

TGAS for dummies

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Created using L^AT_EX

Introduction

Gaia DR1 is twofold (Gaia Collaboration (Brown et al.) 2016, Summary description of Gaia DR1):

- ▶ TGAS: contains the astrometric single star solution for about 2M sources originally observed by Hipparcos and/or Tycho and published in the Tycho-2 catalogue;
- ▶ position and G-magnitude of 1B sources.

The astrometric solutions are based upon the Tycho2/HIP positions (epoch ~ 1991.5) and the Gaia observations already available. The 5p-model (i.e. position at reference epoch, parallax and proper motion) was imposed, whether it was physically appropriate or not. Some statistical quality indicators are nevertheless present.

For processing or observational reasons, some Hipparcos/Tycho2 stars are missing from TGAS:

- ▶ too poor astrometric solution;
- ▶ object too bright;
- ▶ too large proper motion, ...

Application

Retrieve the parallax and its uncertainty for a list of Ba stars with known TYC identifiers (e.g. TYC 35-435-1).

Warnings:

- ▶ DR1 does not contain any spectral information yet so the selection of Ba stars has to take place outside the Gaia framework.
- ▶ TGAS supplies the parallax and its uncertainty but no map of the extinction is provided yet.
- ▶ The observations will not be available for a long time so no processing with an alternative astrometric model is foreseen until then but other models will be considered in Gaia DR3+.

Accessing the Gaia DR1 archive

Even though DR1 is accessible through CDS and several other mirrors, the main repository is at ESAC (Madrid):

<http://archives.esac.esa.int/gaia>



The screenshot shows the Gaia Archive website homepage. At the top, there is a navigation bar with the text "EUROPEAN SPACE AGENCY" and "ABOUT ESAC" on the left, and "SIGN IN" on the right. Below this is a dark red banner with the text "gaia archive" in white, the ESA logo, and a background image of the Gaia satellite. Underneath the banner is a horizontal menu with the following items: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, and DOCUMENTATION. The main content area has a white background and features a large heading "Welcome to the Gaia Archive". Below the heading is a red "DISCLAIMER" section stating that the archive is in prototype status and provides simulated data. This is followed by a paragraph describing the Gaia mission's goals. Below that is a section for acknowledgements. To the right of the text is a large circular graphic of the Gaia satellite. At the bottom of the page, there is a "Top Features" section with three icons: a magnifying glass for "Search", a globe for "Statistics", and a lifebuoy for "Help". To the right of these icons is a "SHARE" button with social media icons for Facebook, Twitter, and LinkedIn. The footer contains the copyright notice "COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED." and the version number "[v0.7.4]".

EUROPEAN SPACE AGENCY ABOUT ESAC SIGN IN

gaia archive

HOME SEARCH STATISTICS VISUALIZATION HELP DOCUMENTATION

Welcome to the Gaia Archive

DISCLAIMER: This archive is currently in **prototype status** and provides **simulated Gaia data**.

Gaia is an ambitious mission to chart a three-dimensional map of our Galaxy, the Milky Way, in the process revealing the composition, formation and evolution of the Galaxy. Gaia will provide unprecedented positional and radial velocity measurements with the accuracies needed to produce a stereoscopic and kinematic census of about one billion stars in our Galaxy and throughout the Local Group. This amounts to about 1 per cent of the Galactic stellar population.

If you use this service in your research, please include the following acknowledgement in any resulting publications:

"This work has made use of data from the ESA space mission Gaia (<http://www.cosmos.esa.int/gaia>), processed by the Gaia Data Processing and Analysis Consortium (DPAC, <http://www.cosmos.esa.int/web/gaia/dpac/consortium>). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement."

Top Features

SEARCH STATISTICS HELP

SHARE

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Gaia Archive front end

So far, there are two ways to query the Gaia archive. The first approach offers a Simbad-like interface, convenient for one specific object or an area of the sky.

The screenshot shows the Gaia Archive search interface. At the top, there is a navigation bar with links for HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. The main header features the Gaia logo and the ESA logo. Below the header, there are tabs for Simple Form, ADQL Form, and Query Results. The Simple Form tab is active, showing a search form with the following fields and options:

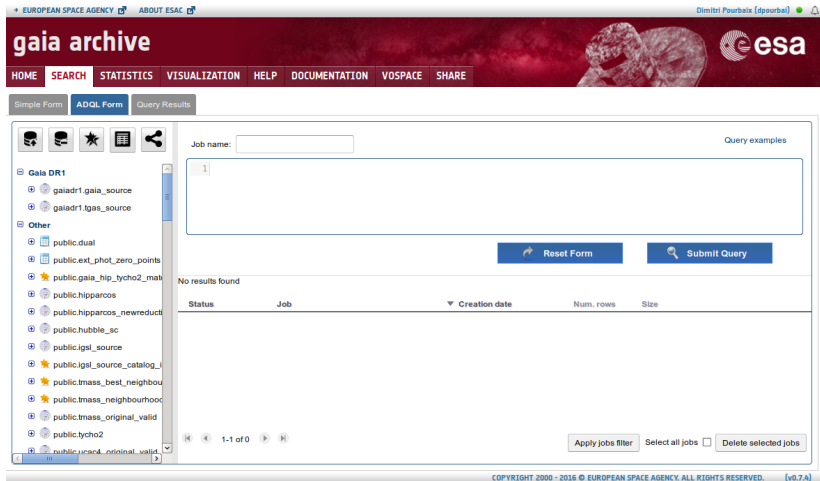
- Position:** Name (selected) or Equatorial
- Target in:** Circle (selected) or Box
- Name:** A text input field followed by a dropdown menu set to "Simbad".
- Radius:** A text input field set to "5" followed by a dropdown menu set to "arc min".
- Search in:** Gala Source (selected) or Tycho-Gaia Astrometric Solution (TGAS). A dropdown menu is set to "galadr1.gala_source".
- Extra conditions:** A section with a right-pointing arrow.
- Display columns:** A section with a right-pointing arrow.
- Max. number of results:** A dropdown menu set to "500".
- Buttons:** Reset Form, Show Query, and Submit Query.

At the bottom of the page, there is a copyright notice: "COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED. (v0.7.4)".

This operation can be repeated for several objects stored in a file.

Maximum power with ADQL

The Astronomical Data Query Language is a dialect of SQL-92. It makes it possible to build rather complex astronomical queries combining several tables.



The screenshot shows the Gaia Archive web interface. At the top, there is a navigation bar with the ESA logo and the text "gaia archive". Below this is a menu with options: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. The "ADQL Form" tab is selected, showing a "Query Results" section. The interface includes a "Job name" field, a "Query examples" link, and a large text area for entering the query. Below the text area are "Reset Form" and "Submit Query" buttons. A message "No results found" is displayed above a table with columns: Status, Job, Creation date, Num. rows, and Size. The table is currently empty. At the bottom, there are navigation controls for the results, including "Apply jobs filter", "Select all jobs", and "Delete selected jobs". The footer contains the copyright notice: "COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED. [v0.7.A]"

Examples of queries

- ▶ Strict join over three tables

```
select tgas.source_id, tgas.ra, tgas.dec, tgas.parallax,  
tgas.parallax_error, sb 9.sb9id from gaiadr1.tgas_source tgas  
join public.igsl_source_catalog_ids xref on tgas.source_id =  
xref.source_id  
join user_dpourbai.sb9list sb9 on ( xref.id_hip = sb9.htid or  
xref.id_tycho = sb9.htid)
```

- ▶ Flexible join over two tables

```
select * from gaiadr1.tgas_source tgas  
join user_dpourbai.cstars cs  
on contains(point('ICRS',tgas.ra,tgas.dec),  
circle('ICRS',cs.ra,cs.dec,0.0013888wc ))=1
```

Ref ADQL: <http://www.ivoa.net/documents/latest/ADQL.html>

Server side versus client side

We are looking for TGAS stars with a specific TYC number. Two options are possible:

- ▶ Download the whole TGAS and take care of the cross-matching locally (client side);
- ▶ Upload the list to the server and let the server takes care of the cross-matching.

If several selections are considered, downloading TGAS once for all will be advantageous. However, in the case of TYC (as well as for HIP, GSC, UCAC, ...), cross-matching tables have been precomputed and stored on the Gaia Archive.

For TYC-like identifiers with a pattern, it is important to use the exact same structure as the one adopted by the Gaia Archive: 'TYC 35-435-1', '0035-00435-1' and '0000 00435 1' are three distinct strings even if they might refer to the same TYC identifier.

Uploading the targets

The screenshot shows the GAIA Catalogue Upload dialog box in the ESA Gaia Archive interface. The dialog box is titled "GAIA Catalogue Upload" and contains the following fields and options:

- Select a file:** A text input field with "Browse..." and "No file selected." next to it.
- (*) File format:** A dropdown menu with "VOTable" selected.
- (*) Table name:** A text input field with "table1" entered.
- Table description:** A text area with "Uploaded from disk" entered.
- Buttons:** "Cancel" and "Upload" buttons.

The background interface shows the "gaia archive" logo, navigation tabs (HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, SHARE), and a sidebar with a tree view of data sources. The main content area displays "No results found" and a "Submit Query" button.

The user can supply some new data through some new tables (VO-tables or CSV files). They become DBMS tables right away.

The query is typed or pasted in the upper window.

The screenshot shows the Gaia Archive query interface. At the top, there's a navigation bar with 'HOME', 'SEARCH', 'STATISTICS', 'VISUALIZATION', 'HELP', 'DOCUMENTATION', 'VOSPACE', and 'SHARE'. Below this is a 'Simple Form' tab, and the 'ADQL Form' tab is active. The 'Query Results' section shows a job named 'vpBa' with the following SQL query:

```

1 select tgas.source_id,xref.original_ext_source_id,parallax,parallax_error from user_gaiadr1.tgas_source tgas
2 join public.gaia_hip_tyc2 match_xref on xref.source_id = tgas.source_id
3 join user_dpourbal.batyc2 ba on ba.col1 = xref.original_ext_source_id
    
```

Below the query input are 'Reset Form' and 'Submit Query' buttons. A table below shows the status of the query job:

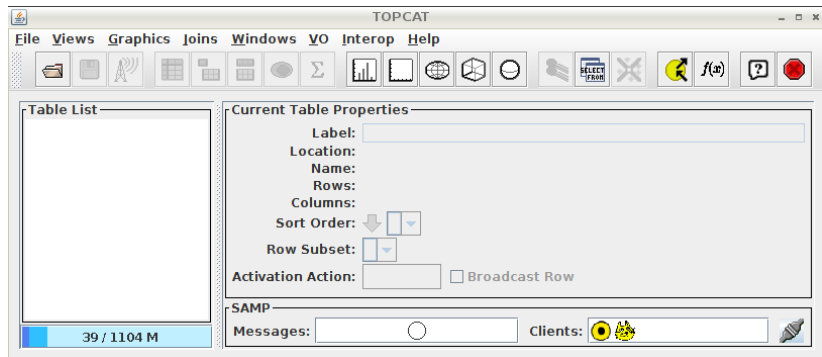
Status	Job	Creation date	Num. rows	Size	Actions
✓	vpBa	08-Sep-2016, 11:17:18	129	5 KB	[Icons]
✗	vpBa	08-Sep-2016, 11:16:48	0 KB	0 KB	[Icons]

At the bottom of the interface, there are navigation controls for the log (1-2 of 2) and buttons for 'Apply jobs filter', 'Select all jobs', and 'Delete selected jobs'.

Once the query is submitted, a new entry appears in the log. As soon as the query is completed ... or it crashes, the corresponding line of the log is updated (number of resulting rows, ...).


TOPCAT

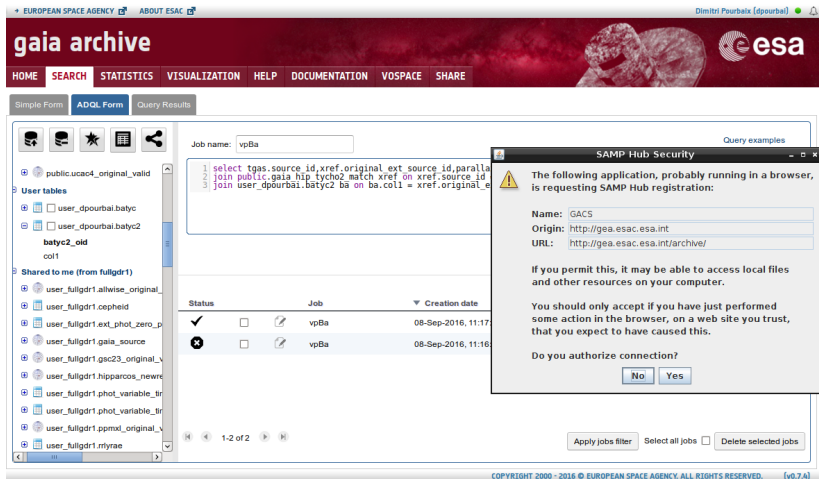
TOPCAT (<http://www.star.bris.ac.uk/~mbt/topcat/>) was designed to view and edit tabular data (regardless of Gaia). Version 4.3-3 (and higher) can communicate with the Gaia archive out of the box.



Make sure TOPCAT is running while logged in GACS.

Simple Application Messaging Protocol

Clicking on  establishes the connection between the server, browser and TOPCAT.



The screenshot shows the Gaia Archive website interface. At the top, there is a navigation bar with links for HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. Below this, there are tabs for Simple Form, ADDL Form, and Query Results. The main content area displays a query execution interface for a job named 'vpBa'. The query is as follows:

```
1 select tgas.source_id,xref_original_ext_source_id,parall
2 join public.gaia hip_tycho2 match xref on xref.source_id
3 join user_dpourbai.batyc2 ba on ba.col1 = xref.original_e
```

The interface shows a table of jobs with the following columns: Status, Job, and Creation date. The table contains two rows for the job 'vpBa':

Status	Job	Creation date
✓	vpBa	08-Sep-2016, 11:17
✗	vpBa	08-Sep-2016, 11:16

A security warning dialog box titled 'SAMP Hub Security' is overlaid on the interface. The dialog contains the following text:

The following application, probably running in a browser, is requesting SAMP Hub registration:

Name: GACS
Origin: http://gea.esac.esa.int
URL: http://gea.esac.esa.int/archive/

If you permit this, it may be able to access local files and other resources on your computer.

You should only accept if you have just performed some action in the browser, on a web site you trust, that you expect to have caused this.

Do you authorize connection?

Buttons: No, Yes

At the bottom of the interface, there are buttons for 'Apply jobs filter', 'Select all jobs', and 'Delete selected jobs'. The footer of the page reads: 'COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED. [v0.7.4]'

SAMP can also be used to establish a connection between TOPCAT and, say, a Python code (with SAMPy package).

SAMP log in

A new dialog box opens and asks for the login and password on the Gaia Archive server.

The screenshot shows the Gaia Archive web interface in Mozilla Firefox. The main content area displays a search form with a job name 'vdba' and a SQL query: `select tps.source_id, sref.original_est_source_id, parallax, parallax_error from user_gaiaid1.tps_source tps join public.gaia_tps_tychos_match tsm on tref.source_id = tps.source_id join user_djorbal.batyc2 ba on ba.col1 = sref.original_est_source_id`. Below the query is a table of jobs:

Job	Creation date	Num. rows	Size
vdba	08-Sep-2016, 11:07:18	129	9 KB
vdba	08-Sep-2016, 11:16:48		0 KB

An authentication dialog box is open in the foreground, titled 'Authentication required for gaia.esa.int'. It prompts for 'User:' (filled with 'djorbal') and 'Password:'. Below the fields are 'OK' and 'Cancel' buttons. The dialog also shows 'Activation Action:' and a 'Broadcast now' checkbox. In the background, a terminal window shows the command `!load new table` and a 'Loading Tables' dialog box displays 'SAMP/GACS:14733262380200'.

View through TOPCAT

It is possible to directly view a sample of the table just transferred in TOPCAT.

The image shows two overlapping windows. The background window is the Gaia Archive website, displaying a query results page. The query entered is: `select tps.source_id,ref_original,est_source_id,parallax,parallax_error from user_gaiad1.tps,source tps join public.gaiu_bip_tych2_mafc01_ari on ref_original,est_source_id join user_gaiad1_bip01_b on ta_scl1 = ref_original,est_source_id`. The results table shows columns for source_id, original parallax, and parallax. The foreground window is the TOPCAT software interface, showing a 'Table Browser for 1: 14723627802000' with a grid of data corresponding to the query results. Below the table browser is a terminal window showing the execution of a command: `./download.py --astro/Gaia/DPAC/TSAS/Overies -v --download/108612-Patches verbal d/estimation & l/variable.pdf`.

Export to CSV

Whereas one can directly access a TOPCAT table from, say, Java or Python, exporting to CSV might offer some more flexibility.

The image shows a screenshot of the TOPCAT software interface. The main window displays a query execution table with the following data:

Job name	Creation date	Num. rows	Size
vst6	08-Sep-2016, 11:17:18	128	5 KB
vst6	08-Sep-2016, 11:16:45		0 KB

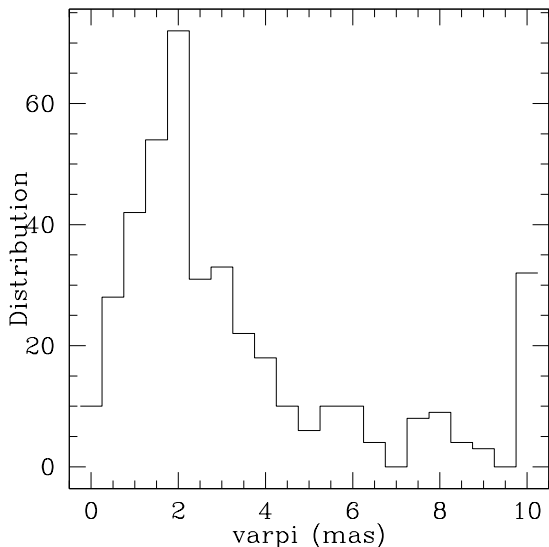
A dialog box titled "TOPCAT" is open, showing the "Current Table" as "Table: 1: 1473262380200" and "Current Subject" as "Sort Order:". The "Output Format" is set to "CSV+header" and the "Location" is "gal7045.csv". The dialog also includes buttons for "Filestore Browser" and "System Browser".

The background window shows a query editor with the following SQL query:

```
select tgas_source_id,xref.original_err_source_id,parallel_err error from user.galdr1.tgas_source tgas
join public.gala_hst_lytobz_match xref on xref.source_id = tgas_source_id
join user.dpsdrbal_bary2 ba on ba.col1 = xref.original_err_source_id
```

Results

Out of the original 557 TYC entries, only 406 turn out to hold a TGAS solution (see DR1 papers for the exact filtering criteria).

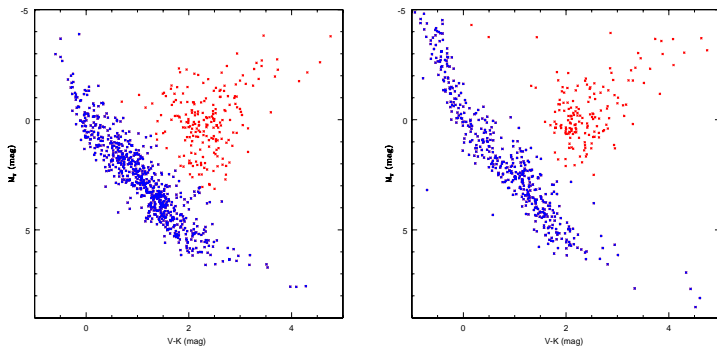


Acknowledgement

This work has made use of data from the ESA space mission Gaia (<http://www.cosmos.esa.int/gaia>), processed by the Gaia Data Processing and Analysis Consortium (DPAC, <http://www.cosmos.esa.int/web/gaia/dpac/consortium>). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement.

Warnings

1. Do not take the cross matching for granted and definitive: it is already anticipated that some ID will change in DR2.
2. Do not forget Hipparcos!



The left plot is based upon TGAS parallaxes only whereas Hipparcos parallaxes for non TGAS stars were used on the right panel.