

VStar Retrieval of Gaia Variable Star Light Curve Data

This plugin allows you to read light curve data for any of the Gaia DR2/DR3 stars that were identified by Gaia processing as variable and therefore have photometry available. Data are accessed directly from the Gaia web service. The passbands can either be the Gaia red (RP), green (G) and blue (BP) or they can be transformed to V, Rc, Ic.

Gaia Mission

Gaia is a spacecraft launched by the European Space Agency (ESA) to measure the positions and distances to stars. The Gaia coverage includes the entire sky from magnitude 5 to 20. In 2022 the project has made its third data release, known as Gaia Data Release 3 (DR3).

Gaia captures photometry in three passbands, shown graphically here₂ and described in detail in the paper Gaia Data Release 2 Photometric content and validation. As part of the processing pipeline, Gaia identifies sources that appear to be variable using a set of machine learning algorithms. Currently (on Apr 2th 2023) the “Gaia Data Release 3 (Gaia DR3) Part 4 Variability” catalog contains 11754237 sources (records).

Obtaining Gaia source_id

Each Gaia star is identified by a unique key, the **source_id**. The Gaia archive is available for interactive and programmatic access with a well-documented set of interfaces. The Help link provides access to a number of tutorials. Only the simple query interface will be discussed here.

Consider the classical Cepheid, XX Mon. From the Gaia archive page, click Search to go to the basic query screen and enter XX Mon in the name field.

The screenshot shows the Gaia Archive 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 are navigation tabs: HOME, SEARCH, SINGLE OBJECT, VISUALISATION, and HELP. The 'SEARCH' tab is active. Under the 'SEARCH' tab, there are three sub-tabs: Basic, Advanced (ADQL), and Query Results. The 'Basic' sub-tab is selected. In the 'Basic' sub-tab, there are two main sections: 'Position' and 'File'. The 'Position' section is active. It contains a 'Name' field with the text 'XX Mon' and a 'Target in' dropdown menu set to 'Circle'. Below the 'Name' field, there is a text box that says 'XX Mon resolved by Sesame Strasbourg (Simbad-NED-VizieR)'. To the right of the 'Name' field, there is a 'Radius' field set to '5' and a unit dropdown menu set to 'arc sec'. Below the 'Position' section, there is a 'Search in:' dropdown menu set to 'gaiadr3.gaiadr3_source'. At the bottom of the interface, there are two expandable sections: 'Extra conditions' and 'Display columns'.

Then open the Display columns section and select the **phot_variable_flag** column. This will allow you to determine if Gaia has identified this star as variable and therefore has light curve data available.

▼ Display columns

<input type="checkbox"/> solution_id	<input type="checkbox"/> designation	<input checked="" type="checkbox"/> source_id	<input type="checkbox"/> random_index	<input type="checkbox"/> ref_epoch
<input checked="" type="checkbox"/> ra	<input type="checkbox"/> ra_error	<input checked="" type="checkbox"/> dec	<input type="checkbox"/> dec_error	<input checked="" type="checkbox"/> parallax
<input type="checkbox"/> parallax_error	<input type="checkbox"/> parallax_over_error	<input type="checkbox"/> pm	<input checked="" type="checkbox"/> pmra	<input type="checkbox"/> pmra_error
<input checked="" type="checkbox"/> pmdec	<input type="checkbox"/> pmdec_error	<input type="checkbox"/> ra_dec_corr	<input type="checkbox"/> ra_parallax_corr	<input type="checkbox"/> ra_pmra_corr
<input type="checkbox"/> ra_pmdec_corr	<input type="checkbox"/> dec_parallax_corr	<input type="checkbox"/> dec_pmra_corr	<input type="checkbox"/> dec_pmdec_corr	<input type="checkbox"/> parallax_pmra_corr
<input type="checkbox"/> parallax_pmdec_corr	<input type="checkbox"/> pmra_pmdec_corr	<input type="checkbox"/> astrometric_n_obs_al	<input type="checkbox"/> astrometric_n_obs_ac	<input type="checkbox"/> astrometric_n_good_obs_al
<input type="checkbox"/> astrometric_n_bad_obs_al	<input type="checkbox"/> astrometric_gof_al	<input type="checkbox"/> astrometric_chi2_al	<input type="checkbox"/> astrometric_excess_noise	<input type="checkbox"/> astrometric_excess_noise_sig
<input type="checkbox"/> astrometric_params_solved	<input type="checkbox"/> astrometric_primary_flag	<input type="checkbox"/> nu_eff_used_in_astrometry	<input type="checkbox"/> pseudocolour	<input type="checkbox"/> pseudocolour_error
<input type="checkbox"/> ra_pseudocolour_corr	<input type="checkbox"/> dec_pseudocolour_corr	<input type="checkbox"/> parallax_pseudocolour_corr	<input type="checkbox"/> pmra_pseudocolour_corr	<input type="checkbox"/> pmdec_pseudocolour_corr
<input type="checkbox"/> astrometric_matched_transits	<input type="checkbox"/> visibility_periods_used	<input type="checkbox"/> astrometric_sigma5d_max	<input type="checkbox"/> matched_transits	<input type="checkbox"/> new_matched_transits
<input type="checkbox"/> matched_transits_removed	<input type="checkbox"/> ipd_gof_harmonic_amplitude	<input type="checkbox"/> ipd_gof_harmonic_phase	<input type="checkbox"/> ipd_frac_multi_peak	<input type="checkbox"/> ipd_frac_odd_win
<input checked="" type="checkbox"/> ruwe	<input type="checkbox"/> scan_direction_strength_k1	<input type="checkbox"/> scan_direction_strength_k2	<input type="checkbox"/> scan_direction_strength_k3	<input type="checkbox"/> scan_direction_strength_k4
<input type="checkbox"/> scan_direction_mean_k1	<input type="checkbox"/> scan_direction_mean_k2	<input type="checkbox"/> scan_direction_mean_k3	<input type="checkbox"/> scan_direction_mean_k4	<input type="checkbox"/> duplicated_source
<input type="checkbox"/> phot_g_n_obs	<input type="checkbox"/> phot_g_mean_flux	<input type="checkbox"/> phot_g_mean_flux_error	<input type="checkbox"/> phot_g_mean_flux_over_error	<input checked="" type="checkbox"/> phot_g_mean_mag
<input type="checkbox"/> phot_bp_n_obs	<input type="checkbox"/> phot_bp_mean_flux	<input type="checkbox"/> phot_bp_mean_flux_error	<input type="checkbox"/> phot_bp_mean_flux_over_error	<input type="checkbox"/> phot_bp_mean_mag
<input type="checkbox"/> phot_rp_n_obs	<input type="checkbox"/> phot_rp_mean_flux	<input type="checkbox"/> phot_rp_mean_flux_error	<input type="checkbox"/> phot_rp_mean_flux_over_error	<input type="checkbox"/> phot_rp_mean_mag
<input type="checkbox"/> phot_bp_rp_excess_factor	<input type="checkbox"/> phot_bp_n_contaminated_transits	<input type="checkbox"/> phot_bp_n_blended_transits	<input type="checkbox"/> phot_rp_n_contaminated_transits	<input type="checkbox"/> phot_rp_n_blended_transits
<input type="checkbox"/> phot_proc_mode	<input checked="" type="checkbox"/> bp_rp	<input type="checkbox"/> bp_g	<input type="checkbox"/> g_rp	<input checked="" type="checkbox"/> radial_velocity
<input type="checkbox"/> radial_velocity_error	<input type="checkbox"/> rv_method_used	<input type="checkbox"/> rv_nb_transits	<input type="checkbox"/> rv_nb_deblended_transits	<input type="checkbox"/> rv_visibility_periods_used
<input type="checkbox"/> rv_expected_sig_to_noise	<input type="checkbox"/> rv_renormalised_gof	<input type="checkbox"/> rv_chisq_pvalue	<input type="checkbox"/> rv_time_duration	<input type="checkbox"/> rv_amplitude_robust
<input type="checkbox"/> rv_template_teff	<input type="checkbox"/> rv_template_logg	<input type="checkbox"/> rv_template_fe_h	<input type="checkbox"/> rv_atm_param_origin	<input type="checkbox"/> vbroad
<input type="checkbox"/> vbroad_error	<input type="checkbox"/> vbroad_nb_transits	<input type="checkbox"/> grvs_mag	<input type="checkbox"/> grvs_mag_error	<input type="checkbox"/> grvs_mag_nb_transits
<input type="checkbox"/> rvs_spec_sig_to_noise	<input checked="" type="checkbox"/> phot_variable_flag	<input type="checkbox"/> i	<input type="checkbox"/> b	<input type="checkbox"/> ecl_lon
<input type="checkbox"/> ecl_lat	<input type="checkbox"/> in_qso_candidates	<input type="checkbox"/> in_galaxy_candidates	<input checked="" type="checkbox"/> non_single_star	<input checked="" type="checkbox"/> has_xp_continuous
<input checked="" type="checkbox"/> has_xp_sampled	<input checked="" type="checkbox"/> has_rvs	<input checked="" type="checkbox"/> has_epoch_photometry	<input checked="" type="checkbox"/> has_epoch_rv	<input checked="" type="checkbox"/> has_mcmc_gspphot

Submit the query and you will see the row of data from the main Gaia table. Make sure the **phot_variable_flag** says “VARIABLE”.

Basic
Advanced (ADQL)
Query Results

1/1 No job

source_id	ra	dec	parallax	pmra	pmdec	ruwe	phot_g_mean_mag	bp_rp	radial_velocity	phot_variable_flag	non_single_star	has_xp_continuous
	deg	deg	mas	mas yr ⁻¹	mas yr ⁻¹		mag	mag	km s ⁻¹			
3105860283909081728	103.0507050071039	-2.8069596245041555	0.2206189026288878	-0.6824064349399178	-0.10901203724307632	0.855873	11.504902	1.6136398	63.539997	VARIABLE	0	true

Make note the **source_id** or copy it to the clipboard.

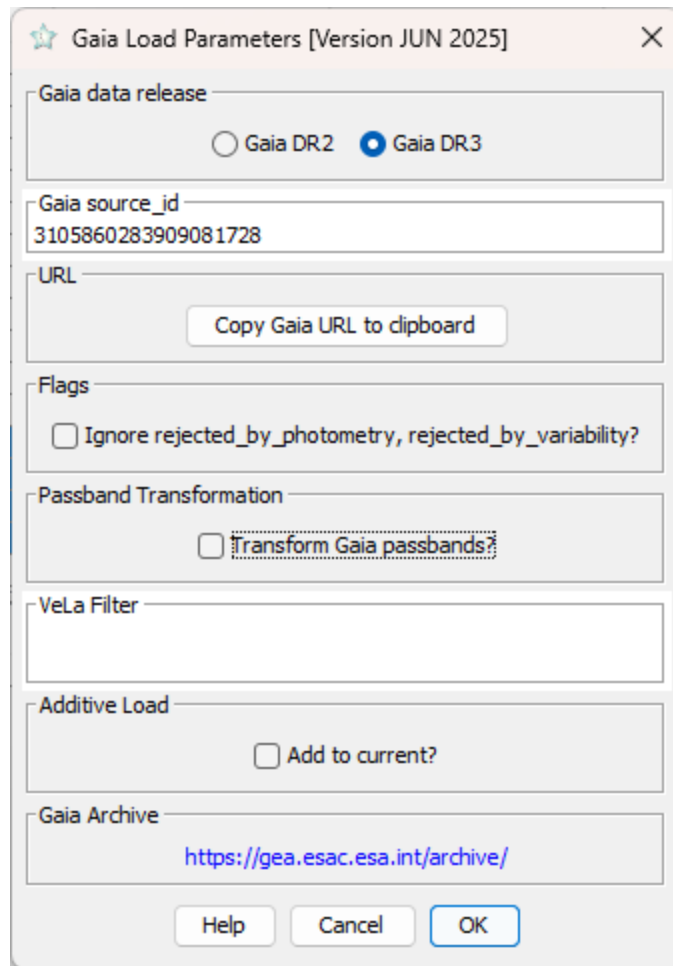


A more advanced approach might do a proximity search using equatorial coordinates and specifying the variable flag equal to "VARIABLE" in the Extra Conditions section.

[Using the Gaia Plugin](#)

The Gaia plugin is installed like any other as described here.

Select "New star from Gaia DR2/DR3 Photometry" on the VStar file menu to open the dialog box.



The image shows a software dialog box titled "Gaia Load Parameters [Version JUN 2025]". It contains several sections for configuring data loading:

- Gaia data release:** Two radio buttons, "Gaia DR.2" and "Gaia DR.3". "Gaia DR.3" is selected.
- Gaia source_id:** A text field containing the value "3105860283909081728".
- URL:** A text field with a "Copy Gaia URL to clipboard" button below it.
- Flags:** A checkbox labeled "Ignore rejected_by_photometry, rejected_by_variability?".
- Passband Transformation:** A checkbox labeled "Transform Gaia passbands?".
- VeLa Filter:** An empty text field.
- Additive Load:** A checkbox labeled "Add to current?".
- Gaia Archive:** A text field containing the URL "https://gea.esac.esa.int/archive/".

At the bottom are three buttons: "Help", "Cancel", and "OK".

Enter the **source_id** you obtained from the Gaia Archive. By default, the Gaia passbands will be represented in VStar as Blue, Green and Red for Gaia's BP, G and RP, respectively. If you would rather have the passbands transformed to V, Rc, Ic, and B¹ check the Passband Transformation box.

For the Gaia DR2 data, the transformation equations from <https://arxiv.org/pdf/1804.09368> (Appendix A) are used. For Gaia DR3, the relations from https://gea.esac.esa.int/archive/documentation/GDR3/Data_processing/chap_cu5pho/cu5pho_sec_photSystem/cu5pho_ssec_photRelations.html are applied.

You can also choose to add the light curve data to the existing VStar observations by checking the Additive Load box.

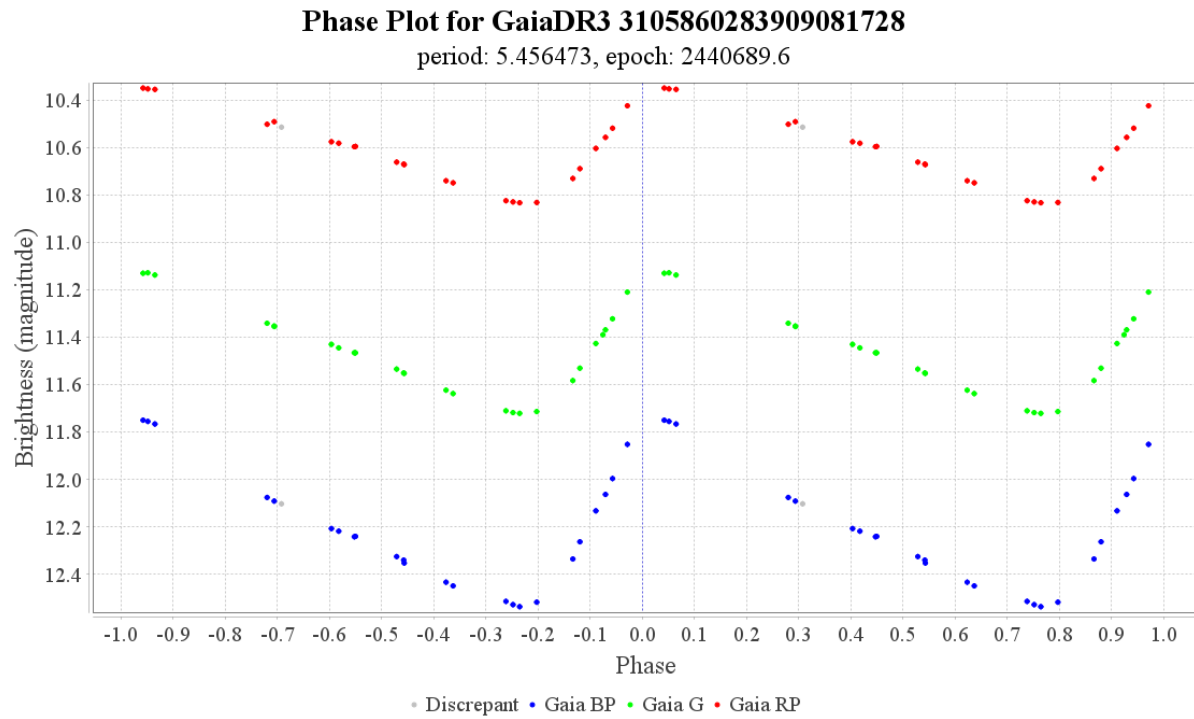
In order to transform the Gaia passbands, three observations in the Gaia passbands closely spaced in time must exist. Therefore, if transformation is selected, Gaia observations that do not occur in triples will be considered invalid and appear at the bottom of the VStar Observations tab. The Gaia variability processing may have marked some observations in the light curve as rejected for processing with the variability machine algorithms. These will be marked as Discrepant in VStar and appear with a gray

¹ Transformation to the B band is only possible for Gaia DR3.

color. If transformation is selected and any one of the three observations involved in the transformation are discrepant, then all three of the resulting V, R and I observations will be marked discrepant.

The observation time from Gaia is Barycentric Julian Date (BJD).

The phase diagram with Gaia DR3 data for the XX Mon is shown below:



Advanced Gaia Queries

You will likely want to perform more advanced queries against the Gaia DR3. The Advanced (ADQL) tab of the Gaia Archive provides access not only to the main Gaia table, but the tables created by the variability processing as well.

The screenshot shows the Gaia Archive website's Advanced (ADQL) query interface. At the top, there's a header with the European Space Agency (ESA) logo and navigation links. Below this is a dark red banner with the 'gaia archive' text and the ESA logo. A navigation bar contains links for HOME, SEARCH, SINGLE OBJECT, VISUALISATION, and HELP. The main interface has three tabs: Basic, Advanced (ADQL), and Query Results. The Advanced (ADQL) tab is active, showing a search bar with 'gaia' entered. To the left is a sidebar with a tree view of data categories: Other, Gaia Data Release 1, Gaia Data Release 2, Gaia Data Release 3 (expanded), Astrophysical parameters, Auxiliary, Cross match, Extra-galactic, Non-single stars, Performance verification, Reference frame, Science alerts, Simulation, Solar system, Spectroscopy, and Variability. Under Variability, several tables are listed, including 'gaiadr3.vari_classifier_re'. The main area has a 'Job name:' field, a 'Query examples' link, and a large text area for 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. At the bottom, there's a pagination bar showing '1-1 of 0' and a 'Download format:' dropdown set to 'VOTable'. Other controls include 'Apply jobs filter', 'Filter this session', 'Select all jobs' (checked), and 'Delete selected jobs'.

gaia

Job name:

Query examples

1

Ctrl+Space for query autocompletion

Reset Form Submit Query

No results found

Status	Job	Creation date	Num. rows	Size
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1-1 of 0

Download format: VOTable

Apply jobs filter Filter this session ☒ Select all jobs ☐ Delete selected jobs

(Cookie policy) (v3.2.1)

You can expand these tables to see the columns and data descriptions are easily accessed from here as well.

Rev	Date	Description
C	2025-06-17	Updated according to the last plugin's release (PMAK)
B	2023-04-02	Updated according to the last plugin's release (PMAK)
A	2020-11-01	Initial release (Cliff Kotnik)