Innovative Scientific Data Exploration and Exploitation Applications for Space Sciences

User manual for SDAs G-Arch and G-Tomo

(D3.3)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement No 101004214

Info Sheet

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Document Revision History

Version	Author	Reason of change	Section(s)
1.0	OCA, ACRI-ST, KNOW	First version	All

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1. Introduction

1.1. Purpose and Scope

This document is the User Manual for the G-Arch and G-Tomo scientific data applications (SDAs) developed by the EXPLORE project. The document is structured as follows:

- Chapter 1 – Introduction (this chapter)
- Chapter 2 – EXPLORE and its scientific Data Applications
- Chapter 3 – User Manual G-Arch
- Chapter 4 – User Manual G-Tomo

1.2. Applicable and Reference Documents

1.2.1. Applicable Documents

Table 1: Applicable documents

Title	Description
[AD-1]	Grant Agreement 101004214 — EXPLORE
[AD-2]	Consortium Agreement – EXPLORE
[AD-3]	Prototype SDAs G-Arch and G-Tomo (D3.1) - EXPLORE
[AD-4]	SDAs G-Arch and G-Tomo (D3.2) - EXPLORE

1.2.2. Reference Documents

Table 2: Reference documents

Title	Description
[RD-1]	Recio-Blanco, A., de Laverny, P., Palicio, P.A. et al. 2023, A&A, 674, 29
[RD-2]	de Laverny, P., Recio-Blanco, A., Worley, C. C. et al. 2012, A&A, 544, 126
[RD-3]	Santos-Peral, P., Recio-Blanco, A., de Laverny, P., Fernández-Alvar, E., & Ordenovic, C. 2020, A&A, 639, A140
[RD-4]	Guiglion, G., de Laverny, P., Recio-Blanco, A. et al., 2016, A&A, 595, 18
[RD-5]	Gaia Collaboration, Recio-Blanco et al. 2023, A&A, 674, 38
[RD-6]	Spitoni, E.; Recio-Blanco, A.; de Laverny, P. et al. 2023, A&A 670, 109
[RD-7]	Lallement, R., Vergely, J.-L., Babusiaux, C., Cox, N.L.J., 2022, A&A, 661, A147 (arxiv:2203.01627)
[RD-8]	Vergely, J.-L., Lallement, R., Cox, N.L.J., 2022, A&A, 664, A174 (arxiv:2205.09087)
[RD-9]	Spitoni, E.; Aguirre Børsen-Koch, V., Verma, K., Stokholm, A., 2022 (in press A&A) arXiv:2204.07597

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[RD-10]	Cox, N.L.J., Vergely, J.-L., Lallement, R., submitted
[RD-11]	EXPLORE Platform Software User Manual, available at https://explore-platform.eu/project/deliverables/ (folder "public")

1.2.3. Abbreviations and Acronyms

Table 3: Abbreviations and acronyms list

1D	One-dimensional
2D	Two-dimensional
3D	Three-dimensional
AI	Artificial Intelligence
CSV	Comma Separated Values
DIB	Diffuse Interstellar Band
DPAC	Data Processing and Analysis Consortium
DR3	Data Release 3
ESA	European Space Agency
FITS	Flexible Image Transport System
ISM	Interstellar Medium
LRO	Lunar Reconnaissance Orbiter
MCMC	Monte-Carlo Markov Chain
ML	Machine Learning
RVS	Radial Velocity Spectrograph
SDA	Scientific Data Application
TBI	To Be Implemented
UI	User Interface
WP	Work Package

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2. EXPLORE and its scientific Data Applications

EXPLORE's main objective is to deploy machine learning (ML) and advanced visualization tools to achieve efficient, user-friendly, realistic exploitation of scientific data from astrophysics and planetary space missions, as well as from supporting ground-based massive surveys. We focus on six different topics, each chosen for their timely importance and their complementary data structures. This diversity and complementarity is key to a future evolution and growth of the platform that is relevant and applicable to the broadest possible user-base within the research community.

Two of EXPLORE's topics are related to Lunar observation, two to Galactic Science and two to stellar characterization. For each of these topics, the state-of-the-art will be enhanced by introducing ML techniques and advanced visualization tools to support "Human Learning". For each topic, specific tools are created. These Scientific Data Application (or simply Apps) are developed on a dedicated cloud solution (the EXPLORE platform, https://explore-platform.eu).

The EXPLORE Apps are also made available on existing cloud platforms such as ESA Datalabs, close to the input data, and open to the community for direct exploitation-on-demand. The EXPLORE Apps are also used by the consortium to produce enhanced scientific datasets for space science mission exploitation, which will be stored in appropriate archives for public access. Datasets from Gaia and recent lunar (LRO, Clementine, Chandrayaan, etc) space missions are at the core of the EXPLORE project and are complemented with data from previous space missions as well as ground-based surveys.

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3. User Manual G-Arch

3.1. Introduction

The scientific objectives and functionalities of the G-Arch scientific data application (app) are described in D3.2 "SDAs G-Arch and G-Tomo" [AD-4].

G-Arch can be started from https://explore-platform.eu/sda/g-arch (login required - self-registration).

G-Arch currently allows to estimate the stellar chemo-physical parameters from combined Gaia RVS spectra of single stars. G-Arch uses the Matisse-Gauguin procedure described in Recio-Blanco et al. 2023 [RD-1].

3.2. Functionality and scope of G-Arch

G-Arch takes as input combined, radial velocity corrected, RVS spectra (averaged over multiple Gaia transits) over the 846-870 nm spectral domain. G-Arch reassesses the continuum placement during the parameterisation procedure. Moreover, the spectra are rebinned from 2400 to 800 pixels sampled every 0.03 nm (without reducing the spectral resolution thanks to the RVS oversampling), which increases their S/N. G-Arch performs a model-driven parametrization for which stellar flux dependencies on atmospheric parameters and surface chemical abundances are interpreted through the comparison of the observed spectra with theoretical ones as described in de Laverny et al. (2012) [RD-2] and Recio-Blanco et al. 2023 [RD-1].

G-Arch allows the user to estimate i) the stellar effective temperature, ii) the surface gravity), iii) the mean metallicity, iv) the abundance of alpha-elements with respect to iron, v) the individual abundances of different elements, depending on their detectability in the RVS spectra and vi) the goodness-of-fit (in logarithm) over the entire spectral range. In addition, G-Arch allows to perform simple tests of the impact of the analysis assumptions, such as normalization polynomial degree.

3.3. Starting G-Arch

G-Arch analyses RVS public spectra from the last Gaia data release (DR3). The choice of the dataset is performed through a list of Gaia source IDs that needs to be provided by the user. G-Arch outputs will be provided in the same order of the input source list.

3.4. Start screen / User Interface

Every time a new instance of G-Arch is started and launched in the browser it will open with the default view (Figure 12).

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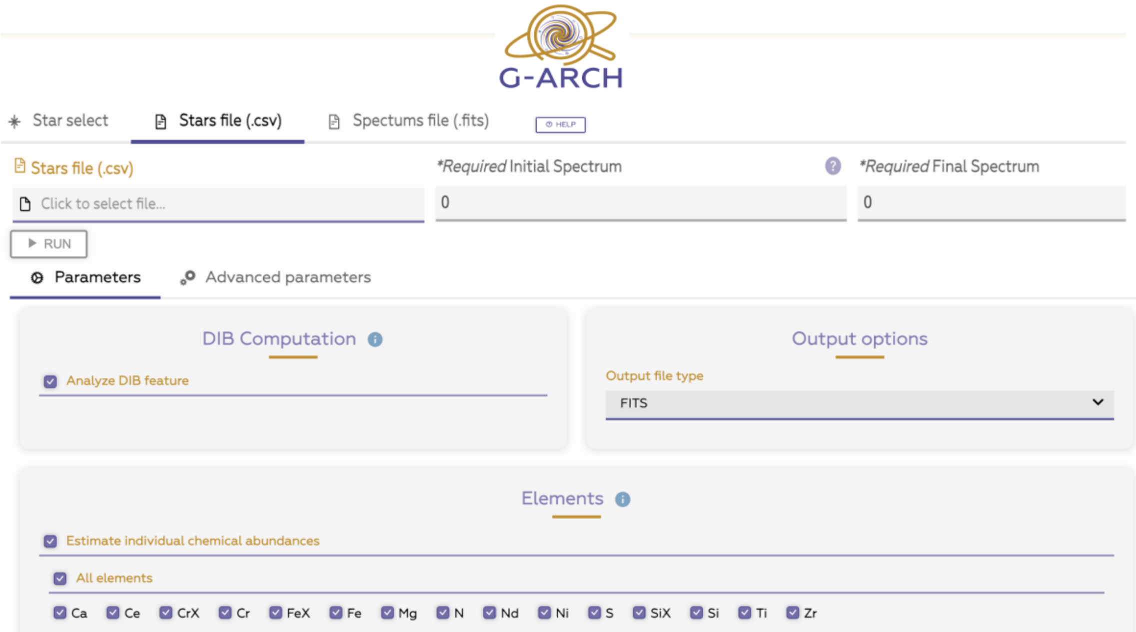

Figure 1. G-Arch user Interface: Start view.

3.5. Selection of input data

The input source list defines the Gaia DR3 source identifications whose RVS spectra must be analysed. The user has three options to do this:

i. To select individual Gaia DR3 sources by clicking on a list of sources (Fig. 2). The selected stars will progressively appear on the right side of the screen.

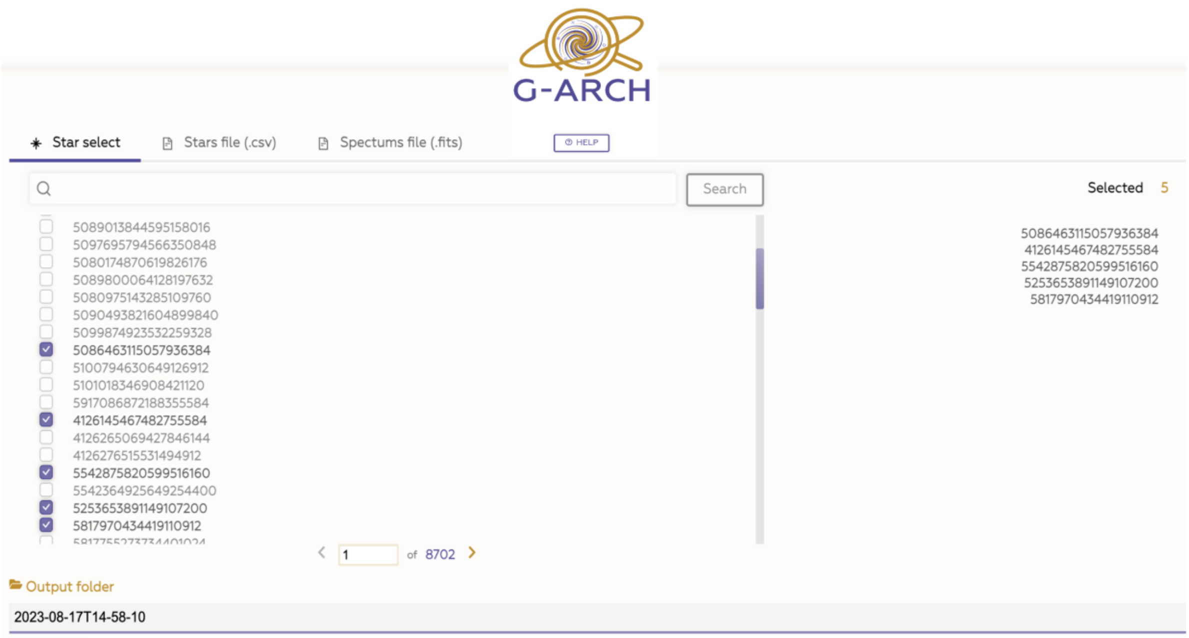

Figure 2. G-Arch User Interface: selection of sources from a proposed list of Gaia DR3 IDs.

ii. To upload a CSV file (Figure 3) file containing the list of desired Gaia DR3 IDs.

Figure 3. G-Arch User Interface: selection of sources uploading a file with the list of Gaia DR3 IDs.

iii. Same as option ii) but uploading the list from a FITS file.

3.6. Set-up of analysis options

Once the input source list is provided by the user, several analysis options can be specified (Figure 4).

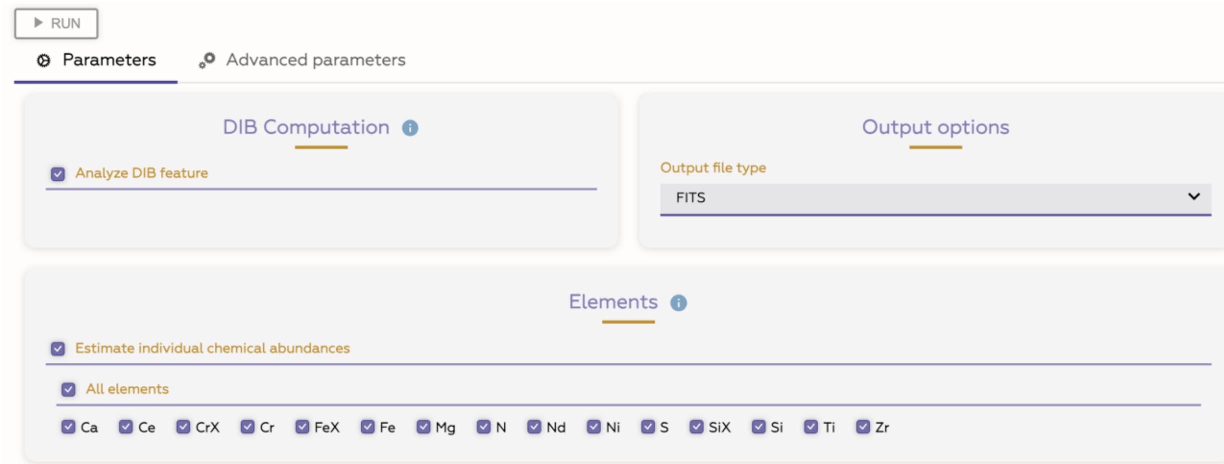

Figure 4. G-Arch User Interface: selection of basic analysis options.

In particular:

- The optional analysis of the RVS Diffuse Interstellar Band.
- The possibility of estimating the abundance of individual chemical elements and which elements (from a proposed list) the user wants to consider.
- The format of the output file

In addition, advanced users (Figure 5) can specify the following options:

- The number of Monte-Carlo realisations of the spectrum flux to estimate the parameter uncertainties.
- The continuum placement (normalization) procedure from, the order of the polynomial used to normalize the input spectrum and the number of iterations

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between the atmospheric parameter estimation procedure and the normalization one. Two proposed continuum placement procedures, AMBREproject1 and AMBREproject2, are proposed from Santos-Peral et al. 2020 [RD-3] and Guiglion et al. 2016 [RD-4], respectively.

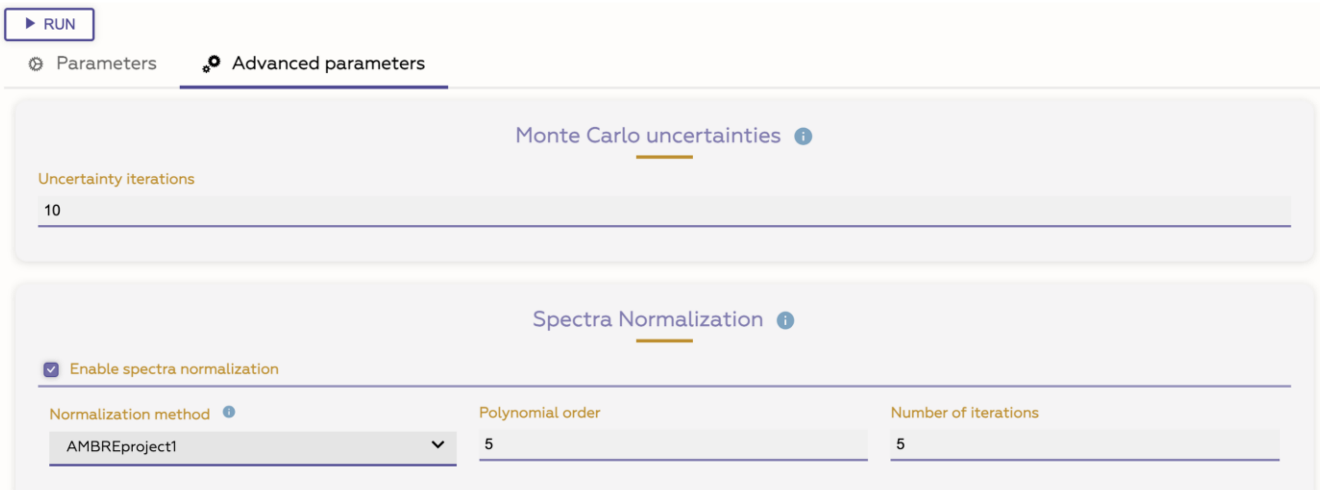

Figure 5. G-Arch User Interface: selection of advanced analysis options.

3.7. Run Matisse

Clicking on the "Run" button starts the spectral analysis. A screen showing the logs of the analysis on the fly is at the user disposal (Figure 6).

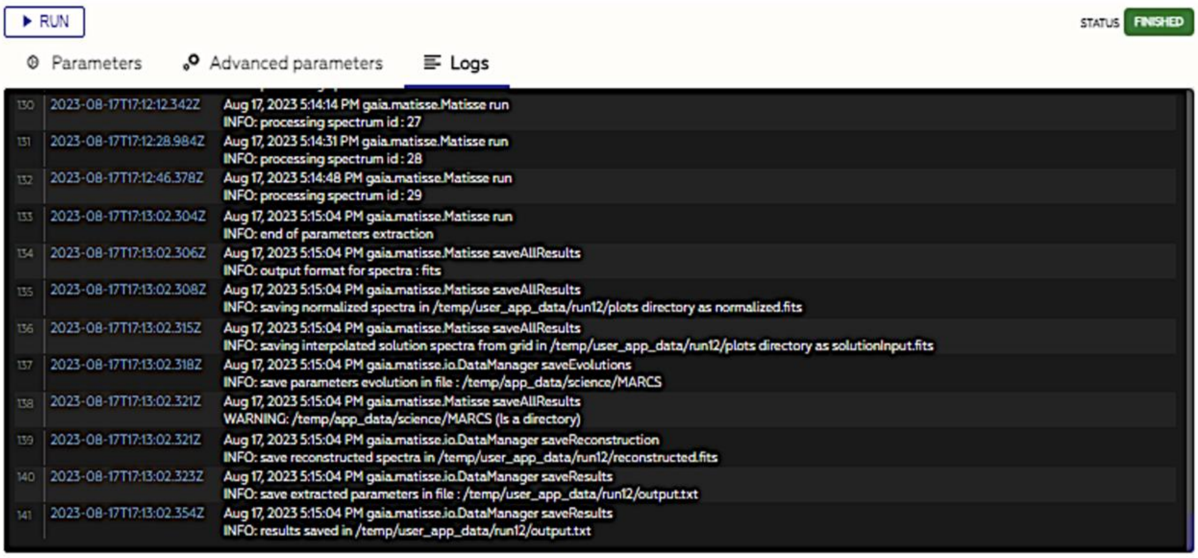

Figure 6. G-Arch User Interface: example of the "Logs" output during Matisse running.

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3.8. Visualisation of the output

3.8.1. Before finishing the analysis

A specific part, at the bottom of the G- Arch's UI is dedicated to the output. Before running the analysis, or before finishing it, the Output Folder (of the current run) is empty, and no plotting of the results is possible (Figure 7).

Note: user have access to all results from previous runs (either from the current session or past sessions).

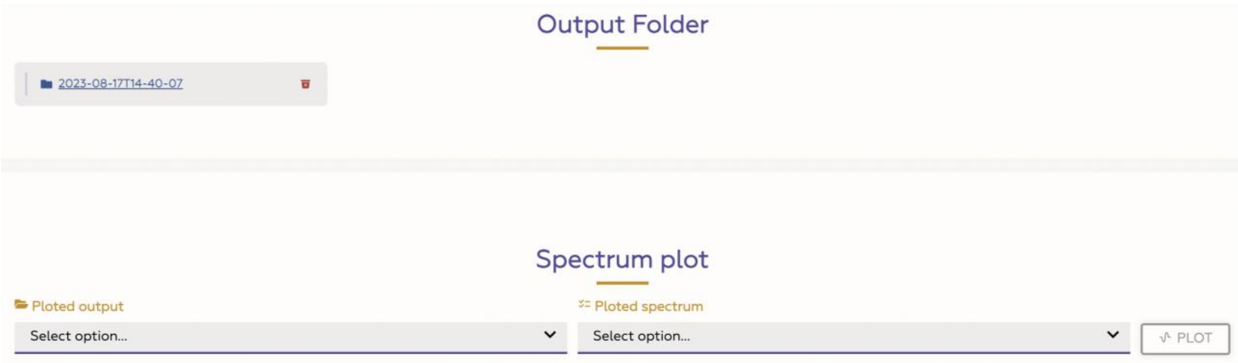
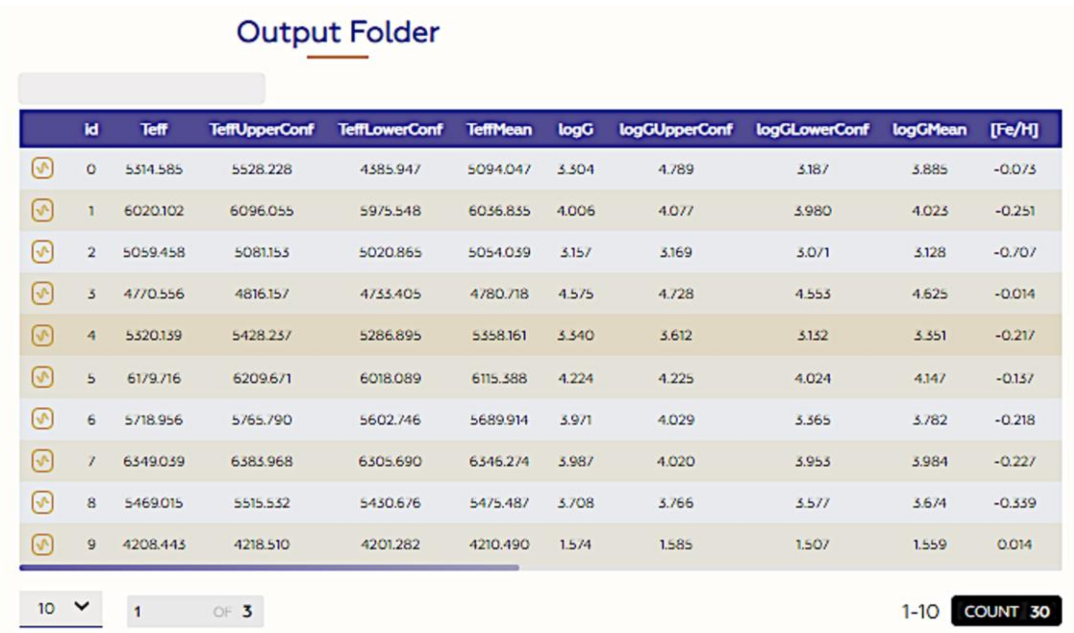


Figure 7. G-Arch User Interface: Output folder and visualization options before the end of the analysis.

3.8.2. The Output Folder

At the end of the analysis, the output folder can be visualized through the UI as in Figure 8. The number of displayed objects can be chosen by the user. In addition, a scroll bar allows the user to visualize all the output columns in a convenient way.



Output Folder

Id	Teff	TeffUpperConf	TeffLowerConf	TeffMean	logG	logGUpperConf	logGLowerConf	logGMean	[Fe/H]
0	5314.585	5328.228	4385.947	5094.047	3.304	4.789	3.187	3.885	-0.073
1	6020.102	6096.055	5975.548	6036.855	4.006	4.077	3.980	4.023	-0.251
2	5059.458	5081.153	5020.865	5054.039	3.157	3.169	3.071	3.128	-0.707
3	4770.556	4816.157	4733.405	4780.718	4.575	4.728	4.553	4.625	-0.014
4	5320.139	5428.237	5286.895	5358.161	3.340	3.612	3.132	3.351	-0.217
5	6179.716	6209.671	6018.089	6115.388	4.224	4.225	4.024	4.147	-0.137
6	5718.956	5765.790	5602.746	5689.914	3.971	4.029	3.365	3.782	-0.218
7	6349.039	6383.968	6305.690	6346.274	3.987	4.020	3.953	3.984	-0.227
8	5469.015	5515.532	5430.676	5475.487	3.708	3.766	3.577	3.674	-0.339
9	4208.443	4218.510	4201.282	4210.490	1.574	1.585	1.507	1.559	0.014

10 | 1 OF 3 | 1-10 COUNT 30

Figure 8. G-Arch User Interface: An example of the output folder, showing the atmospheric parameters of the first nine objects. A scroll bar allows the user to visualize further columns.

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3.8.3. Plotting and validating the results

To validate the results of the analysis, the UI allows the user to perform three types of visualizations:

i. *Kiel diagram (Teff vs. Logg):* Stellar evolution distributes stars in a particular way along the effective temperature (Teff) versus surface gravity (log g) plane. For this reason, this is a key validation plot allowing the user to verify the good quality of the results checking the existence of well-known evolutionary sequences as the Red Giant Branch or the Main Sequence (Figure 9). In addition, a third parameter from the output can be chosen as colour code by the user.

ii. *Evolution of [alpha/Fe] abundances with respect to metallicity:* Milky Way stellar populations have known dependences of their abundance of alpha-elements with respect to iron (see for instance Gaia Collaboration, Recio-Blanco et al. 2023 [RD-5] or Spitoni et al. 2023 [RD-6]. The [alpha/Fe] vs. [M/H] plot (Figure 10) allows the user to check the scientific validity of these abundances, but also to chemically classify the analysed objects as belonging to the halo or the disc, for instance. Finally, as for the Kiel diagram, a third parameter from the output can be chosen by the user as colour code.

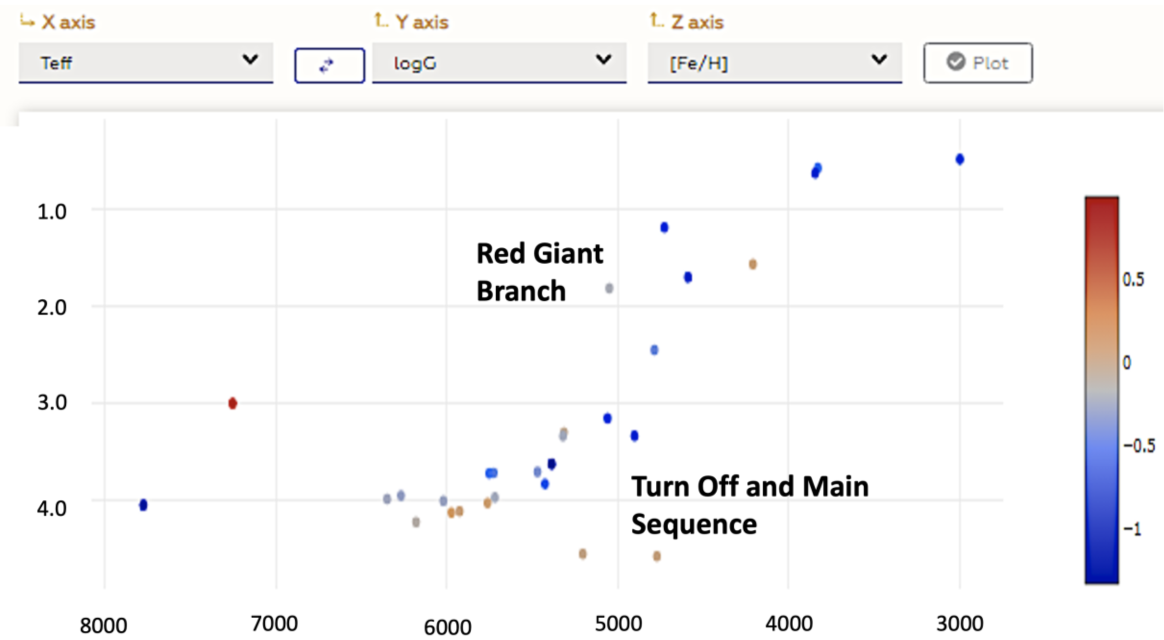

Figure 9. G-Arch User Interface: Kiel diagram output plot allowing to visualize and scientifically validate the estimated atmospheric parameters through the identification of stellar evolutionary sequences. The estimated stellar metallicity is used as colour-code.

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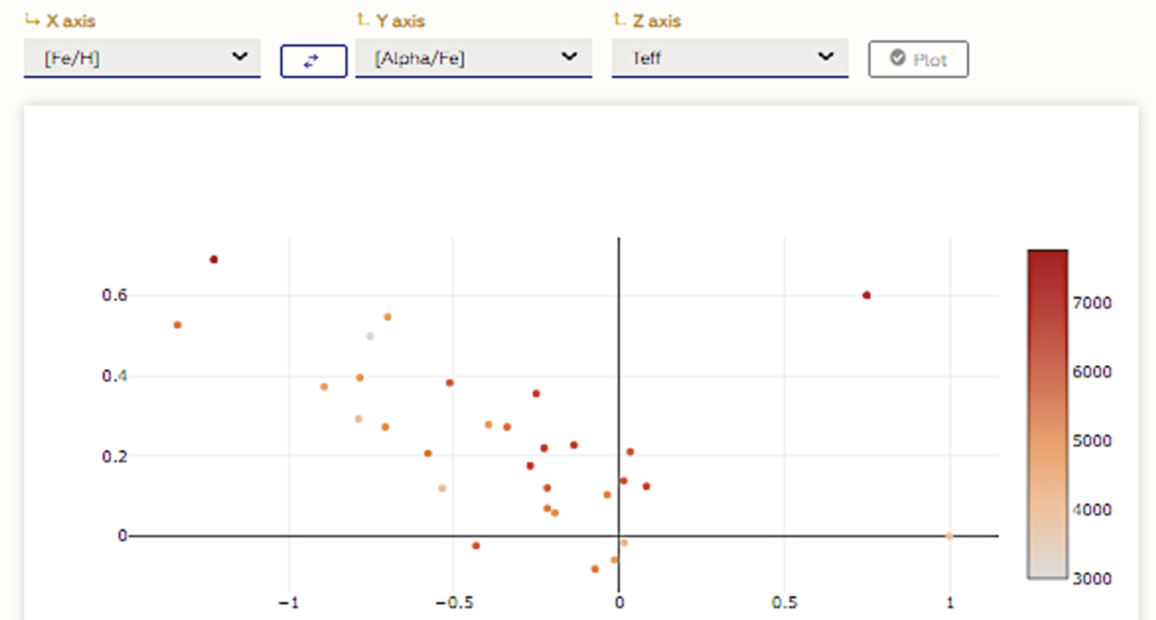

Figure 10. G-Arch user interface: plot of the evolution of the [alpha/Fe] abundances with respect to metallicity. The expected trend is found for metallicities lower than Solar (zero value on the x-axis). An outlier of the analysis can be identified at a metallicity of around 0.75 dex.

iii. *Fitting of the input spectra:* a synthetic (theoretical) spectrum corresponding to the output estimated parameters of each analysed star is produced by G-Arch. To verify the quality of the spectral fitting, and therefore of the output parameters, a plot allows to visualise both the input observed spectrum and the output synthetic one, that is supposed to reproduce it (Figure 11). The similarity between the two is quantified by the goodness-of-fit output column (logChi). The user can choose which spectrum to visualize from the input list by choosing its number (first column of the output file). The input spectrum is visualized both before and after the continuum normalization. This allows the user to verify the impact of the continuum placement operation.

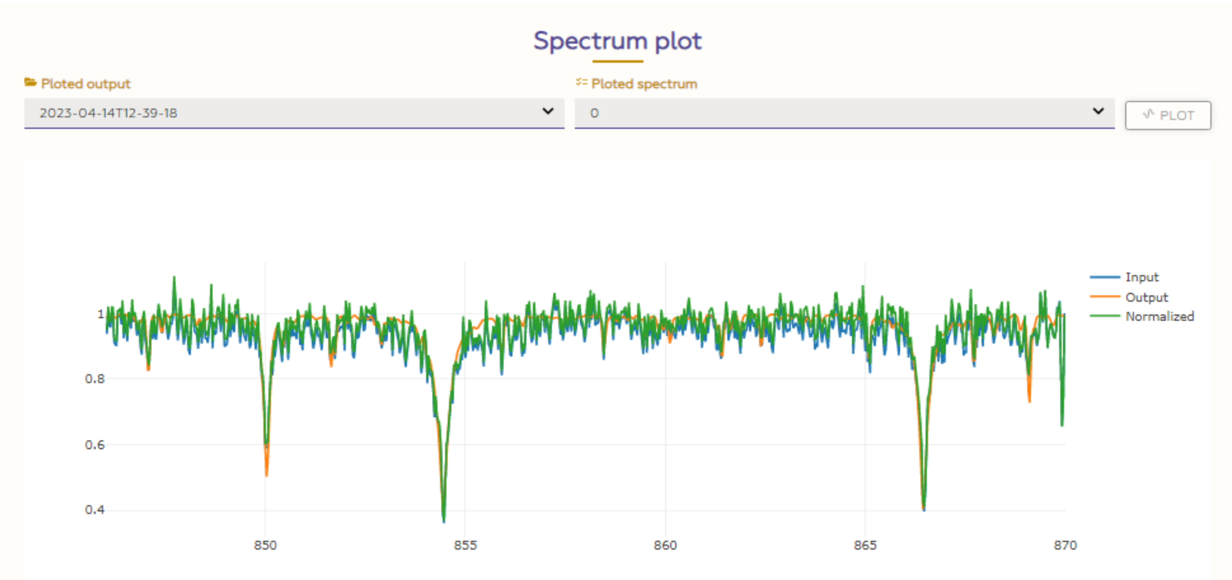

Figure 11. G-Arch user interface: plot of the first analysed spectrum (number 0) in the list (blue). The continuum normalized input spectrum is overplotted (blue). In addition, the output synthetic spectrum corresponding to the derived atmospheric parameters by Matisse is also shown in orange.

4. User Manual G-Tomo

4.1. Introduction

The scientific objectives and functionalities of the G-Tomo scientific data application (app) are described in D3.2 “SDAs G-Arch and G-Tomo” [AD-4].

G-Tomo can be started from https://explore-platform.eu/sda/g-tomo (login required - self-registration).

G-Tomo currently provides access to 5 different data cubes as listed below in Table 4. Two additional datasets (862.1 nm DIB and extinction density) are in preparation.

Table 4: Available datasets (extinction cubes) in G-Tomo. Two datasets are under preparation. The extent of the map is the distance from the centre (Sun) to the edge of the map (in the Galactic plan). For all cubes the height is limited to 400 pc above and below the Galactic plane.

Reference	Description	Extent	Sampling	Resolution	Size
Lallement et al. (2022)	Highest resolution (v1)	3 kpc	10 pc	25 pc	6 x 6 x 0.8 kpc
	Largest distance (v1)	5 kpc	20 pc	50 pc	10 x 10 x 0.8 kpc
Vergely et al. (2022)	Highest resolution – smallest extent (v2)	1.5 kpc	5 pc	10 pc	3 x 3 x 0.8 kpc
	Medium resolution - medium extent (v2)	3 kpc	10 pc	25 pc	6 x 6 x 0.8 kpc
	Lowest resolution - largest extent (v2)	5 kpc	20 pc	50 pc	10 x 10 x 0.8 kpc
Cox et al. (2023)	*DIB density*	*Tbc*	*Tbc*	*Tbc*	*tbc*
	Extinction density	*Same as DIB density map*	*Same as DIB density map*	*Same as DIB density map*	*Same as DIB density map*

The input data and the algorithms and methodology used for the 3D reconstruction of 3D dust extinction and DIB abundances are describe in detail in Lallement et al. (2022) [RD-7], Vergely et al. (2022) [RD-8], and Cox et al. (2023) [RD-10].

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G-Tomo is a browser-based web application. It is available on different science analysis/exploitation platforms. Each of these platforms have their own interface and process to search for, and run, applications. We refer the user to the information provided by the respective platforms. For the EXPLORE platform information is available at [RD-11]. It is noted that G-Tomo can also be run locally (from source code available on the GitHub repository).

4.2. User Interface

4.2.1. Initial view

Every time a new instance of G-Tomo is started and launched in the browser it will open with the default view (Figure 12). This is the starting point to select a specific G-Tomo service.

Figure 12. User Interface: Start view.

G-Tomo offers 3 operational services. Two additional services are in beta and will be available soon (more information below).

Table 5: Available services in G-Tomo.

Service	Description
Extinction profiles	Extraction and visualisation of differential and cumulative extinction profiles to astrophysical objects. Targets can be entered individually (coordinate or target name) or a list of target coordinates/names can be uploaded.
Integrated extinction	Total integrated extinction towards a list of targets (provided by the user) is computed. Requires users to provide a distance for each object.
Extinction maps	Extract and visualise 2D slices from the 3D cube.
*Volumetric viewer**	*Extract and visualise 3D sub-cubes from the main 3D cube for volumetric rendering.*
*Sky map extinction**	*Computation and visualisation of the integrated extinction in the plane of the sky. User provides a min and max distance between which the integrated extinction is computed.*

* *Internal beta-testing, to be released soon.*

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Each service can be accessed by clicking on the associated tab. An additional tab labelled "Information" directs the user to additional information on G-Tomo and its available services and datasets.

4.2.2. Selecting different cubes

As noted above, G-Tomo provides access to different datasets for interstellar extinction and DIB carrier density distributions. Any of the datasets (cf. Table 4) can be selected using the pull-down menu in the top-right of the G-Tomo screen (Figure 13). Users can easily switch between datasets and run each service on the selected data. This allows exploring details in the different maps each of which have their specific pros and cons.

Figure 13. User Interface: data selection dropdown.

Higher resolution maps are recommended for users interested in detailed structures in the galactic dust distribution relatively close to the Sun. Larger maps are most useful to understand larger structures in the Galactic dust distribution traced to further distances from the Sun (the accuracy of small-scale structures is less).

4.3. 1D extinction profiles (differential and cumulative)

The initial view of the "Extinction profiles" service is shown in Figure 14. It consists of two main areas. On the left is the "input" panel, on the right the "output" panel.

The input panel has two tabs: "Single Target" and "Bulk Upload". These input forms are to retrieve line-of-sight extinction profiles for single objects or for list of user-provided objects (by file upload). The use of both options is explained in the following sections.

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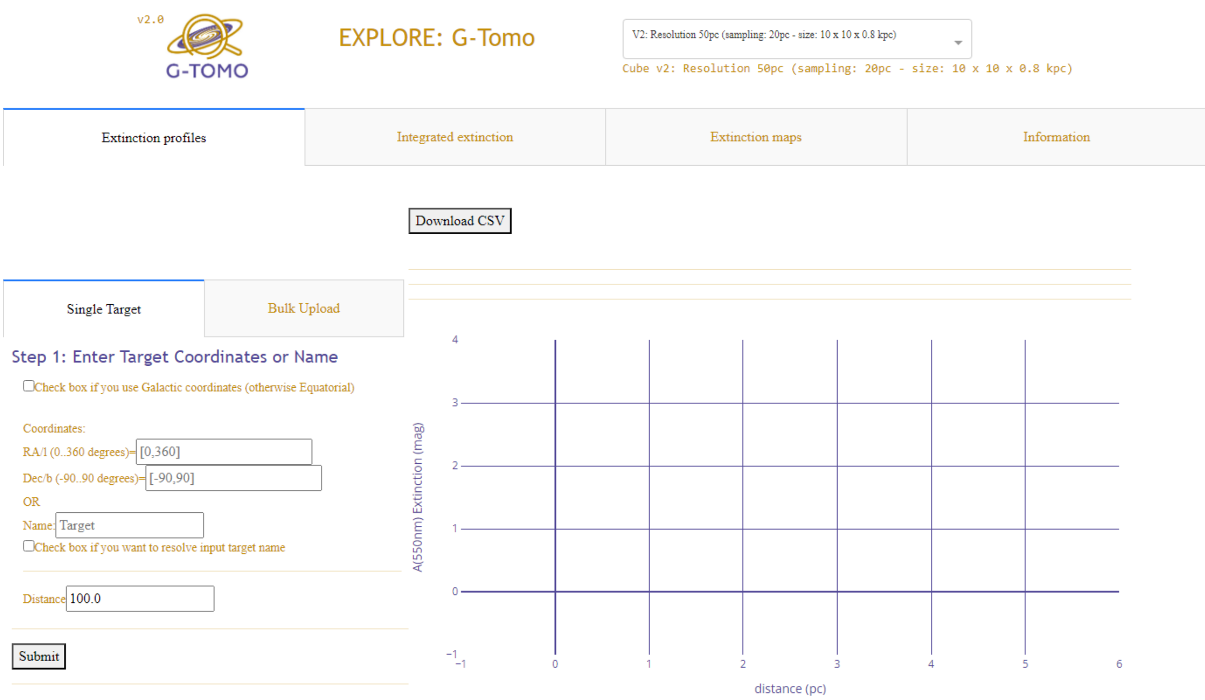

Figure 14. Extinction profile service.

4.3.1. Single object

Step 1.

To extract the line-of-sight extinction (both differential and cumulative) enter the sky coordinates of your line-of-sight (❶) or the object name (❷). The object name is resolved by the Simbad service. Check box (❸) to use the target name as input. By default input coordinates are Equatorial (J2000). If you wish to input galactic coordinates check the box (❹).
Finally, you can input a distance (optional) which will display a circle on the cumulative plot at that distance (if you hoover on this circle, it will display the values).
If you have entered your input, click the submit button (❺) to request your data.
Two example inputs are shown in Figure 16.

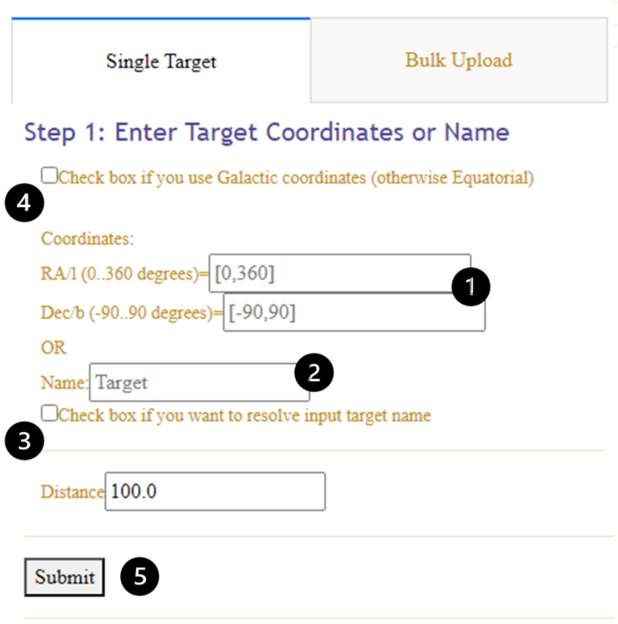

Figure 15. Single target input form.

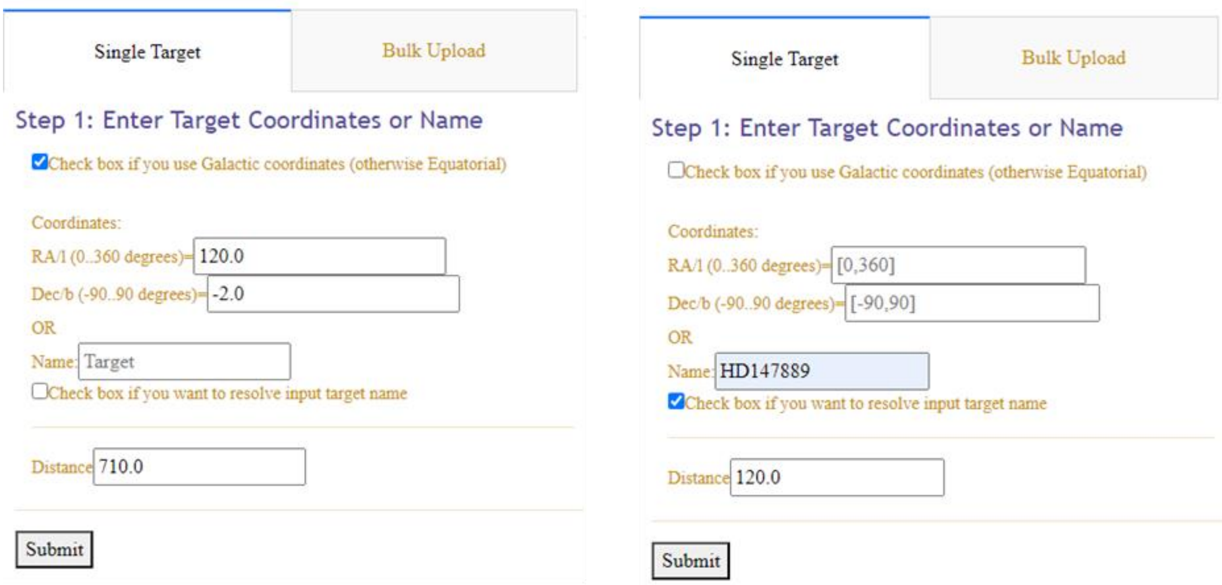

Figure 16. Example inputs: Galactic coordinates (left) and target name (right).

Step 2.

To plot the extract 1D profile, select your object from the pull-down menu (❶; Figure 17). This will update the right panel plot window as shown in Figure 18 for target HD147889. Figure 19 shows an example result for the same line-of-sight but using the higher resolution dataset.

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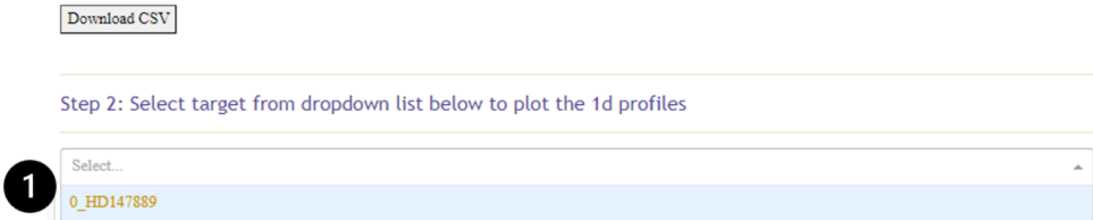

Figure 17. Select target for plotting.

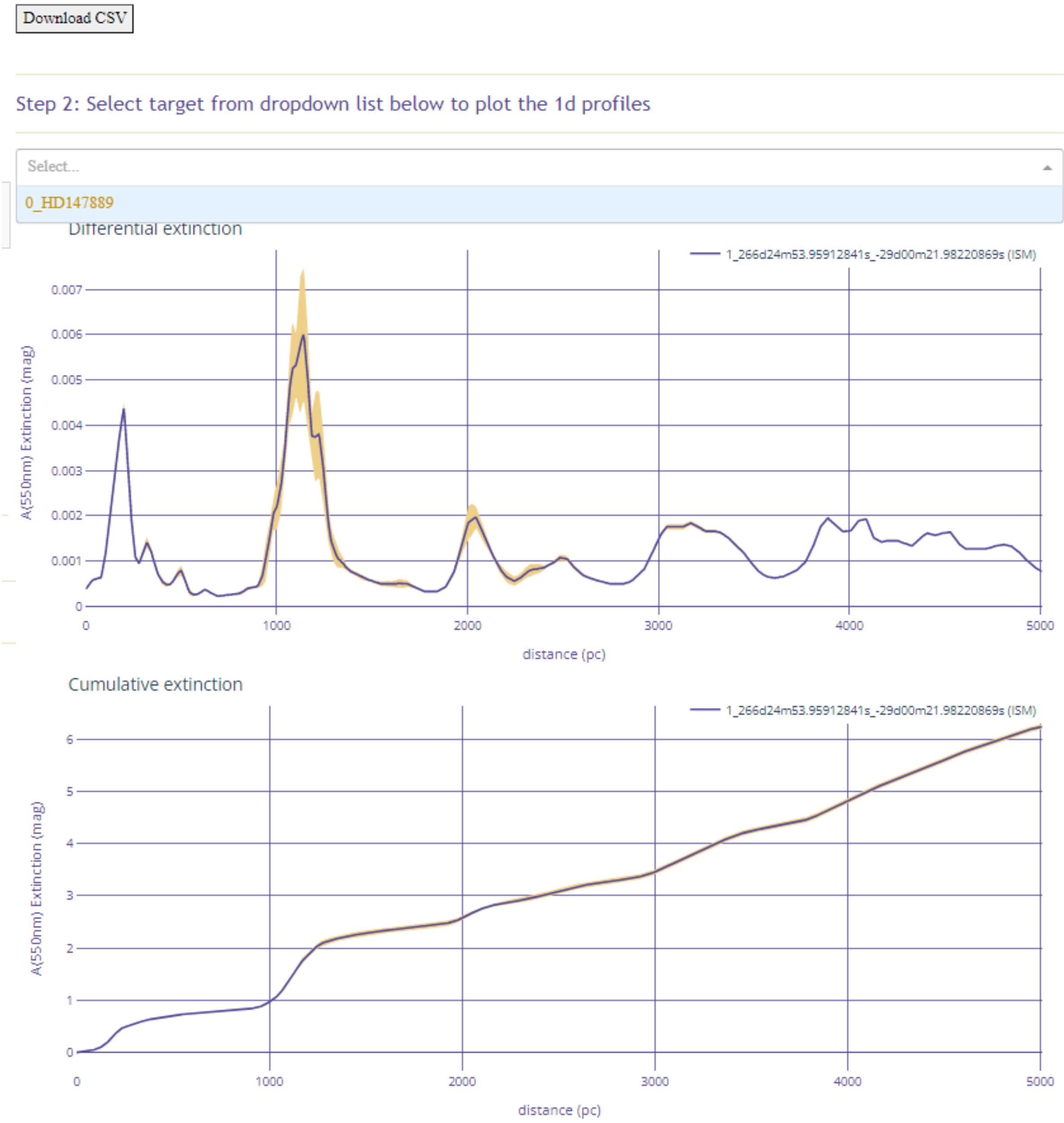

Figure 18. Line-of-sight profiles for the selected object.

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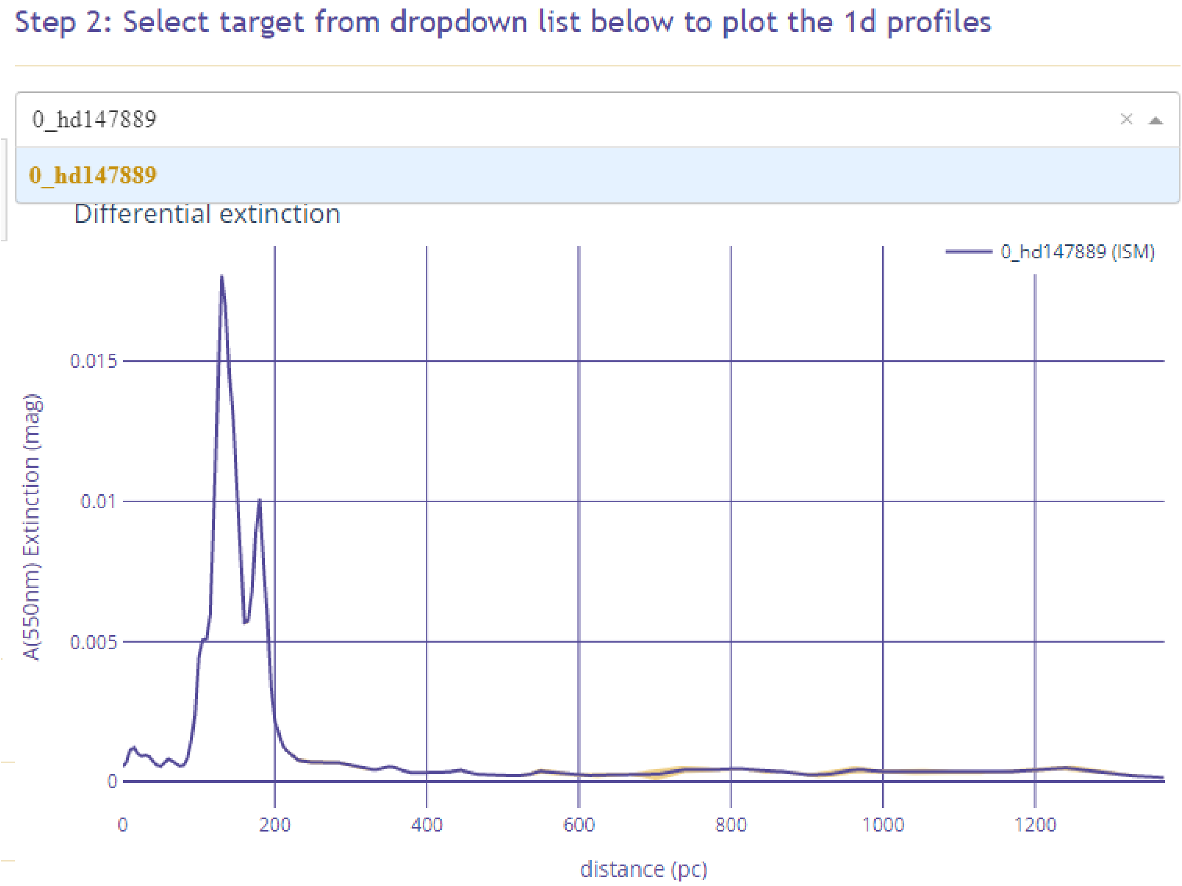

Figure 19. 1D profile for HD147889 using a higher resolution dataset compared to Figure 18.

Note: Irrespective of entering coordinates or object name the 1D profile will always show the entire line-of-sight profile from the centre of the cube (i.e. the position of the Sun) up to the edge of the cube in that direction.

4.3.1.1. Save the results

The 1D profiles can be downloaded by clicking the "Download CSV" button located just above the target selection dropdown menu (see e.g. Figure 17). The output file includes both differential and cumulative profiles as well as the uncertainties.

4.3.2. Multiple objects

Step 1.

To generate 1D profiles for a list of sightlines you need to prepare a CSV file. Example CSV files can be downloaded via the "Information" tab. Basic examples are shown in Table 6 and Table 7.

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Table 6. Example CSV "coord.csv" (input coordinates).

```
l, b
209.0137, -19.3816
359.94487, -00.0439
121.174, -21.5733
```

Table 7. Example CSV "targets.csv" (input target names)

```
targets
HD37022
4U1907+09
Polaris
```

Once the CSV files are prepared, they can be uploaded (❶). The user needs to alert the service if the input is a list of galactic coordinates (❷) or a list of target names (❸). If none of the boxes are checked a list of equatorial coordinates is assumed. The uploaded file is parsed, and the result shown in a table below the input form (Figure 21). If the input file is parsed correctly, you can click submit (❹) to retrieve the 1D profiles for your sightlines.

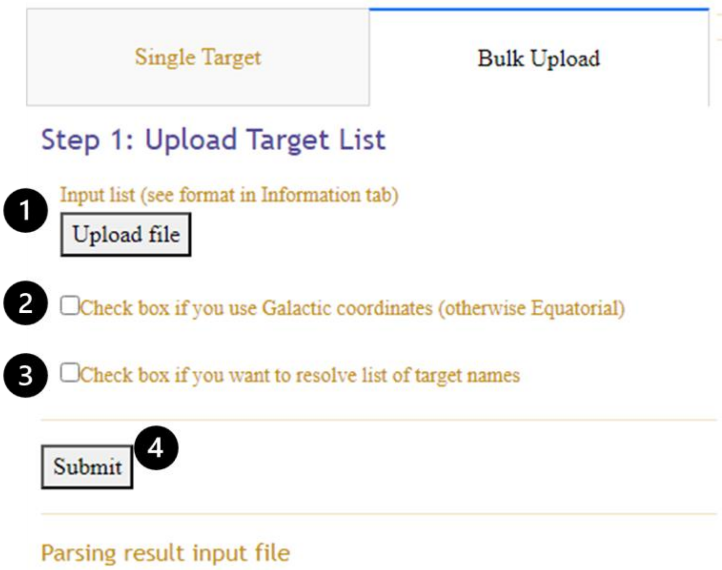

Figure 20. Bulk upload input form.

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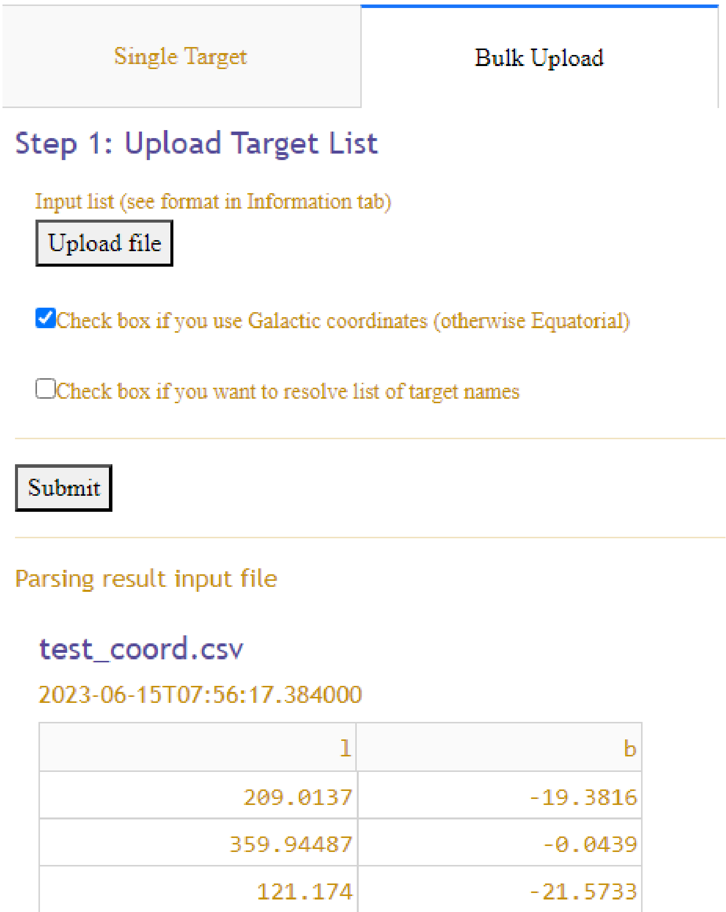

l	b
209.0137	-19.3816
359.94487	-0.0439
121.174	-21.5733

Figure 21. Result of parsing the input CSV.

Step 2.

To plot the extracted 1D profiles, select your object from the pull-down menu (Figure 22). This will update the right panel plot window as shown in Figure 23.

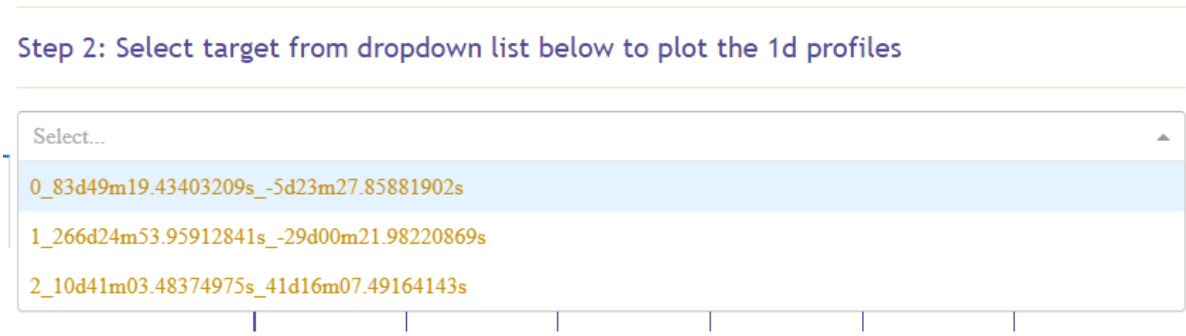

Figure 22. Target selection (Step 2) following bulk upload.

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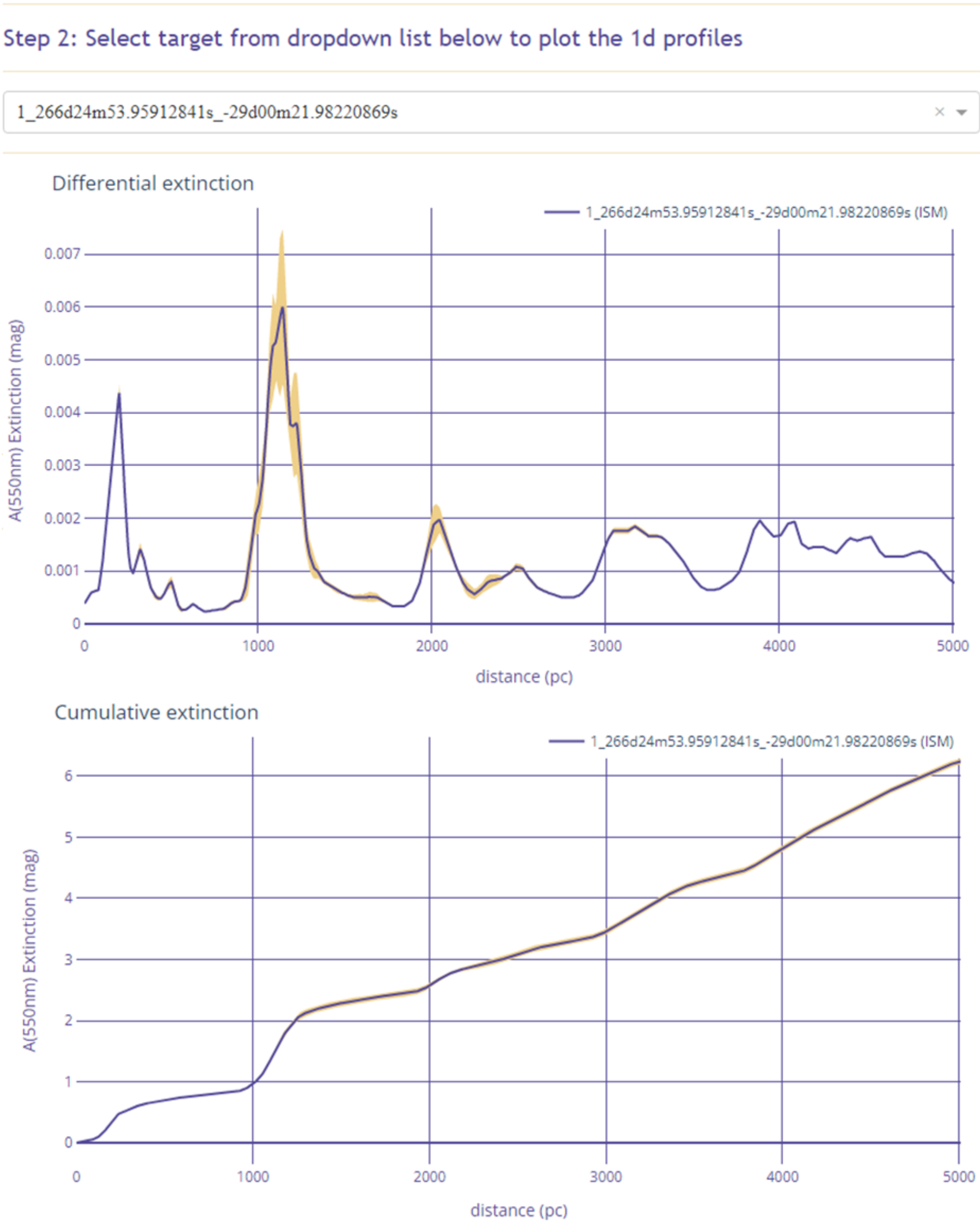

Figure 23. Extinction profiles for target "1" from the bulk upload service is plotted.

4.3.2.1. Save the results

The 1D profiles can be downloaded by clicking the "Download CSV" button located just above the target selection dropdown menu (see e.g. Figure 17). The output file includes both differential and cumulative profiles as well as the uncertainties for each of the input targets (in the order of the input file).

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4.4. Integrated extinction

The G-Tomo service "Integrated extinction" is access by selecting the corresponding tab (Figure 24).

Contrary to the "Extinction profile" service this service only provides integrated extinction values for a list of sky positions (input coordinates + distances). It is well suited to extract extinction values for 100s to 10,000s of targets.

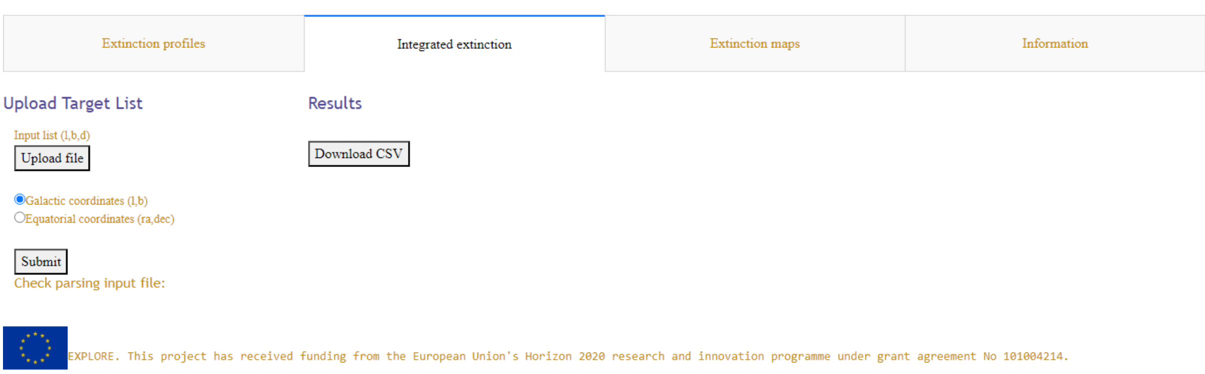

Figure 24. Initial view "Integrated extinction" service.

To obtain integrated visual extinction please provide a list of input coordinates together with distances. The format is illustrated in Table 8.

Table 8. Example CSV "lbd.csv" (input coordinates + distances).

```
l, b, d
0.0, 0.0, 1500.0
10.0, -5.0, 100.0
270.0, 1.5, 341.0
```

Once prepared the CSV can be uploaded using the "Upload file" button. The file read and the parsed result is shown in a table below the input form (Figure 25).

To start the computations click on "Submit". Depending on the number of coordinates in the input list the processing can take from several minutes to several hours.

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Upload Target List

Input list (l,b,d)

Upload file

Galactic coordinates (l,b)
Equatorial coordinates (ra,dec)

Submit

Check parsing input file:

test_lbd.csv

2023-06-15T07:55:31.496000

l	b	d
0	0	1500
10	-5	100
270	1.5	341

Figure 25. Integrated extinction. Upload and parsing of target list.

Once completed the results are shown in a table on the left of the input form (Figure 26). Results can be downloaded ("Download CSV") or exported to the EXPLORE user workspace ("Export").

Results

Download CSV
Export

ra	dec	dist	ext	exterr
266.4049882865447	-28.936177761791473	1500	2.28887	0.05336
276.67453101478606	-22.655813778220043	100	0.06515	0.00199
139.61375882748231	-47.28946989214116	341	0.12395	0.00088

Figure 26. User Interface: result. Table preview. Export/save.

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4.5. 2D extinction maps

The 2Dd extinction map service is access through the corresponding tab "Extinction maps". The initial view, showing the input form, of the 2D map service is shown in Figure 27.

To extract a 2D slice from the 3D data cube you are required to provide two coordinate sets:

1. Spherical coordinates of the map origin
   - Longitude of the origin
   - Latitude of the origin
   - Distance of the origin
2. Polar coordinates of the direction defining the normal to the plane of the image
   - Longitude of the normal
   - Latitude of the normal

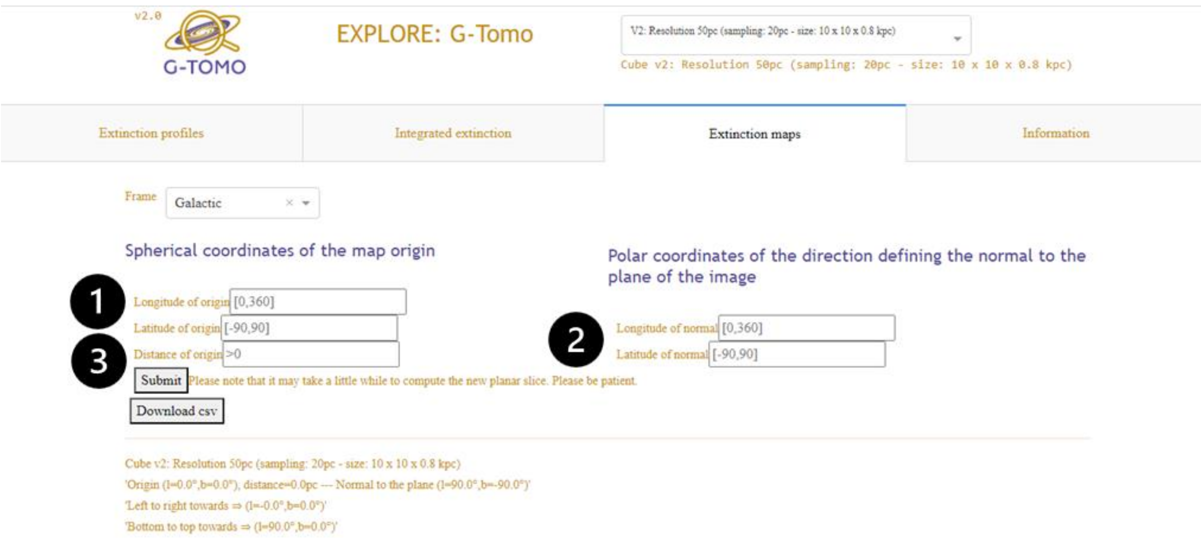

Figure 27. User Interface: 2D slicing input parameters.

Two example inputs and corresponding outputs are shown in Figure 28 and Figure 29. In the first case we request a slice along the galactic plane. The origin is set to zero, corresponding to the position of the Sun. The latitude of the normal is set to 90 degrees, indicating to take a "horizontal" slice from the cube. In the second case, still with the Sun at the origin, we set the longitude and latitude of the normal to 45 degrees, resulting in a thin slice.

Note: You can change the data cube selection to create maps of different extent and resolution (Figure 30).

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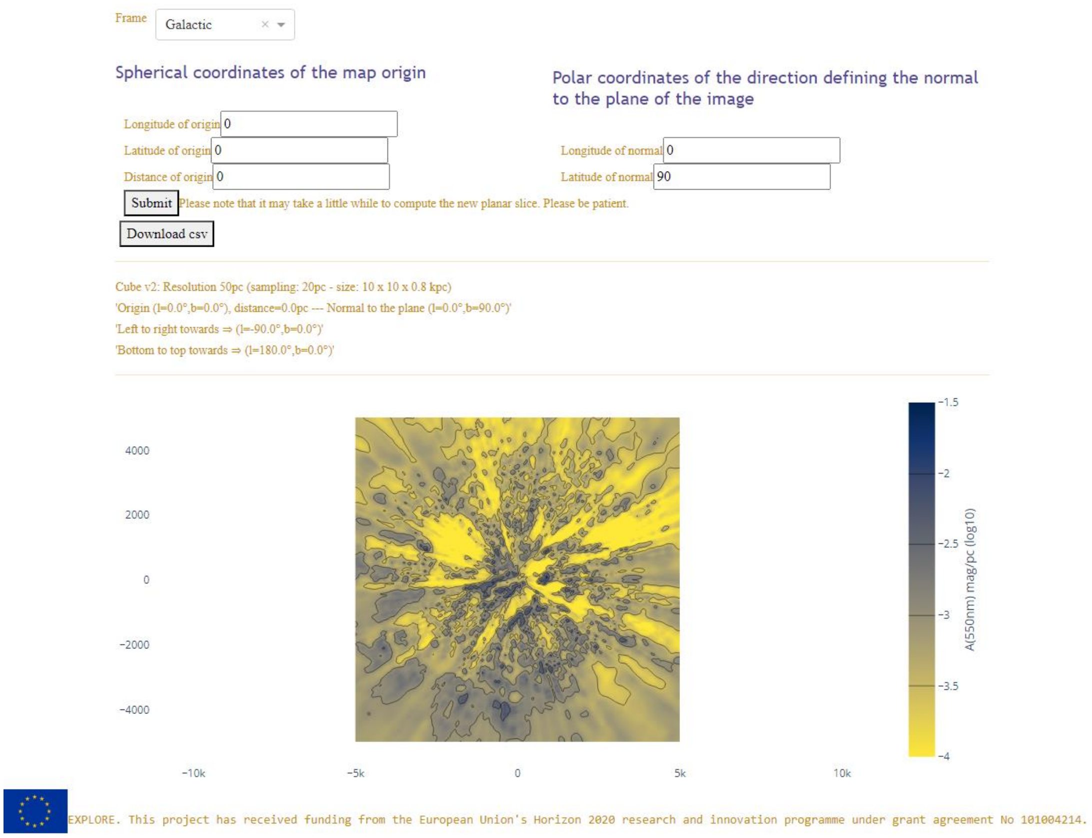

Figure 28. 2D map service result. Slice through the galactic plane.

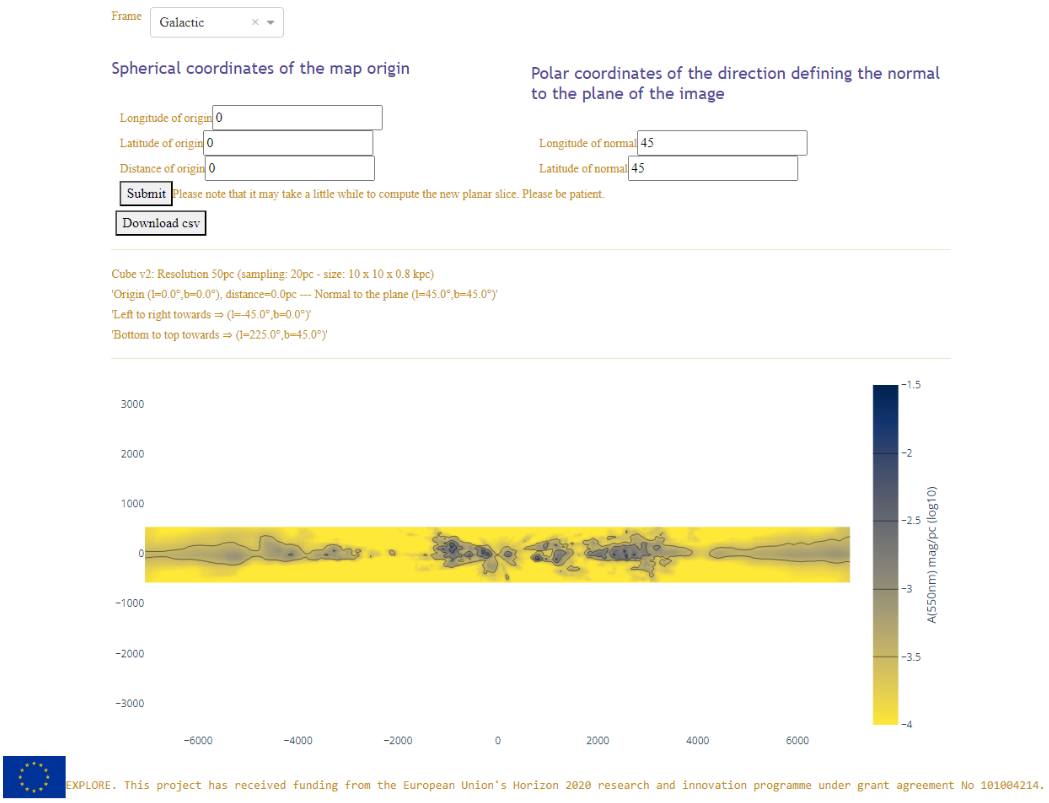

Figure 29. 2D map service result: map perpendicular to the galactic plane.

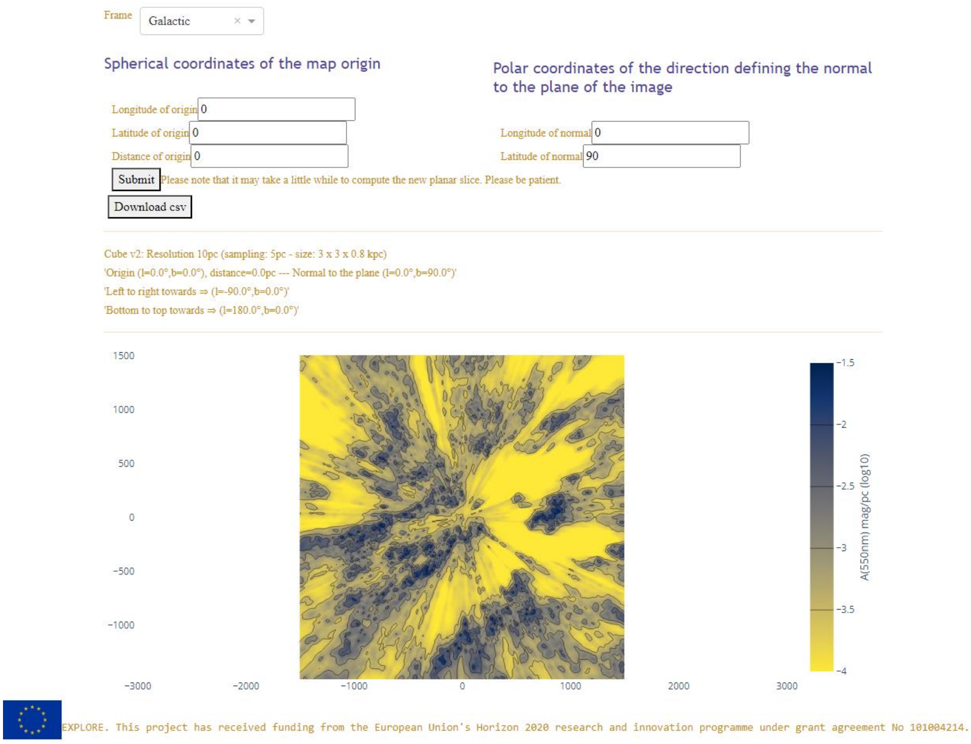

Figure 30. 2D map service: galactic plane slice using the high resolution dataset.

Tip 1: For horizontal maps, if increasing longitudes are not in the right sense then the solution is to map again using an opposite latitude for the vector perpendicular to the image.

Tip 2: In case the view is not correct (e.g., view from above or below for maps parallel to the plane) try to invert the perpendicular. For the map parallel to the plane this will change the view from above or below.

4.5.1.1. Map interaction

The 2D maps are interactive (Figure 31). You can zoom in on specific regions. On hoovering the tooltip provides information on exact coordinates.

Note: maps are displayed in log10(mag/pc) units.

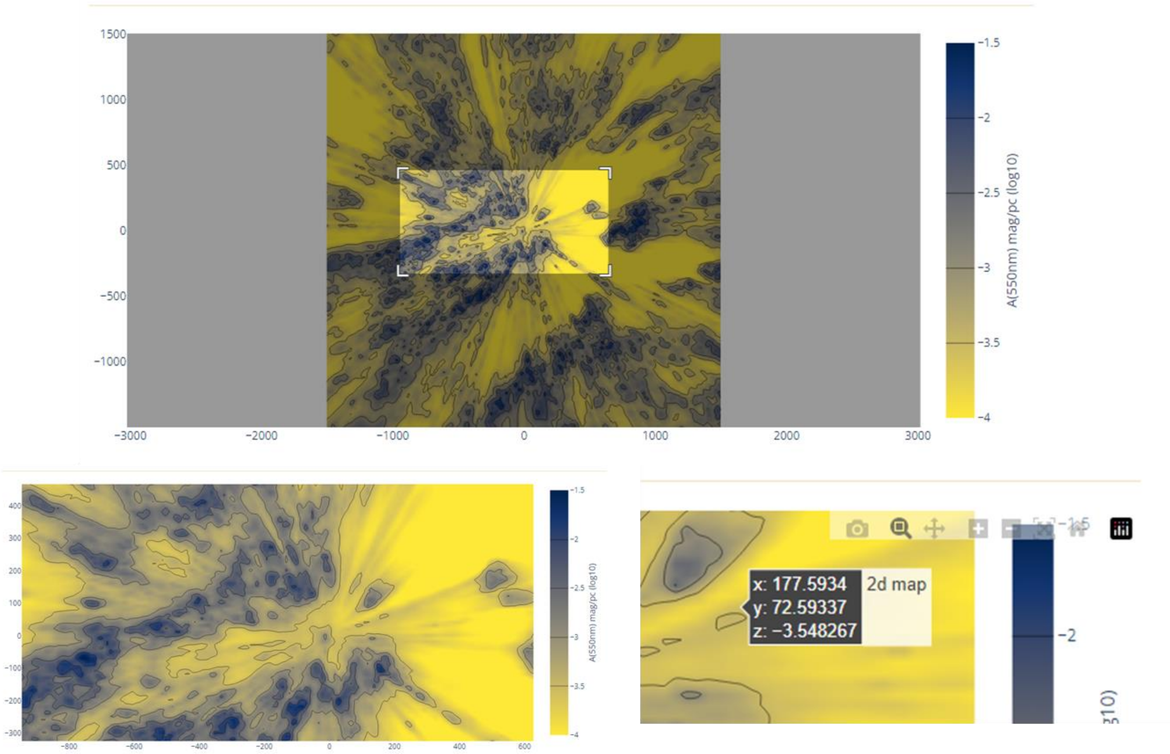

Figure 31. Interactive 2D plot. Zoom in/out. Moving the mouse cursor over a data point (hovering) reveals additional information..

4.5.1.2. Save the results

The plotted 2D map can be downloaded as a CSV file via the “Download csv” button located directly below the “Submit” button.

The 2D export CSV file contains 3 columns: X, Y, Z, where X and Y form the 2D plane and Z gives the log10 extinction value in the XY-plane.

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4.6. 3D visualisation (beta-testing)

The 3D-visualisation and annotation service has five (5) areas for user interaction.

1. Sub-cube selection
2. 3D rendering
3. Slicer
4. 2D density map
5. Annotations

The initial view is shown in Figure 32. By default a sub-cube of 1000 x 1000 x 400 pc, centred on the Sun position (distance = 0), is rendered.

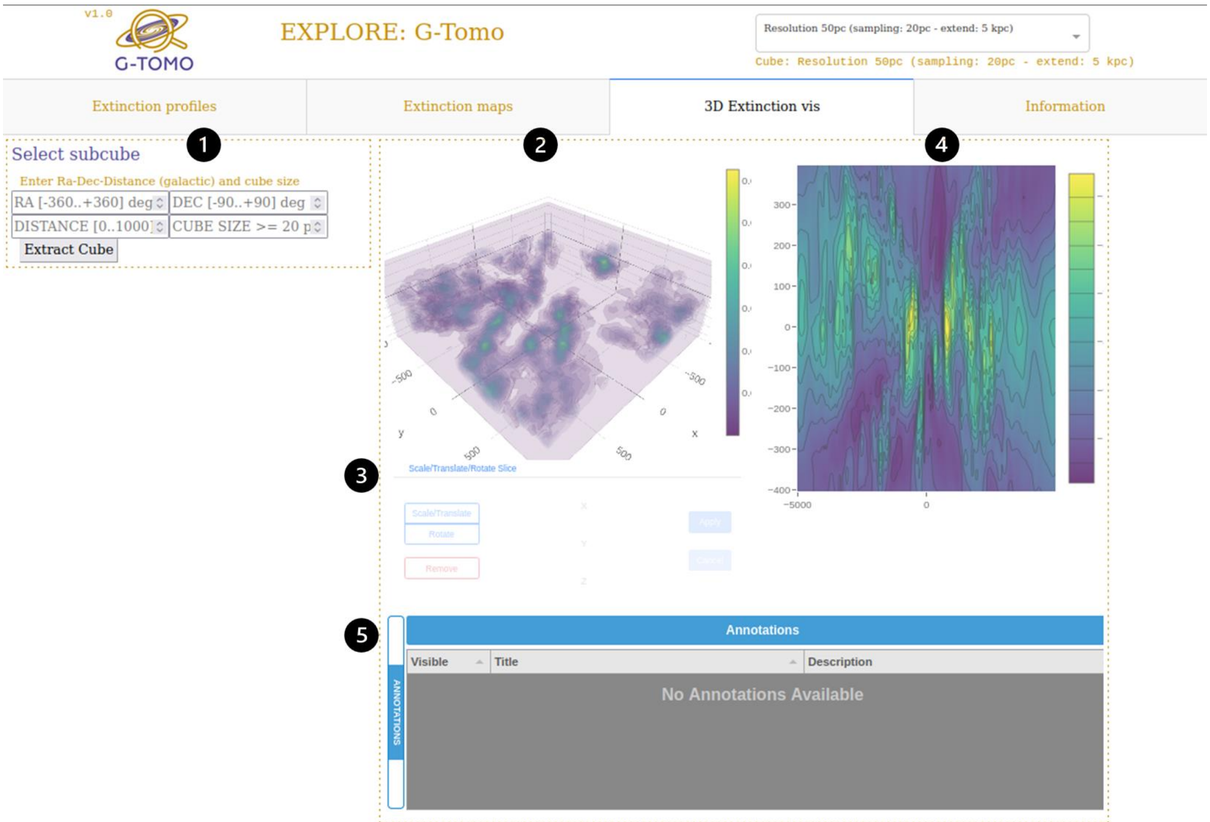

Figure 32. 3D extinction visualisation. Initial view.

4.6.1. Sub-cube selection

The left-side panel "Select sub-cube" is used to extract specific volume from the selected dataset (Figure 33). A new sub-cube is specified its origin point (defined as a sky coordinate + distance) and its size. The distance and size are given in parsec.

Warning: interactivity reacts slower the larger the size of the extracted cube.

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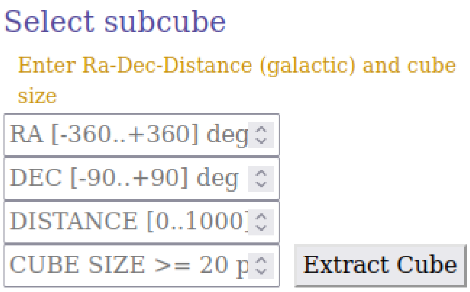

Figure 33. Sub-cube panel.

4.6.2. Volumetric (3D) rendering

The volumetric rendering shows the cloud structure in 3 dimensions. User can rotate, zoom, and pan the view using the buttons in the modebar (Figure 34).

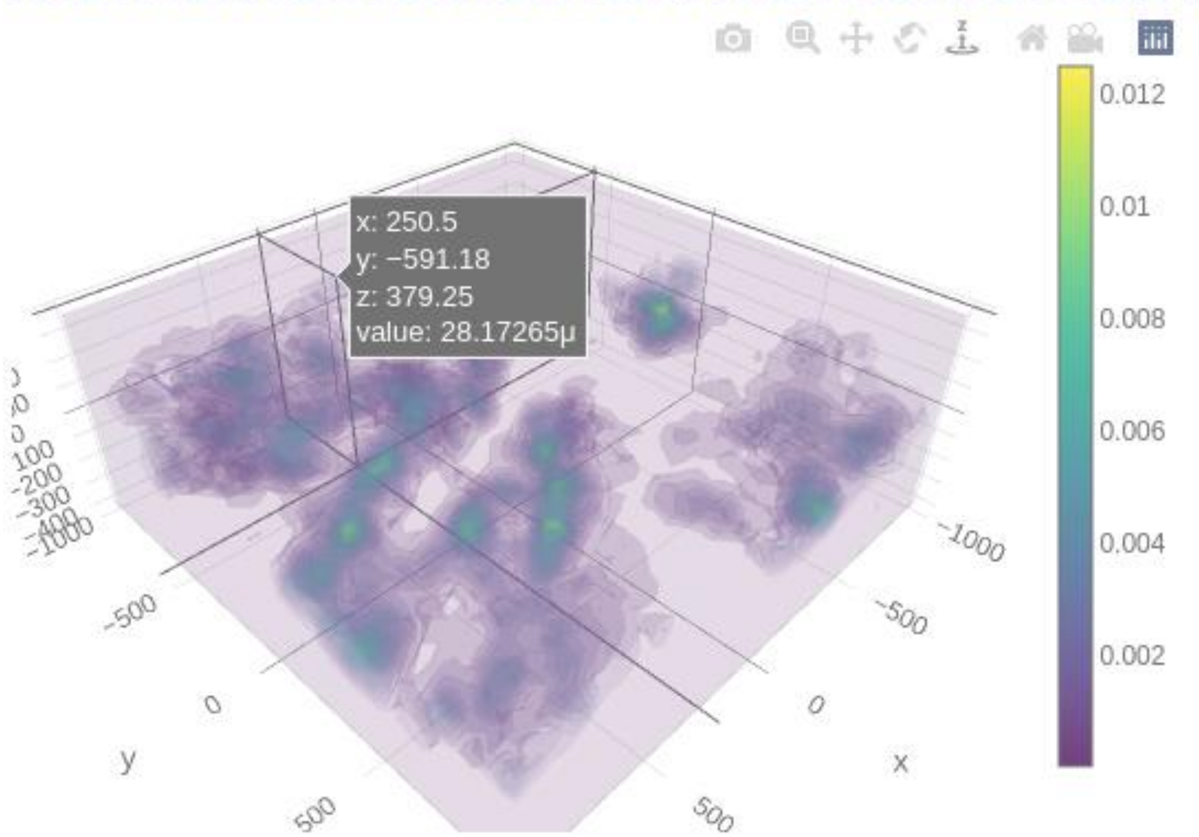

Figure 34. 3D (volumetric) rendering of the selected sub-cube. Zooming, rotating and panning is done using the different buttons in the modebar (moving with the mouse cursor over the icons will reveal their function).

4.6.1. Slicer

The controls in the slicer panel (3) are used to interactively define and manipulate a planar (2D) slice of the 3D data. To start the slicing the press the ‘z’-key and double-click on a point in the 3D plot. This draws the slicing plane (Figure 35; panel a). To

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activate the slicing tools click either the “Scale/Translate” or “Rotate” buttons. Now you can use the sliders to modify the 2D planar slice (Figure 35; panels b, c).

Click “apply” to update the 2D density map shown on the right. To remove the slice, click on “Remove”.

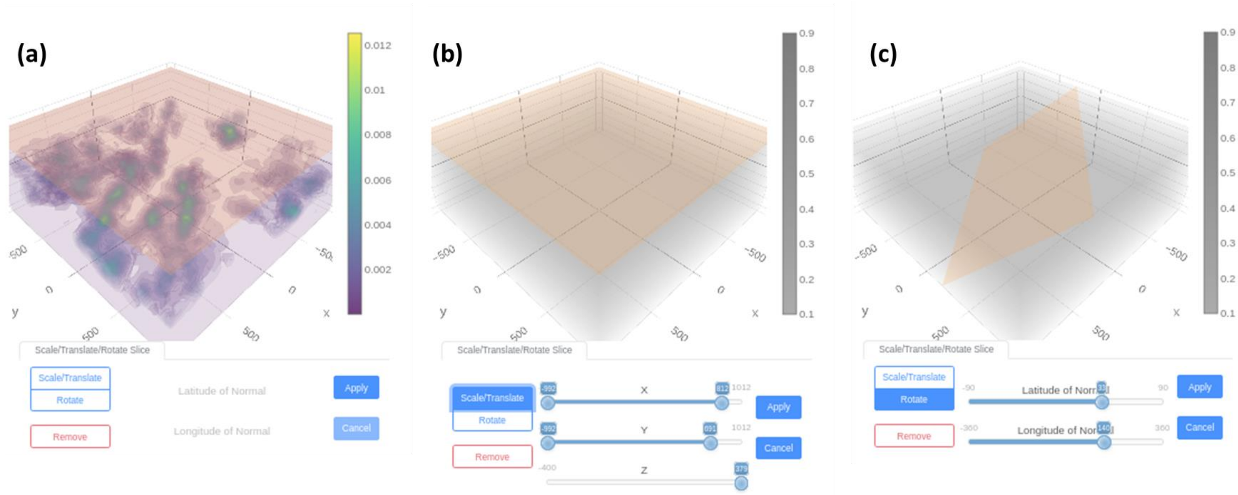

Figure 35. Slicer. To start the slicer hold the ‘z’ key and double-click on a data point in the plot. This will draw a planar slice (panel a). To manipulate the slice click on “ScaleTranslate” or “Rotate”. ScaleTranslate allows to adjust the X, Y, and Z positions of the slice. Rotate, allows to change the orientation of the normal to the planar slice.

4.6.2. 2D density map

The 2D density plot updates when clicking the “Apply” button.

4.7. Extinction sky map (beta-testing)

The service “Sky Extinction maps” (in beta-testing) provides a new view on the distribution of dust (DIB carrier data to be integrated later) in the Galaxy. Integrated dust extinction is shown in a galactic coordinate sky map (Figure 36). This service uses a composite data cube reconstructed from the version 2 data cubes (10 pc resolution up to 1500 pc, 25 pc resolution from 1500 to 3000 pc and 50 pc resolution from 3000 to 5000 pc). The sky is sampled at 0.5° intervals, and the distance at 10 pc.

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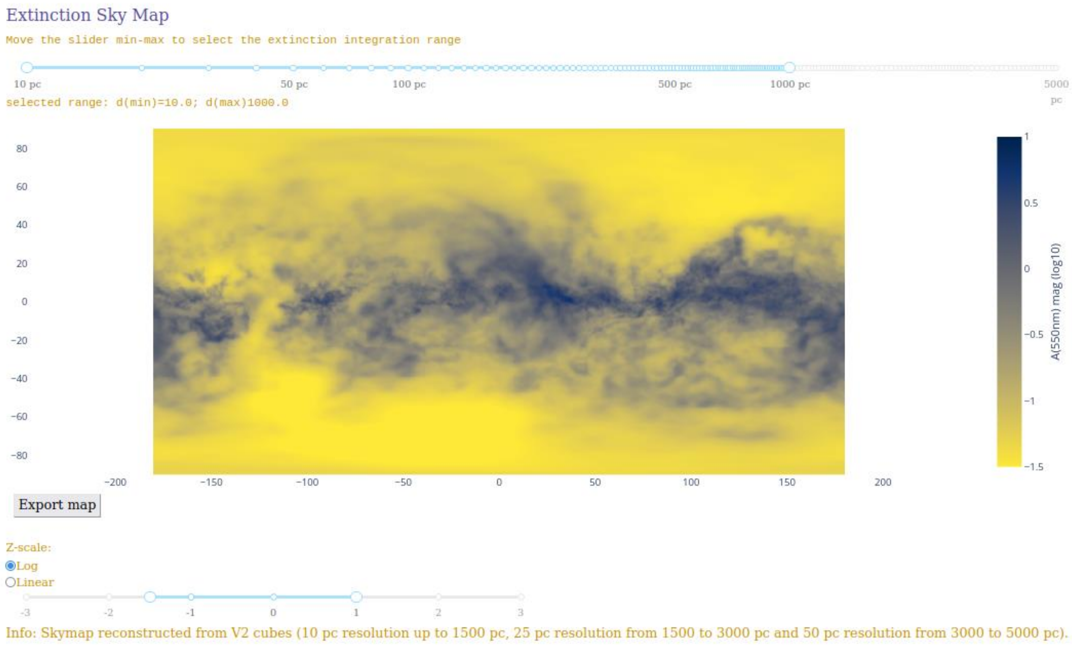

Figure 36. Extinction galactic coordinate sky map.

The default map shows the integrated extinction in the full sky between 10 and 1000 pc (Figure 36).

The top slider is used to set a minimum and maximum distance in between the cumulative extinction is computed. This enables a more accurate view of the distribution of dust at specific locations (distances). For instance, increasing the max distance to 5000 pc emphasizes the dust toward the galactic centre (Figure 37). Similarly, one can also create a view of the nearby dust clouds as shown in Figure 38. The plot is interactive, allowing to zoom in/out and pan, and can be customised further by changing the z-scale ('log' or 'linear') and the min/max scales (Figure 38).

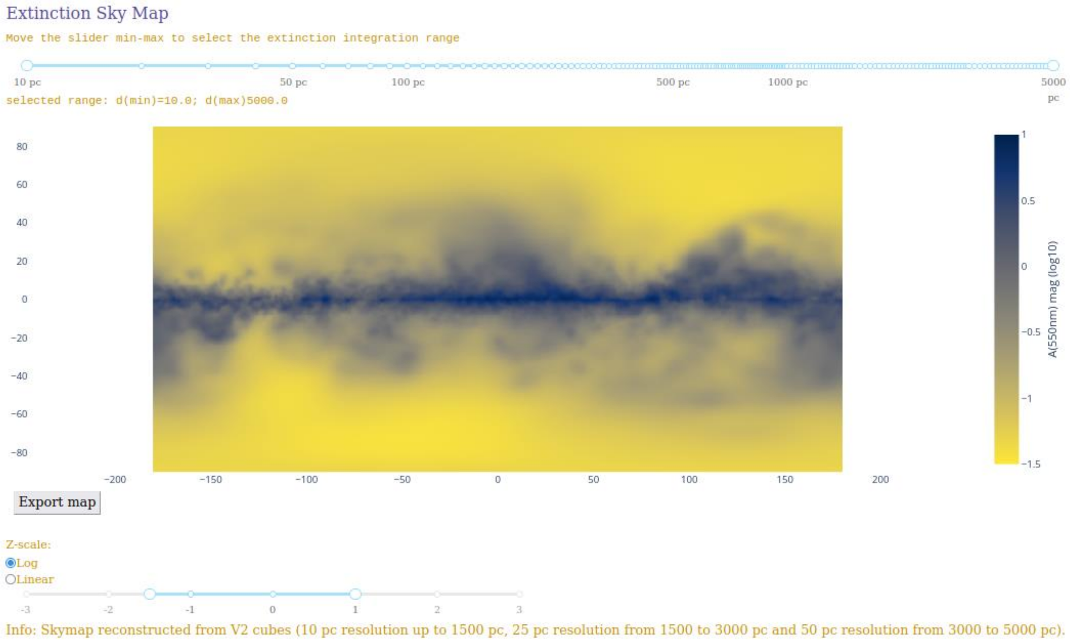

Figure 37. Extinction sky map. Full range: 0-5000 pc. Z-scale: logarithmic.

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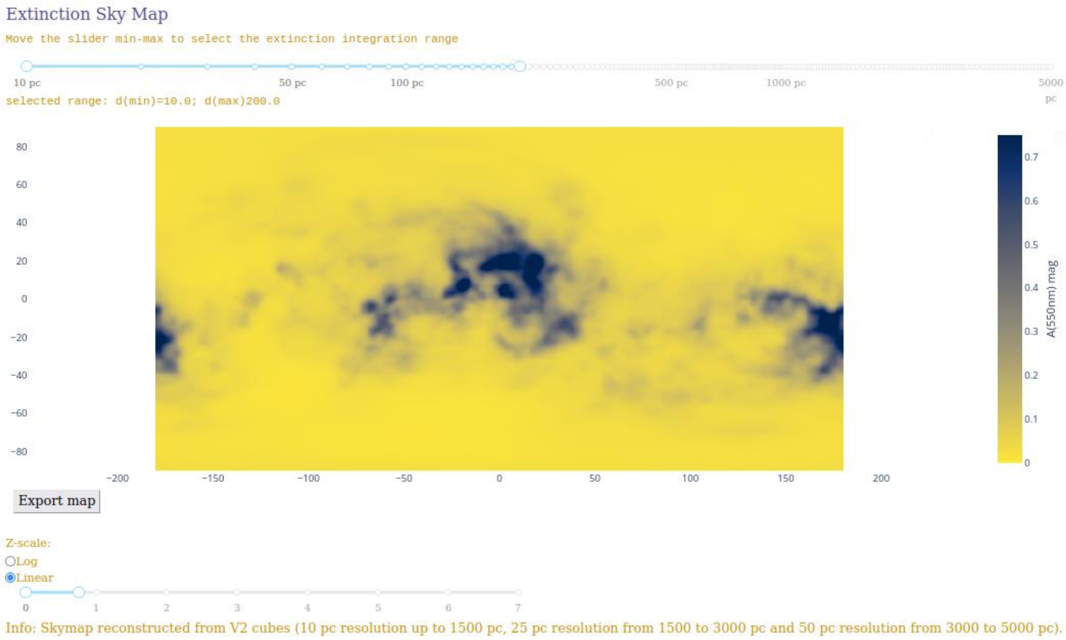
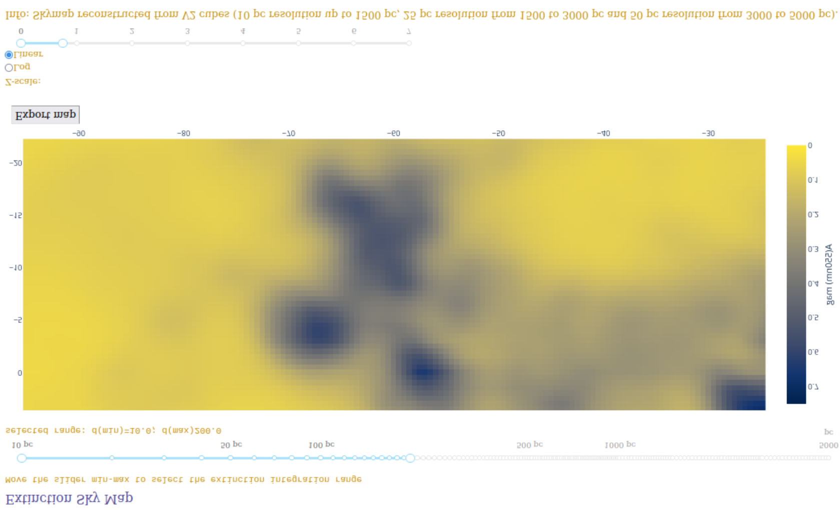


Figure 38. Extinction sky map. Distance range: 0-200 pc. Z-scale: linear.

The following figure shows a zoom at galactic longitude 300° and latitude -10°, in the direction of the Chamaeleon dark clouds.



4.8. Annotations

Under development.

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