Enabling Open Science

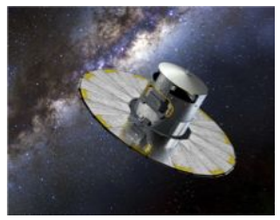
International dimensions - the example of Astronomy

Mark Allen (Strasbourg astronomical Data Centre - CDS)

EOSC Policy Workshop, Strasbourg 3 May 2022

International Astronomy data infrastructure

Archives and data services of Terrestrial and Space Observatories, Instruments and missions and projects



esa

cnes

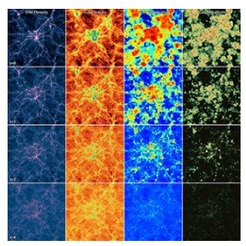
ESO

NASA

+ many more…

Simulation and modeling data

e.g. Illustris project



Astronomy Data Centres

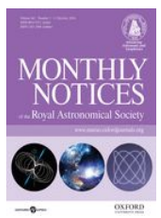
astrophysics data system

CDS — Strasbourg astronomical Data Centre

NED — Data centres in USA, UK, Canada…

Data published in, and associated with Journals

Astronomy & Astrophysics



AAS

+ more…

Virtual Observatory (VO) interoperability standards

IVOA

22 national / international members

Open Science projects

e.g. ESCAPE — European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

Research data, e-Infrastructures and other wider initiatives …

RDA RESEARCH DATA ALLIANCE

ICSU WORLD DATA SYSTEM

CORE TRUST SEAL

EUROPEAN OPEN SCIENCE CLOUD

Commercial Cloud services…

Data sharing in astronomy

Early international collaboration on standards

– Format (FITS) 1981.
– Bibliographic identifiers ‘bibcode’ 1989.

‘Virtual Observatory’ Interoperability of data and tools

- Standards agreed and maintained in IVOA (since 2002).
- Open and inclusive framework – ***anyone can “publish” a data resource in the VO, anyone can develop a VO-enabled tool to access data.***
- > 100 “authorities” provide a resource in the Virtual Observatory registry.
- Implemented in data services of major facilities.

A visual example of FAIR

NGC 4039 - an interacting galaxy

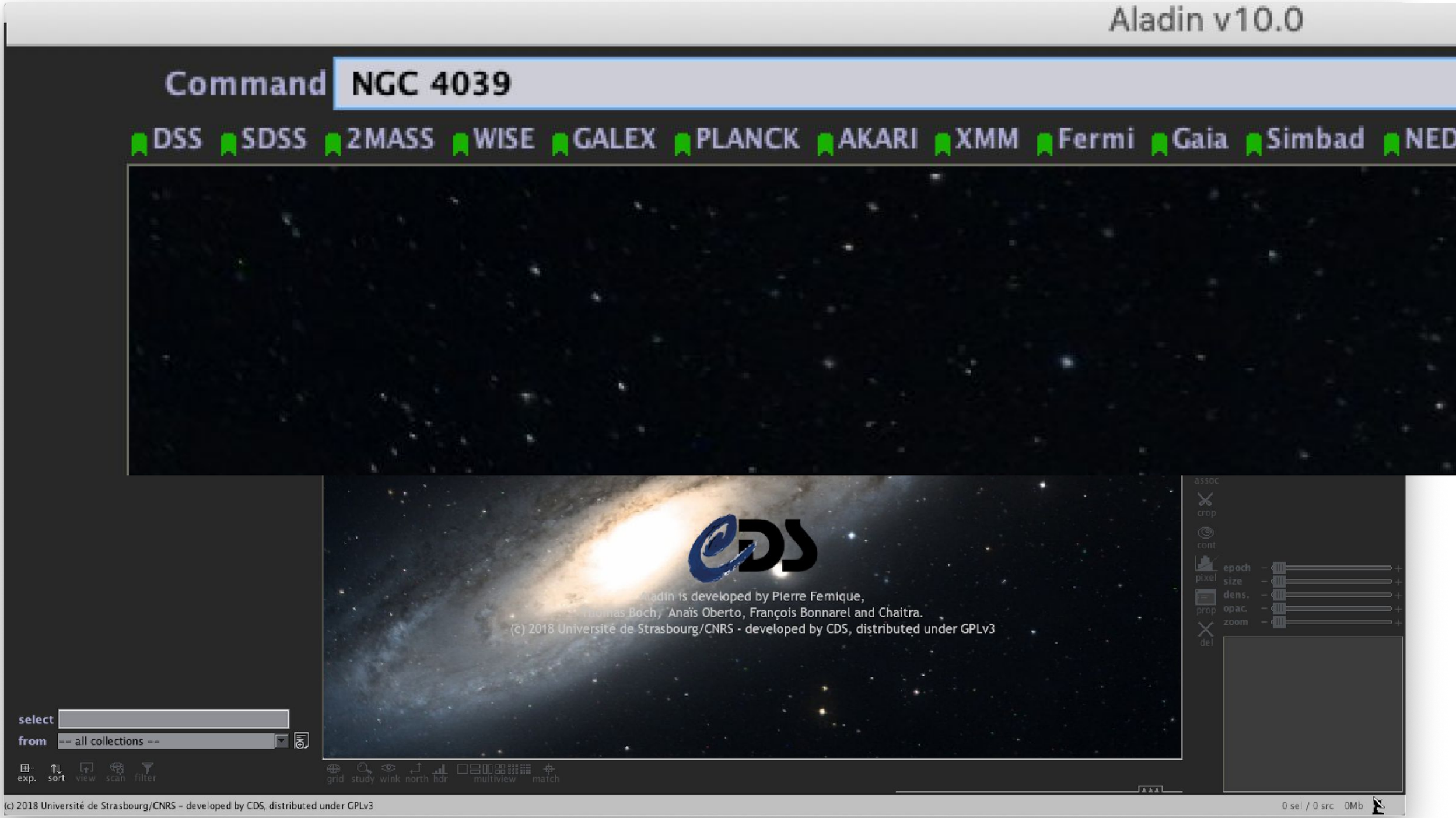
Find the data available

Access the data

Interoperable use of the data with other data

Re-use the data

Findable


Aladin v10.0
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DSS
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WISE
GALEX
PLANCK
AKARI
XMM
Fermi
Gaia
Simbad
NED
Aladin is developed by Pierre Fernique,
Thomas Boch, Anaïs Oberto, François Bonnarel and Chaitra.
(c) 2018 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3
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(c) 2018 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3
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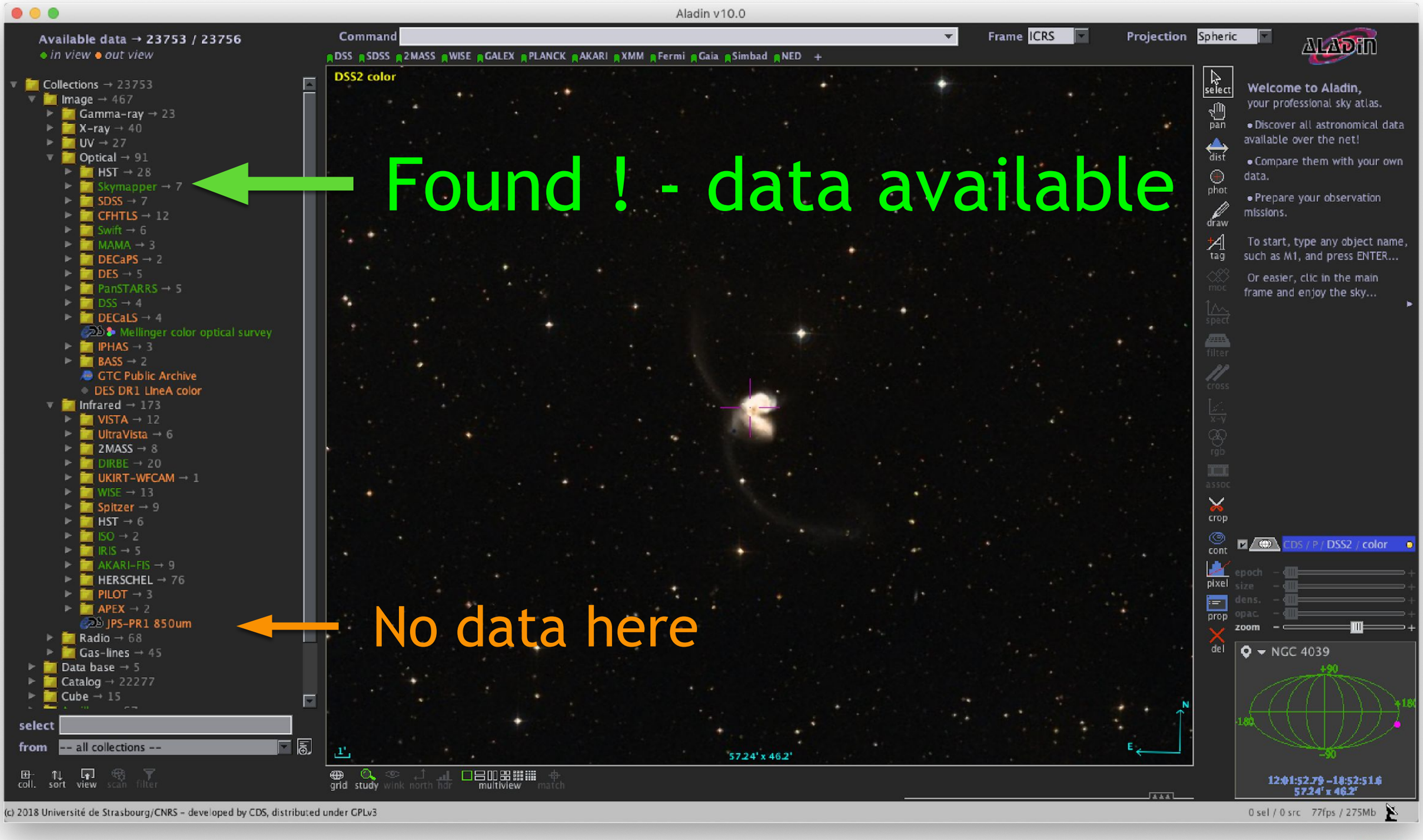
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Image → 467
Gamma-ray → 23
X-ray → 40
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Optical → 91
HST → 28
Skymapper → 7
SDSS → 7
CFHTLS → 12
Swift → 6
MAMA → 3
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BASS → 2
GTC Public Archive
DES DR1 LineA color
Infrared → 173
VISTA → 12
UltraVista → 6
2MASS → 8
DIRBE → 20
UKIRT-WFCAM → 1
WISE → 13
Spitzer → 9
HST → 6
ISO → 2
IRIS → 5
AKARI-FIS → 9
HERSCHEL → 76
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Welcome to Aladin,
your professional sky atlas.
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• Compare them with your own data.
• Prepare your observation missions.
To start, type any object name, such as M1, and press ENTER...
Or easier, clic in the main frame and enjoy the sky...
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57.24' x 46.2'
(c) 2018 Université de Strasbourg/CNRS - developed by CDS, distributed under GPLv3
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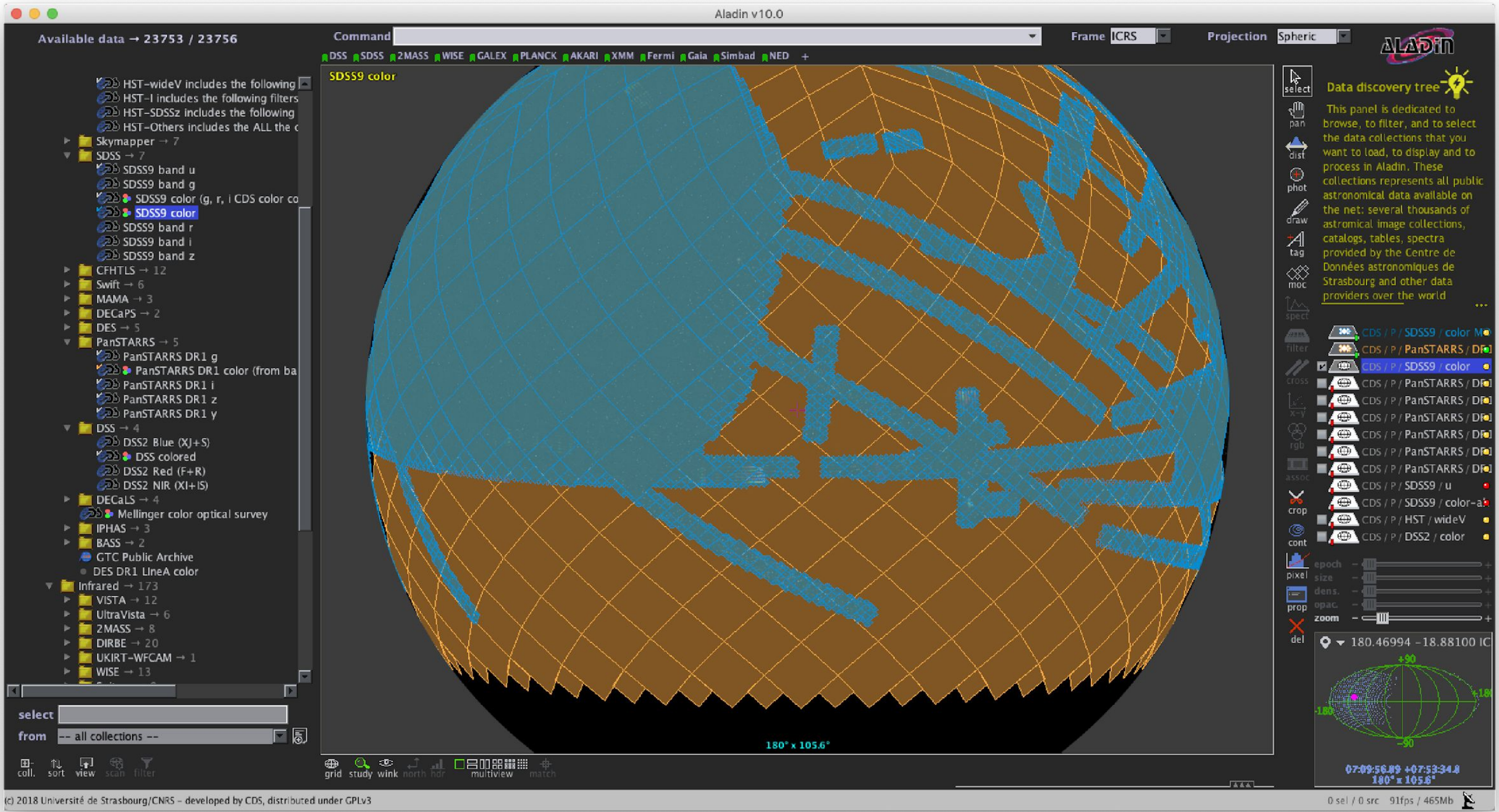
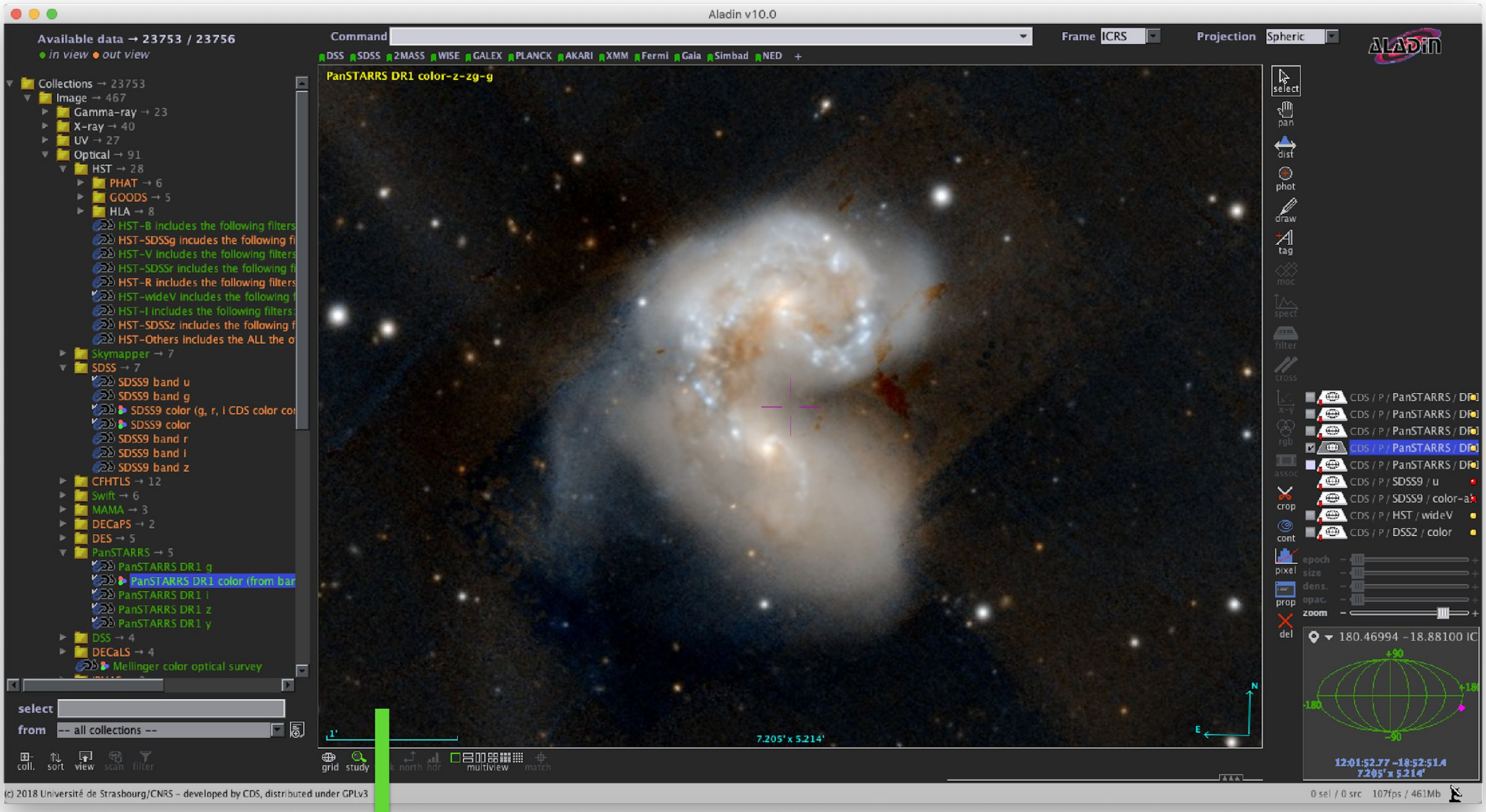
...based on standardised coverage map indexing

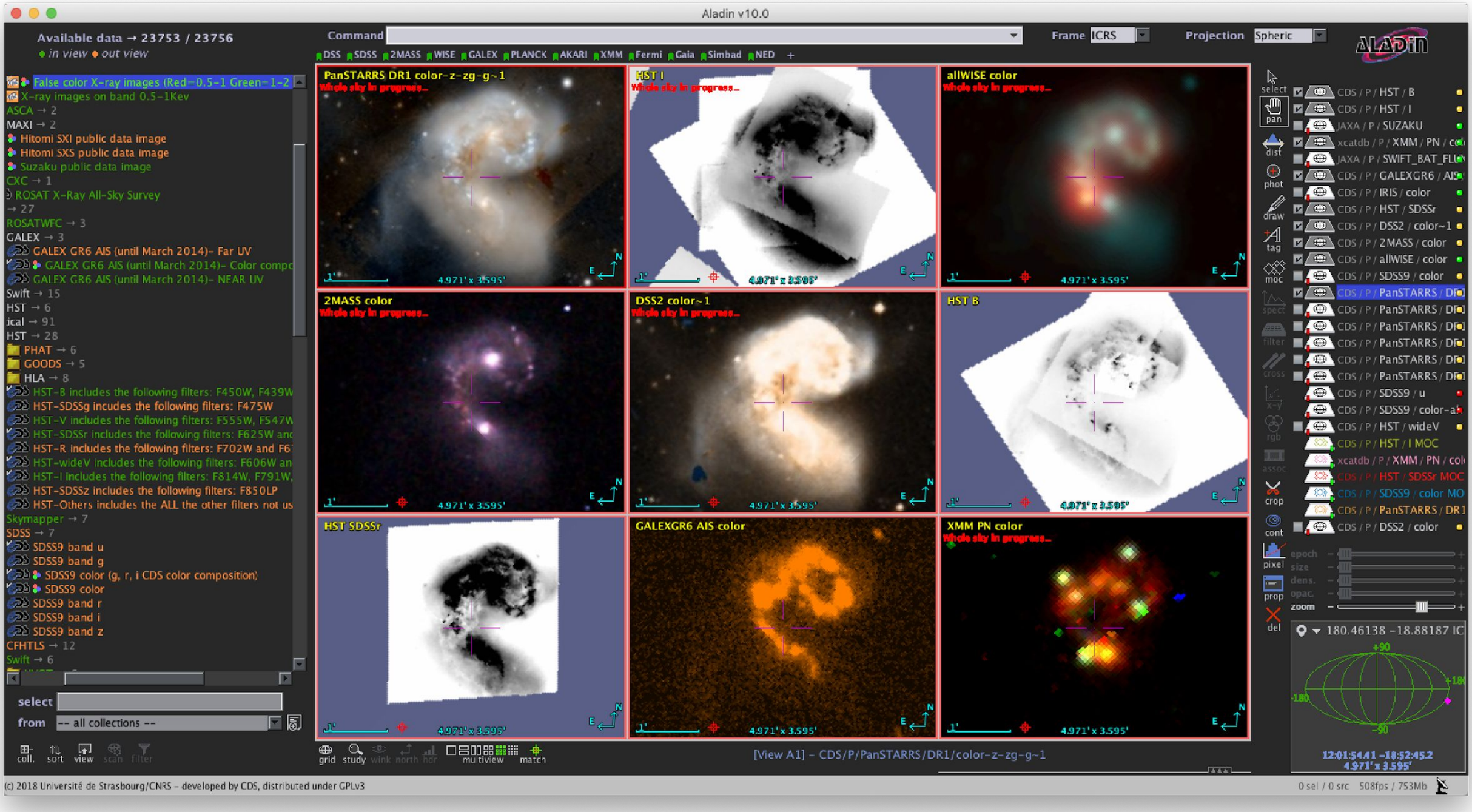


Accessible



Download in science/visualisation formats

Interoperable



Reusable

Services for extracting :cut-outs of the data for re-use

jupyter hips2fits (unsaved changes)

File Edit View Insert Cell Kernel Widgets Help Not Trusted Python 3

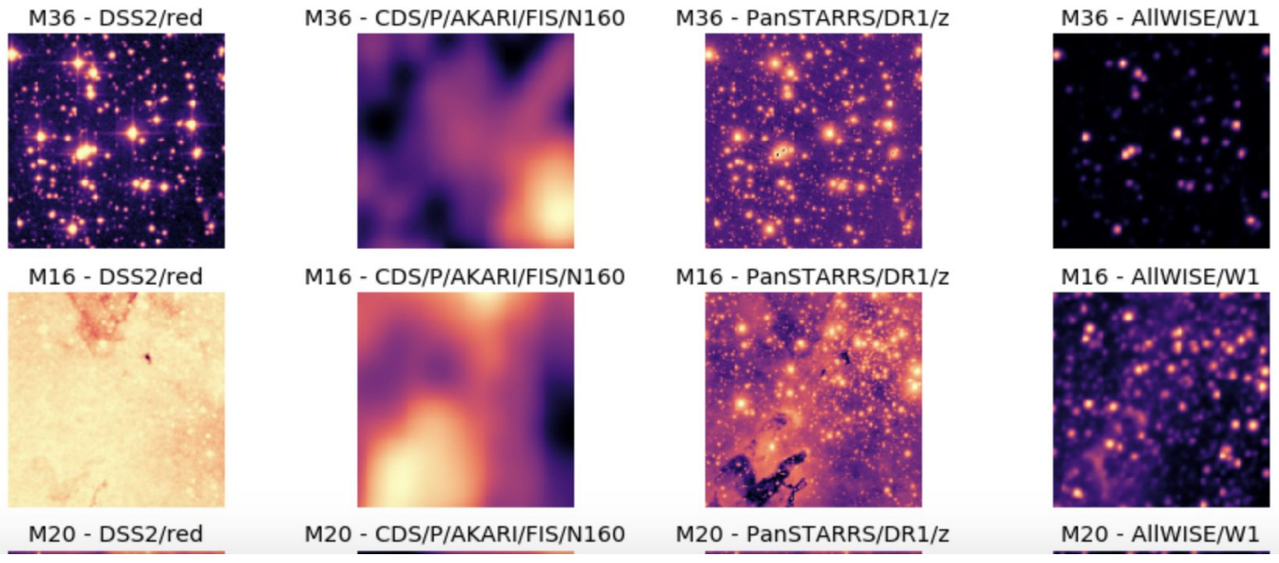
Run Code

```
i = 0
for obj in objects:
    for hips in hips_list:
        axs[i].set_axis_off()

        axs[i].set_title('{} - {}'.format(obj, hips))
        sc = SkyCoord.from_name(obj)
        ra = sc.icrs.ra.deg
        dec = sc.icrs.dec.deg
        url = 'http://alasky.u-strasbg.fr/hips-image-services/hips2fits?hips={}&width={}&height={}&fov={}&projection=TA
        hdu = fits.open(url)

        hdu.writeto('{}-{}.fits'.format(obj, hips.replace('/', '_')), overwrite=True)
        im = hdu[0].data
        norm = ImageNormalize(im, interval=MinMaxInterval(),
                              stretch=AsinhStretch())
        axs[i].imshow(im, cmap='magma', norm=norm, origin='lower')

        i += 1
```



Interoperability Standards

Community defined and supported Virtual Observatory standards

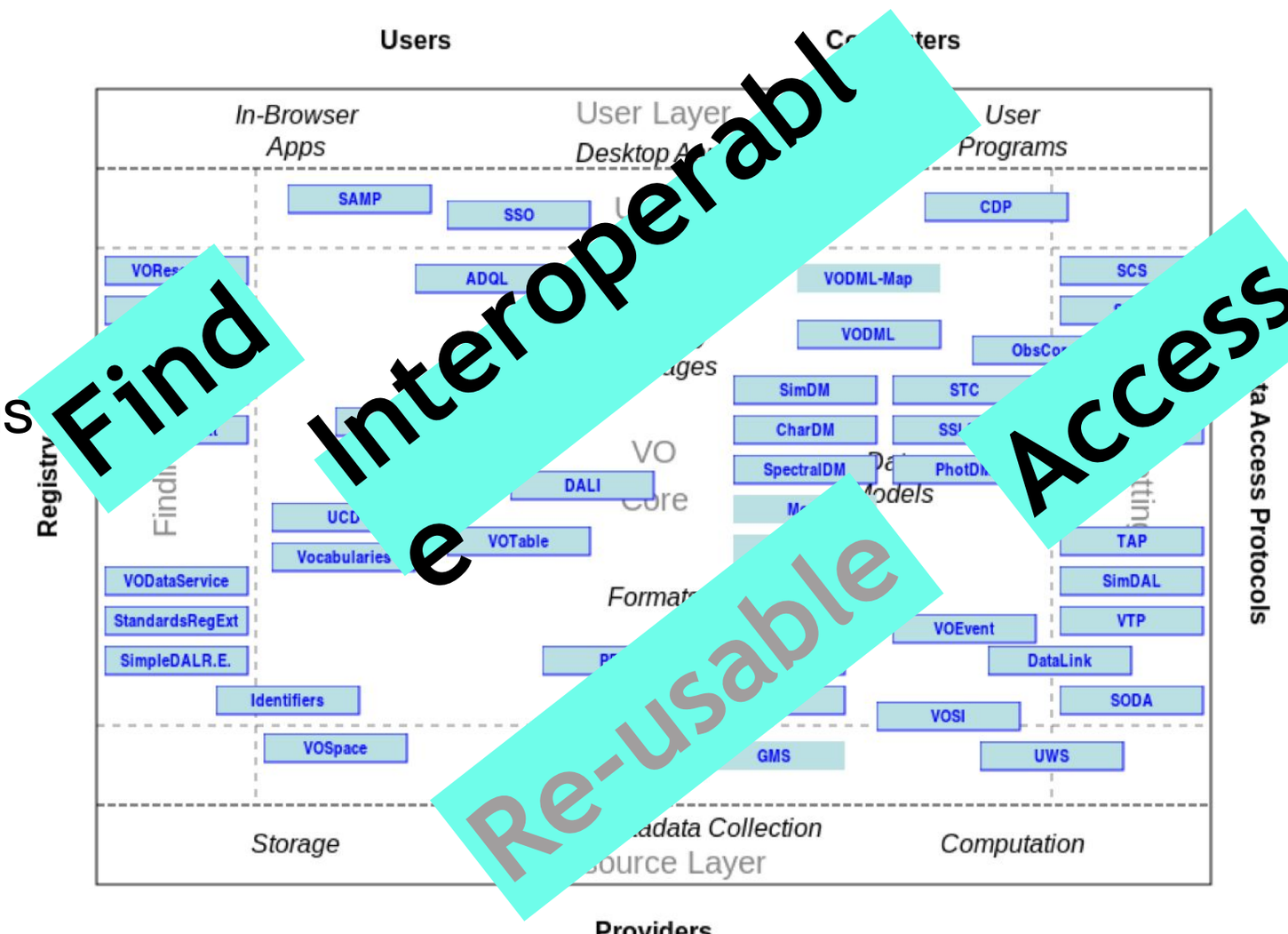
- IVOA formed in 2001.
  - VO is a framework with many portals and compatible tools.
  - Many lessons-learned about difficulties of interoperability!!

Governance

- International level.
- National members and International Organisations

Coordination

- National Projects.
- Euro-VO.



ESCAPE – ***addressing the Open Science challenges*** of astronomy, astroparticle and accelerator particle physics ESFRI and RIs

Builds on complementary expertise in data stewardship:

- Astronomy Virtual Observatory infrastructure
- High Energy physics expertise in Exabyte-scale data management and large-scale distributed computing

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

Interoperability standards for ESFRI needs are an integrated part of the ESCAPE work program

Data Lake:
Build a scalable, federated, data infrastructure as the basis of open science for the ESFRI projects within ESCAPE.

Software Repository:
Repository of "scientific software" as a major component of the “data” to be curated in EOSC.

Science Platforms:
Flexible science platforms to enable the open data analysis tailored by and for each facility as well as a global one for transversal workflows.

Citizen Science:
Open gateway for citizen science on ESCAPE data archives and ESFRI community

Virtual Observatory:
Extend the VO *FAIR* standards, methods and to a broader scientific context; prepare the VO to interface the large data volumes of next facilities.

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

International Dimensions

- **Standardisation at the international level:**
  - Needs policies to facilitate inclusion of international standards into the EOSC Interoperability Framework.

    (Keeping in mind that there will be other EOSC-like projects)

- **ON-BOARDING of international catalogues to EOSC:**
  - E.g. It makes sense to include Virtual Observatory Registry, the ‘Astronomy Catalogue’ as a whole. (~25000 resources)
  - Currently on-boarded to EUDAT B2FIND – but EOSC portal does not enable finding of the resources! *Let’s fix that!*

- **International cooperation/competition:**
  - European coordination visible at international level (IVOA etc.).
  - *Coming soon: e.g. NASA Open Source Science Initiative, and NASA*

Concluding with questions…

- What are we doing to make sure that EOSC will interface with international systems ?

- What policies can we establish to enable on-boarding of whole domain international catalogues ?

- What policies will sustain European contributions to the coordination of international standards ?