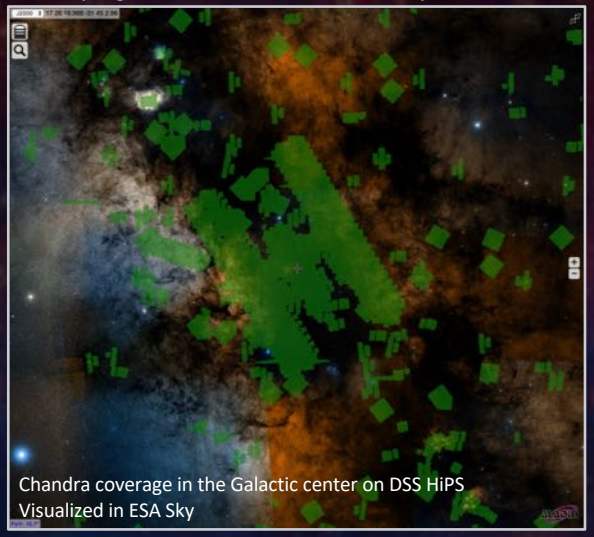
Visualize sky regions with source overlays as you zoom in/out



Chandra HiPS of NGC 6231 with CSC1.1 sources in ESA Sky

HEALPix Multi-Order Coverage maps (MOCs)

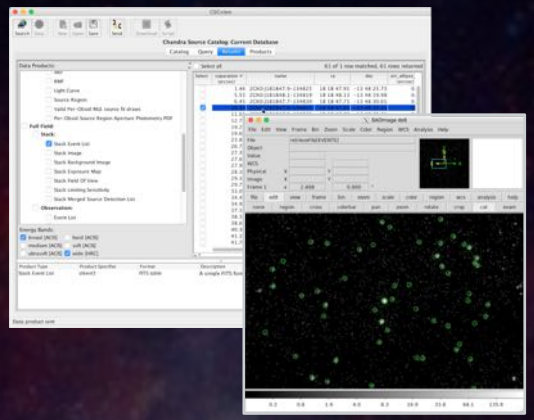
Find sky regions that have been observed by Chandra



Chandra coverage in the Galactic center on DSS HiPS Visualized in ESA Sky

VO-enabled archive interfaces: ChaSeR & CSCview

Discovery, Query & Access Chandra data through VO interfaces
VO: ADQL, VOTable, SAMP



Access Chandra data from other VO tools and services with:

- Simple Cone Search
- Simple Image Access (SIAP)
- Table Access Protocol (TAP)

More Chandra VO

bit.ly/cxc-iau30

International Virtual Observatory Alliance

CHANDRA X-RAY OBSERVATORY
CXC
Smithsonian Astrophysical Observatory
NASA

Image credit: X-ray: NASA/CXC/UMass/D. Wang et al.; Optical: NASA/ESA/STScI/D.Wang et al.; IR: NASA/JPL-Caltech/SSC/S.Stolovy

Japanese Virtual Observatory, NAOJ

The Japanese Data Hub for Astronomy

JVO provides astronomers with observational data from Subaru, ALMA, Nobeyama, ISAS, GAIA, and others through VO services worldwide.

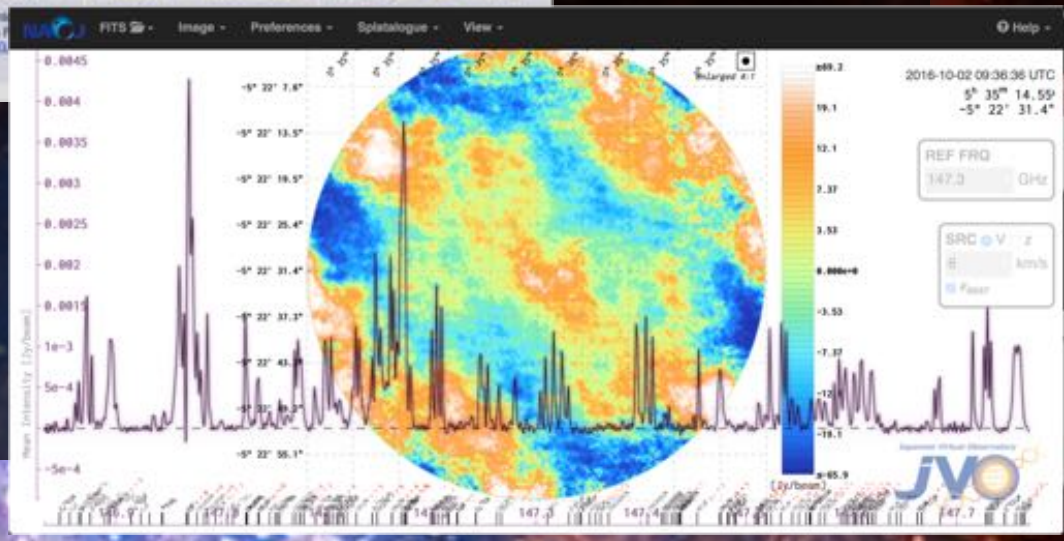
http://jvo.nao.ac.jp/

NINS 自然科学研究機構

国立天文台 NAOJ National Astronomical Observatory of Japan

JVO provides a unique quick-look service for the ALMA FITS files.

↓



One stop data services from Japanese telescopes and those from all over the world.

Visit us at http://jvo.nao.ac.jp/

International Virtual Observatory Alliance

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

Spanish Virtual Observatory (SVO)

- *IVOA member since 2004.*
- *Coordination of VO activities in Spain.*
- *Four major lines of work:*
  - *VO compliance of astronomical archives.*
  - *Development of VO tools.*
  - *VO-science.*
  - *Education & Outreach.*

http://svo.cab.inta-csic.es

Astronomical archives

We host the largest VO data centre managed by a Spanish institution.

VO-science

VO project providing the largest number of VO-science papers.

Discovery of wide low and very low-mass binary systems using Virtual Observatory tools

M. C. Gálvez-Ortiz, E. Solano, N. Lodieu, M. Aberasturi

Monthly Notices of the Royal Astronomical Society, Volume 466, Issue 3, 21 April 2017,

A search for new hot subdwarf stars by means of virtual observatory tools II

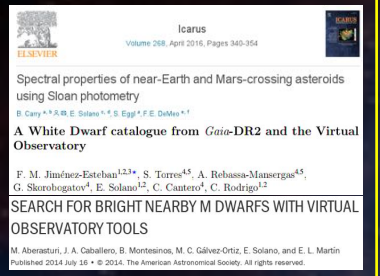
E. Pérez-Fernández, A. Ulla, E. Solano, R. Oreiro, C. Rodrigo

Monthly Notices of the Royal Astronomical Society, Volume 457, Issue 3, 11 April 2016, Pages 3396–3408, https://doi.org/10.1093/mnras/stw200

Estimates of the atmospheric parameters of M-type stars: a machine-learning perspective

L M Sarro, J Ordieres-Meré, A Bello-García, A González-Marcos, E Solano

Monthly Notices of the Royal Astronomical Society, Volume 476, Issue 1, 1 May 2018, Pages 1120–1139, https://doi.org/10.1093/mnras/sty165



Icarus
Volume 268, April 2016, Pages 340-354

Spectral properties of near-Earth and Mars-crossing asteroids using Sloan photometry

B. Carry, E. Solano, E. S. Eggl, F. E. DeMeo

A White Dwarf catalogue from *Gaia*-DR2 and the Virtual Observatory

F. M. Jiménez-Esteban, S. Torres, A. Rebassa-Mansergas, G. Skorobogatov, E. Solano, C. Cantero, C. Rodrigo

SEARCH FOR BRIGHT NEARBY M DWARFS WITH VIRTUAL OBSERVATORY TOOLS

M. Aberasturi, J. A. Caballero, B. Montesinos, M. C. Gálvez-Ortiz, E. Solano, and E. L. Martín

And many more....

VO tools

We develop VO tools and services for data publishing and data analysis.

VOSA — Stellar parameters from SED fitting.

Clusterix 2.0 — Stellar cluster membership probability.

SVO DISCOVERY TOOL — Data discovery in VO archives

SVOCat
Easily publishing catalogues in the VO (and web)

Education and Outreach

- *Liaison with Universities.*
- *VO-schools.*
- *Citizen-science.*

International Virtual Observatory Alliance

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

The **NOAO Data Lab**

We seek to empower astronomers through efficient exploration and analysis of large astronomy datasets with an emphasis on NOAO wide-field telescopes.

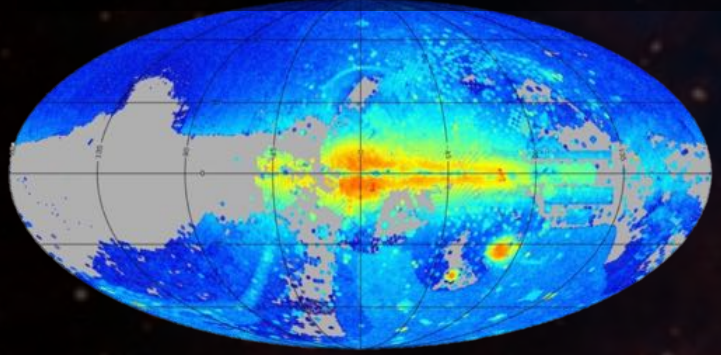
datalab.noao.edu

International Virtual Observatory Alliance

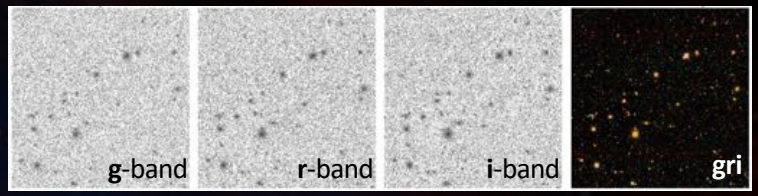
Credit: X-ray: NASA/CXC/CfA/R. Tullmann et al.; Optical: NASA/AURA/STScI

datalab.noao.edu

Large Catalogs – TB-scale databases



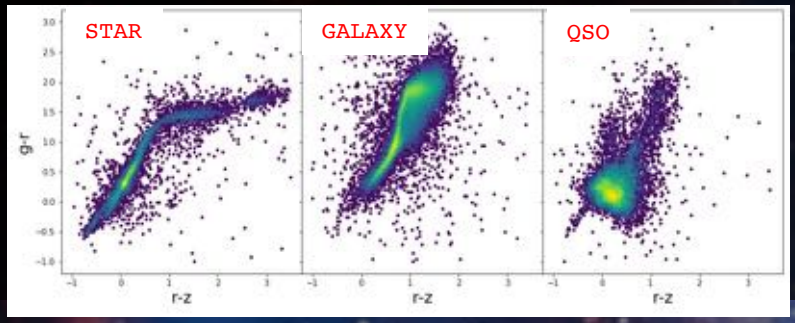
Pixel Data – images in NOAO Science Archive



NOAO DATALAB

Virtual Storage – 1 TB per user

Compute Processing – workflows close to the data



Visualization – data exploration

IVOA International Virtual Observatory Alliance

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

European Virtual Observatory

Euro-VO

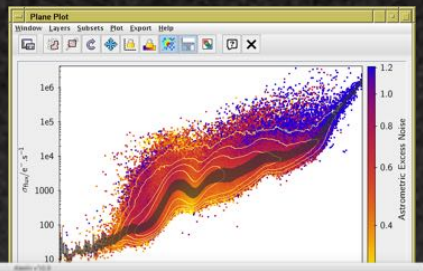
EURO-VO *supports the utilization of VO tools and services by the scientific community, technology take-up and VO compliant resource provision, and building of the technical infrastructure.*

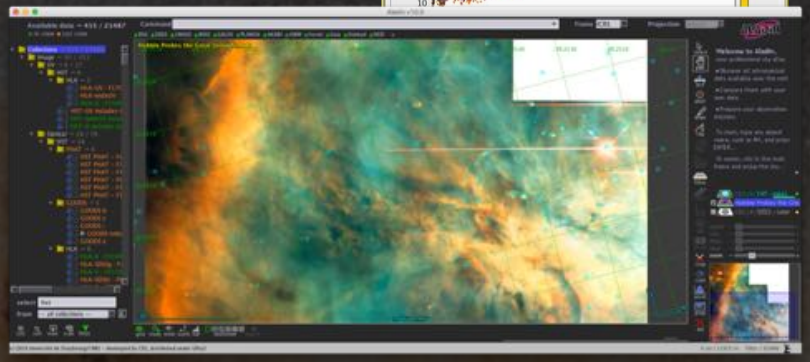
International Virtual Observatory Alliance

Image credit: CDS

Virtual Observatory Schools and tutorials

Learn how to use VO tools for your own science!
Aladin, TOPCAT, VOSA, ADQL queries, 100s of VO services and much more.





Euro-VO Supports Data Providers:
Technical forums and coordination of requirement gathering and support of implementation

Support of technical work to build the VO:
Participation in IVOA to make the standards, and building VO compliant tools for science

Supported via European projects:
Euro-VO has been supported by EC funded projects, the current one being the H2020 ASTERICS Cluster (WP4)

EURO VO

Asterics
Astronomy ESFRI & Research Infrastructure Cluster

http://euro-vo.org

IVOA

International Virtual Observatory Alliance

Image cred

Excellent presentation about VO and Education

IVOA @ IAU GA 2018

- Many visitors to the booth!
  - Some introduced to VO for 1st time
  - Detailed advice for super-users
- IVOA interaction with IAU
  - Presented IVOA to the new President and President-elect
  - IAU General secretary
  - New Division B President (*Facilities, Technologies and Data Science*), and new President of Commission B2 (*Data and Documentation*)
  - WG - *Virtual Astronomy and Data Centers*
    - Future of this WG needs to be defined now
      - A place for IVOA information to be passed to IAU ?
      - A place to develop a resolution about IVOA for IAU GA 2021?

Newsletter – Aug 2018

IVOA Newsletter - August 2018

Subscribe | Newsletter archives | Write to the editors

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 observato[ry]. The IVOA now comprises 20 VO programs from Argentina, Armenia, Australia, Brazil, Canada, C[hina], Europe, France, Germany, Hungary, India, Italy, Japan, Russia, South Africa, Spain, Ukrai[ne], [Kin]gdom, and the United States and an inter-governmental organization (ESA). Members[hip] [nat]ional and international programs according to the IVOA Guidelines for Participation. [Abo]ut 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 po[ssibilities] for scientific research based on data discovery, efficient data access, and interoperability. The vision is o[f] astronomy archives connected via the VO to form a multiwavelength digital sky that can be searched, visualize[d] 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

Gaia DR2 and the VO: A two-way success story

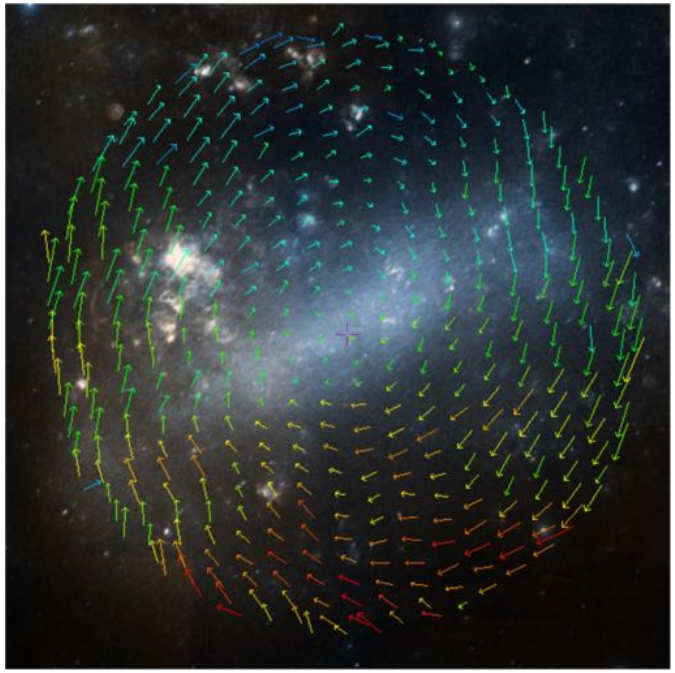
When, on 25th April at 12:00 sharp, thousands of astronomers opened TOPCAT, searched for "Gaia DR2" and found four services (ARI, CDS, ESA, GAVO) willing to answer significantly complex queries over the impressive 1.7 billion source catalogue, very few were aware that perhaps the most intensive and decisive operational test since the formation of the VO in 2002 was running at that precise moment.

And it was a successful test. The VO behaved as good technology should behave: transparent to the users whilst empowering them to perform scientific queries without noticing

Please contribute for the next issue!

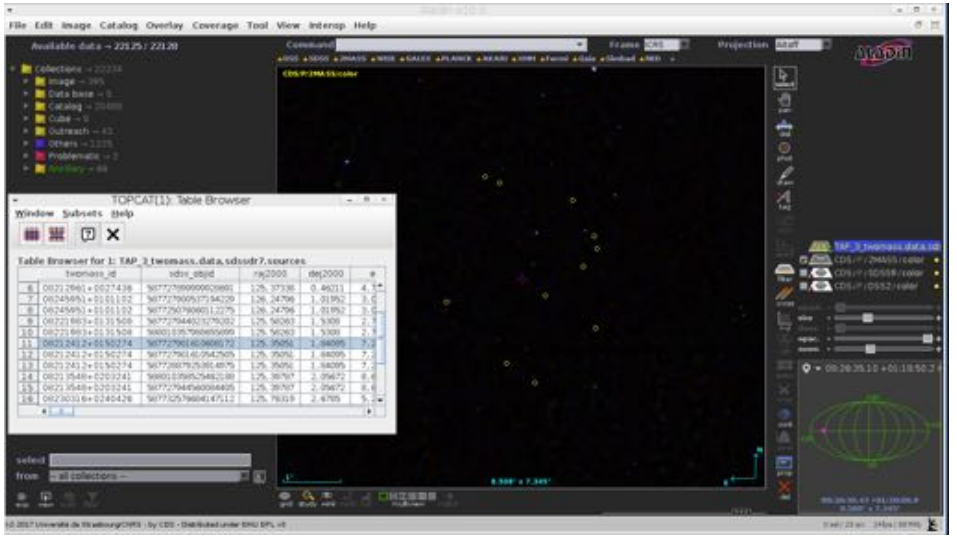
VO tutorials in ADASS

All sky astronomy with HiPS and MOCS



A comprehensive use case scenario of VO standards and protocols

Education IG



News from IVOA members

US: LSST, AURA

- LSST
  - Implementing TAP (using CADC software) and experimenting with an ADQL translator for QServ backend database.
  - Added support for ObsCore to Firefly.
  - Investigating a mapping from the LSST data model to ObsCore and CAOM2.
  - Beginning work on VOSpace and HiPS.
  - Looking at mapping LSST alert packets (currently using Apache Avro) to VOEvent.
  - Would like to have discussions on authenticated access to IVOA services, transport of large tabular data results, and improving Python client software.
- AURA
  - Interested in Science Platform standardization.

US: NAVO

- Focus on science white papers for the Decadal Survey, due Jan 19 2019)
  - AstroData2020s Science Workshop, Pasadena, CA
  - Astrophysics Archives for the 2020s Special Session at the 233rd AAS meeting, Seattle (Jan 6-10 2019)

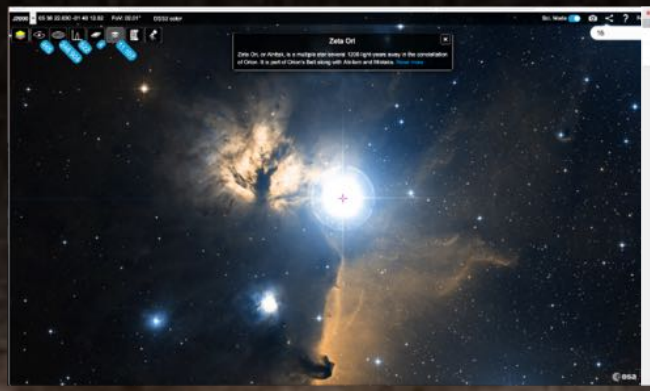
- NAVO archives: supported NASA Science Mission Directorate (SMD) meetings to develop strategy for cross-disciplinary approach to data Archives, Processing and Data Exploitation.

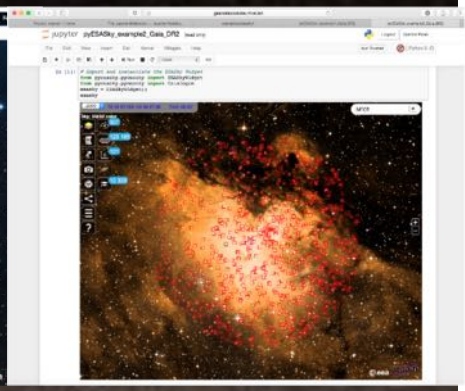
- NAVO enhancement to Python Astroquery library
  - simple standard way to access the Virtual Observatory Registry of available resources.
- Upcoming workshop: "Using Python to Search NASA's Astrophysics Archives," at the January AAS meeting.

- USVOA web site redirected to NAVO site at https://heasarc.gsfc.nasa.gov/vo/summary/

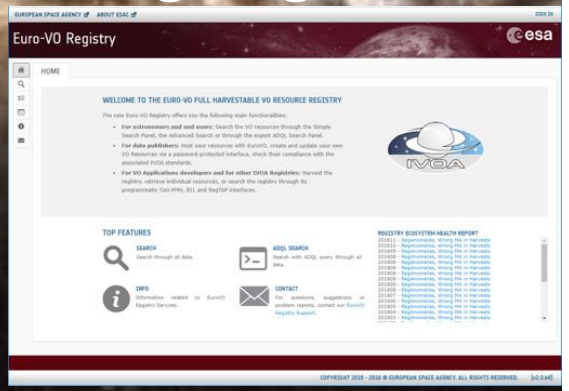
ESA VO activities since May 2018

- ESASky version 3.0
  - Solar System Objects
  - New Design with logos
  - Jupyter Notebooks API





- New GUI for Euro-VO Registry development on-going

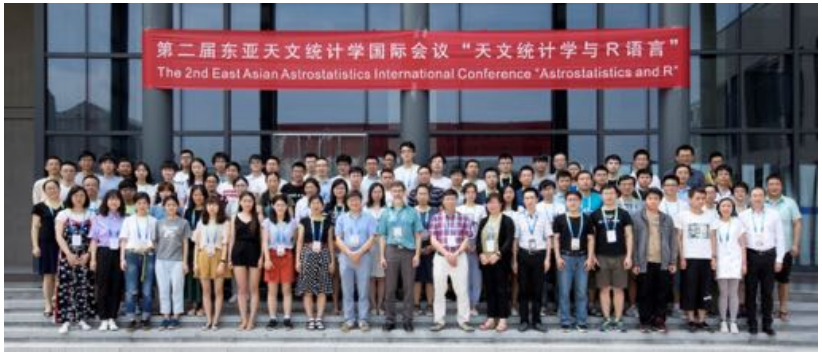


- New TAP services for XMM-Newton and European HST Archives and SCS for Gaia Archive

- New Visibility and Observation planning protocol being proposed for IVOA discussion/endorsement. Workshop at ESAC showed large interest from data providers.

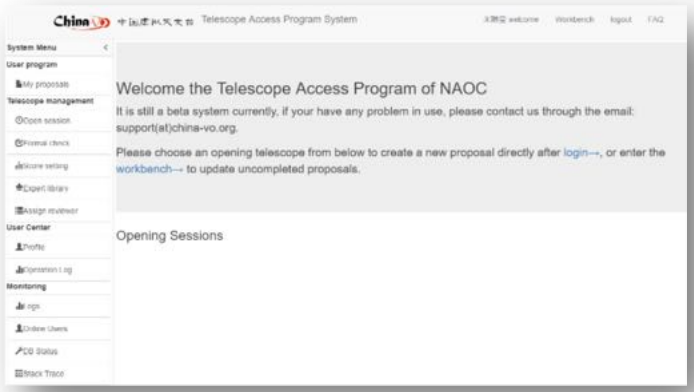
China-VO hosted the 2nd East Asian Workshop on Astrostatistics

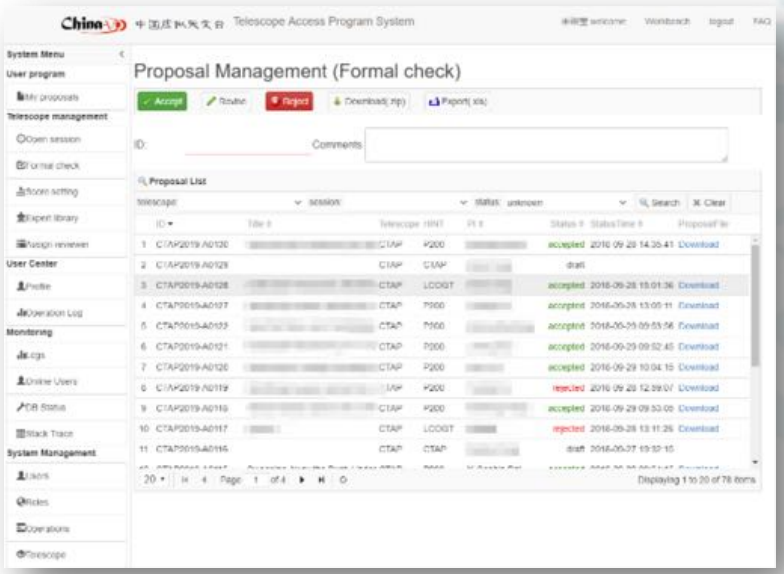
- The Workshop were held on July 9-13, 2018 in Nanjing，and on July 16-20, 2018 in Guiyang. This workshop is organized by East Asian Core Observatories Association and hosted by the China-VO (NAOC), PMO, and Guizhou Normal University.
- A total of 129 participants from 28 astronomical research institutes of China, Japan, Vietnam and Mongolia attended to the workshop.
- Prof. Eric Feigelson from Penn State University is the instructor of the workshop. During the workshop, Prof. Feigelson covered the topics of density estimation & local regression, statistical inference, regression, multivariate clustering & classification, Bayesian inference, time series analysis, good statistical practices in astronomy, etc. and illustrated by code examples in R.



Telescope Access Program Became User of the China-VO

- The Telescope Access Program (TAP) is a program to give astronomers based in China direct access to competitive instrumentation on intermediate- and large-aperture optical/infrared telescopes outside of China.
- TAP Supported telescopes:
  - Canada-France-Hawaii Telescope (3.6m): 4-7 nights [February, 2019 - July, 2019]
  - Palomar Hale Telescope (5.1m, P200): ~22 nights [February, 2019 - July, 2019]
  - Las Cumbres Observatory (1m network): 200 hours [December, 2018 - May, 2019]
  - Las Cumbres Observatory (LCO) telescopes
- The China-VO began to support proposal submission and data archiving of the TAP since September, 2018.
  - 48 proposal were collected for the Semester 2019A

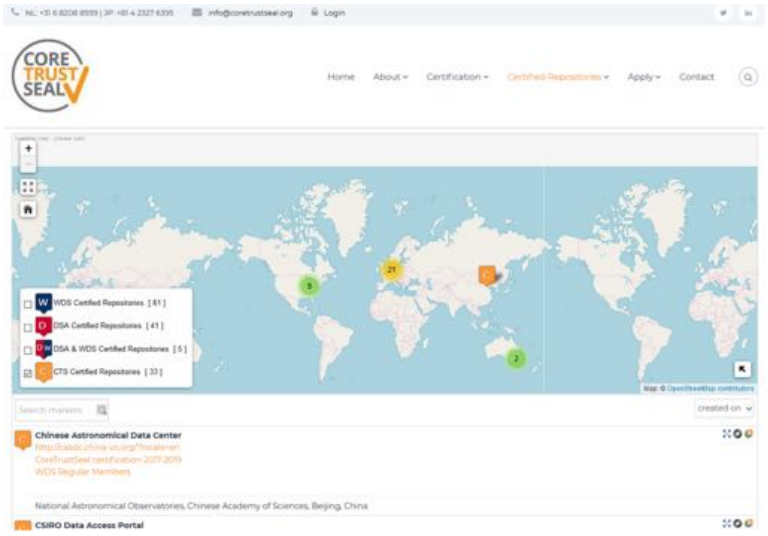




Chinese Astronomical Data Center passed CoreTrustSeal

- On October 25, Chinese Astronomical Data Center (CAsDC) passed the CoreTrustSeal certification, and continues its Regular Membership in the WDS.

- The CAsDC is the first data center certified by the CoreTrustSeal in Asia.



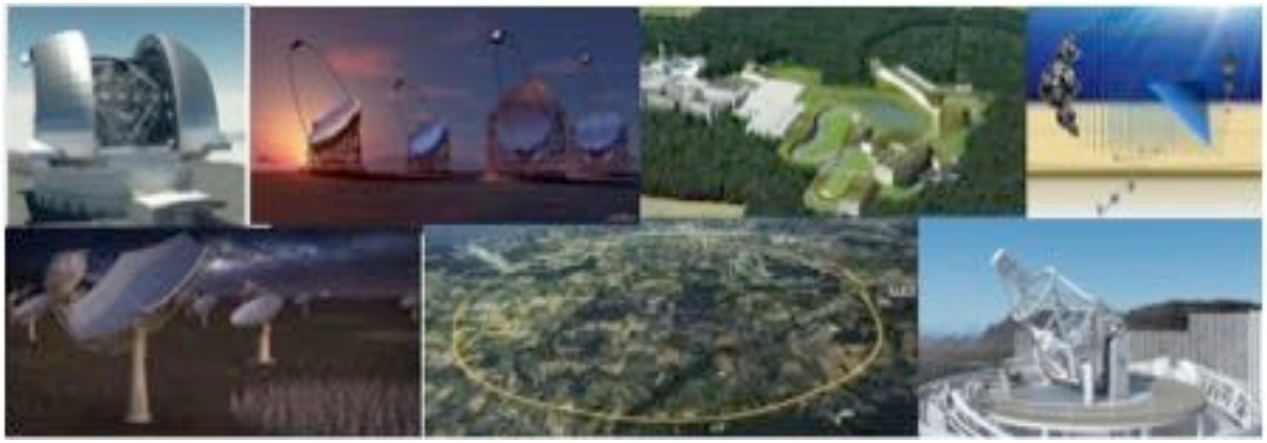
Euro-VO: participation in ESCAPE project

ESCAPE
European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

- New project successfully proposed in the Horizon 2020 Work Programme INFRAEOSC-04-2018 call:
  - "Connecting ESFRI infrastructures through Cluster projects"
- **European Science Cluster of Astronomy & Particle physics ESFRI**
- Coordinator: G. Lammana (LAPP, CNRS-IN2P3)
- 16 M€ over 42 months (start Feb 2019)

- CDS (M. Allen) leads one of the 6 Work Packages:
  CEVO — Connecting ESFRI projects to EOSC through VO framework

CEVO Partners (16): CNRS-CDS, INAF, INTA, UHEI, UEDIN, HITS, ASTRON, CNRS-CPPM, CTAO, EGO-Virgo, ESO, JIVE, KIS, ObsParis, SKAO, ROB

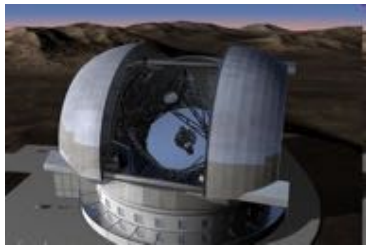


SVO

- EPSC2018 2 oral contributions
  - A citizen-science project to identify NEAs and Mars crossers using the Virtual Observatory
  - Physical properties of asteroids using the WFCAM Transit Survey and the Virtual Observatory
- SEA2018
  - The Gran Telescopio Canarias VO-compliant archive (oral)
  - The Pleiades as seen by TGAS and the VO (poster)
  - Clusterix. A VO tool for the determination of membership probabilities in stellar clusters (poster)
  - SVO Discovery Tool. A new tool to facilitate the discovery of archive information (poster)
  - VOSA for the characterization of high-mass X-ray binaries (poster)
  - Identification and characterization of ultracool dwafs in extragalactic fields using VO tools (poster)
  - VOSA. The Spanish VO SED Analyzer (poster)
  - Management of asteroseismic models in the VO framework (poster)
  - Identification and characterization of asteroids in large area surveys (RoPACS) using the Virtual Observatory (poster)
- New filter added to the SVO Filter Profile Service. 4469 filter already available.

Evolving the VO from interoperable data collections to an integrated system of services for data-intensive science

Vobs.it

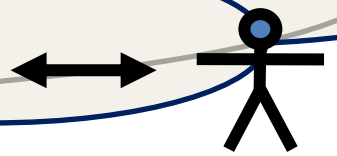



Archive
Archive
Archive
Archive

world-wide Science Cloud → «data lake»

Need to find, access, interoperate, re-use

Virtual Observatory

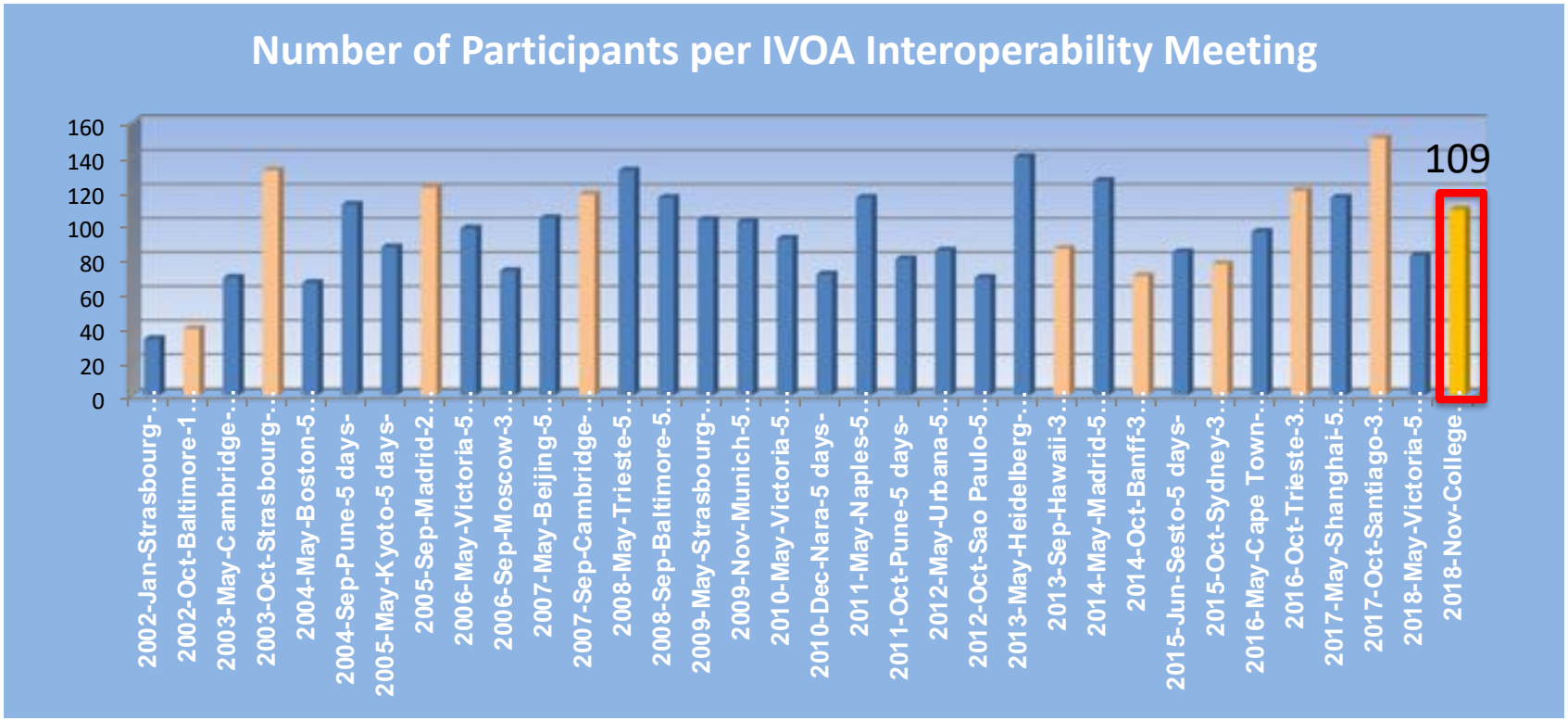


- NOVA
  - We have initiated a study to determine elements of a blockchain (token based) open development modelfor astronomy that incl udes actors in the ecosystem such as astropy, public universities IVOA, etc.
- GAVO
  - Work on reviewing VODataService (STC in the Registry, better VOSI metadata, auxiliary resources)
  - Blog : https://blog.g-vo.org


This Meeting
IVOA

Attendance

IVOA InterOp Meeting: Nov 8-10, 2018
College Park, Maryland, USA



WG Chairs and Vice-Chairs

Changed / Extended* in May 2018

New changes since July 2018

- ***Applications***:
  Tom Donaldson, Raffaele D'Abrusco
- ***DAL***:
  Marco Molinaro, James Dempsey
- ***Registry***:
  Theresa Dower, Pierre Le Sidaner
- ***DM***:
  Mark Cresitello-Dittmar*, Laurent Michel*
- ***GWS***:
  Brian Major*, Giuliano Taffoni*
- ***Semantics***:
  Mireille Louys*, Markus Demleitner

IG Chairs and Vice-Chairs

Changed / Extended* in May 2018

New changes since July 2018

- ***DCP*:**
  André Schaaff, Tim Jenness
- ***KDD:***
  Kai Polsterer, **Matthew Graham**
- ***Ops*:**
  Tom McGlynn*, Mark Taylor*
- ***SS:***
  Baptiste Cecconi, **Steve Joy**

TCG, CSP and Exec

Changed / Extended* in May 2018

New changes since July 2018

TCG:

Patrick Dowler, Janet Evans

CSP New Members:

Raffaele D'Abrusco, Gregory Dubois-Felsmann,

Mark Lacy

Exec:

Mark Allen, Chenzhou Cui

Exec Secretary: Janet Evans **-- OPEN**

Let's get to work

Programme for November 2018 Interop in College Park, MD -- last edit (11/05) - I

Session	Time	Room	Session	Notes
Thursday Nov 08, 2018				
0	8:30-10:30	Diamondback	TCG Meeting	WG/IG chairs
	10:30–11:00	***Break***		
Thursday Nov 08, 2018				
1	11:00–11:15	Terrapin	Welcome and Logistics	Peter Teuben
	11:15–11:35		State of the IVOA	Mark Allen
	11:35-11:45		State of the TCG	Patrick Dowler
	11:45–12:15		Charge to Working Groups	WG/IG Chairs
	12:15-12:30		Science Priorities	Raffaele D'Abrusco
	12:30–14:00	***Lunch*** (not catered)		
2	14:00–15:30	Salon 1&2	DAL1	
		Salon 3	Theory	
	15:30 –16:00	***Break***		
3	16:00–17:30	Salon 1&2	Ops	
		Salon 3	DM 1	
	17:30–19:00	Diamondback	***Executive Committee Meeting***	

Many thanks to our hosts and local organisers !

IVOA InterOp Meeting: Nov 8-10, 2018
College Park, Maryland, USA

USVOA

National Aeronautics and Space Administration

NAVO: NASA Astronomical Virtual Observatories