# EXPLORE

# Innovative Scientific Data Exploration and Exploitation Applications for Space Sciences

Nick Cox @SCIOPS 2022

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# SPACE-30-SCI-2020: Scientific data exploitation

**Specific Challenge:**

Support the data exploitation of European missions and instruments, in conjunction, when relevant, with international missions.

**Expected Impact:**

A higher number of scientific publications based on Europe's space data, high-level data products made available through appropriate archives, and tools and methods developed for the advanced processing of data. Proposals are also expected to add value to existing activities on European and international levels, and to enhance and broaden research partnerships.

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# SPACE-30-SCI-2020 → EXPLORE

"EXPLORE's main objective is to develop and deploy a suite of scientific applications […], to achieve efficient […] exploitation of scientific data from astrophysics and planetary space missions, […]."

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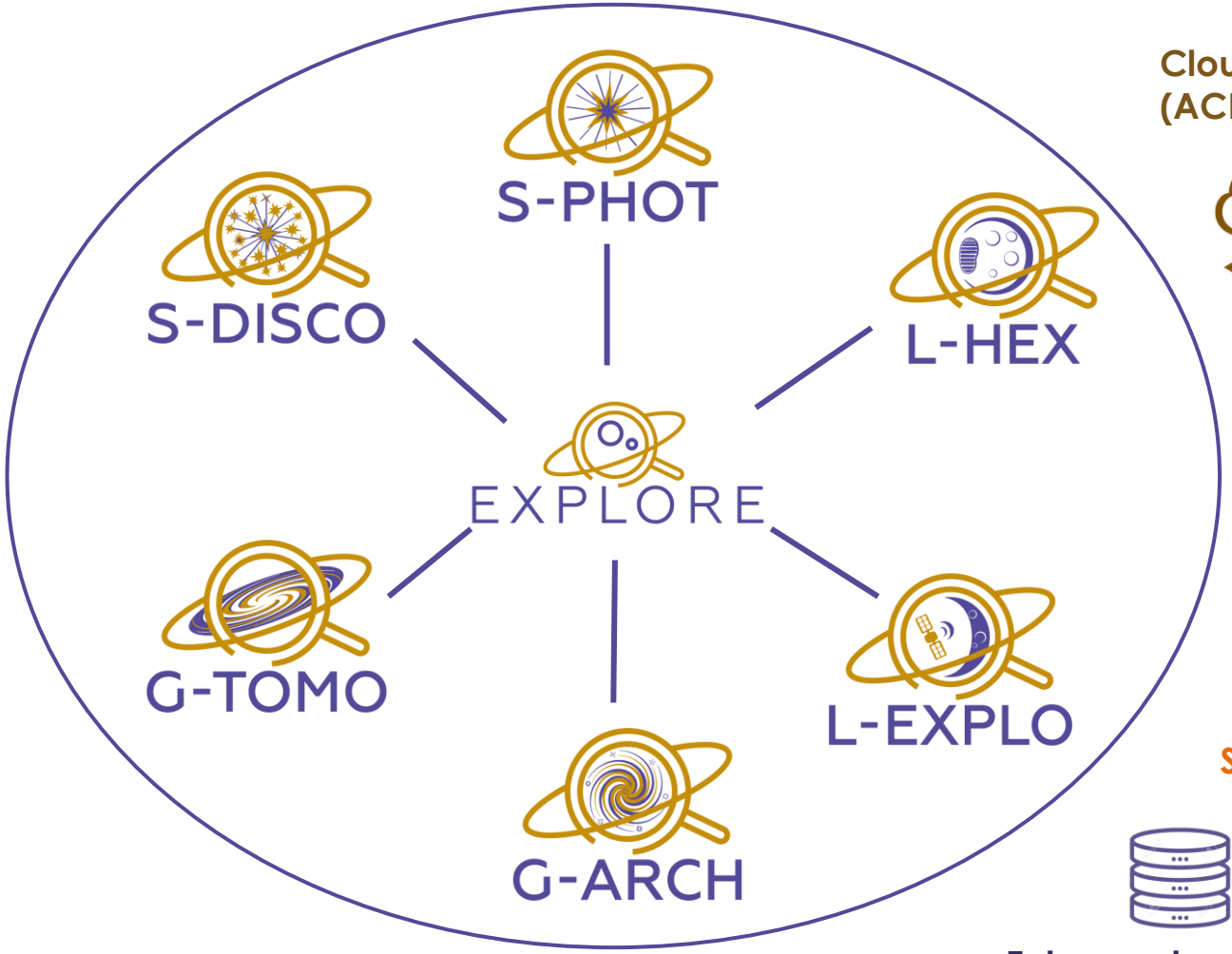
# EXPLORE – Space Science in the Cloud

**Lunar exploration and Gaia science applications powered with advanced visualization and machine learning features**




Space and ground-based data

Cloud Platforms (ACRI-ST, ESA, EU)

Science Archives

Enhanced products

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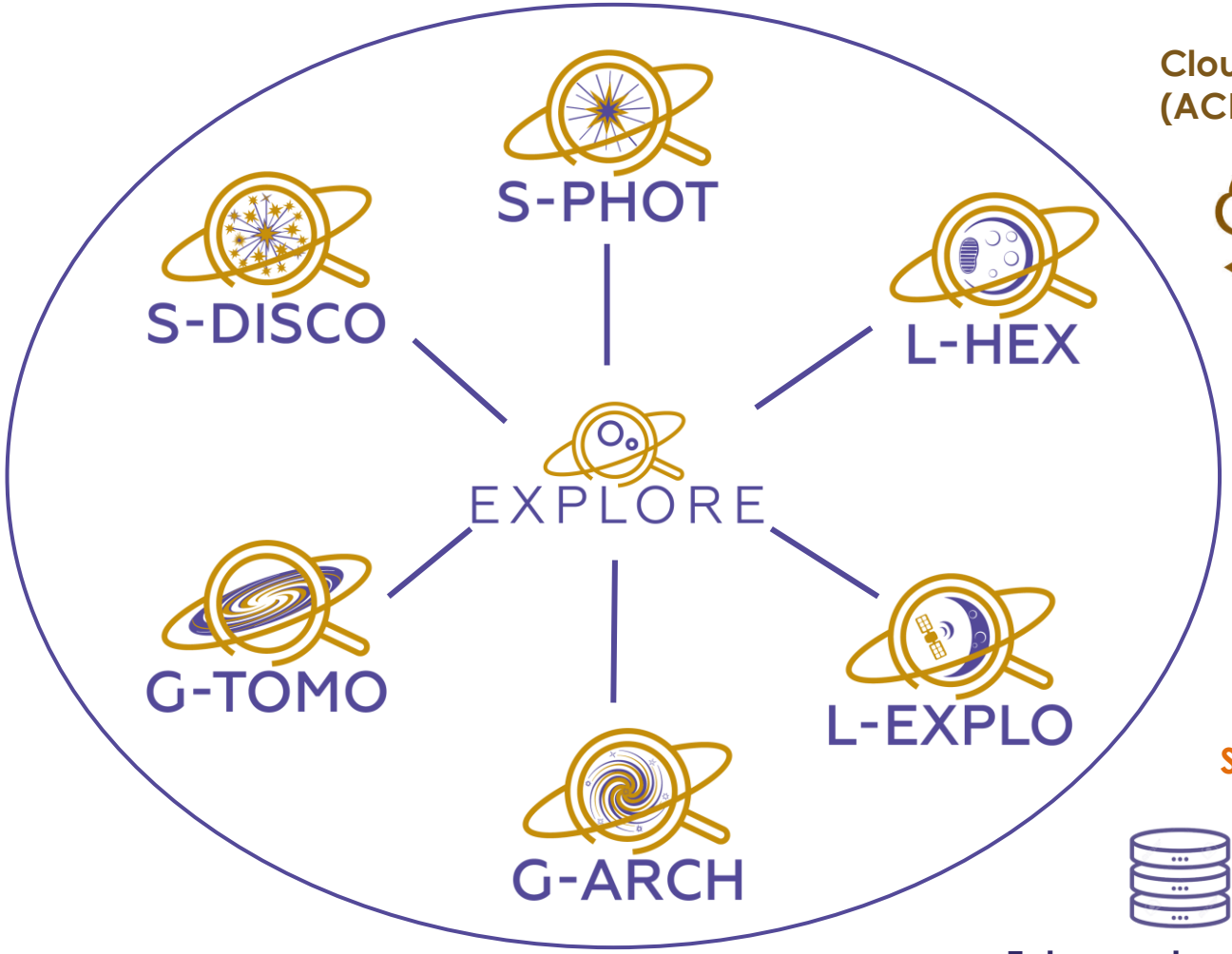
# EXPLORE – Space Science in the Cloud

**Lunar exploration and Gaia science applications powered with advanced visualization and machine learning features**




Space and ground-based data

Cloud Platforms (ACRI-ST, ESA, EU)

FAIR+open data, code, and science

Science Archives

Enhanced products

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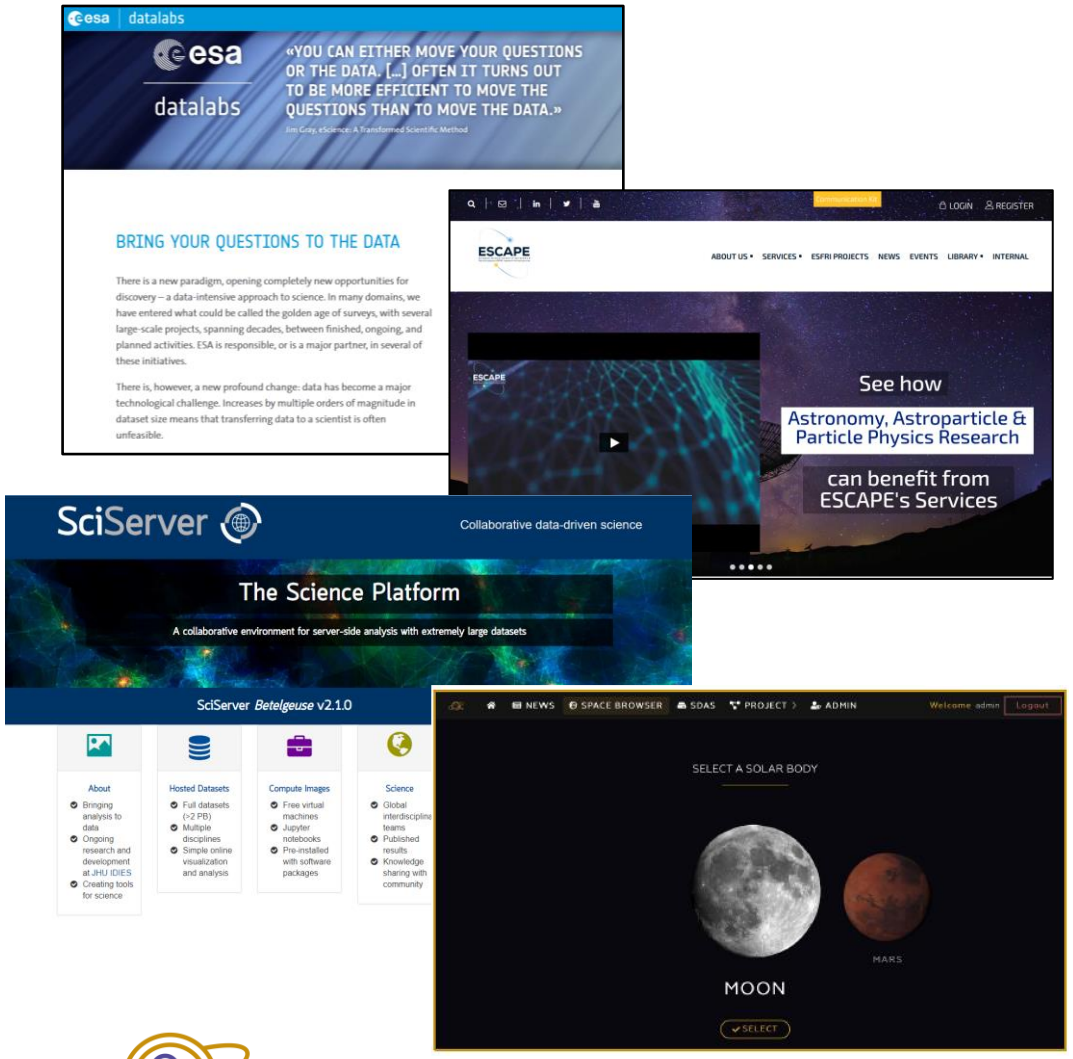
# Science Platforms & EXPLORE-platform




**Science Platforms** → scientific applications in the 'cloud' (close to the data)

For **space sciences**

- US: SciServer, CyVerse (generic)
- Europe: ESA Datalabs, ESCAPE SAP → EOSC ecosystem

EXPLORE **dev/test** platform for SDA (with limited resources 👥&🖥)

Beyond project EXPLORE platform could offer **bespoke niche services**

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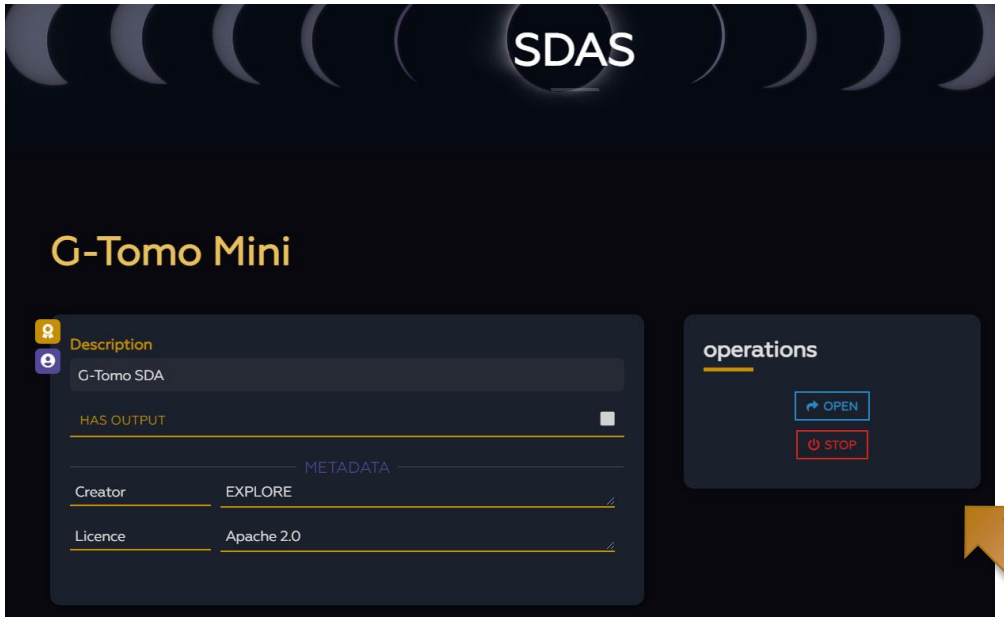
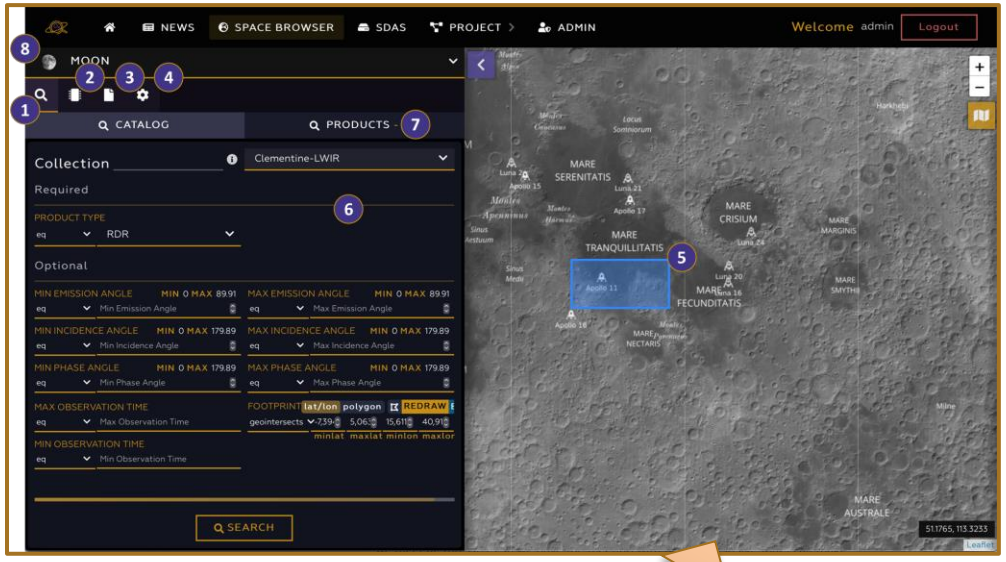
# EXPLORE dev platform

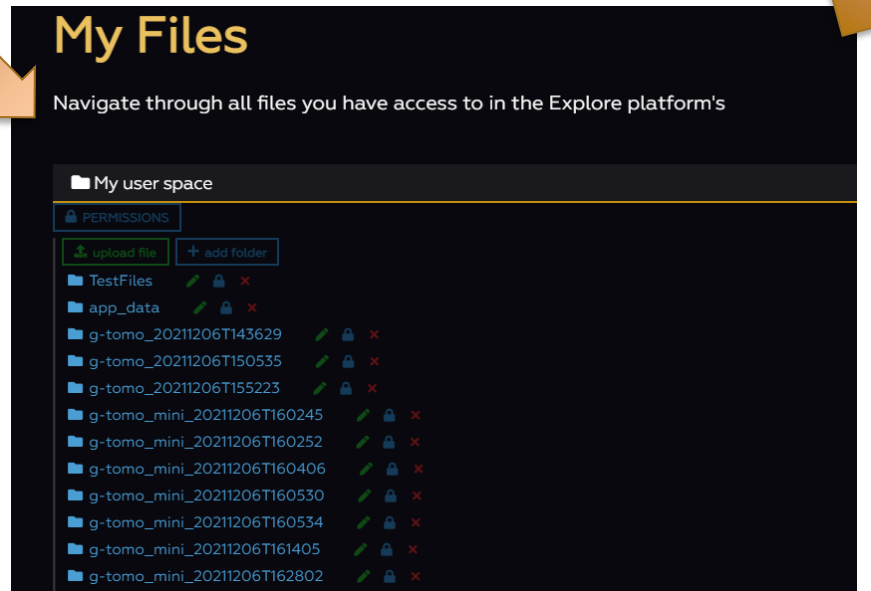
## Applications




## Space browser




## User workspace





https://explore-platform.eu

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# Scientific Data Applications (SDAs)?

- Applications / tools for scientific data exploration, visualisation, analysis
- Deployed on science 'cloud' platforms and accessed through a web frontend interface (UI) or API.
- Let users interact remotely with data (bringing the users to the tools and data rather than bringing the tools/data to the user)
- Container approach to create, deploy, and share open-source, interoperable SDAs
- SDAs to demonstrate and promote, leading by example, space science exploitation and uptake of science platforms.

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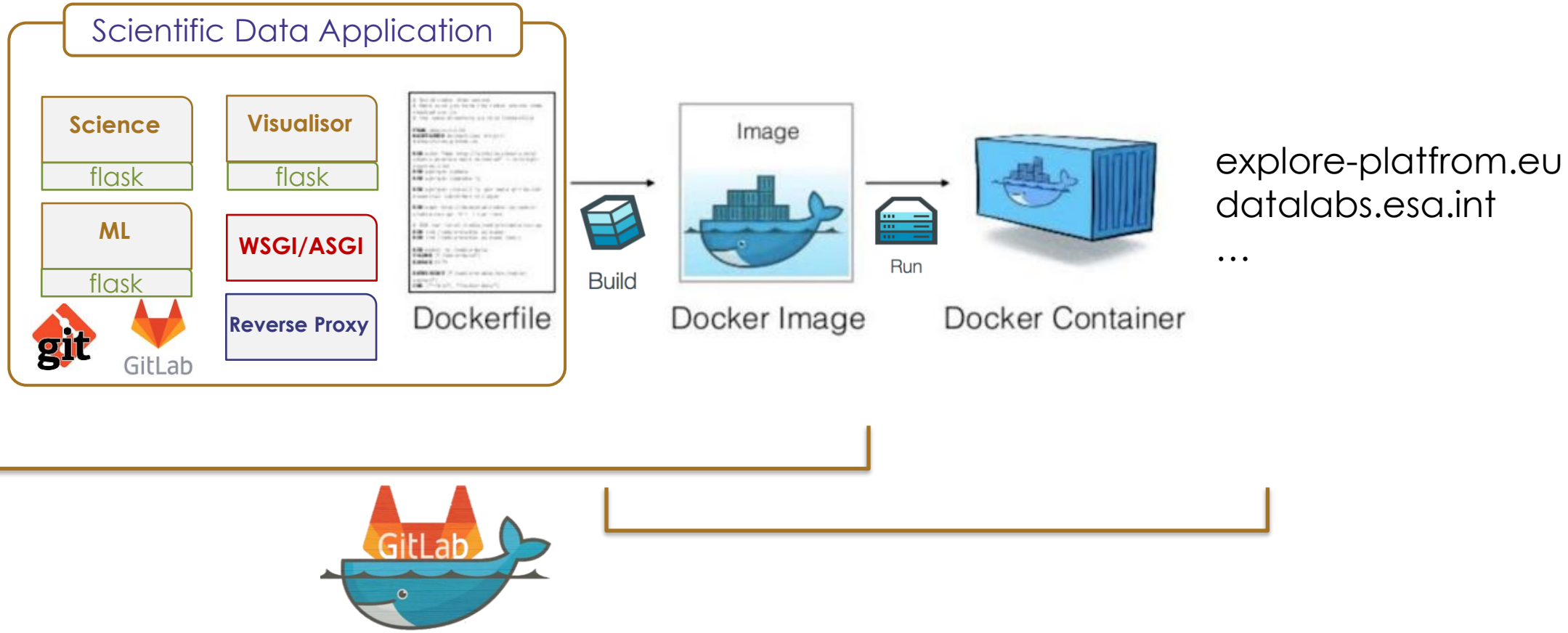
# dev-build-deploy process

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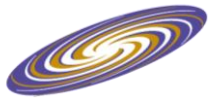
# Scientific Data Applications

***Led by Science Experts***

***G-Arch:*** *Galactic Archaeology*



***G-Tomo:*** *Galactic Interstellar Tomography*

***S-Phot:*** *Stars and their Blue/Red Excess*

***S-Disco:*** *Spectral Discovery for Stars*

***L-Explo:*** *Exploring the Moon with multi-scale data*

***L-Hex:*** *Lunar Human Exploration tools*

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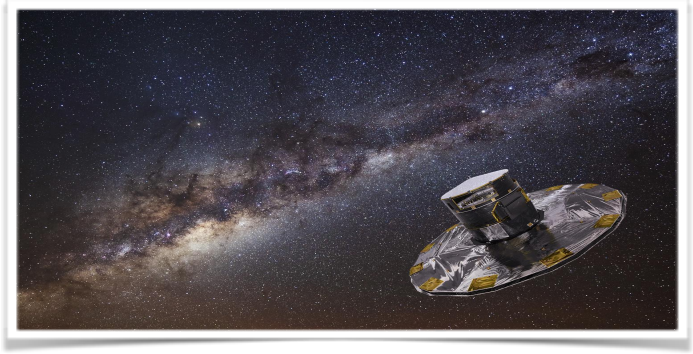
# EXPLORE SDA – S-Disco

- Surveys are gathering complex multidimensional data for millions/billions of sources.
- One can no longer examine them all by eye.
- ML/AI can be used to find "the ones that do not look like the others" = anomalies/outliers/novelties.
- The purpose is to promote a new way to look at data, and create a channel for the discovery of new phenomena.

- GAIA and APOGEE data retrieved for all overlapping sources.
- algorithm hyper-parameters explored and selected.



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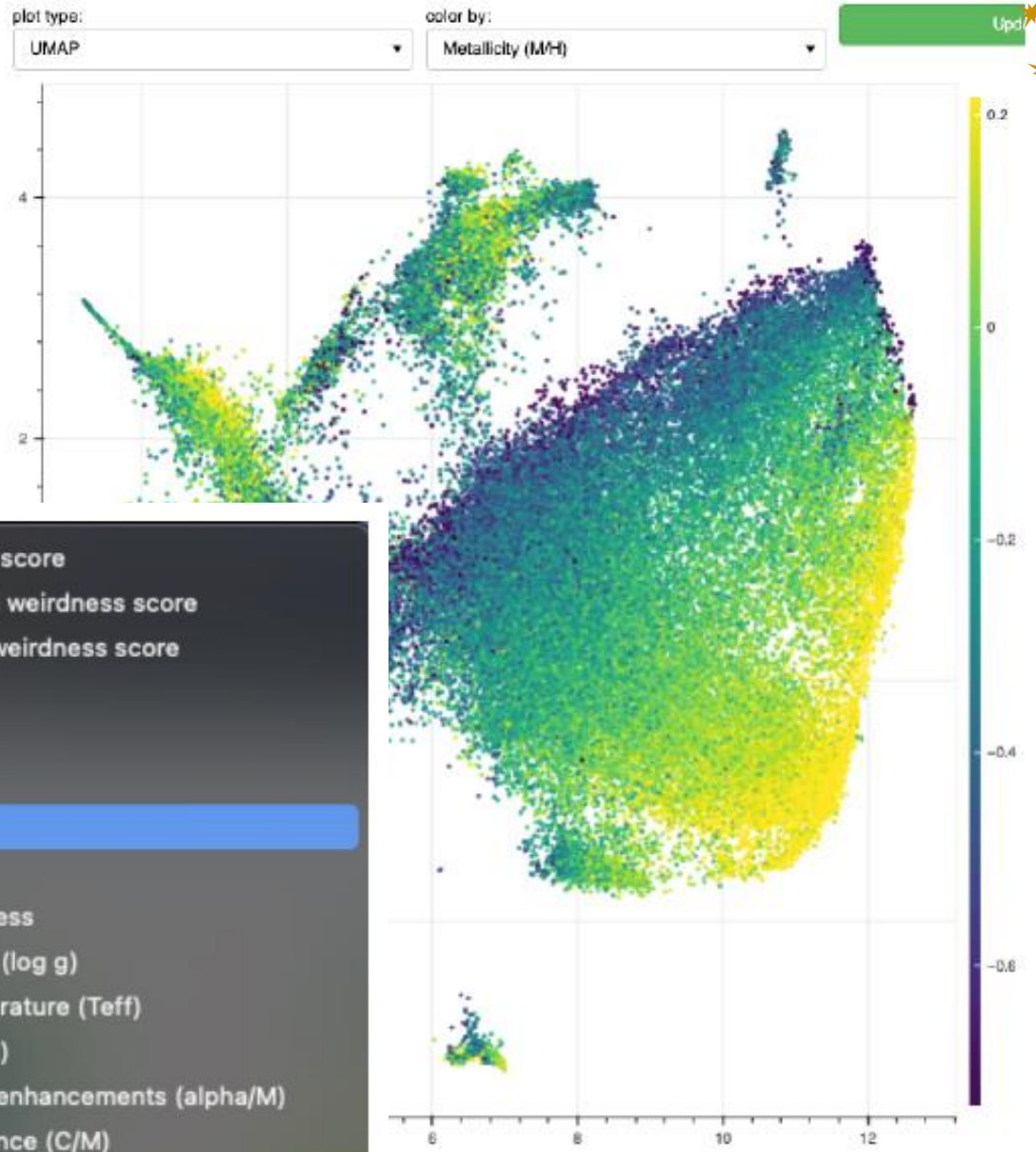
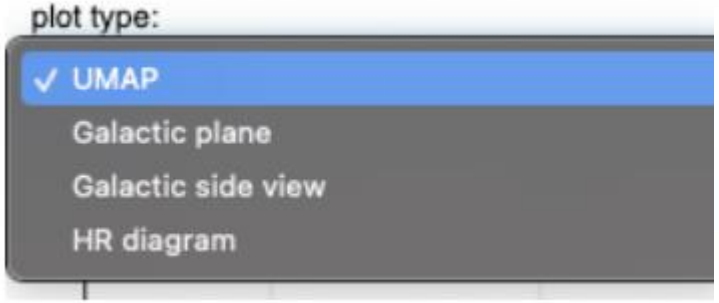
# EXPLORE SDA – S-Disco

- Total W score - The mean (feature) pairwise distance
- Spectral NN W score - The mean (feature) pairwise distance from 250 (feature) NN
- Spatial NN W score - The mean (feature) pairwise distance from 250 (Euclidean) NN







Plots are interactive:

- Can select and inspect single objects
- See where they move between views
- Can select multiple and plot median spectrum

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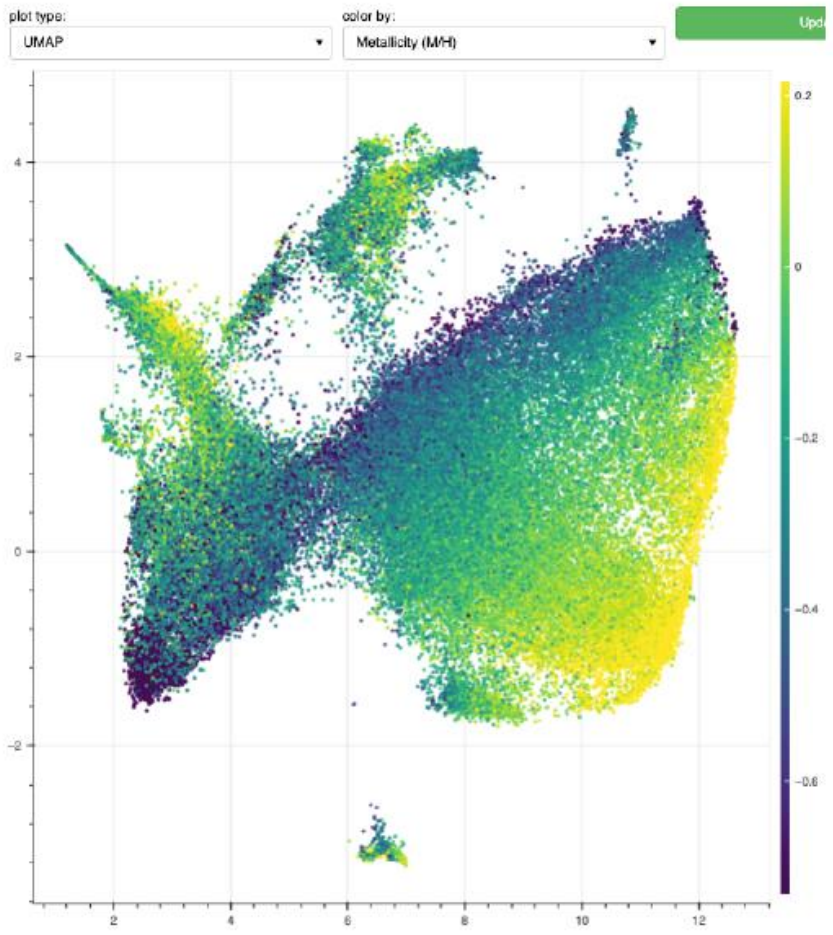
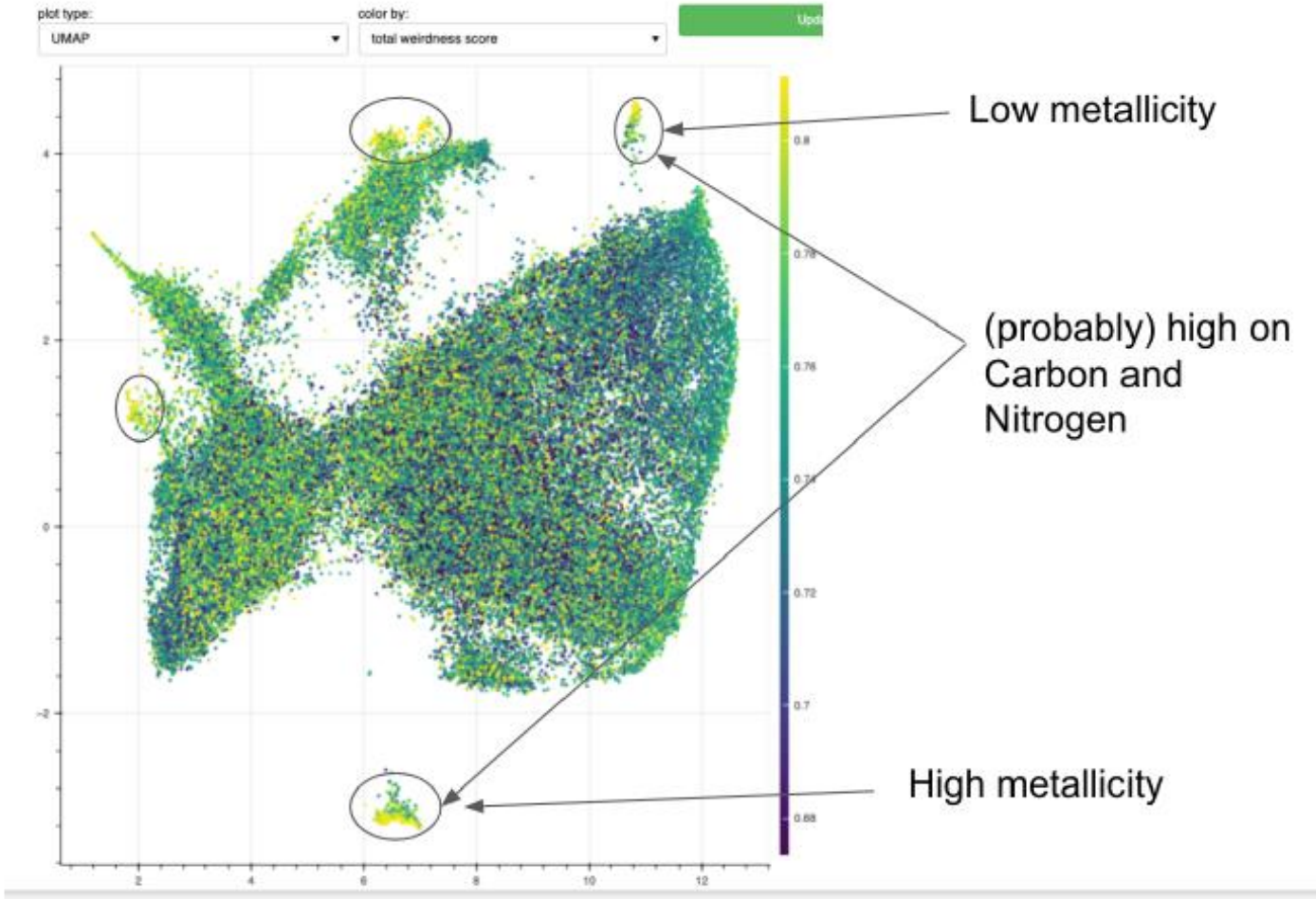
# EXPLORE SDA – S-Disco




UMAP + Z




UMAP – weirdness score

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# EXPLORE SDA – S-Phot

- New surveys are providing data on 10% of all stars in the Galaxy
- Allows population and evolution studies
  - Example Gaia: 1 billon accurate distance to stars
- Applications
  - Identifying stars with infrared or blue excess (star formation; activity; star death)
  - Mapping the solar neighbourhood
- Requirements
  - Determine accurate stellar parameters
  - Correlating many different databases with disparate information

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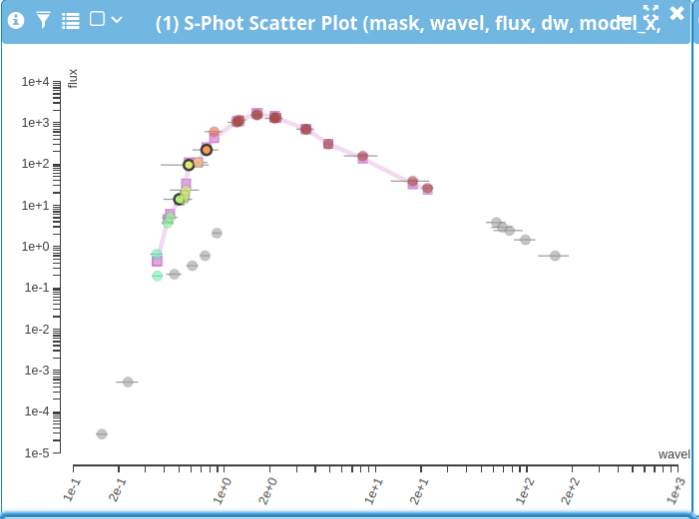
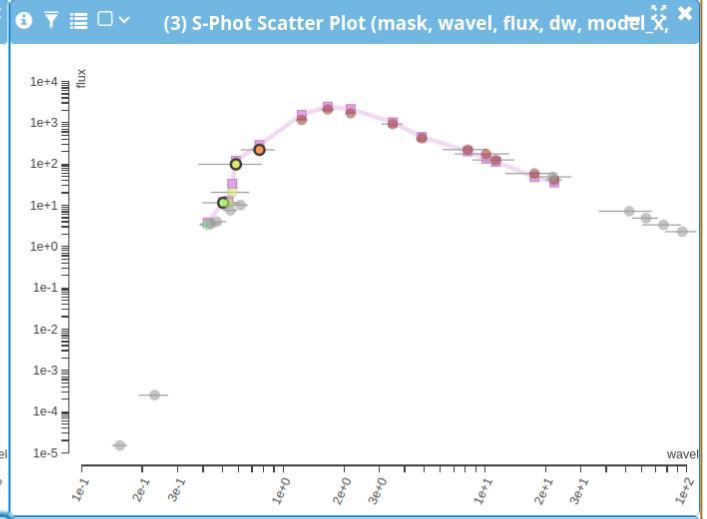
# EXPLORE SDA – S-Phot




(2) Table (catname, svoname, filter) Dataset:VY_Leo_Plot.csv

| Selected | catname | svoname | filter |
|---|---|---|---|
| | Gaia | filter column... | filter column... |
| ✓ | Gaia | GAIA/GAIA3.Gbp | BPmag |
| ✓ | Gaia | GAIA/GAIA3.G | Gmag |
| ✓ | Gaia | GAIA/GAIA3.Grp | RPmag |

Select Filtered | Deselect All | Clear Filters | First | Prev | 1 | Next | Last

(4) Table (catname, svoname, filter) Dataset:EU_Del_Plot.csv

| Selected | catname | svoname | filter |
|---|---|---|---|
| | filter column... | filter column... | filter column... |
| ✗ | Gaia | GAIA/GAIA3.Gbp | BPmag |
| ✗ | Gaia | GAIA/GAIA3.G | Gmag |
| ✗ | Gaia | GAIA/GAIA3.Grp | RPmag |

Select Filtered | Deselect All | Clear Filters | First | Prev | 1

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# EXPLORE SDA – S-Phot





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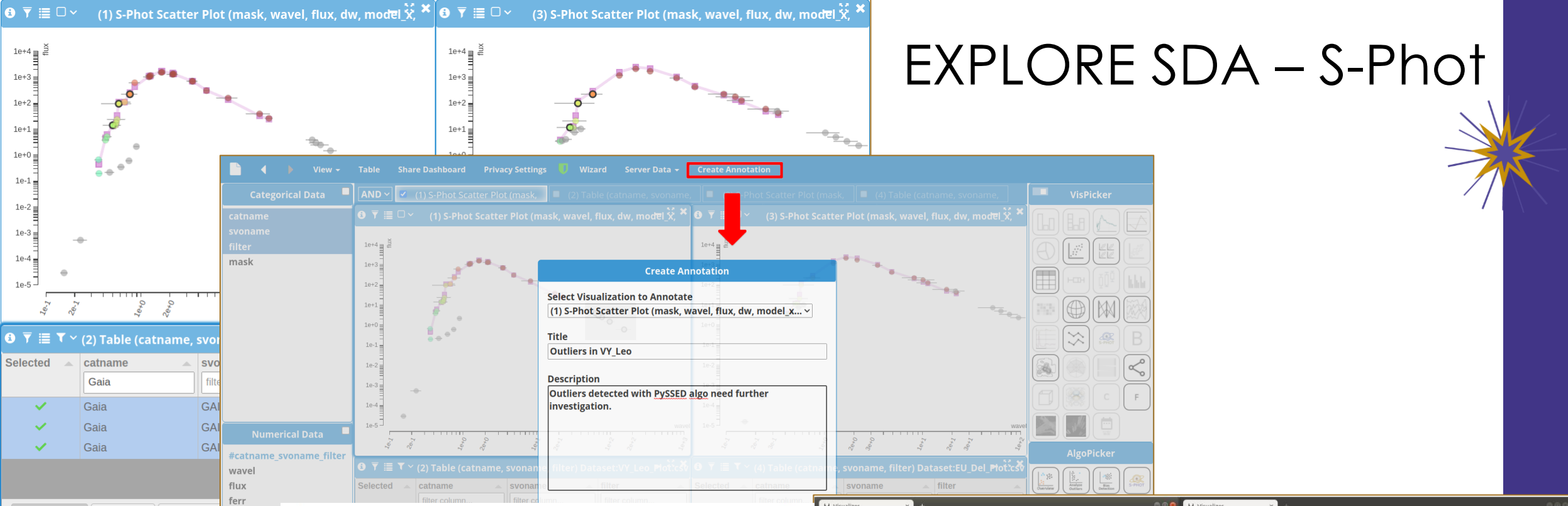
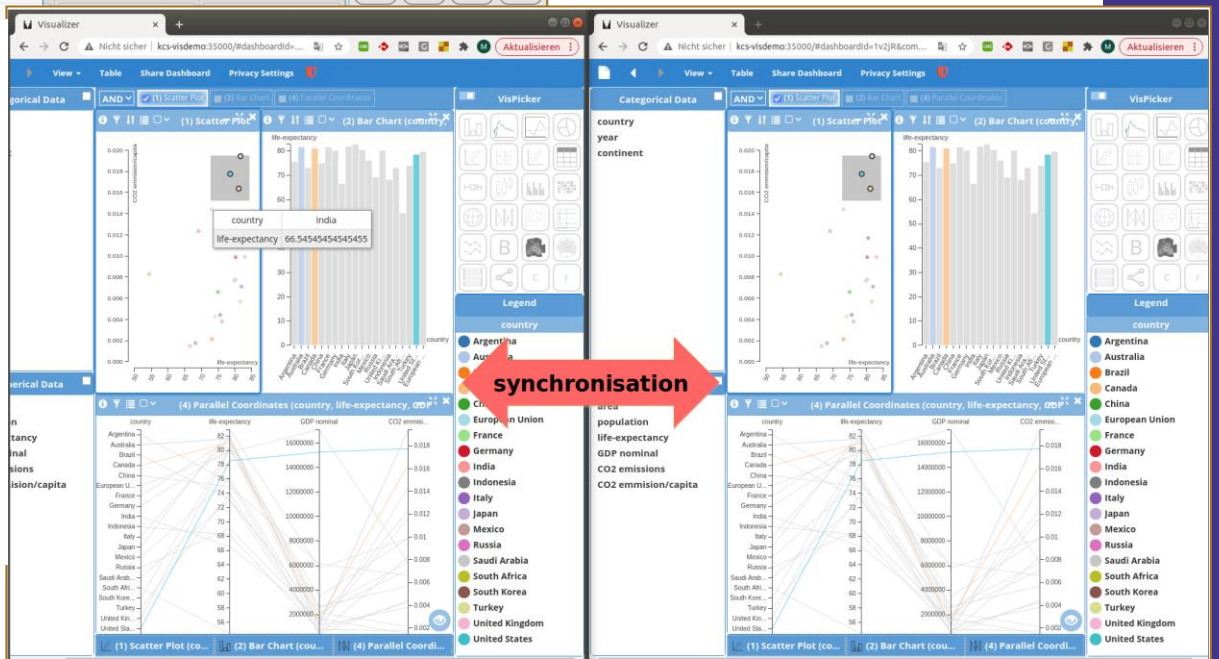
# EXPLORE SDA – S-Phot

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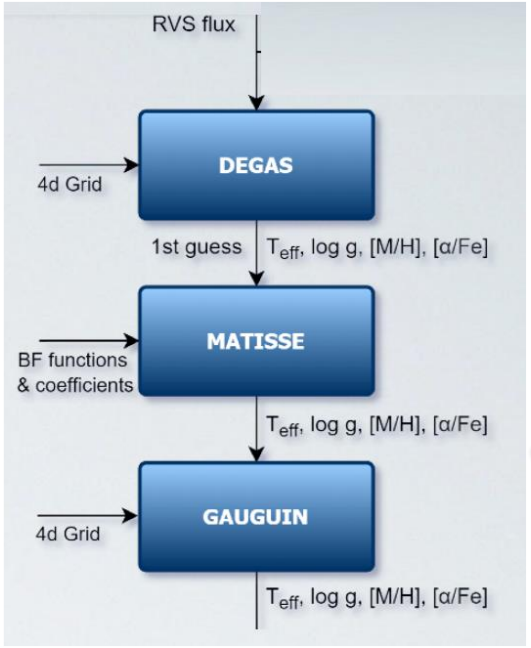
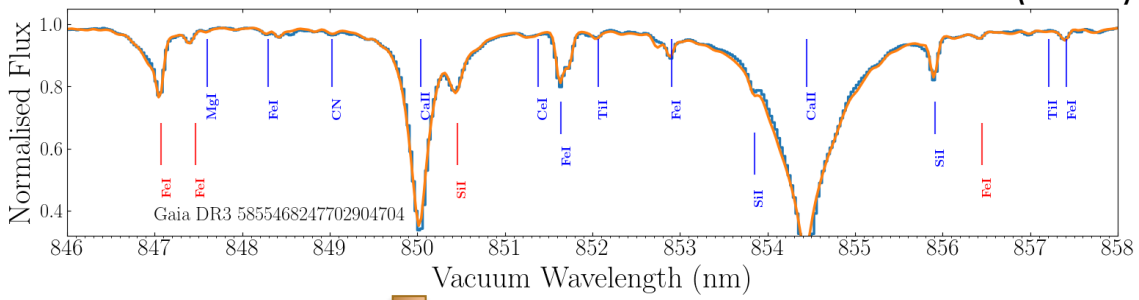
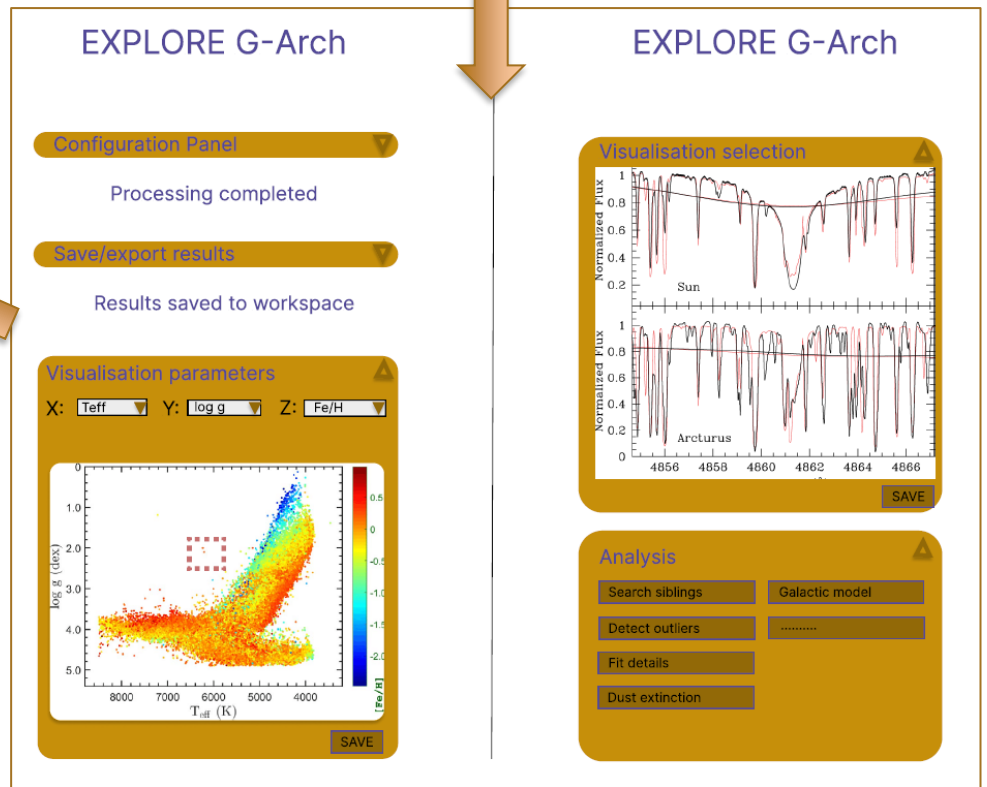
# EXPLORE SDA – G-Arch

Stellar parameter fit and abundance retrieval




From Recio-Blanco et al. (2022)




Work in progress:

- Spectral similarity finder
- Inference of parameters for "Failed Fits"

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# Invitation to join as beta user and get early access

- Looking for few extra beta users for each SDA
- In-person at EAS on June 29th (afternoon)
- Contact us at contact@explore-platform.eu

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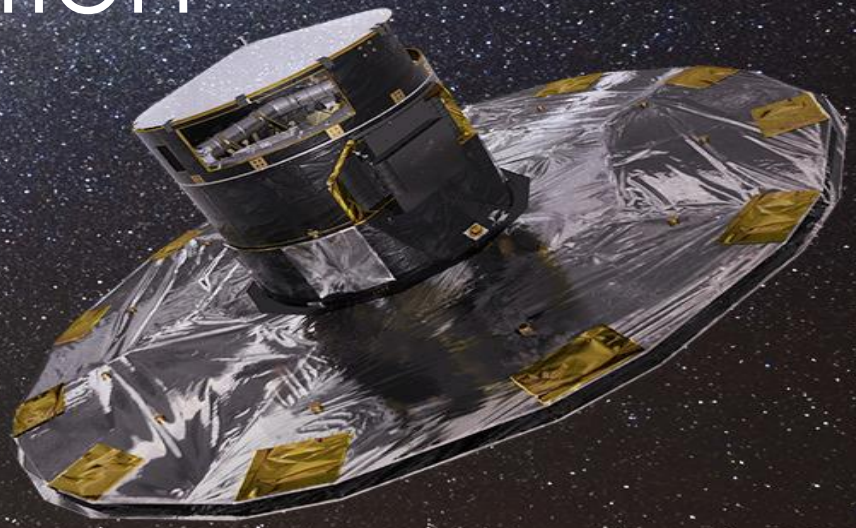
# Thank you for your attention

More info on:

explore-platform.eu

Get in touch:

contact@explore-platform.eu



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