

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 Tycho and published in the Tycho-2 catalogue;
- ▶ position and G-magnitude of 1B sources.

The astrometric solutions are based upon the Tycho2 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 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 guess 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. 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, and the ESA logo on the right. Under the banner is a navigation menu with links: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, and DOCUMENTATION. The main content area has a heading "Welcome to the Gaia Archive". Below this is a red "DISCLAIMER" section stating that the archive is in prototype status and provides simulated data. The text describes the Gaia mission's goals and the role of the DPAC. A large illustration of the Gaia spacecraft is on the right. Below the disclaimer is a section for "Top Features" with icons and links for Search, Statistics, and Help. At the bottom, there is a footer with copyright information and a version number (v0.7.4).

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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 front end search interface. At the top, there is a header with the European Space Agency (ESA) logo and the text "gaia archive". Below the header, there is a navigation bar with links: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. The "SEARCH" link is highlighted. Below the navigation bar, there are three tabs: Simple Form, ADQL Form, and Query Results. The "Simple Form" tab is selected. The main search area contains several input fields and buttons. On the left, there are radio buttons for "Name" (selected) and "Equatorial". To the right, there is a "Target in" section with radio buttons for "Circle" (selected) and "Box". Below these, there is a "Name" input field, a "for" dropdown menu (set to "Simbad"), and a "Radius" input field (set to "5") with a unit dropdown menu (set to "arc min"). Below the "Name" input field, there is a "Search in:" section with radio buttons for "Gaia Source" (selected) and "Tycho-Gaia Astrometric Solution (TGAS)". To the right of these radio buttons is a dropdown menu (set to "gaiadr1.gai_source"). Below the "Search in:" section, there are two expandable sections: "Extra conditions" and "Display columns". At the bottom of the search area, there is a "Max. number of results:" input field (set to "500"), a "Reset Form" button, a "Show Query" button, and a "Submit Query" button. The footer of the page contains the text "COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED." and a version number "(v0.7.4)".

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

Relational DataBase Management System

The Gaia data are stored in several rectangular tables (i.e. each row of a table has the same number of columns). A table represents a relation (in the mathematical sense) between the columns of that table. The rows of a table are independent. Relational algebra defines 3 operations to manipulate table(s)

- ▶ Projection (π): generates a table with only a subset of the columns of the original table;
- ▶ Selection (σ): generates a table with only the rows that satisfy a relation between some columns;
- ▶ Joint (\bowtie): combines two tables into one where one column is common.

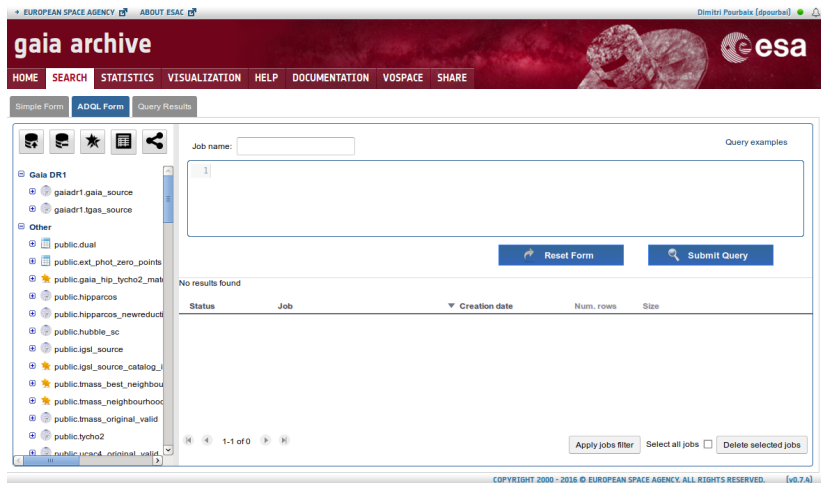
Our example becomes: $\pi_{\varpi, \sigma_{\varpi}}(TGAS \bowtie XmTYC \bowtie BaList)$.

The language commonly used to access such a database is Structured Query Language.

A general introduction to databases can be found in *Database System Concepts* by Silberschatz, Korth, & Sudarshan.

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's a header with the European Space Agency (ESA) logo and the text "gaia archive". Below the header, there's a navigation bar with links: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. The "SEARCH" link is highlighted. Below the navigation bar, there's a sub-header with "Simple Form", "ADQL Form" (selected), and "Query Results". The main content area is divided into two sections. The left section is a sidebar with a tree view of data sources, including "Gaia DR1" and "Other". The right section is the query editor, which has a "Job name:" field, a "Query examples" link, and a large text area for the query. Below the text area, there are "Reset Form" and "Submit Query" buttons. Below these buttons, there's a message "No results found" and a table with columns: Status, Job, Creation date, Num. rows, and Size. The table is currently empty. At the bottom of the table, there's a pagination control showing "1-1 of 0" and buttons for "Apply jobs filter", "Select all jobs", and "Delete selected jobs".

EUROPEAN SPACE AGENCY ABOUT ESAC Dimitri Pourbaix [dpourbaix]

gaia archive

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Simple Form **ADQL Form** Query Results

Job name:

Query examples

1

Reset Form Submit Query

No results found

Status	Job	Creation date	Num. rows	Size
--------	-----	---------------	-----------	------

1-1 of 0

Apply jobs filter Select all jobs Delete selected jobs

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Ref AQDL: <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 make use one uploads 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 Archive web interface. At the top, there's a header with the European Space Agency logo and the text 'gaia archive'. Below the header is a navigation bar with links: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. The main content area is divided into two sections: 'Simple Form' and 'ADQL Form'. The 'ADQL Form' section is active, showing a 'Job name' field and a 'Query Results' table. A modal dialog box titled 'GAIA Catalogue Upload' is overlaid on the interface. The dialog box contains the following fields and options:

- Select a file:** A 'Browse...' button and the text 'No file selected.'
- (*) File format:** A dropdown menu with 'VOTable' selected.
- (*) Table name:** A text input field containing 'table1'.
- Table description:** A text input field containing 'Uploaded from disk'.
- (*) mandatory field** label below the table description field.
- Buttons:** 'Cancel' and 'Upload' buttons at the bottom.

The background interface shows a list of data sources on the left, including 'Gaia DR1' and 'Other'. The 'Query Results' table is empty, showing 'No results found'.

The user can supply some new data through some new tables (VO-tables or CSV files).

New DBMS entries

Once these tables are uploaded, they become part of the DMBS (user's working area) and can be used in any query.

The screenshot displays the Gaia Archive web interface. At the top, there is a header with the European Space Agency (ESA) logo and navigation links: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VOSPACE, and SHARE. Below the header, there is a sub-header with tabs: Simple Form, ADQL Form (selected), and Query Results. The main content area features a search form with a 'Job name:' label and a text input field containing the number '1'. To the right of the input field is a 'Query examples' link. Below the input field are two buttons: 'Reset Form' and 'Submit Query'. The search results section shows 'No results found'. Below this, there is a table with columns: Status, Job, Creation date, Num. rows, and Size. The table is currently empty. On the left side of the interface, there is a sidebar with a list of database tables, including 'public.gaia_hip_tycho2_mat', 'public.hipparcos', 'public.hipparcos_newreduct', 'public.hubble_sc', 'public.igsl_source', 'public.igsl_source_catalog', 'public.tmass_best_neighbour', 'public.tmass_neighbourhood', 'public.tmass_original_valid', 'public.tycho2', and 'public.uca4_original_valid'. Under the 'User tables' section, there are 'user_dpourbai.batyc', 'batyc_old', and 'col1'. At the bottom of the sidebar, there is a section 'Shared to me (from fulgdr1)' with a table listing 'user_fulgdr1.talwine_original'. The footer of the interface contains the copyright notice: 'COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED. (v0.7.6)'.

The query can be typed or pasted in the upper window.

The screenshot shows the Gaia Archive query interface. At the top, there's a header with the ESA logo and navigation links. Below that, a sidebar lists various data tables. The main area contains a query input field with the following SQL query:

```
select tgas.source_id,xref.original_ext_source_id,parallax,parallax_error from user_gaiadr1.tgas_source tgas
join public.gaia_hip_tych2 match xref on xref.source_id = tgas.source_id
join user_dpourbal.batyc2 ba on ba.col1 = xref.original_ext_source_id
```

Below the query input, there's a table showing the status of the query job. The table has columns: Status, Job, Creation date, Num. rows, and Size.

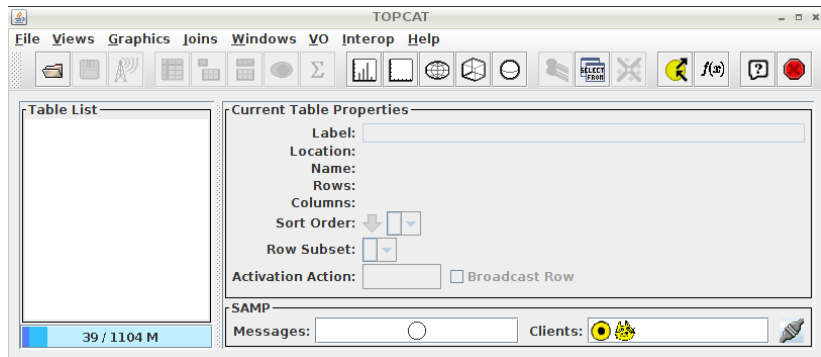
Status	Job	Creation date	Num. rows	Size
✓	vpBa	08-Sep-2016, 11:17:18	129	5 KB
✗	vpBa	08-Sep-2016, 11:16:48	0 KB	

At the bottom of the interface, there's a footer with copyright information: "COPYRIGHT 2000 - 2016 © EUROPEAN SPACE AGENCY. ALL RIGHTS RESERVED. (v0.7.4)"

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). It was updated to communicate with the Gaia archive out of the box (4.3-3).



Make sure TOPCAT is running.

Simple Application Messaging Protocol

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

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gaia archive

HOME SEARCH STATISTICS VISUALIZATION HELP DOCUMENTATION VOSPACE SHARE

Simple Form ADQL Form Query Results

- public.ucac4_original_valid
- User tables
 - user_dpourbai.batyc
 - user_dpourbai.batyc2
 - batyc2_oid
 - col1
- Shared to me (from fullgdr1)
 - user_fullgdr1.allwise_original
 - user_fullgdr1.cepheld
 - user_fullgdr1.ext_phot_zero_p
 - user_fullgdr1.gaia_source
 - user_fullgdr1.gsc23_original_v
 - user_fullgdr1.hipparcos_newre
 - user_fullgdr1.phot_variable_tir
 - user_fullgdr1.phot_variable_tir
 - user_fullgdr1.ppmx ORIGINAL_V
 - user_fullgdr1.rhyrae

Job name:

```

1 select tgas.source_id,xref.original_ext_source_id,parallela
2 join public.gaia_hip_tycho2_match xref on xref.source_id
3 join user_dpourbai.batyc2 ba on ba.col1 = xref.original_e

```

Status		Job	Creation date
<input checked="" type="checkbox"/>	<input type="checkbox"/>	vpBa	08-Sep-2016, 11:17
<input checked="" type="checkbox"/>	<input type="checkbox"/>	vpBa	08-Sep-2016, 11:16

1 - 2 of 2

SAMP Hub Security

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?

No Yes

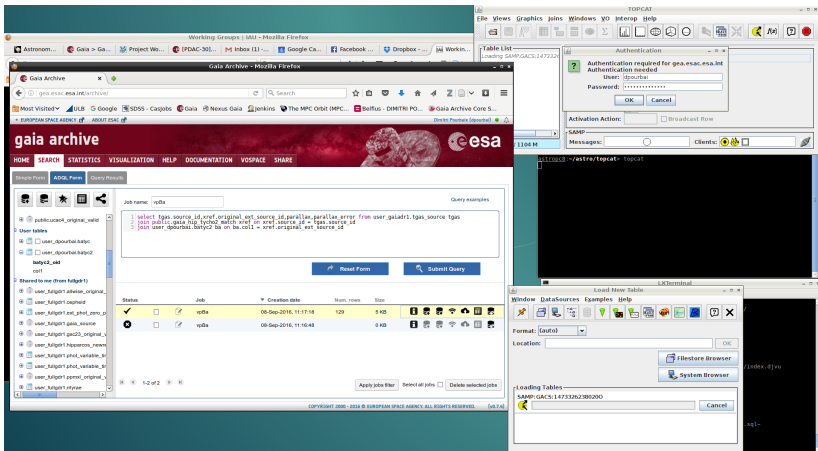
Apply jobs filter Select all jobs Delete selected jobs

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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.



View through TOPCAT

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

The screenshot shows a web browser window displaying the Gaia Archive website. The website has a red header with the text "gaia archive" and navigation links: HOME, SEARCH, STATISTICS, VISUALIZATION, HELP, DOCUMENTATION, VSPACE, SHARE. Below the header, there is a "Simple Form" section with a "Job name" field containing "vblia". A "Query examples" section shows a SQL query:

```
select tps.source_id, tps.original_ext, tps.source_id, tps.parallax, tps.error from user_gaiadr1.tps_source tps join public.gaiadr1.tps_source tps on tps.source_id = tps.source_id join user_gaiadr1.tps_source tps on tps.source_id = tps.source_id
```

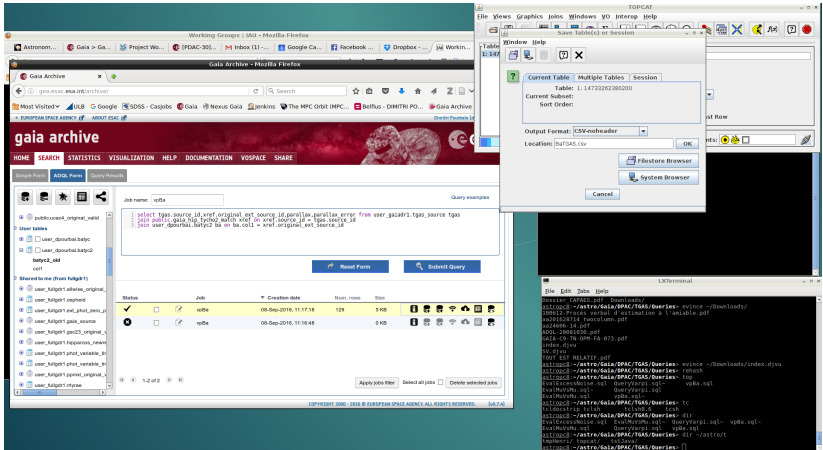
. Below the query, there is a "Status" section showing a table of jobs. The table has columns: Status, Job, Creation date, Rows, Size. The first job is "vblia" with a status of "Success" and a creation date of "08-Sep-2016, 11:17:18". The second job is "vblia" with a status of "Error" and a creation date of "08-Sep-2016, 11:16:48".

Overlaid on the right side of the browser window is a TOPCAT window. The TOPCAT window has a menu bar with "File", "Views", "Graphics", "Joins", "Windows", "YO", "Interop", "Help". Below the menu bar is a "Table Browser for 1: 1473262380200" window. This window displays a table with columns: source_id, original_ext, parallax, parallax_error. The table contains 19 rows of data. Below the table is a "Table Editor" window with a menu bar: "File", "Edit", "Jobs", "Help". The "Table Editor" window displays a SQL query:

```
select tps.source_id, tps.original_ext, tps.source_id, tps.parallax, tps.error from user_gaiadr1.tps_source tps join public.gaiadr1.tps_source tps on tps.source_id = tps.source_id join user_gaiadr1.tps_source tps on tps.source_id = tps.source_id
```

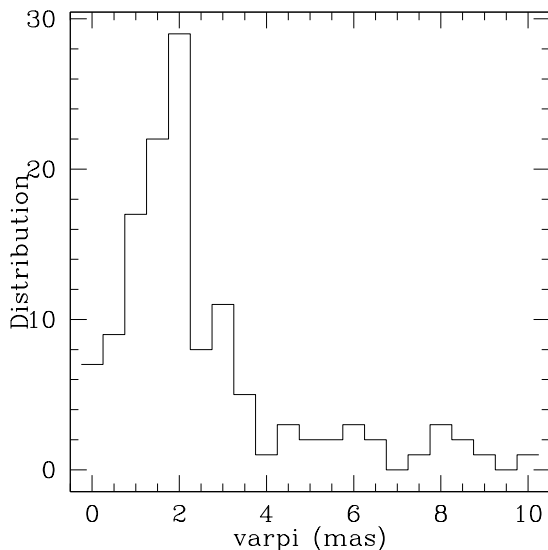
Export to CSV

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



Results

Out of the original 557 TYC entries, only 129 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.