


AstroORDAS

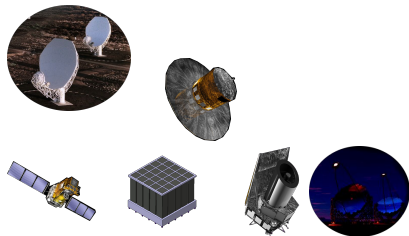
Astronomical Open Research Data Analysis Services

Swiss Open Research Data Grants Track B: Establish projects

<https://www.astro.unige.ch/astroordas/>

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Swiss SKA days 2024
EPFL, Geneva Campus Biotech

<https://github.com/oda-hub/>

Platforms for Coding and for using Tools and Workflows

Development environment allows to write code, e.g. in python.

But this is never enough, need existing assets: data and data transformation tools.

environment to develop research code

The screenshot shows a JupyterLab interface with three main panels. The left panel is a file browser showing a directory structure for '02-cosmology'. The middle panel displays a scatter plot of data points in a polar coordinate system, with axes ranging from 0 to 10 and 0 to 315 degrees. The right panel shows a light curve plot with data points and error bars, and a legend for different instruments: ISRI, EM-X1, EM-X2, and SR. Below the plots, there is a table of links to various resources like 'ast_rates.pdf', 'st_models.pdf', etc.

jupyterhub

VRE at CERN

renku

colab

OPEN OnDemand

analysis tools and workflows

The screenshot shows the Galaxy for Astronomy interface. The left sidebar lists various tools like 'Send Data', 'Collection Operations', 'Expression Tools', etc. The main area displays a workflow titled 'Example Multi-Wavelength Light-Curve Analysis'. The workflow consists of several steps: 'T1', 'T2', 'Name', 'HESS', and 'light_curve'. Each step has an 'output (text)' box. The 'light_curve' step is connected to a 'HESS' step. The right side of the interface shows a visualization of the workflow's output, which is a multi-wavelength light curve plot. The plot shows data points for different instruments and a color-coded background. The plot is titled 'analysis (PR 91)' and has a URL 'https://mmoda.io/'.

MMODA
Multi-Messenger Online Data Analysis

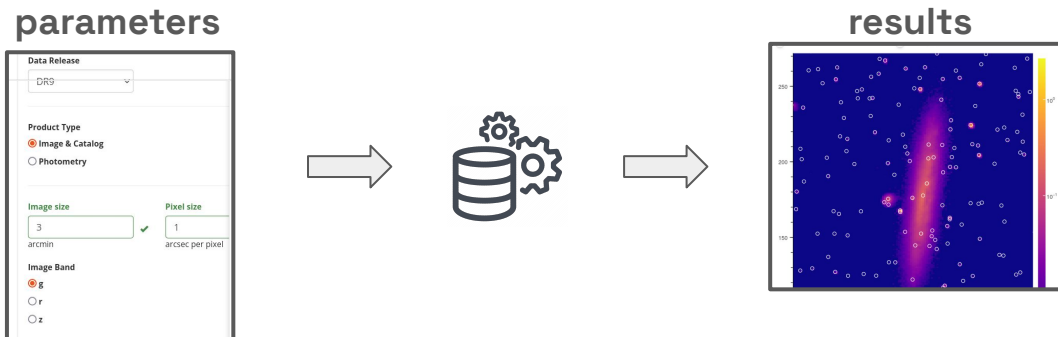
AstroORDAS Workflows and Tools are functions producing data given some input. Workflows are linked look.

Tools may be accessible from dedicated UI or from an API from another platform.

An Analysis Service in AstroORDAS

“Services” in AstoORDAS are live services producing research data.

Not data storage services, compute, TAP, etc - although all these are used in alignment with the live services.



Typically are containers annotated as **functions** with **input** and **output**.

They be realised live a **web service endpoint** (e.g. swagger), a **tool in a workflow language** (e.g. CWL) or a **function** general purpose language, and can be converted between these forms.

VO provides interfaces to manage data but not functions (note though Execution Planner).

Compare to AWS Lambdas, WikiFunctions, the spirit of serverless compute.

If you know about **catalog of analysis functions** a thing in academia let me know! The closest I know is [HEASoft](#), and [Galaxy](#).

Functions with parameters are reproducible data products

Unlike static data, functions with no parameters can be simply recomputed (giving identical result) or recomputed with some changes, reproducing the result in new conditions.

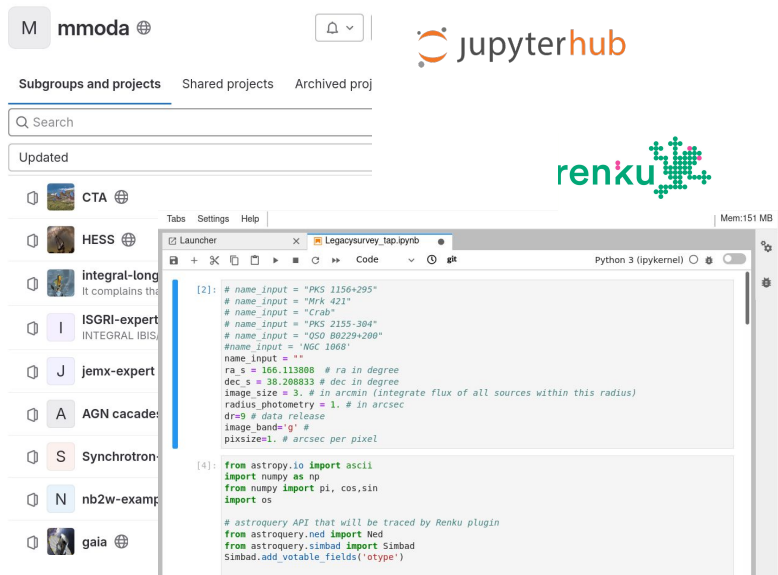
MMODA Gallery keeps track of user-selected computations done by MMODA services.

The screenshot displays the MMODA Gallery web interface. At the top, there is a navigation bar with links for Dashboard, Content, Structure, Appearance, People, Modules, Configuration, Reports, and Help. The user is logged in as 'Hello Volodymyr Savchenko Proftest'. The main search area includes an 'Object name' field with the value '1E 1740.7-2942' and buttons for 'Resolve' and 'Explore'. Below this are fields for 'RA' (265.97845833) and 'Dec' (-29.74516667). There are also 'Start time' (2017-03-06T13:26:48.0) and 'End time' (2017-03-06T15:32:27.0) fields, along with a 'Time unit' dropdown set to 'ISO/ISOT'. A green banner below the search area reads 'MMODA Gallery - Object : 1E 1740.7-2942'. The main content area is titled 'Long baseline products' and shows two product cards. The first card is for 'IGR J16194-2810' with sources 1A 1742-294, 1A 1743-288, 1E 1740.7-2942, etc., and a data time span from 2004-02-15T04:31:21 to 2023-09-10T08:25:58. The second card is for 'GX J+4' with sources 1A 1742-294, 1E 1740.7-2942, 3A 1822-371, etc., and a data time span from 2005-05-01T00:00:00 to 2022-08-31T23:59:59. Below these cards, it says 'All other products for the source' followed by the number '2818'.

Service development environment

Developing tools is hard. Developing domain-specific analysis is very hard. **MMODA** answer is division of labor, we create JupyterLab, (in Jupyterhub, renkulab) development environment allowing **expert users** to **easily contribute analysis workflows**, adding semantics of **input parameters, output data**, and any additional dependencies.

We **do not reinvent** workflow language, but instead map **easy tool construction and update in a notebook** into other tool forms.

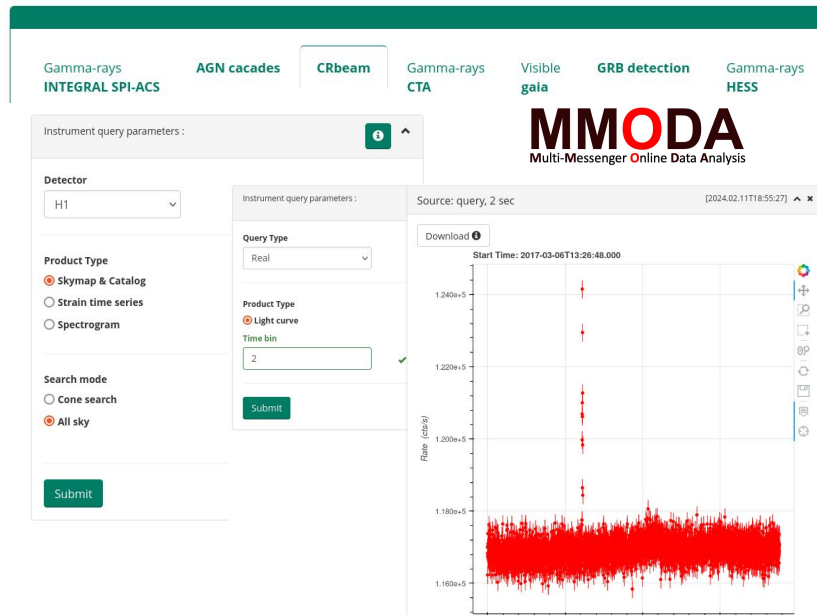
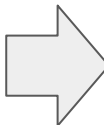


The screenshot shows the JupyterLab interface for the 'mmoda' project. On the left, there is a sidebar with a search bar and a list of subgroups and projects, including CTA, HESS, integral-long, ISGRI-expert, jemm-expert, AGN cacade, Synchrotron, nb2W-examp, and gaia. The main area displays a code editor with Python code for querying astronomical data. The code includes comments and imports for 'astroquery' and 'astropy'. The code is as follows:

```
[2]: # name_input = "PKS 1156+295"
# name_input = "Mrk 421"
# name_input = "Crab"
# name_input = "PKS 2155-304"
# name_input = "OSO B0229+200"
#name_input = "NGC 1068"
name_input = "*"
ra_s = 166.113908 # ra in degree
dec_s = 38.208833 # dec in degree
image_size = 3. # in arcmin (Integrate flux of all sources within this radius)
radius_photometry = 1. # in arcsec
dr=9 # data release
image_band='g' #
pixsize=1. # arcsec per pixel

[4]: from astropy.io import ascii
import numpy as np
from numpy import pi, cos,sin
import os

# astroquery API that will be traced by Renku plugin
from astroquery.ned import Ned
from astroquery.simbad import Simbad
Simbad.add_votable_fields('otype')
```



The screenshot shows the MMODA web interface. At the top, there are navigation tabs for 'Gamma-rays INTEGRAL SPI-ACS', 'AGN cacades CRbeam', 'Gamma-rays CTA', 'Visible gaia', 'GRB detection', and 'Gamma-rays HESS'. The main content area is titled 'Instrument query parameters:' and includes a dropdown menu for 'Detector' (set to 'H1'). Below this, there are sections for 'Product Type' (with radio buttons for 'Skymap & Catalog', 'Strain time series', and 'Spectrogram'), 'Search mode' (with radio buttons for 'Cone search' and 'All sky'), and a 'Submit' button. To the right, there is a 'Source: query, 2 sec' section with a 'Download' button and a plot showing a light curve. The plot has a y-axis labeled 'Flux (cts/s)' ranging from 1.1600e+5 to 1.2400e+5 and an x-axis representing time. The plot shows a noisy signal with several sharp peaks. The MMODA logo 'Multi-Messenger Online Data Analysis' is visible in the top right corner.

Compute and Data access

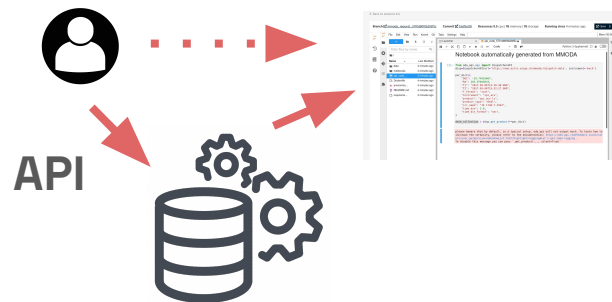
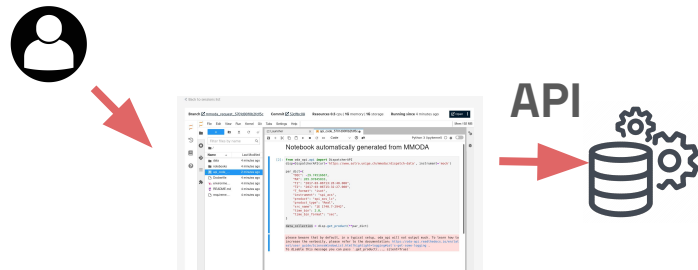
Tools need access to storage and distributed compute.

Two ways to access capacity outside simple code/tool:

1. Talking to a service by accessing **API from within interactive session**: dask cluster, S3 storage, HTTP or posix.
2. Launching the **entire session** or **batch tool** on the **resource next to the data**. Workflow from pure functions ensures controlled access to data, HTC.

We also developed runtime introspection intercepting external resource queries to create annotations.

This allows access to private and public infrastructures of the developers, with a focus on **CSCS**.



Publications integration:

Paper production:

MMODA platform and the AstroORDAS project has features for publishing research assets.

- All **queries** are **reproducible**, and semantically annotated.
- **Publishing** research data but also **analysis tools**

We are working with “almost traditional” publishers and journals especially innovative like EPIScience.

Including tight data-paper connection in a form of a “live paper”.

And also paper **consumption**:

We made a tool for **paper analysis**, extracting semantic data, based on ontologies from IVOA + expansion.

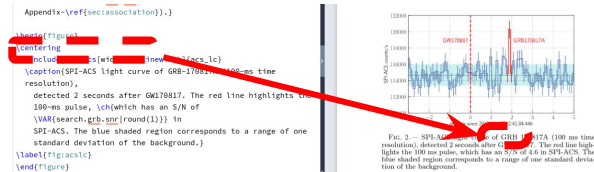
Based in this semantic data, made **predictions for telescope followup**.

Publication analysis engine is itself a MMODA tool.



WorkflowHub interface showing a workflow titled "No description specified". The interface includes buttons for "Workflow Inputs", "Workflow Outputs", and "Workflow Actions". Below the buttons, the workflow ID and DOI are displayed: "SEEK ID: https://workflowhub.eu/workflows/415/version-1" and "DOI: 10.48546/workflowhub.workflow.415.1". A table lists the inputs:

ID	Name	Description	Type
i1	n/a	n/a	string
i2	n/a	n/a	string
do_core_search	n/a	n/a	boolean



Product Type: Telescope type prediction

Query parameters | Log | Share | API code

text

We report the following classifications of optical transients from spectroscopic observations with the Kast spectrograph on the Shane telescope. The targets were supplied by ZTF. All observations were n on 2024 Aug 27 UT. Classifications were performed with SNIID (Blond Tonny, 2007, ApJ, 666, 1024).

Name	IAU Name	RA (J2000)	Dec (J2000)	z	Type	PH
ZTF24aaqzuz	2024rqf	15:56:04.46	+28:54:01.79	0.06101	la	
ZTF24abcubkx	2024sst	23:05:56.43	+16:28:22.05	0.07595	la	

Source Name | Image

- table_atel_sensitivity | View
- table_predicted_sensitivity | View
- table_source_classes | View
- table_sources | View
- table_suggested_workflows | View
- table_telescopes | View

Source: table_pi

Show 10 entries

Download

number

Source: table_sources

Show 50 entries

Download

Show 50 entries

Search:

Predicted Sensitivity

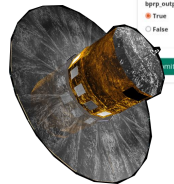
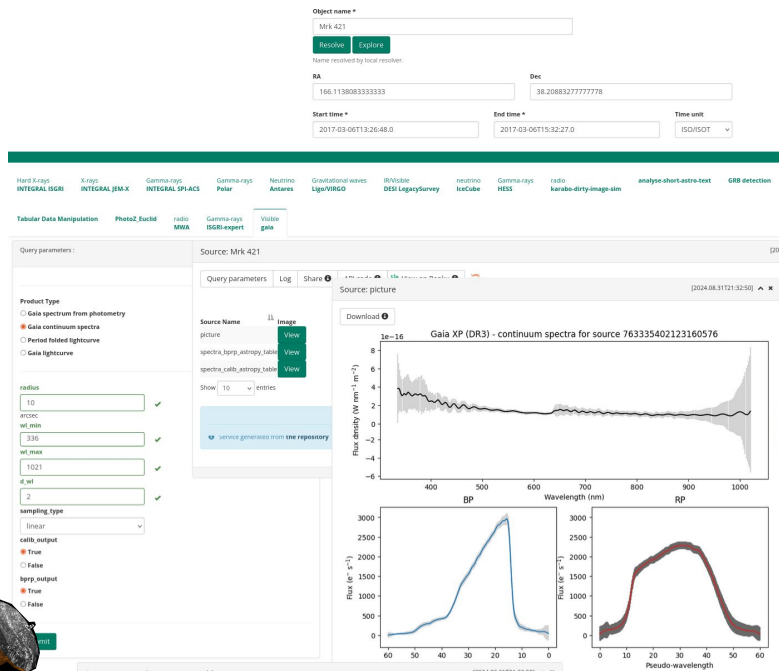
- x-ray
- optical
- infrared

Showing 1 to 3 of 1

AstroORDAS new telescopes for MMODA and Galaxy

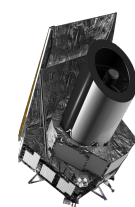
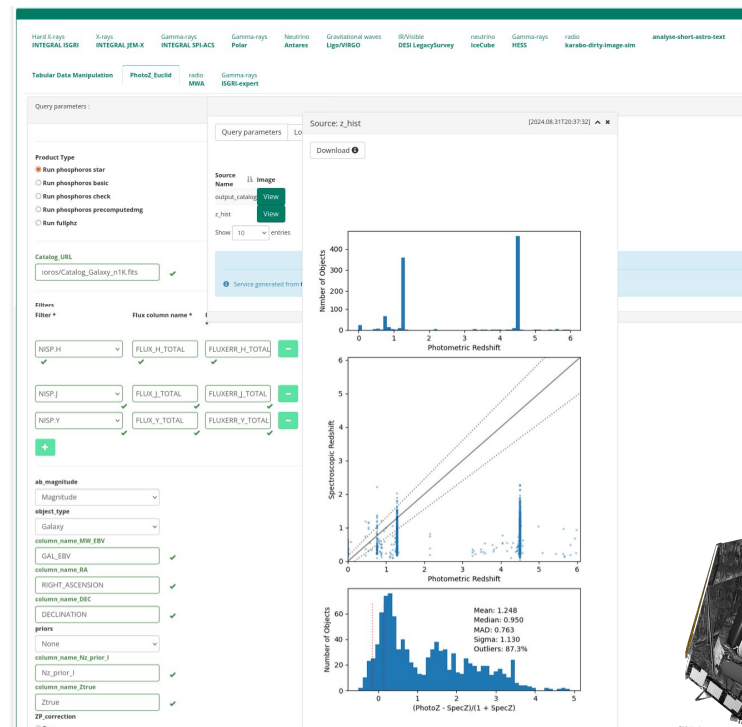
Gaia

Milestone astrometric mission, we include tools for accessing its



Euclid

Recently launched cosmology mission, we include tool computing Photometric Redshift.



Cherenkov Telescope Array Observatory (CTAO)

H.E.S.S.: older telescope, public data.

For CTAO, CRbeam generates model prediction and, Gammapy simulates synthetic data.

Object name *
crab
Resolve Explore
Name resolved by local resolver.
RA 83.62874999999998 Dec 22.01
Start time * 2001-03-06T13:26:48.0 End time * 2027-03-06T15:3
Hard X-rays INTEGRAL ISGR1 X-rays INTEGRAL JEM-X Gamma-rays INTEGRAL SPI-ACS Gamma-rays Polar Neutrino Antares Gravitational waves Ligo/VIRGO IR/Visible DESI Legacy Survey neutrino IceCube Gamma-rays HESS
Tabular Data Manipulation PhotoZ_Euclid radio MWA Gamma-rays ISGR1-expert Visible gale
Query parameters: Source: crab
Product Type Image Lightcurve Spectrum
Emax 100 TeV Emin 1 TeV Radius 1 deg pixelize
Source: crab
Query parameters Log Share API code View on Renku
Source: png [2024.08.31T21:49:16]
Download
Source Name fits png Show
23°00' 22°30' 00' Dec
counts per pixel 35 30 25 20 15

Galaxy for Astronomy Workflow Visualize Data Help User
Tools search tools
Inputs
Send Data
Collection Operations
Expression Tools
Text Manipulation
Filter and Sort
Astro tools (staging)
Astro Tools
Join, Subtract and Group
CRBeam simple
1: CRbeam (PR 77)
2: astropy fit2ctav
3: Tabular Data Manipulation (PR 129)
out_Generate_events
Event_file (auto)
FITS file to dump
output (tabular, csv)
fn
out_histogram_column (auto)
out_histogram_column (auto)
out_histogram_picture (auto)
Galaxy for Astronomy Using 28.9 MB
History search datasets
Unnamed history
1: Tabular Data Manipulation (PR 129) → Histogram Counts in logspace, picture
2: Tabular Data Manipulation (PR 129) → Histogram Counts in logspace, data
3: astropy fit2ctav on data 76
8,371 lines
Normal tabular: histogram 7
CSV

Here for a change Galaxy is shown.

Planned to be used as one of the offered components in Science Data Challenge

AstroORDAS Radio



MWA GLEAM: an interface to SkyView incorporating it in AstroORDAS/MMODA and Galaxy

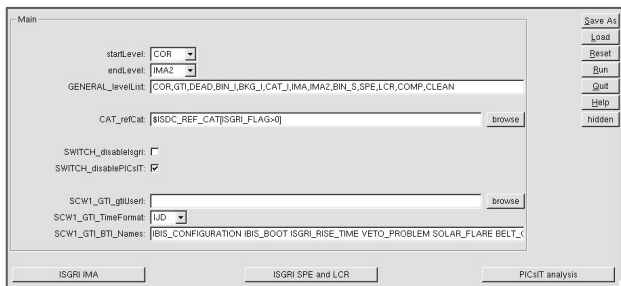
Karabo Simulation, dirty image.

Use Case for new GUI for existing tooling

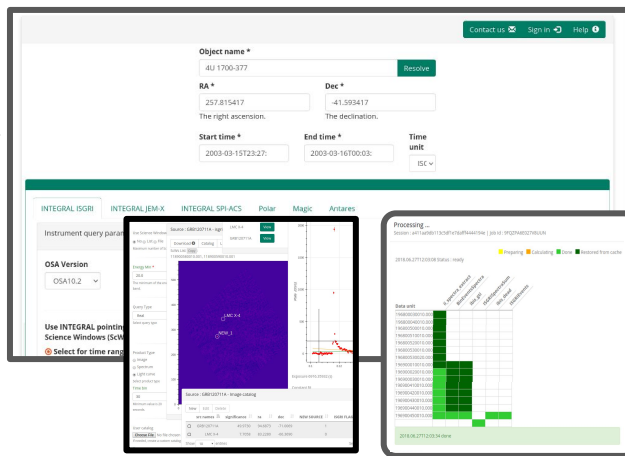


As much as the GUI for tools is needed (for simple analysis), it can be provided in Web platforms like MMODA. Lot's of modern GUI Desktop Apps are web apps anyway (e.g. electron-based). Typically also supports mobile.

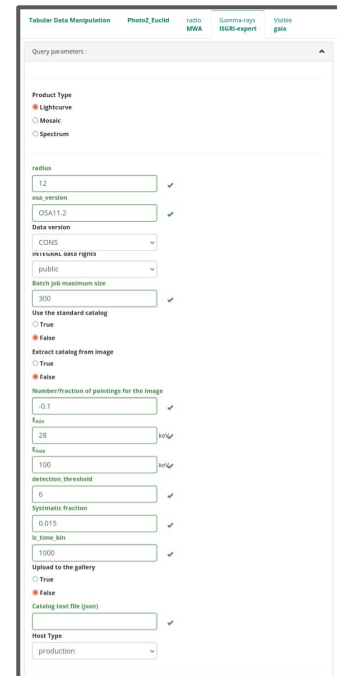
INTEGRAL OSA



INTEGRAL ODA



High-level analysis



And because it's Web, no need to install and no need to copy the data. Can rent resources owned by someone else.

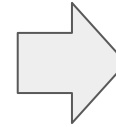
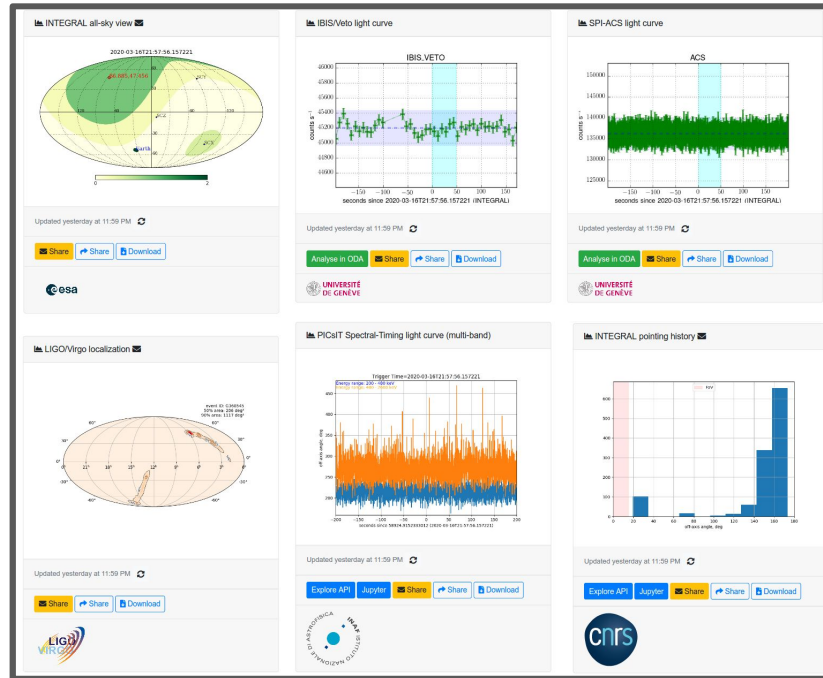
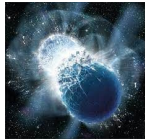
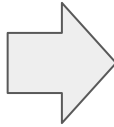
Now deployed at **ESA!**

MMODA
Multi-Messenger Online Data Analysis

Use Case of multi-messenger transients

Web brings diverse resources together **fast**. This matches the world of transients, since we have all the tooling in the same place. One the most used MMODA services is all-sky gamma-ray observations with INTEGRAL.

SciMMA, MOSSAIC,
VOEvent, GCN,
ATel, Kafka, ...







TIMESTAMP	TOPIC	TITLE	SUBMITTER
4 months ago	hermes.message	INTEGRAL follow-up of S231016an	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231015bc	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231015m	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231015g	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231014aa	Volodymyr Savchenko

Conclusions, Sustainability, Dissemination

- AstroORDAS aims to develop **an ecosystem of cloud-based services and technologies** to provide **added value to data** from science data centers for astronomy, astroparticle and cosmology projects.
- **Sustainability** enabled by:
 - modular open-source design (see [code](#))
 - community engagement by [crowdsourcing](#) workflows.
 - coordination with many similar Open Research projects and engagement in particular projects.
- Assets living past AstroORDAS:
 - analysis tools integrated in multiple **MMODA** and **Galaxy** instances
 - interactive visualisation libraries, [JS libraries](#)
 - technologies for connection to data and storage
 - publication technologies
- **EuroScienceGateway** continues connecting **Galaxy** platform to Astronomy. Galaxy has very large support (>100k unique users recently). Small new Galaxy EU project starting soon.
- **EU ACME** funding is just starting and will last for 5 years, including **MMODA** with CTAO, SKAO, KM3Net, ET etc.
- New ORD project **Solidipes** for enhancing reproducible publishing.
- MMODA/AstroORDAS already being used in a growing list of [publications](#)

Functions

Dashboard Content Structure Appearance People Modules Configuration Reports Help Hello VolodymyrSavchenkoProdTest Log out

MMODA Multi-Messenger Online Data Analysis  UNIVERSITÉ DE GENÈVE FACULTÉ DES SCIENCES  ISDC  EPFL  KAU My account Sign out

API token Contact us Help

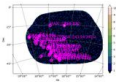
Object name *
1E 1740.7-2942
Resolve Explore

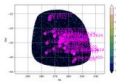
RA 265.97845833 Dec -29.74516667

Start time * 2017-03-06T13:26:48.0 End time * 2017-03-06T15:32:27.0 Time unit ISO/ISO

MMODA Gallery - Object : 1E 1740.7-2942

Long baseline products

IGR J16194-2810
Sources 1A 1742-294, 1A 1743-288, 1E 1740.7-2942, 4...
Instrument isgri

Data time span: 2004-02-15T04:31:21 - 2023-09-10T08:25:58
Revolution span: 163 - 2684

GX 1+4
Sources 1A 1742-294, 1E 1740.7-2942, 3A 1822-371, 4...
Instrument isgri

Data time span: 2005-05-01T00:00:00 - 2022-08-31T23:59:59
Revolution span: 311 - 2543

All other products for the source

2818

