

Authors: Miriam Cortés-Contreras, Enrique Solano. CAB (INTA-CSIC). Spanish Virtual Observatory (SVO), January 2022. Updated by Alba Aller, CAB (INTA-CSIC, SVO), October 2022.

NOTE: The tutorial has been tested using Firefox v89.0.2 (64-bit).

- **Scientific background:** Transients can be defined as astrophysical phenomena whose duration is significantly lower than the typical timescale of the stellar and galactic evolution (from seconds to years in contrast to millions or billions of years). Supernovae, novae, gamma-ray burst..., are some examples of transient events. In most cases, a fast, multiwavelength characterization is required to properly understand the true nature of the transient. Follow-up observations made by both professional and amateur astronomers using ground- and space-based facilities are key to achieve this goal.

Here we propose an alternative approach using the existing information in astronomical archives and benefiting from the advantages that the Virtual Observatory offers in terms of discovery, access and analysis of astronomical data. Using **TOPCAT**, **Vizier** and **SPLAT-VO**, and two services developed in the framework of the Spanish Virtual Observatory (**SVO Discovery Tool** and **VOSA**) we will validate and characterize a cataclysmic variable identified by the Gaia Science Alerts project. Cataclysmic variable stars (CVs) are interacting binary systems composed by a white dwarf that accretes material from a companion star. Because of its accreting nature, the system irregularly presents an important increase of brightness and then drop back down to a quiescent state.



Cataclysmic variable (source: Wikipedia)

## ■ Workflow:

1. **Target selection.** From the Gaia Science Alerts project we will select an object classified as “unknown” and suspect of being a cataclysmic variable:
  - Open your web browser and go to: <http://gsaweb.ast.cam.ac.uk/alerts/alertsindex>
  - In the search box (top right) type “Gaia19fdn”. This object has been classified as unknown and has the following statement under the *Comment* column: “Gaia source coincident with CV candidate brightens by more than 1 mag”.

Gaia Alerts Alerts Index All-Sky Alerts Search GaiaX Test Surveys-ATels Tools Documentation About Log In

## Index to Gaia Photometric Alerts

If you publish any results based on these Gaia discoveries, we would appreciate an acknowledgement along the lines of: "We acknowledge ESA Gaia, DPAC and the Photometric Science Alerts Team (<http://gsaweb.ast.cam.ac.uk/alerts/>)"

These are all the alerts raised to date. You might wish to view or download these as a table in CSV format or using any of the tools described in this page.

See [here](#) for an explanation of the columns.

Show 10 entries Search:

Name	TNS	Observed	RA (deg.)	Dec. (deg.)	Mag.	Historic mag.	Historic scatter	Class	Published	Comment	RVS
Gaia19fdn	AT2019vcr	2019-11-16 14:48:51	151.31404	19.18553	17.03	18.22	0.20	unknown	2019-11-18 14:26:12	Gaia source coincident with CV candidate brightens by more than 1 mag	

Showing 1 to 1 of 1 entries (filtered from 18,183 total entries)

Previous 1 Next

2015 - Institute of Astronomy, University of Cambridge, UK - Privacy policy

- Click on the name "gaia19fdn" (column "Name"). A new tab will open with a file card containing information like the coordinates and the magnitude variation over time.

2. **HR diagram.** Cataclysmic variables occupy the intermediate region in the Hertzsprung-Russell diagram (HRD) between the main sequence and the white dwarf locus.

We will draw our target in a HRD diagram using TOPCAT and the VizieR service.

- Obtaining the data:**
  - We will gather Gaia EDR3 data from the VizieR service. Open your web browser and go to <http://vizier.u-strasbg.fr/>
  - Write "Gaia" in the **Free text search** and click on the *Find catalogues* button.

Portal Smbad VizieR Aladin X-Match Other Help

### VizieR

VizieR provides the most complete library of published astronomical catalogues – tables and associated data – with verified and enriched data, accessible via multiple interfaces. Query tools allow the user to select relevant data tables and to extract and format records matching given criteria. Currently, 21460 catalogues are available [more info](#)

Free text search:

Position:


Go to the classic form

- Look for "Gaia DR3 Part 1. Main source (Gaia Collaboration, 2022)" in the list of results and click on the VizieR button to query the VizieR table.

Catalogue	Records	Description	Access					
I/324	1.223e+9	The Initial Gaia Source List (IGSL) (Smart, 2013)						
I/337	1.147e+9	Gaia DR1 (Gaia Collaboration, 2016)						
I/345	1.719e+9	Gaia DR2 (Gaia Collaboration, 2018)						
I/347	1.332e+9	Distances to 1.33 billion stars in Gaia DR2 (Bailer-Jones+, 2018)						
I/350	1.825e+9	Gaia EDR3 (Gaia Collaboration, 2020)						
I/352	1.468e+9	Distances to 1.47 billion stars in Gaia EDR3 (Bailer-Jones+, 2021)						
I/355	1.914e+10	Gaia DR3 Part 1. Main source (Gaia Collaboration, 2022)						

- The query returns several catalogues for Gaia DR3 Part 1. Click on the first one ([l/355/gaiadr3](#)).

**Catalog**


[Gaia DR3 is available in CDS](#)  
[Gaia DR3 in Vizier](#)

The Vizier service is now hosted by CDS domain (cds.uistra.fr). Please, modify your configuration for the new domain.

I/355	Gaia DR3 Part 1. Main source (Gaia Collaboration, 2022)	Similar Catalogs	2022yCat.1355...0G	ReadMe+ftp
<a href="#">l/355/gaiadr3</a>	<a href="#">acknowledge and cite Gaia DR3</a>		<a href="#">spectrum</a>	<a href="#">timeSerie</a>
<input type="checkbox"/> <a href="#">l/355/gaiadr3</a>	(c) Gaia data release 3 (Gaia DR3). (original column names in green) [timeSerie] (1811709771 rows)			<a href="#">spectrum</a>
<input type="checkbox"/> <a href="#">l/355/paramp</a>	(c) 1D astrophysical parameters produced by the Apsis processing chain developed in Gaia DPAC CU8 (1590932717 sources) (astrophysical_parameters) (original column names in green) (1590932717 rows)			
<input type="checkbox"/> <a href="#">l/355/paramsup</a>	(c) Additional parameters from the Apsis processing chain, compared to the main table astrophysical parameters, from modules that produce more than one result for a parameter (473020612 sources) (astrophysical_parameters_sup) (original column names in green) (473020612 rows)			
<input type="checkbox"/> <a href="#">l/355/tgextmap</a>	Total Galactic Extinction (TGE) map for extinction parameters A0 (original column names in green) (4177920 rows)			
<input type="checkbox"/> <a href="#">l/355/tgextopt</a>	Optimum version of the Total Galactic Extinction Map, derived from the table tgextmap.dat (total_galactic_extinction_map) at a single HELPix level 9 (3145728 rows)			
<input type="checkbox"/> <a href="#">l/355/oaaninfo</a>	Content of a Self-Organized Map calculated from a dataset composed by outliers by the Apsis module OA (oa_neuron_information) (original column names in green) (900 rows)			

- In the **Target Name** (resolved by Sesame) or **Position** box on top left, write the coordinates of the object: 151.31404 +19.18553. Then change the target dimension to 5 arcsec and click the **Submit** button.

[Simple Target](#) [List Of Targets](#) [Fast Xmatch with large catalogs or Simbad](#)

Target Name (resolved by Sesame) or Position:    Target dimension:

NOTE: The epoch used for the query is the original epoch of the table(s) ☒ Radius ☐ Box size

---

[Gaia DR3 Part 1. Main source \(Gaia Collaboration, 2022\)](#) [Similar Catalogs](#) [2022yCat.1355...0G](#) [ReadMe+ftp](#)

[acknowledge and cite Gaia DR3](#) [Post annotation](#) [spectrum](#) [timeSerie](#)

[l/355/gaiadr3](#) Gaia data release 3 (Gaia DR3). (original column names in green) [timeSerie] (1811709771 rows) [spectrum](#)

---

[Simple Constraint](#) [List Of Constraints](#) **Submit** [Reset All](#)

Query by [Constraints](#) applied on Columns (Output Order: ☒ + ☐ -)

Standard ☒ Original ☐

Show	Sort	Column	Clear	Constraint	Explain (UCD)
<input type="checkbox"/>	<input type="radio"/>	DR3Name		(char)	Unique source designation (unique across all Data Releases) (designation) (meta.id)
<input checked="" type="checkbox"/>	<input type="radio"/>	RA_ICRS		deg	(i) Right ascension (ICRS) at Ep=2016.0 (ra) (pos.eq.ra:meta.main)
<input checked="" type="checkbox"/>	<input type="radio"/>	DE_ICRS		deg	(i) Declination (ICRS) at Ep=2016.0 (dec) (pos.eq.dec:meta.main)
<input type="checkbox"/>	<input type="radio"/>	SolID			Solution Identifier (solution_id) (meta.version)
<input checked="" type="checkbox"/>	<input type="radio"/>	Source			(i) Unique source identifier (unique within a particular Data Release) (source_id) (meta.id:meta.main)
<input type="checkbox"/>	<input type="radio"/>	RandomI			Random index for use when selecting subsets (random_index) (meta.code)
<input checked="" type="checkbox"/>	<input type="radio"/>	e_RA_ICRS		mas	Standard error of right ascension (ra_error) (stat.error:pos.eq.ra)
<input checked="" type="checkbox"/>	<input type="radio"/>	e_DE_ICRS		mas	Standard error of declination (dec_error) (stat.error:pos.eq.dec)
<input checked="" type="checkbox"/>	<input type="radio"/>	Plx		mas	(n)(i) Parallax (parallax) (pos.parallax.trig)

- Launch TOPCAT: If you downloaded the Jar file, open a terminal and type: `java - jar topcat-full.jar &` ; if you have the MacOS installation, open the TOPCAT application.
- Back to VizierR, on the top right corner of the results' page, you will see the text **Send to VO tools**. Click on the antenna icon below the text. A SAMP Hub Security window will pop-up. Click on **Yes** to authorize the connection. Then click on **Broadcast** button near the antenna in the VizierR window. A table named "gaiadr3" will be loaded in TOPCAT.

The 2 columns in **color** are computed by VizieR, and are **not part of the original data**.

[I/355/gaiadr3](#) Gaia DR3 Part 1. Main source (Gaia Collaboration, 2022)  
[Post annotation](#) Gaia data release 3 (Gaia DR3). (original column names in green) (1811709771 rows)

[start AladinLite](#) [plot the output](#) [query using TAP/SQL](#)

Full	RA	ICRS	DE	ICRS	Source	e RA	ICRS	e DE	ICRS	Plx	e Plx	PM	pmRA	e pmRA	pmDE	e pmDE	RUWE	FG
	deg		deg			mas		mas		mas	mas	mas/yr	mas/yr	( $\mu$ )	mas/yr	( $\mu$ )		c/s
151.31405347582		+19.18551111348		626719772406892288		0.1326		0.1415	2.9292	0.1693	13.378	-13.344	0.151	-0.962	0.133	1.025	1068.85368	1.53

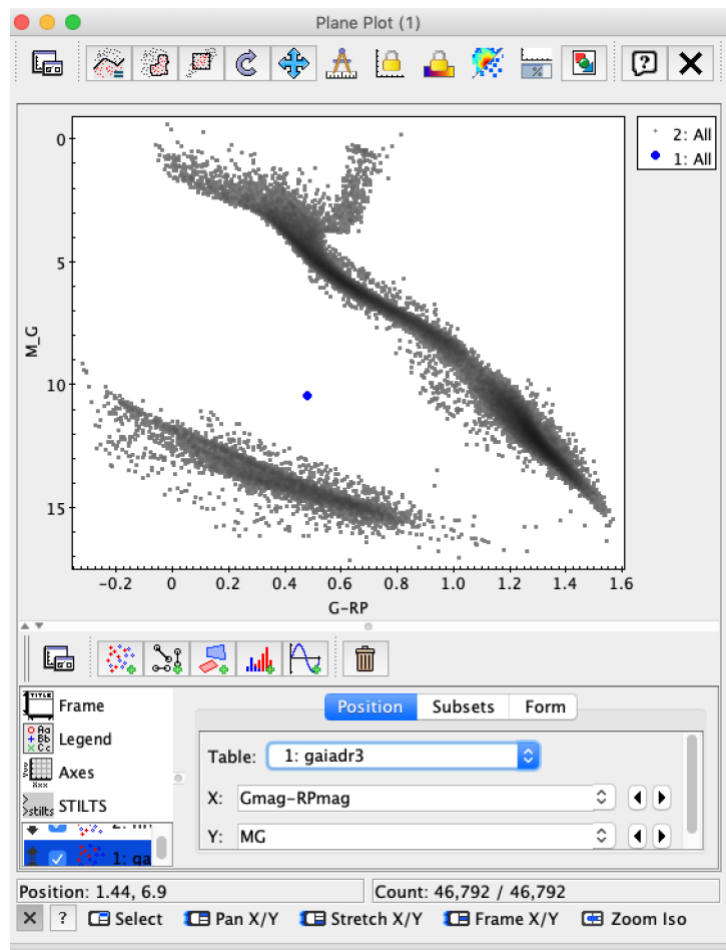
[plot the output](#) [query using TAP/SQL](#)

© Université de Strasbourg/CNRS  
 f t o Contact

- Download the file "[hrdiagram\\_dr3.xml](#)". It contains the astrometric solution for more than 46000 Gaia sources with good parallaxes and colours. We will use it as a reference for the HRD.

## ● Exploring the data:

- In TOPCAT, load the file "hrdiagram\_dr3.xml": **File** → **Load table** → **Filestore Browser**. Select the file and click OK. You will see the table loaded in the **Table List** box, to the left. By double clicking on it you can open the table to make a visual inspection of its content.
- To plot the HRD: **Graphics** → **Plane Plot** (or click on the 11<sup>th</sup> icon starting from the left). A new window will pop up.
  - Select your table "hrdiagram\_dr3.xml"
  - X axis will be (G-RP) (difference in magnitude in the Gaia G and RP bands)
  - Y axis: M\_G (absolute magnitude in the G band).
- On the left panel of this window, go to **Axes** → **Coords** and select **Y Flip**.
- The color of the sources can be changed in the **Plane Plot** window by clicking on the name of the plane (hrdiagram\_dr3.xml; it should be highlighted in blue), then click on **Subsets** (the tag in between *Position* and *Form*) and change the red color to, for instance, light gray.
- In order to overplot in this HRD the gaiadr3 source we need first to create a new column with the absolute magnitude in the G band. For this, we will proceed as follows:
  - Click on *gaiaedr3* in the Table List box of the TOPCAT main window (it should be highlighted in blue).
  - Views** → **Column info** (or click on the 6<sup>th</sup> icon starting from the left). A new window (Table columns) will pop up. Click on the first icon starting from the left (a green cross). A new window (define synthetic column) will pop up. Name it **MG** and write in the **Expression** box:
 
$$\text{Gmag} - 5 * \log_{10}(1000./\text{plx}) + 5$$
  - Click OK
- In the same Plane Plot window: **Layers** → **Add Position Control**. A new line will appear below the left box. In the frame to the right, select the table "gaiadr3" and plot (Gmag-RPmag) on the X axis and MG on the Y axis. The source lies between the main sequence and the white dwarf locus, as expected for a cataclysmic variable star.



2. **Spectral Energy Distribution (SED)**. Close binary stars of different effective temperature will present two differentiated distributions, one per each component in the system. We will now build the SED of our target using VOSA (VO SED Analyzer).
  - Open your web browser and go to: <http://svo2.cab.inta-csic.es/theory/vosa> Log in with your user and password if you already have an account. Complete the registration process, otherwise. To do that, click on *Register* and fill in the fields (e- mail address, name and password).
  - Create a single object data file typing the coordinates of the object in the RA and DEC boxes to the right. You can write the name of the object in the description box ("Gaia19fdn"). Click on the *Create* button.
    - RA: 151.31404
    - DEC: +19.18553



- Click the *Continue* link to keep going. You will be redirected to the initial page with this data file selected.
- Go to [Objects](#) → [Distances](#) tab to obtain the distance to the target. Keep the search radius at 5 arcsec. Click on *Search for Obj. Distances*. Distances from different catalogs will be shown. To make the Gaia DR3 distances the final ones, select them using the radio button on the right and click *Save Obj. Distances*. The distance and its error should appear boldfaced under the *Final* column.

**GAIA DR3 (viz)**

$\Delta$ (arcsec)	RA (deg)	DEC (deg)	Plx (mas)	$\Delta$ Plx (mas)	D (pc)	$\Delta$ Dis (pc)	
0.0828	151.31405347582	+19.18551111348	2.9292	0.1693	341.390	19.731	<input checked="" type="radio"/>

- Move to [Build SEDs](#) → [VO photometry](#). Here we will be able to look for photometric information of our objects in different VO archives and services. In order not to slow down too much the tutorial, click on *unmark All* and select only 2MASS, WISE, Gaia DR3 (CDS), Pan-Starrs PS1 DR2, and GALEX GR6+7. Then, click *Query selected services* at the bottom of the page. Once this is done, a summary table with the VO photometry (in flux units) will appear.
- Go to [Build SEDs](#) → [SED edit/visualize](#). This tag gives us the possibility of visualizing/modifying the SED before the model fitting. VOSA gathers from VO services not only the photometric information but also different metadata of interest (Object name, observing date and information on quality). In particular, VOSA uses the information on quality to automatically identify bad photometric points and remove them from the fitting (see next step). Upper limits are treated in a similar way. The user can manually override this selection of photometric points by ticking/unticking the appropriate boxes. For this use case, do not make any change in the SED edit/visualize section.

Files	Objects	Build SEDs	Analyse SEDs	HR Diag.	Results	Help
Stars and brown dwarfs (Change)			File: Gaia19fdn (info) (Change)			

VO Photometry

SED edit/visualize

### Object data

See object:

**obj\_151.31404\_+19.18553**

Position: (151.31404,+19.18553) Distance: 341.390 pc

Data for this object:

	Observed			Dereddened			Point Opts					Actions	
Filter	$\lambda_{\text{med}}$	Obs.Flux	$\Delta$ Obs.Flux	Flux	$\Delta$ Flux	$\Delta F/F$	In SED	NoFit	Uplim	Bad	Ignore	Delete	Source
GALEX/GALEX.FUV	1548.85	1.524e-15	1.321e-16	1.524e-15	1.321e-16	8.67e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	GALEX-GR6+7
GALEX/GALEX.NUV	2303.37	7.337e-16	4.180e-17	7.337e-16	4.180e-17	5.70e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	GALEX-GR6+7
PAN-STARRS/PS1.g	4810.16	2.081e-16	4.396e-18	2.081e-16	4.396e-18	2.11e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pan-Starrs PS1 DR2
GAIA/GAIA3.Gbp	5035.75	2.035e-16	8.578e-18	2.035e-16	8.578e-18	4.22e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Gaia DR3 (CDS)
GAIA/GAIA3.G	5822.39	1.421e-16	2.077e-18	1.421e-16	2.077e-18	1.46e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Gaia DR3 (CDS)
PAN-STARRS/PS1.r	6155.47	1.291e-16	1.151e-18	1.291e-16	1.151e-18	8.91e-3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pan-Starrs PS1 DR2
PAN-STARRS/PS1.i	7503.03	1.172e-16	5.181e-18	1.172e-16	5.181e-18	4.42e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pan-Starrs PS1 DR2
GAIA/GAIA3.Grp	7619.96	1.121e-16	7.816e-18	1.121e-16	7.816e-18	6.97e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Gaia DR3 (CDS)
PAN-STARRS/PS1.z	8668.36	1.026e-16	5.785e-18	1.026e-16	5.785e-18	5.64e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pan-Starrs PS1 DR2
PAN-STARRS/PS1.y	9613.60	1.159e-16	7.436e-18	1.159e-16	7.436e-18	6.42e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pan-Starrs PS1 DR2
2MASS/2MASS.J	12350.00	7.802e-17	1.028e-17	7.802e-17	1.028e-17	1.32e-1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2MASS
2MASS/2MASS.H	16620.00	6.215e-17	0.000e+00	6.215e-17	0.000e+00	0.00e+0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2MASS
2MASS/2MASS.Ks	21590.00	2.914e-17	5.234e-18	2.914e-17	5.234e-18	1.80e-1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2MASS
WISE/WISE.W1	33526.00	5.434e-18	2.152e-19	5.434e-18	2.152e-19	3.96e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WISE
WISE/WISE.W2	46028.00	2.190e-18	1.856e-19	2.190e-18	1.856e-19	8.47e-2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WISE
WISE/WISE.W3	115608.00	9.654e-19	0.000e+00	9.654e-19	0.000e+00	0.00e+0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WISE
WISE/WISE.W4	220883.00	1.763e-18	0.000e+00	1.763e-18	0.000e+00	0.00e+0	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WISE

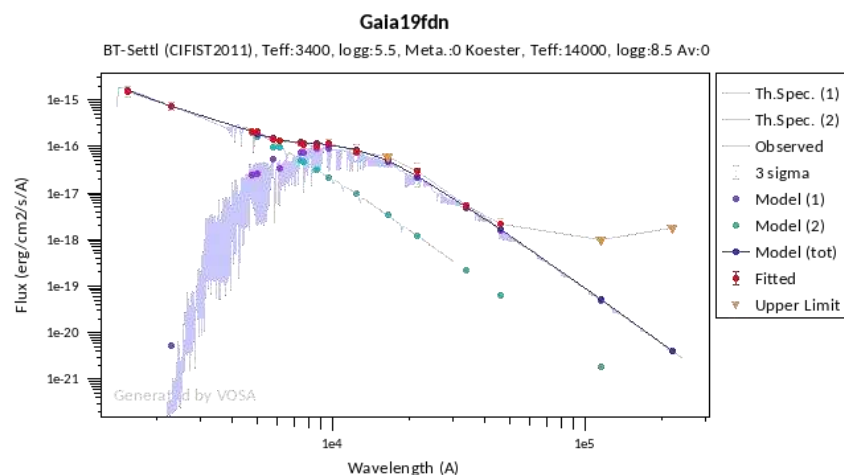
(Add a new point)

- Move to [Analyse SEDs](#) → [Binary Fit](#). Different grids of theoretical models covering different ranges of physical parameters are displayed. For this tutorial select the “Koester WD models” and “BT-Settl (CIFIST)” for fitting the white dwarf and the main sequence components of the system, respectively.

At the bottom of the page, in **Options for this fit**, select “Include model spectrum in fit plots? (The fit process will be slower, because getting the spectra from the VO can take some time)”. Click on *Next: Select model params* at the bottom of the page.

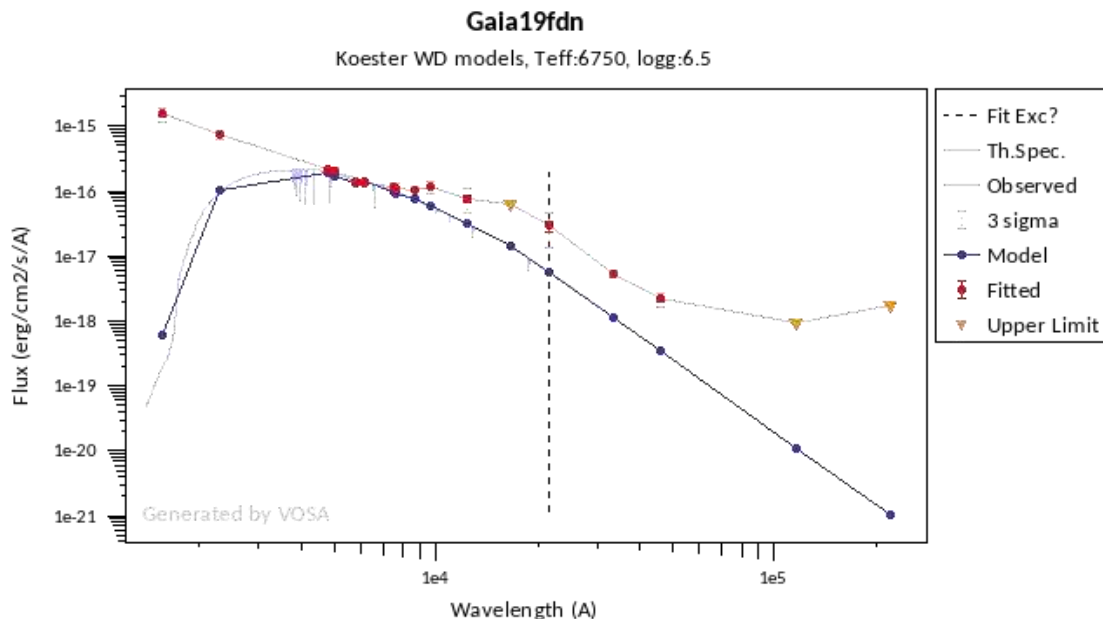
- To save time, for BT-Settl set the logg range to 4.5 – 5.5. For Koester set the temperatures range to 5000 – 15000 K. Click on *Next: Make the fit*.

A summary table will appear. Click on the *Show graphs* button above the table to see the SEDs plot.



Both components of the systems have been fitted with temperatures of 14000 K and 3400 K for the white dwarf and the low-mass star secondary, respectively.

- To see the importance of the binary fitting, try yourself by fitting only the white dwarf component. For this, move to the tab [Analyse SEDs → Chi-square Fit](#) instead and select the “Koester WD models” with the same parameter restrictions. The observational SED shows an infrared excess compared to the models due to the presence of the cool component and the estimated effective temperature (6750 K) comes from a poor SED fitting and does not represent the real temperature of the white dwarf.



3. [Search for spectroscopic information.](#) Cataclysmic variables show H $\alpha$  emission due to accretion. Let's look for spectra of our source in VO archives to see if this feature is present.

- Open your web browser and go to: <http://sdc.cab.inta-csic.es/SVODiscoveryTool/>. The SVO Discovery Tool will help you getting basic information like physical parameters and photometry in the VizieR service, as well as images and spectra in all the Virtual Observatory.
- Copy the coordinates of the object in the *List of object coordinates* box: 151.31404 +19.18553. Select the *Spectra* mark box under **VO Services** to obtain all available spectra of the target. Click on *Submit Query* at the bottom. A summary table shows that there are 27 spectra from the ESO spectra service. On the bottom table, click on the number 27 to list the spectra. They were taken with the X-Shooter instrument. You can download them by ticking them and clicking on *Download selected*. They will be saved in a zip file. But you can also keep the window open and launch SPLAT-VO.





## SVO DISCOVERY TOOL

List of object names  
(one line each)

List of object coordinates  
(RAJ2000, DEJ2000)  
(one line each)

Allowed format:

239.1667629 -22.0277814  
15:56:40.023 -22:01:40.01

Radius:  arcsec

### VO Services

- ☐ Images  
☒ Spectra

- Launch SPLAT-VO: Open a terminal and type `./splat-vo/bin/splat/splat &` (or the corresponding path in your local installation).

**IMPORTANT NOTE:** The latest version of SPLAT-VO (v3.15.1) was compiled with java 8 (Java SE 8 [1.8.0\_221]). Higher java versions may lead installation errors and/or malfunctioning of the application. Check your java version (`java -version`) and, if necessary, change it to java 8.

- Go back to the SVO Discovery Tool and locate the spectrum named “ADP.2015-03-03T11:28:24.310”. Click on *Send to SAMP Hub* to the right. A SAMP Hub Security window will pop-up. Click on Yes to authorize the connection. A new window will pop up in SPLAT-VO with the query of the spectrum. Note that, if other VO tools (TOPCAT, Aladin,...) are open, the spectrum will also send to them. It does not matter.
- Select the first line, which is the science spectrum (see the `eso_category` column) and click on *Download selected*. The spectrum will be loaded and listed in the *Global list of spectra* panel on the SPLAT-VO main window.

Starlink SPLAT-VO: Query VO for Spectra

File Options Resolver Interop Help

Search parameters:

Simple Query

Object:  Lookup

RA:  Dec:

Radius:  MAXDEC

Band:

Time:

Query Format:

Wavelength calibration:

Flux calibration:

Optional Parameters

Use:  Name:  Value:  UCD:

Query: <SERVO>REQ:EST=queryData5/5/27=0.16656969566666

Query results:

id	name	access_url	service_def	error_message	semantics	description	content_type	content_length
1	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
2	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
3	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
4	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
5	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
6	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
7	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
8	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
9	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624
10	ADP.2015-03-03T11:28:24.310	https://archive.eso.org/data/...	ADP_2015		#image	cutout of the requested	application/x-sinkable	134624

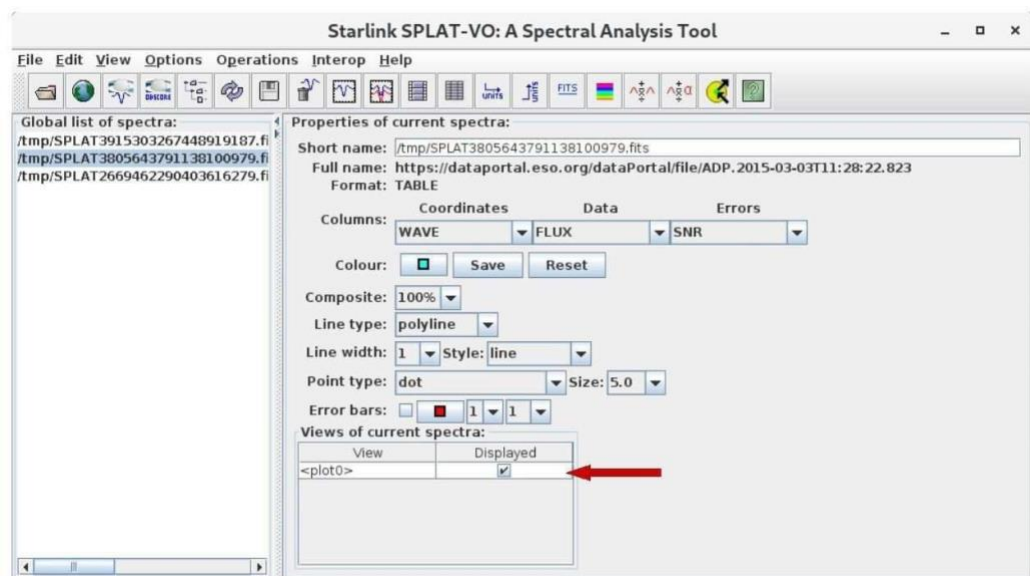
Display selected Display all Download selected Download all Deselect table Deselect all Data link Services

Select all Deselect all

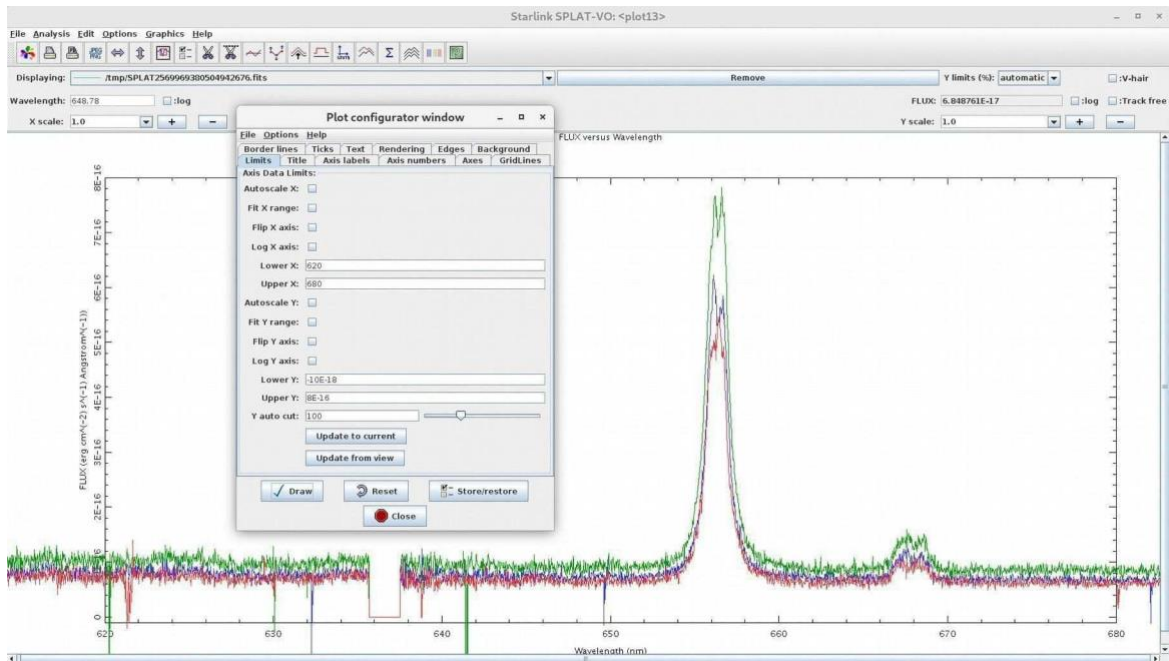
Query results... Add New Ser...

Save query results Restore query results Close

- Repeat the same steps to load these two spectra: ADP.2015-03-03T11:28:22.823 and ADP.2015-03-03T11:28:24.993. When you are done, if you wish, you can close the auxiliary window “Starlink SPLAT-VO: Query for VO spectra”.
- In the SPLAT-VO main window, select the first spectrum and open it: [View](#) → [Display in new plots](#) (or double click on the name of the spectrum). A new window will pop-up with the spectrum.
- Again in the SPLAT-VO main window, select the second spectrum. In the right side of the window, at the bottom, you will see a table that lists the active plots. Tick the box under *Displayed* to display it together with the previous spectrum. Do the same with the third spectrum. You can change the colour of the displayed spectrum in this same panel, under the selection of columns to be displayed.



- Go to the plot window. Go to [File](#) → [Configure](#) (or click on the 8<sup>th</sup> icon from the left). A new window will pop-up. Untick the *Autoscale X* and *Autoscale Y* boxes and change the wavelength and flux ranges. Then click on the *Draw* button.
  - Lower X = 620
  - Upper X = 680
  - Lower Y = -10E-18
  - Upper Y = 8E-16



This is the H $\alpha$  emission line at 656.28 nm, which shows strong variability associated to the accreting process typical of cataclysmic variables.