

Transient characterization using the Virtual Observatory

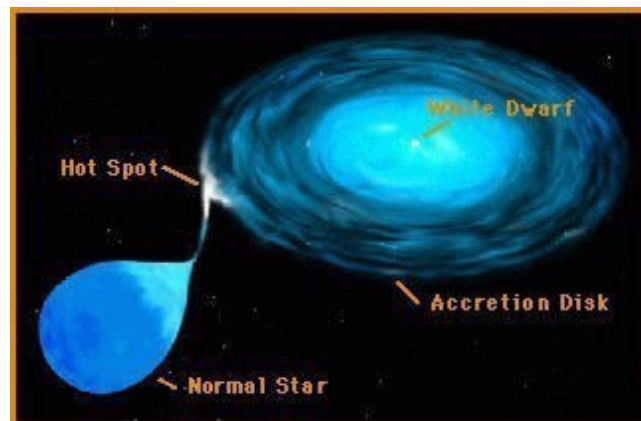
Authors: Miriam Cortés-Contreras, Enrique Solano. CAB (INTA-CSIC). Spanish Virtual Observatory (SVO).

27th January 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 Simbad 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 EDR3 (Gaia Collaboration, 2020)" in the list of results and click on the VizieR button to query the VizieR table.

Catalogue	Records	Description	Access
I/324 <input type="button" value="Q"/>	1.223e+9	The Initial Gaia Source List (IGSL) (Smart, 2013)	<input type="button" value="VizieR"/> <input type="button" value="Ftp"/> <input type="button" value="ReadMe"/> <input type="button" value="TAP"/> <input type="button" value="Xmatch"/>
I/337 <input type="button" value="Q"/>	1.147e+9	Gaia DR1 (Gaia Collaboration, 2016)	<input type="button" value="VizieR"/> <input type="button" value="Ftp"/> <input type="button" value="ReadMe"/> <input type="button" value="TAP"/> <input type="button" value="Xmatch"/>
I/345 <input type="button" value="Q"/>	1.719e+9	Gaia DR2 (Gaia Collaboration, 2018)	<input type="button" value="VizieR"/> <input type="button" value="Ftp"/> <input type="button" value="ReadMe"/> <input type="button" value="TAP"/> <input type="button" value="Xmatch"/>
I/347 <input type="button" value="Q"/>	1.332e+9	Distances to 1.33 billion stars in Gaia DR2 (Bailer-Jones+, 2018)	<input type="button" value="VizieR"/> <input type="button" value="Ftp"/> <input type="button" value="ReadMe"/> <input type="button" value="TAP"/> <input type="button" value="Xmatch"/>
I/350 <input type="button" value="Q"/>	1.825e+9	Gaia EDR3 (Gaia Collaboration, 2020)	<input type="button" value="VizieR"/> <input type="button" value="Ftp"/> <input type="button" value="ReadMe"/> <input type="button" value="TAP"/> <input type="button" value="Xmatch"/>

- The query returns five catalogues for Gaia EDR3. Click on the first one

(l/350/gaiaedr3).

Simple Target **List Of Targets** Fast Xmatch with large catalogs or Simbad

Target Name (resolved by Sesame) or Position: Clear J2000 2 arcmin

Target dimension: 2 arcmin

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

l/350 Gaia EDR3 (Gaia Collaboration, 2020) [acknowledge and cite Gaia EDR3](#) [Similar Catalogs](#) [2020yCat.1350....0G](#) [ReadMe+ftp](#)

l/350/gaiaedr3 Post annotation

1. **l/350/gaiaedr3** (c) Gaia data early release 3 (Gaia EDR3). (Download all Gaia Sources as VOTable, FITS or CSV [here](#). Query from the command line using [find_gaia_edr3](#) available in cdsclient [here](#))
(original column names in green) (1811709771 rows)
2. **l/350/agncriid** AGN cross-identifications (AgnCrossId.csv) (original column names in green) (1614173 rows)
3. **l/350/tyc2tdsc** (c) Tycho-2 merged with the TDSC catalog and TDSC supplement (2561887 rows)
4. **l/350/comscanl** (c) *Representation of the Gaia scanning law over the 34 month time period covered by the Gaia Data Release 3 (original column names in green) (Note) (8967691 rows)
5. **l/350/frames** Sources used to compute the Gaia reference frame (FrameRotatorSource.csv) (original column names in green) (429249 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: Clear 151.31404 19.18553 J2000 5 arcsec

Target dimension: 5 arcsec

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

l/350 Gaia EDR3 (Gaia Collaboration, 2020) [acknowledge and cite Gaia EDR3](#) [Similar Catalogs](#) [2020yCat.1350....0G](#) [ReadMe+ftp](#)

l/350/gaiaedr3 Post annotation

1. **l/350/gaiaedr3** Gaia data early release 3 (Gaia EDR3). (Download all Gaia Sources as VOTable, FITS or CSV [here](#). Query from the command line using [find_gaia_edr3](#) available in cdsclient [here](#))
(original column names in green) (1811709771 rows)

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"/>	EDR3Name	<input type="text"/>	(char)	Unique source designation (unique across all Data Releases) (designation) (Note 1) (meta.id)
<input checked="" type="checkbox"/>	<input type="radio"/>	RA_ICRS	<input type="text"/>	deg	(i) Barycentric right ascension of the source (ICRS) at Ep=2016.0 (ra) (pos.eq.ra;meta.main)
<input checked="" type="checkbox"/>	<input type="radio"/>	e_RA_ICRS	<input type="text"/>	mas	Standard error $e_{RA} = e_{RA} \cos DE$ of the right ascension of the source in ICRS at Ep=2016.0 (ra_error) (stat.error;pos.eq.ra)
<input checked="" type="checkbox"/>	<input type="radio"/>	DE_ICRS	<input type="text"/>	deg	(i) Barycentric declination of the source (ICRS) at Ep=2016.0 (dec) (pos.eq.dec;meta.main)
<input checked="" type="checkbox"/>	<input type="radio"/>	e_DE_ICRS	<input type="text"/>	mas	Standard error of the declination of the source in ICRS at at Ep=2016.0 (dec_error) (stat.error;pos.eq.dec)
<input checked="" type="checkbox"/>	<input type="radio"/>	Source	<input type="text"/>		(i) Unique source identifier (unique within a particular Data Release) (source_id) (Note 2)

- 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 "gaiaedr3" will be loaded in TOPCAT.

VizierR Send to VO tools

Search Criteria Show the target form Show constraint information

The 14 columns in color are computed by VizierR, and are not part of the original data (note that the computed coordinates are computed from the positions and the proper motions given in the table)

l/350/gaiaedr3 Gaia EDR3 (Gaia Collaboration, 2020) [2020yCat.1350....0G](#) [ReadMe+ftp](#)

l/350/gaiaedr3 Post annotation

Gaia data early release 3 (Gaia EDR3). (Download all Gaia Sources as VOTable, FITS or CSV [here](#). Query from the command line using [find_gaia_edr3](#) available in cdsclient [here](#))

(original column names in green) (1811709771 rows)

☒ start AladinLite ☒ plot the output ☒ query using TAP/SOL

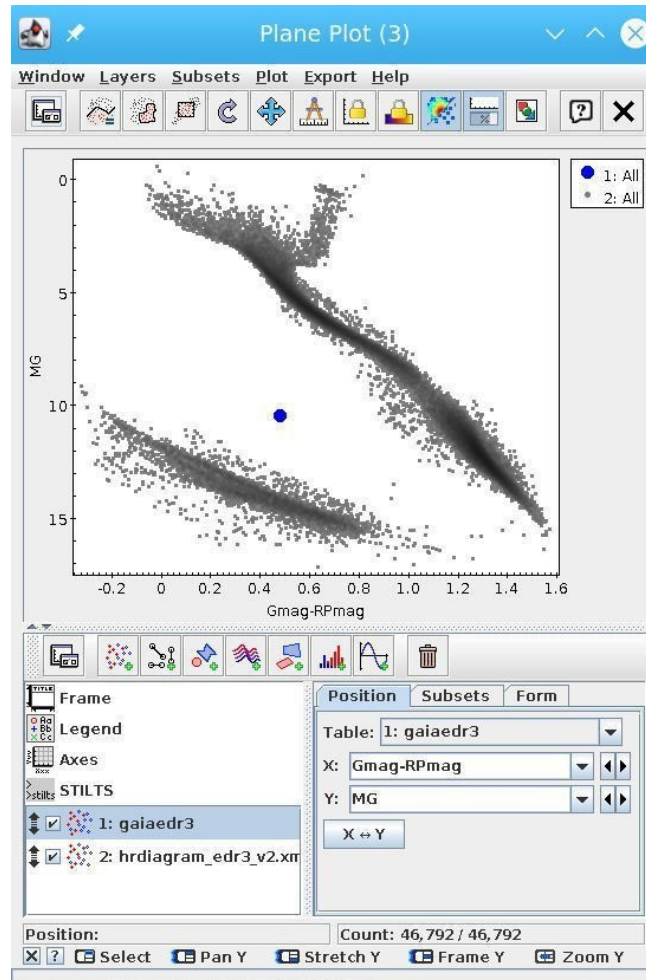
Full	RA_ICRS	e_mas	DE_ICRS	e_mas	Source	Plx	e_mas	PM	pmRA	e_mas	pmDE	e_mas	RUWE	FG	e_mas	Gmag	e_mag	FBP	e_mas
151.31405347582	0.1326	+19.18551111348	0.1415	626719772406892288	2.9292	0.1693	13.378	-13.344	0.151	-0.962	0.133	1.025	1.0689e+03	1.5385e+01	18.115070	0.015869	6.8137e+02	2.8673e+01	

- Download the file "[hrdiagram.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_edr3_v2.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 11th icon starting from the left). A new window will pop up.
 - Select your table "hrdiagram_edr3_v2.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_edr3_v2.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 gaiaedr3 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 6th 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:

$$Gmag-5*\log10(1000./plx)+5$$
 - Click OK
- In the same Plane Plot window: [Layers](#) → [Add Position Control](#). In the frame to the right, select the table "gaiaedr3" 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

Upload your own data file (max size = 50Mb)

It must comply with the required format (you can download some examples of input files). A small utility is also available to help you to convert an original file in ascii (csv) or vortable to VOSA input format. You can also use SpecPhot to get photometric information in VOSA input format from a spectrum / list of spectra.

File to upload: No file selected.

Description:

File type: ☒ Fluxes (erg/cm²/Å) ☐ Fluxes (Jy) ☐ Magnitudes

SED plots: (Å)

Create a single object data file

Just write the coordinates (in decimal degrees) of one object that you want to study and we will create a single object data file with the adequate format. RA and DEC are compulsory.

RA: (deg)

DEC: (deg)


Obj Name:


SED plots: (Å)

- 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 EDR3 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.

Object			Final		User		GAIA eDR3 (viz)							
Name	RA (deg)	DEC (deg)	Dis (pc)	ΔDis (pc)	D (pc)	ΔDis (pc)	Δ (arcsec)	RA (deg)	DEC (deg)	Plx (mas)	ΔPlx (mas)	D (pc)	ΔDis (pc)	
Gaia19fdn	151.31404	19.18553	---	---	<input type="text" value="---"/>	<input type="text" value="---"/>	<input type="radio"/>	0.0828	151.31405347582	+19.18551111348	2.9292	0.1693	341.390	19.731

Save Obj. Distances





- 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 EDR3 (Vizier), 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.

FilesObjectsBuild SEDsAnalyse SEDsHR Diag.ResultsHelp

Stars and brown dwarfs (Change)File: Transiente tutorial (info) (Change)

VO PhotometrySED edit/visualize

Object data

See object: Gaia19fdn excess See all

Gaia19fdn

Position: (151.31405347582,19.18551111348) Distance: 341.390 pc

Data for this object:

Send final SED to SAMP Hub

Filter	λ_{med}	Observed		Dereddened		$\Delta F/F$	In SED	Point Opts				Delete	Source	RA (VO)
		Obs.Flux	Δ Obs.Flux	Flux	Δ Flux			NoFit	Uplim	Bad	Ignore			
GALEX/GALEX.FUV	1549.02	1.524e-15	1.321e-16	1.524e-15	1.321e-16	8.67e-2	✓						GALEX-GR6+7	151.31420800
GALEX/GALEX.NUV	2304.74	7.328e-16	4.175e-17	7.328e-16	4.175e-17	5.70e-2	✓						GALEX-GR6+7	151.31420800
PAN-STARRS/PS1.g	4810.88	2.114e-16	4.466e-18	2.114e-16	4.466e-18	2.11e-2	✓						Pan-Starrs PS1 DR2	151.31405772
GAIA/GAIA3.Gbp	5035.75	2.035e-16	8.578e-18	2.035e-16	8.578e-18	4.22e-2	✓						Gaia eDR3 (viz)	151.31405347582 +
GAIA/GAIA3.G	5822.39	1.421e-16	2.077e-18	1.421e-16	2.077e-18	1.46e-2	✓						Gaia eDR3 (viz)	151.31405347582 +
PAN-STARRS/PS1.r	6156.36	1.310e-16	1.168e-18	1.310e-16	1.168e-18	8.91e-3	✓						Pan-Starrs PS1 DR2	151.31405772
PAN-STARRS/PS1.i	7503.68	1.182e-16	5.224e-18	1.182e-16	5.224e-18	4.42e-2	✓						Pan-Starrs PS1 DR2	151.31405772
GAIA/GAIA3.Grp	7619.96	1.121e-16	7.816e-18	1.121e-16	7.816e-18	6.97e-2	✓						Gaia eDR3 (viz)	151.31405347582 +
PAN-STARRS/PS1.z	8668.56	1.027e-16	5.792e-18	1.027e-16	5.792e-18	5.64e-2	✓						Pan-Starrs PS1 DR2	151.31405772
PAN-STARRS/PS1.y	9613.45	1.162e-16	7.458e-18	1.162e-16	7.458e-18	6.42e-2	✓						Pan-Starrs PS1 DR2	151.31405772
2MASS/2MASS.J	12350.00	7.802e-17	1.028e-17	7.802e-17	1.028e-17	1.32e-1	✓						2MASS	151.31428200
2MASS/2MASS.H	16620.00	6.215e-17	0.000e+00	6.215e-17	0.000e+00	0.00e+0	✓						2MASS	151.31428200
2MASS/2MASS.Ks	21590.00	2.914e-17	5.234e-18	2.914e-17	5.234e-18	1.80e-1	✓						2MASS	151.31428200
WISE/WISE.W1	33526.00	5.434e-18	2.152e-19	5.434e-18	2.152e-19	3.96e-2	✓						WISE	151.314045300
WISE/WISE.W2	46028.00	2.190e-18	1.856e-19	2.190e-18	1.856e-19	8.47e-2	✓						WISE	151.314045300
WISE/WISE.W3	115608.00	9.654e-19	0.000e+00	9.654e-19	0.000e+00	0.00e+0	✓						WISE	151.314045300
WISE/WISE.W4	220883.00	1.763e-18	0.000e+00	1.763e-18	0.000e+00	0.00e+0	✓						WISE	151.314045300

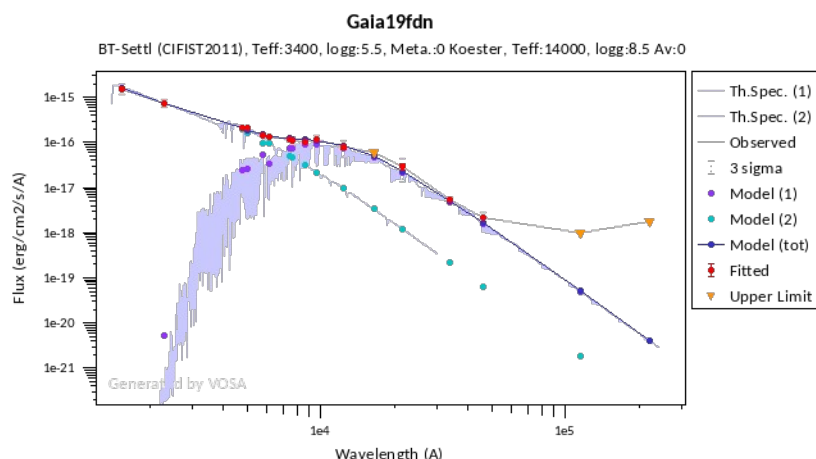
Apply changes

- 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.

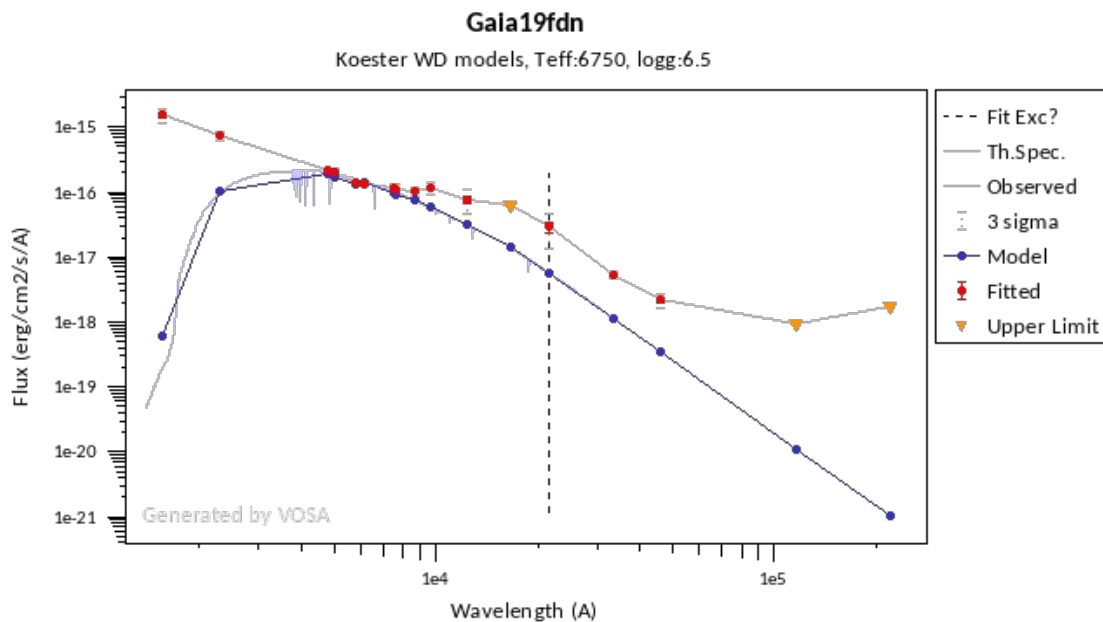
- To save time, for BT-Settl set the logg range to 4.5 – 5.5. For Koester set the temperatures range to 5000 – 15000 K. Click on *Next: Make the fit*.

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 α 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)

151.31404 +19.18553

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

Search parameters:
Single Query

Object: Lookup Clear

Radius: MAXRCI

Band:

Time:

Query Format:

Wavelength calibration:

Flux calibration:

Query: <SERVER>REQ=QUERYDATA&SZZ=0.16656565656565656

Optional Parameters

Use	Name	Value	UCD
<input type="checkbox"/>			

Select all Deselect all Update

Query results:

id	access_url	service_def	error_message	status	semantics	description	content_type	content_length
1	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
2	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
3	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
4	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
5	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
6	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
7	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
8	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
9	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000
10	vo/eso.org/ADP.2015-03-03T11:28:24.310	ADP.2015-03-03T11:28:24.310		success	science	cutout of the requested application=fts-intable	application=fts-intable	139000

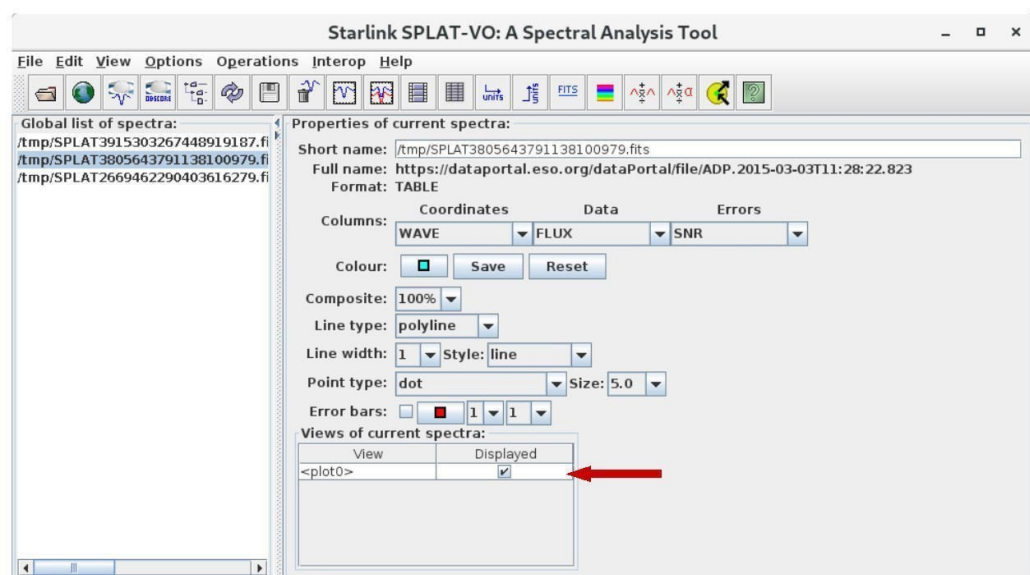
Display selected Display all Download selected Download all Deselect table Deselect all Data link Services

Select all Deselect all

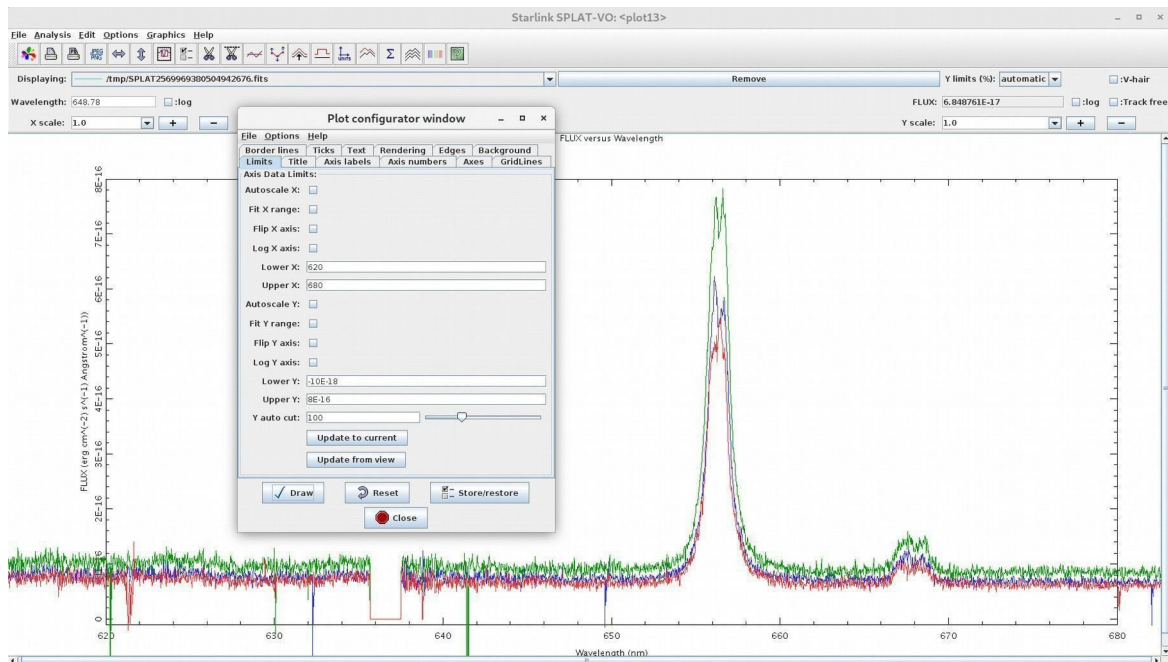
Query results: Add New Ser...

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 8th 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 α emission line at 656.28 nm, which shows strong variability associated to the accreting process typical of cataclysmic variables.