IVOA in the multi-messenger landscape

Ada Nebot

Low-Latency alerts & Data analysis for Multi-messenger Astrophysics Workshop

13 - 14 January 2022

The VO and the IVOA: what?

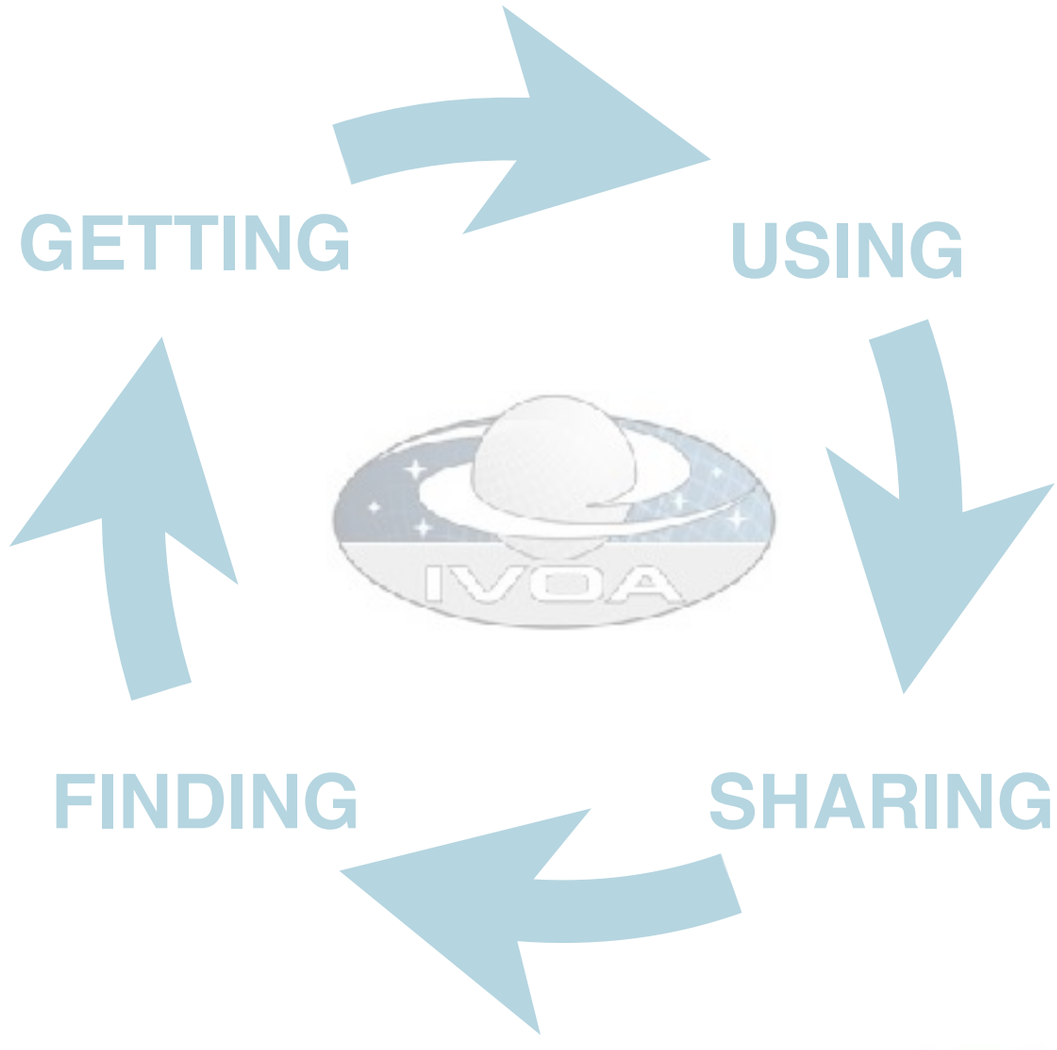
"A multi-wavelength digital sky that can be searched, visualised and analysed in new and innovative ways"

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/**

- Exec, Tech Coordination, Standards & processes, Media, Science priorities
- **6 Working Groups:**
  - Applications, access, models, grid & web services, registry, semantics
- **8 Interest Groups**
  - Time-domain, radio, solar system, education, data curation, knowledge & discovery, theory
- Completely open to participation

Want to join the IVOA?

- Meetings: 2 interoperability meetings per year
- Email list: https://www.ivoa.net/members/index.html
- GitHub: https://github.com/ivoa-std)

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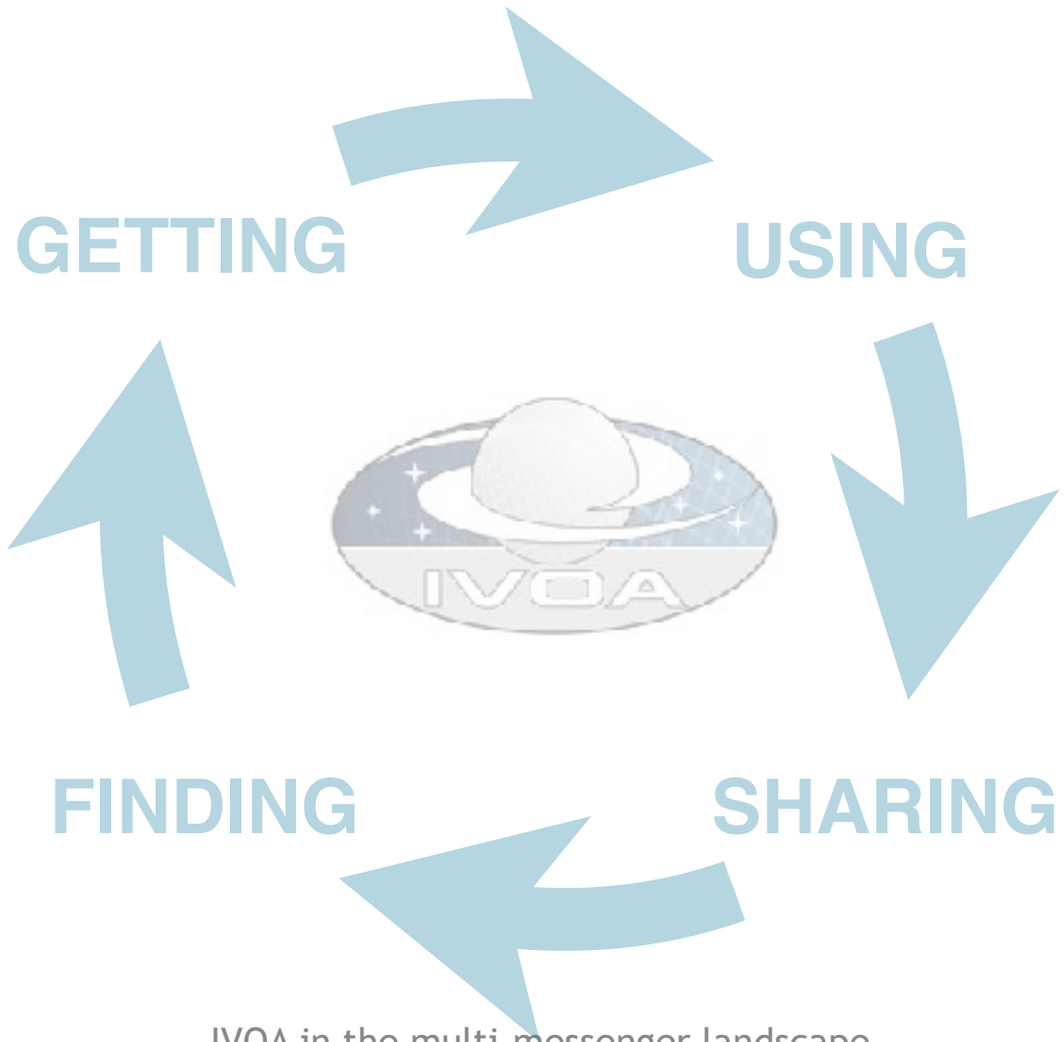
The VO and the IVOA: where?

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 documentarists are involved



(Some) identified needs of the multi-messenger community

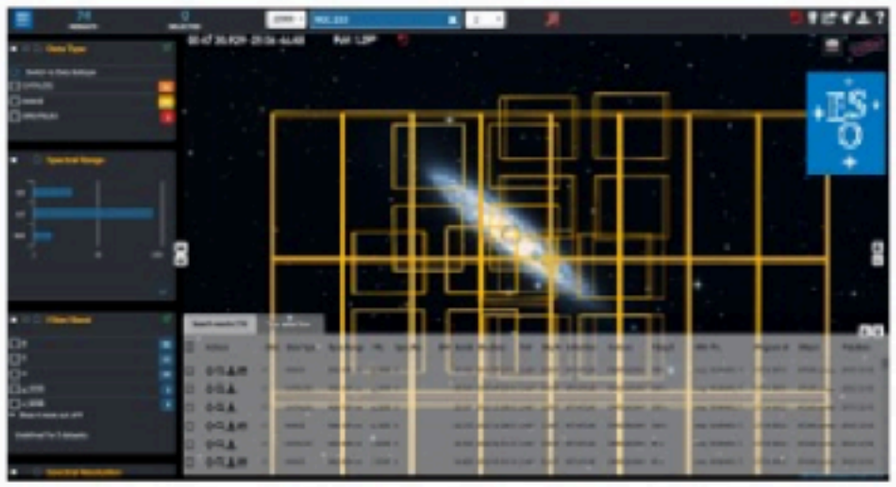
To characterise and classify sources…

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

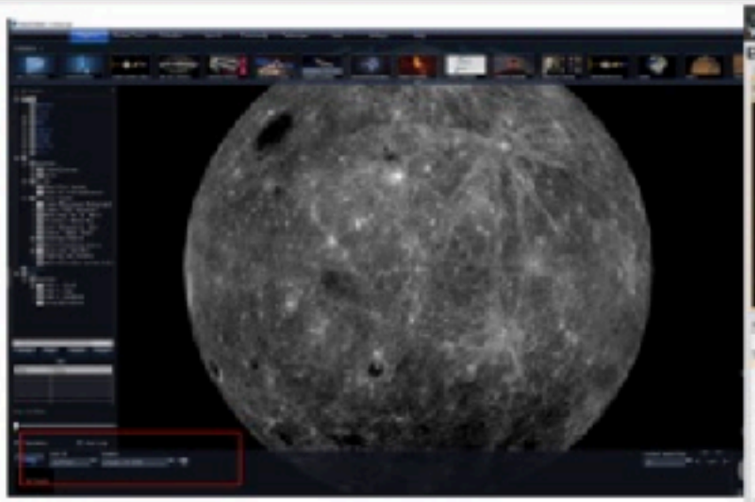
The IVOA should match user's needs

How is the IVOA easing user needs?

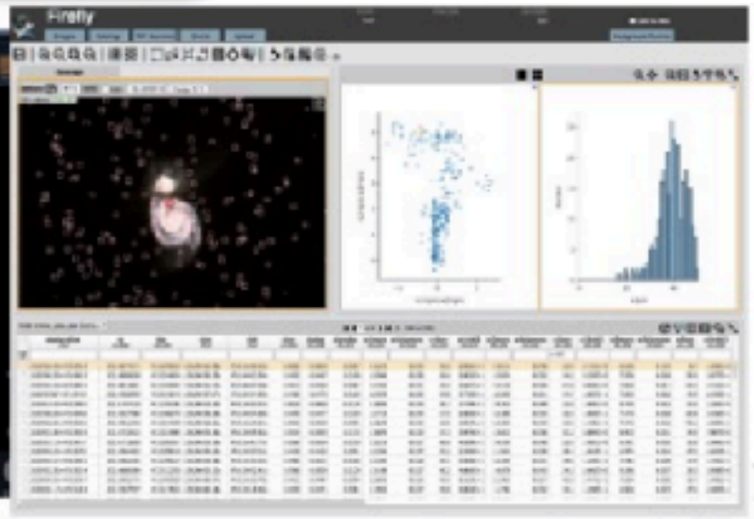
VO embedded in astronomy services



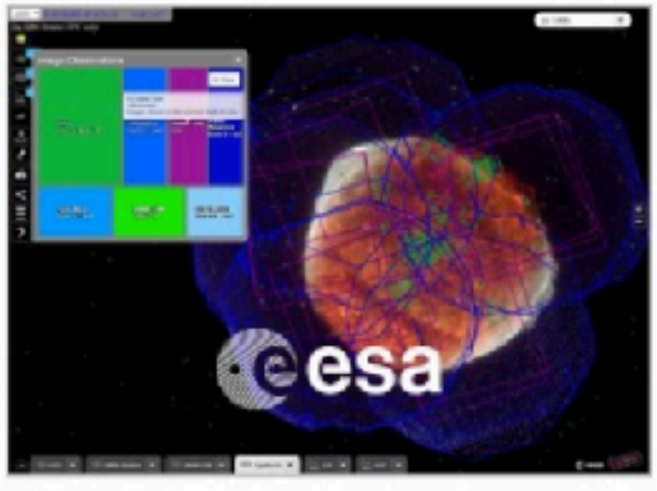
ESO Science Portal



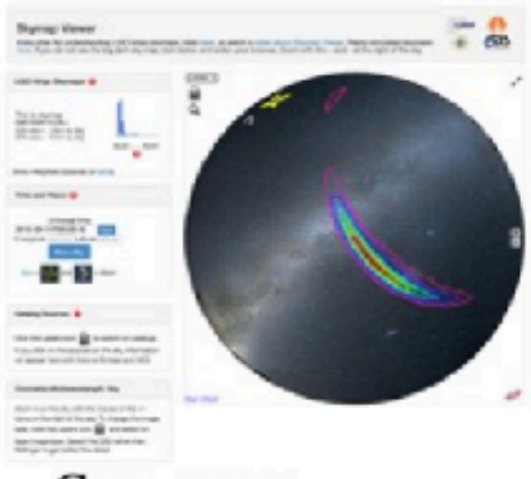
WWT



Firefly
Caltech-IPAC



ESA Sky



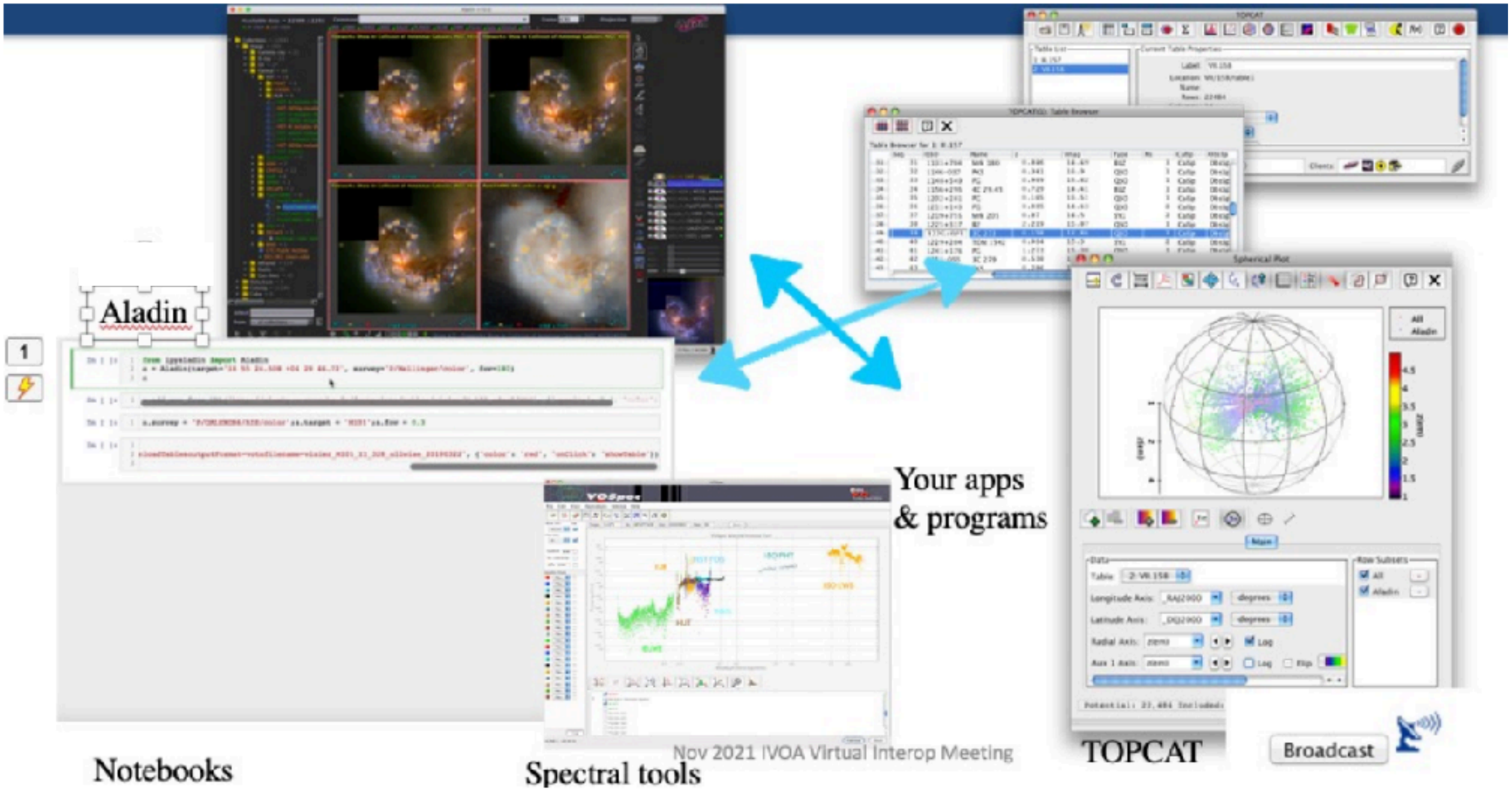
Grav. waves

CDS reference data service

SVO Filter Profile service

How is the IVOA easing user needs?

Interoperable applications and services



How is the IVOA easing user needs?

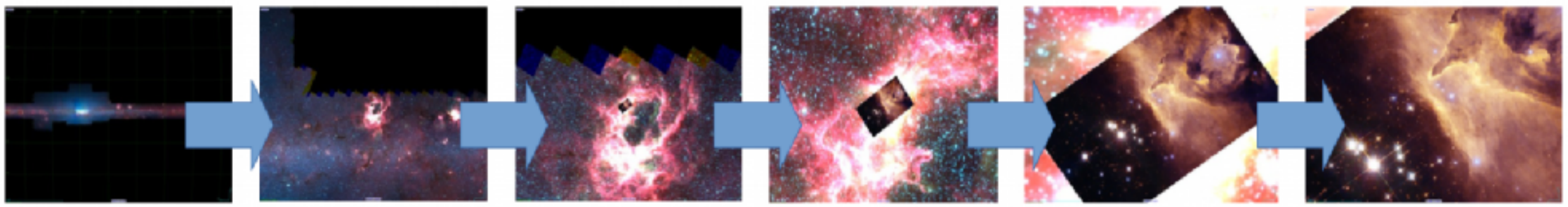
- **Multi-wavelength / messenger approach**
  - Combining data from missions covering different wavelength ranges through data curation
    - Source identification (e.g. Simbad, NED)
    - Cross-matching techniques (e.g. CDS xmatch service)
  - Enabling access to different types of data defining similar language to access data
    - simple things: Cone search
    - complex things: TAP + ADQL, …

How is the IVOA easing user needs?

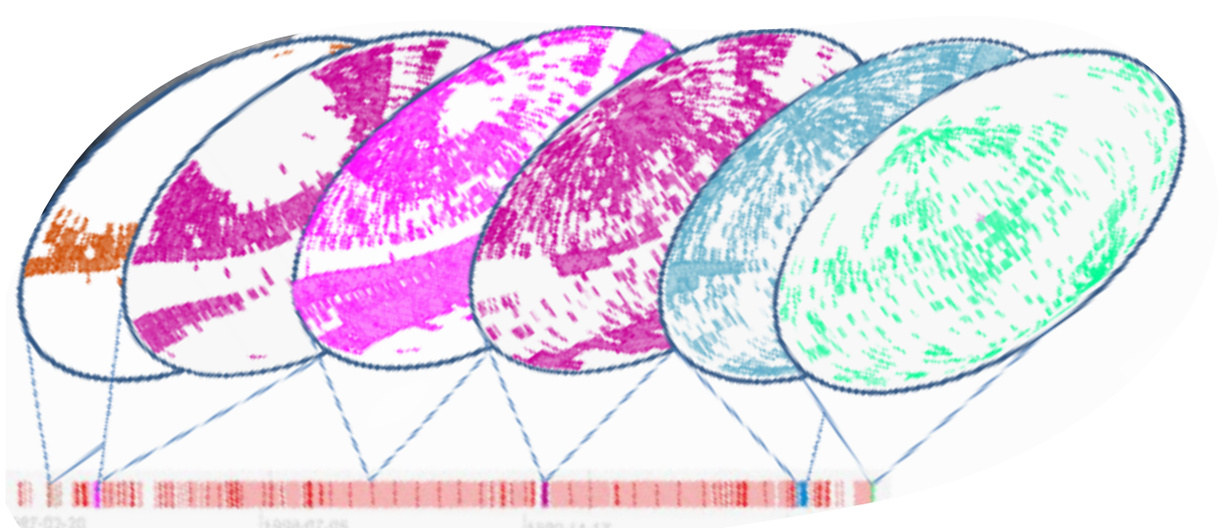
- **Follow-up observations, and coordination**
  - Transmission of alerts using a common standard format (VOEvent)
  - Planning observations
    - When is this area of the sky visible from this place?
    - Definition of a common standard for object visibility (ObjVisSAP)
  - Coordination of observations:
    - What area of the sky is planned to be observed, when and at which wavelength?
    - Definition of a common standard for observatories to share that type of information (ObsLocTAP)

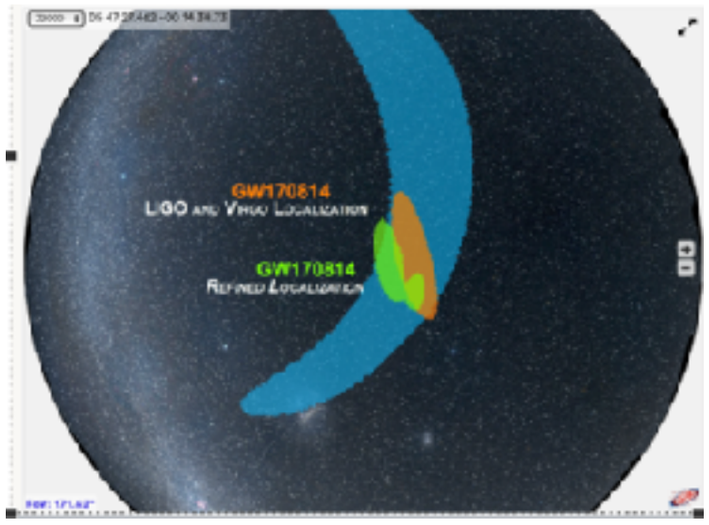
How is the IVOA easing user needs?

- **Visualisation & navigation through the data**
  - Fast access and navigation through large images and catalogs is possible using a hierarchical way HiPS, MOC (see G. Greco et al. 2022)
    - MOC allows us to e.g. find the intersection in space and in time of different surveys (existing or planned) and filter catalogs by the area of interest (https://cds-astro.github.io/mocpy/)
  - Send / receive (share) data among services & tools with SAMP



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





What are the challenges of the IVOA

Some challenges

- New projects coming up
- PB scale missions coming up
- Support science platforms with analysis close to data
- Support new data-types driven by growth in size and complexity of data sets

The IVOA needs the community to participate!

Do you want to publish your data into the VO?

Starting point: https://wiki.ivoa.net/twiki/bin/view/IVOA/PublishingInTheVO

email: ada.nebot@astro.unistra.fr

To summarise…

- Interoperability is possible thanks to the definition and / or adoption of standards which set the common language and technology between **services** and **tools**.
- To improve involvement of different communities in the discussion, development and improvements of the standards we need to support meetings (like this one) between **technical and scientific community** to tackle specific questions

  ➡**Projects & missions involvement**
- Training schools for interoperability aimed at early career scientists

  ➡Having feedback sessions to report and collect requirements
- **Share with others at international level through the IVOA channels**
  - Networking during the IVOA interoperability meetings — meetings 2/yr
  - IVOA email — http://ivoa.net/members/index to register
  - GitHub https://github.com/ivoa-std