



# ESCAPE

European Science Cluster of Astronomy &  
Particle physics ESFRI research Infrastructures

## EOSC Activities in Astronomy and Astrophysics. The ESCAPE project

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IBERGRID 2022. 10 October 2022. Faro

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n° 824064.



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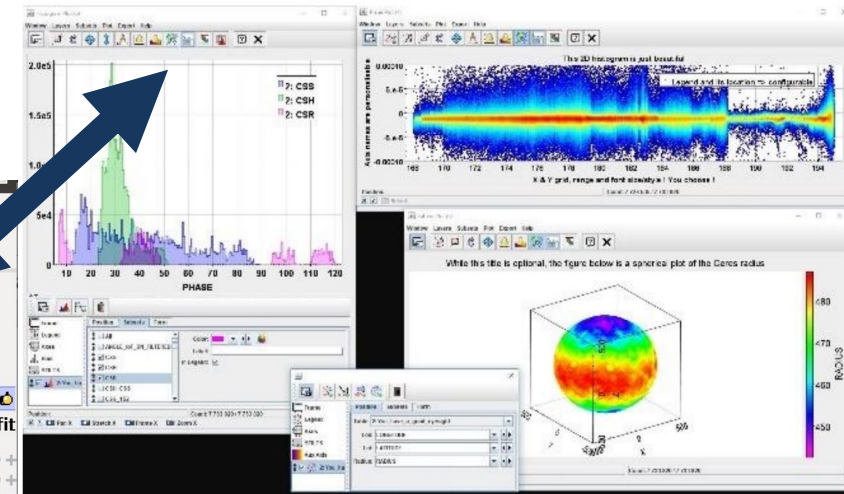
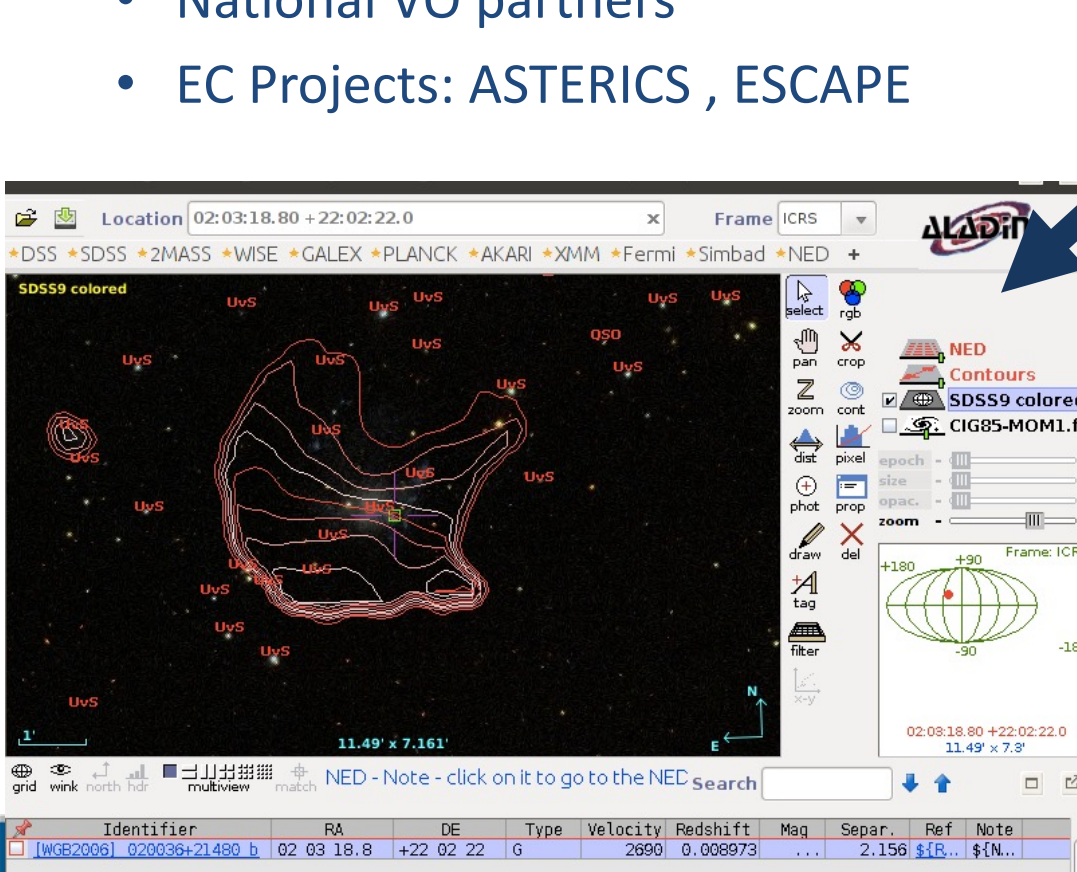


# OUTLINE

- Highlights of Open Science in A&A before EOSC
- The ESCAPE consortium
- ESCAPE services
  - CEVO
  - DIOS
  - ESAP

## International Virtual Observatory Alliance

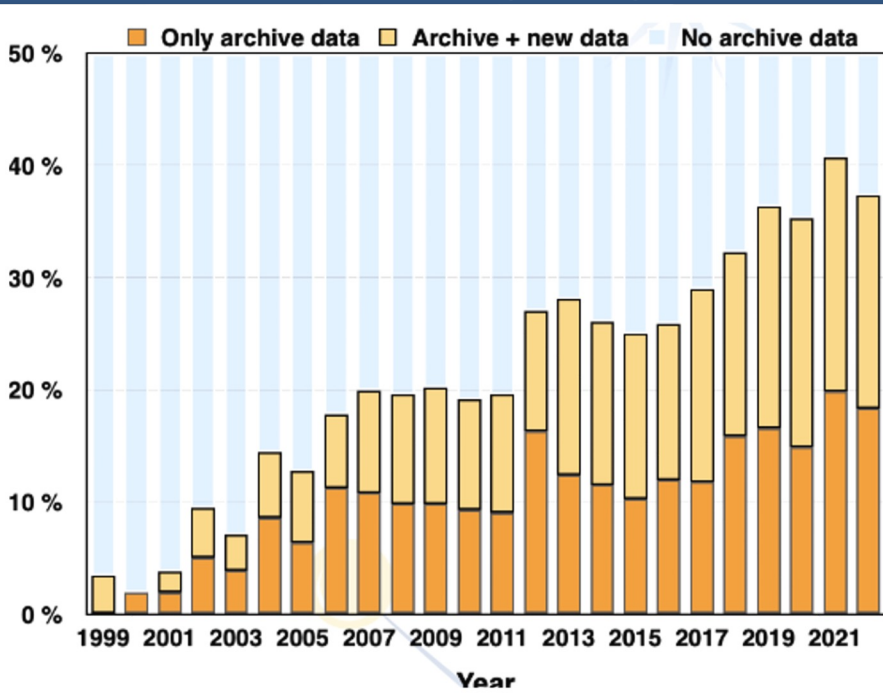
- Bottom-up initiative from 2001
- Pioneer in Open data sharing
- Coordinated in Europe by Euro-VO
  - National VO partners
  - EC Projects: ASTERICS , ESCAPE



Source: *Batiste Rousseau, Stéphane Érard*



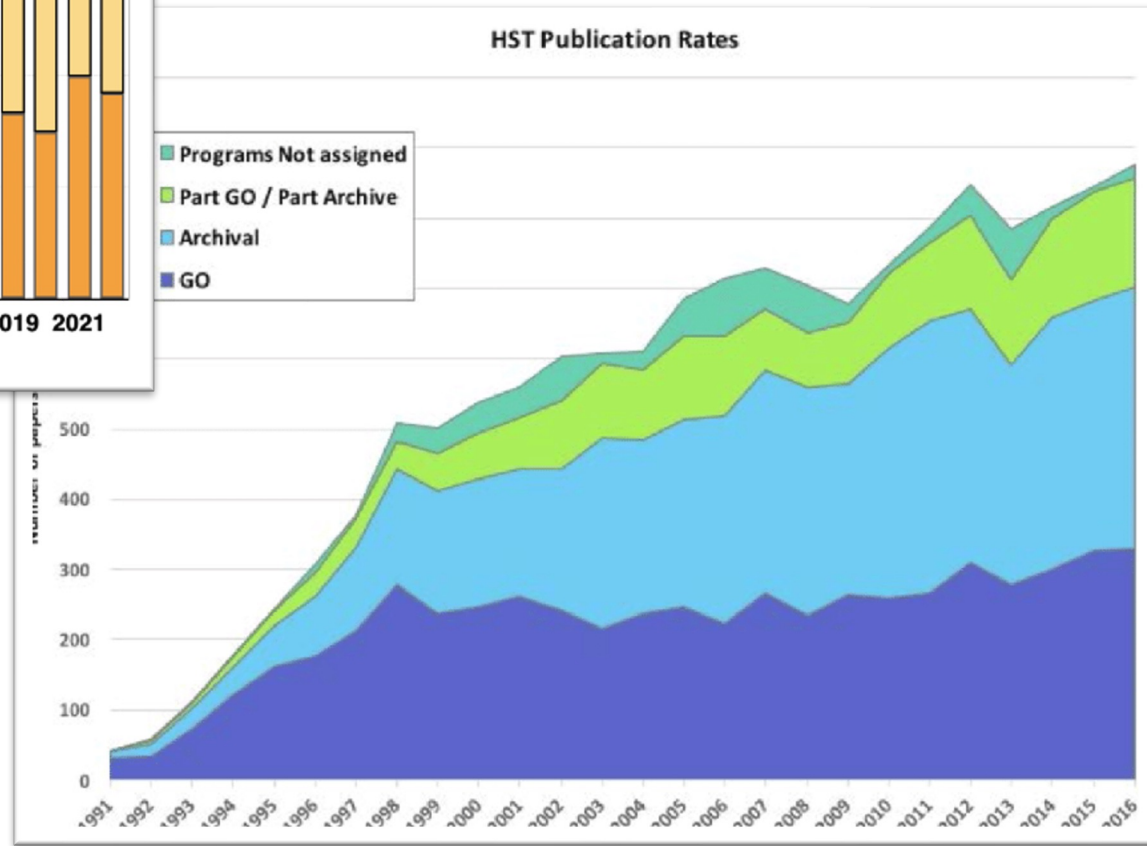
# Highlights: Opening A&A data



- Data are preserved in archives
- Published after an embargo period
- Culture of re-using data

Source: M. Romaniello's talk "The VO-Service at ESO". ESO Telescope Bibliography

*Enhancing the scientific  
returns from investments  
in astronomical  
infrastructures*



Source: 10.1051/epjconf/201818610003

# A&A Workflows, Research Objects

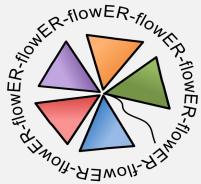
*Just some examples to show the early engagement of the A&A community with the Open Science*



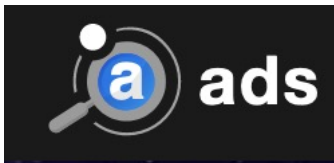
“Astrophysics Source Code Library”. Funded in 1999



FP7-270192 “Advance Workflow Preservation Technologies for Enhanced Science” (2010-2013)



FP7-312579 “Building an European Research Community through Interoperable Workflows and Data” (2012-2014)



Astrophysics Data System by NASA. Linking publications to data



# ESCAPE

## Consortium:



Source: <https://projectescape.eu/sites/default/files/2022-04-12%20%E2%80%94%20CiMMA%20Webinar.pdf>

- Budget: **15.98 M€**
- From **Feb. 2019** until **Jan. 2023 (extended)**
- Coordinator: **CNRS-LAPP**

# ESCAPE SERVICES



Credit: ESCAPE



# CEVO - Connecting ESFRI projects to EOSC through the VO framework

- New / Updated standards to support a wider community
- ESFRI data published according to FAIR principles through the VO
- Community training: data providers and scientists
- IVOA Registry into EOSC via EUDAT B2FIND

The screenshot displays the EUDAT B2FIND website interface. The top navigation bar includes links for DATA CATALOGUE, REPOSITORIES, COMMUNITIES, FOR PROVIDERS, FOR USERS, and ABOUT. The main content area shows search results for the query 'ivoa alma', displaying 410 datasets found. The results are ordered by Relevance. The first result is 'Joint ALMA Observatory', followed by 'JVO ALMA VO Service', and 'ALMaQUEST. IV. ALMA-MaNGA QUEnching & star formation'. The 'ALMaQUEST' entry is expanded, showing a detailed description of the survey and its goals. The right sidebar provides additional information about the IVOA organization, including a description, social media links, and a list of related datasets.

**GO TO EUDAT WEBSITE**

**EUDAT**

DATA CATALOGUE REPOSITORIES COMMUNITIES FOR PROVIDERS

FOR USERS ABOUT

**Datasets**

**Spatial Coverage**

ivoa alma

**410 datasets found for "ivoa alma"**

Order by: Relevance

**Joint ALMA Observatory**

JAQ/ALMA Organization

**JVO ALMA VO Service**

ALMA VO Service VOSI capabilities standard interface VOSI availability standard interface JVO ALMA FITS data archive (TAP service) JVO ALMA FITS data archive (SIA service) JVO...

**ALMaQUEST. IV. ALMA-MaNGA QUEnching & star formation**

The ALMaQUEST (ALMA-MaNGA QUEnching and SStar formation) survey is a program with spatially resolved 12CO(1-0) measurements obtained with the Atacama Large Millimeter Array for 46 galaxies selected from the Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) DR15 optical integral-field spectroscopic survey. The aim of the ALMaQUEST survey is to investigate the dependence of star formation activity on the cold molecular gas content at kiloparsec scales in nearby galaxies. The sample consists of galaxies spanning a wide range in specific star formation rate (sSFR), including starburst (SB), main-sequence (MS), and green valley (GV) galaxies. In this paper, we present the sample selection and characteristics of the ALMA observations and showcase some of the key results enabled by the combination of spatially matched stellar populations and gas measurements. Considering the global (aperture-matched) stellar mass, molecular gas mass, and star formation rate of the sample, we find that the sSFR depends on both the star formation efficiency (SFE) and the molecular gas fraction ( $f_{H_2}$ ), although the correlation with the latter is slightly weaker. Furthermore, the dependence of sSFR on the molecular gas content (SFE or  $f_{H_2}$ ) is stronger than that on either the atomic gas fraction or the molecular-to-atomic gas fraction, albeit with the small HI sample size. On kiloparsec scales, the variations in both SFE and  $f_{H_2}$  within individual galaxies can be as large as 1-2dex, thereby demonstrating that the availability of spatially resolved observations is essential to understand the details of both star formation and quenching processes.

Cone search capability for table J/ApJ/903/145/table1 (ALMaQUEST targets and CO(1-0) sensitivities)

Infrared astronomy Interstellar medium Optical astronomy Radio spectroscopy Spectroscopy

Star forming regions Stellar masses Surveys observational astro... stellar astronomy

**Identifier**

DOI <http://doi.org/10.26093/cds/vizier.19030145>

Source <https://cdsarc.cds.unistra.fr/viz-bin/cat/J/ApJ/903/145>

Related Identifier <https://ui.adsabs.harvard.edu/abs/2020ApJ...903..145L>

Metadata Access [http://dc.g-vo.org/r1/q/mh/pubreq.xml?verb=GetRecord&metadataPrefix=oai\\_b2find&identifier=ivo://CDS.VizieR/J/ApJ/903/145](http://dc.g-vo.org/r1/q/mh/pubreq.xml?verb=GetRecord&metadataPrefix=oai_b2find&identifier=ivo://CDS.VizieR/J/ApJ/903/145)



- Curated Zenodo community:
- <https://zenodo.org/communities/escape2020>
- Integrated with several tools to enable a complete software life-cycle

e.g

Integration with ESAP for software execution (next slides)

The screenshot shows the Zenodo website interface for the ESCAPE 2020 community. The header includes the Zenodo logo, a search bar with 'Search ESCAPE 2020', and links for 'Upload', 'Communities', 'Log in', and 'Sign up'. The main content area is titled 'ESCAPE 2020' and displays search results for 'All versions'. On the left, there are filters for 'Access Right' (Open (32)), 'File Type' (Zip (16), Pdf (12), Json (4), Gz (3), Simg (2), Tar (2)), and 'Keywords' (ESCAPE (7), Jupyter-notebook (4), Astronomy (2), CTA (2), Analysis (2), ATLAS (1), Astronomy And Astrophysics (1), Astroparticle Physics (1), Compact Groups (1), Data Analysis (1)). The search results list three items:

- ctape\_io\_mchdf5** (February 7, 2020 (0.1), Software, Open Access) by Vuillaume, Thomas; Aubert, Pierre; Garcia, Enrique; Description: ctape plugin for reading and converting Monte-Carlo files (contains the same information as Simtel files); Uploaded on February 7, 2020.
- JColl88/sdc1-solution-binder: SDC1 Solution 1.0.0** (September 24, 2021 (1.0.0), Software, Open Access) by Alex Clarke; James Collinson; Description: The SKA Science Data Challenge 1 (SDC1, https://astronomers.skatelescope.org/ska-science-data-challenge-1/) tasked participants with identifying and classifying sources in synthetic radio images. Here we present an environment and workflow for producing a solution to this challenge that can easily b; Uploaded on September 24, 2021.
- AMIGA-IAA/hcg-16: Repo synced with Zenodo** (September 28, 2021 (v1.2.1), Software, Open Access) by Mike Jones; Sebastian Luna-Valero; Julián Garrido; Susana Sánchez Expósito; Description: This zenodo registry is related to the GitHub repository hcg-16 (https://github.com/AMIGA-IAA/hcg-16), which hosts a pipeline to reproduce the data reduction and analysis of Jones et al. 2019. This and future releases will be archived with Zenodo; Uploaded on September 28, 2021.

At the bottom, a partial view of another release is visible:

- Gammapy: Python toolbox for gamma-ray astronomy** (May 13, 2022 (v0.20), Software, Open Access) by Donath, Axel; Deil, Christoph; Terrier, Régis; Ruiz, José Enrique; King, Johannes; Remy, Quentin; Jouvain, Léa; Sinha, Atrayee; Pintore, Fabio; Wood, Matthew; Olivera, Laura; Paz Arribas, Manuel; Giunti, Luca; Khélifi, Bruno; Acero, Fabio; Owen, Ellis; Nöthe, Maximilian; Vorokh, Olga; Sipőcz, Brigitta; Lefaucheur, Julien; Nigro, Cosimo; Robitaille, Thomas; Harris, Jonathan; Fidalgo, David; Mohrmann, Lars; Lennarz, Dirk; Hajlaoui, Jalel; de Almeida Coutinho, Alexis; Wegenmat, Matthias; Papadopoulos, Dimitri; Chakraborty, Nachiketa; Droettboom, Michael; Watson, Jason; Voruganti, Arjun; Poon, Helen; Tollerud, Erik; Armstrong, Thomas; Joshi, Vikas; Bray, Erik; Aguasca Cabot, Arnaud; Emery, Gabriel; Tiziani, Domenico; Minaya, Ignacio; Brügg, Kai; Siejkowski, Hubert; Gogia, Arpit; Tibaldo, Luigi; Gallant, Yves; Spir-Jacob, Marion; Chen, Andrew; Zanin, Roberta; Bradley, Larry; Lenain, Jean-Philippe; Nakashima, Kaori; de Bony, ...

# DIOS – Data Infrastructure for Open Science

Distributed data infrastructure capable of managing Exa-scale data



Data manager and orchestrator

Data transfer

Auth/Authz/IM

ESCAPE DL architecture applied to implement a Data Management System prototype for the SKA Regional Centre Network

## SKAO RUCIO DATA LAKE



# ESAP – ESFRI Science Analysis Platform

## Toolkit for building custom science platform.

- Integration of catalogue services
- Upload of data from the VO ecosystem (SAMP)
- Data orchestration among different services

The screenshot displays the ESAP interface with a dark header bar containing navigation links: Archives, Multi Query, Interactive Analysis, Batch Analysis, Asynchronous Jobs, and IVOA-SAMP. A user profile dropdown is visible on the right with options: Logout, Susana Sánchez, and Expósito. Below the header, three service tiles are shown: WSRT-Apertif (Apertif Surveys), ASTRON VO (ASTRON Virtual Observatory), and Zooniverse. The ASTRON VO tile is active, showing the 'ASTRON Data Explorer' interface. This interface includes a 'Query' section with dropdowns for 'Catalog' (ASTRON\_VO), 'Target', 'RA (degrees)', 'dec (degrees)', and 'search radius (degrees)', and a 'Processing Level' dropdown (Processed). Below these is a 'Submit' button. The 'Query results for ASTRON\_VO' section shows a table with 6 results. The table has columns: Basket, Collection, RA, Dec, fov, DataProduct Type, Calibration Level, Size, and Link to data. The first three rows are visible, each with a checked checkbox in the 'Basket' column and a 'Download data' link.

Basket	Collection	RA	Dec	fov	DataProduct Type	Calibration Level	Size	Link to data
<input checked="" type="checkbox"/>	lotss-dr1	170.4	49.7	3.1	image	3	48.5 MB	<a href="#">Download data</a>
<input checked="" type="checkbox"/>	lotss-dr1	170.4	49.7	3.2	image	3	436.5 MB	<a href="#">Download data</a>
<input checked="" type="checkbox"/>	lotss-dr1	172.6	47.5	3.3	image	3	53 MB	<a href="#">Download data</a>

# ESAP – ESFRI Science Analysis Platform

- Load software from the OSSR catalogue
- Interactive data analysis through BinderHub services

The diagram illustrates the workflow for loading software from the OSSR catalogue and performing interactive data analysis through BinderHub services. It consists of two main panels connected by a large blue arrow.

**Left Panel: Interactive Analysis Workflows**

- Navigation Bar:** Archives, Multi Query, **Interactive Analysis**, Batch Analysis, Asynchronous Jobs, IVOA SAM.
- Header:** ESCAPE ESAP | Open-source Scientific Software and Service Repository.
- Search:** Search for Workflows (input field), Next (button).
- Advanced Search:** [Advanced Search](#) (link).
- Workflow List:**
  - CSIC-IAA HCG-16 workflow** (checked)
    - Description: Analysis of Hickson Compact Group 16
    - Link: <https://github.com/AMIGA-IAA/hcg-16>
    - Author:
    - Runtime Platform: Python
    - Keywords: jupyter-notebook
  - CDS MOCpy**
    - Description: Experiment with Multi-Order Coverage maps
    - Link: <https://github.com/cds-astro/mocpy>
    - Author:
    - Runtime Platform: Python
    - Keywords: jupyter-notebook

**Right Panel: Interactive Analysis Compute Facilities**

- Navigation Bar:** Archives, Multi Query, **Interactive Analysis**, Batch Analysis, Asynchronous Jobs.
- Header:** ESCAPE ESAP | Open-source Scientific Software and Service Repository.
- Search:** Search for Facilities (input field), << (button).
- Facility List:**
  - JIVE BinderHub**
    - Description: JIVE BinderHub
    - Link: <http://jupyterjive.nl/binderhub/>
  - MyBinder**
    - Description: MyBinder
    - Link: <https://mybinder.org/>
  - Rosetta @ INAF OATS**
    - Description: The Rosetta platform deployed at INAF OATS computing centre
    - Link: <https://esap-rosetta.oats.inaf.it/>



# THANK YOU!



ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 824064.

## References:

- [The ESCAPE project: Data Lake and Science Platform](#), Y. Grange, K. Kliffen, J. Swinbank
- [CEVO achievements and outlook](#), M. Allen
- The ESAP GUI: <https://sdc-dev.astron.nl/esap-gui/>