

TOPCAT and Gaia DR3

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Outline

TOPCAT

- Very short intro

Accessing Gaia Data from TOPCAT

- Database Queries (TAP/ADQL)
- Sky Region (Cone Search)
- Catalogue matching (CDS X-Match, TAP Upload, Pair match, pre-calculated)
- Ancillary Data (DataLink, Activation Actions)

DR3 Examples (*TOPCAT \geq v4.8-7 recommended if you try this at home*)

- Cluster identification using Proper Motions
- Galactic Extinction Map
- QSO Candidates
- XP Sampled spectra

TOPCAT

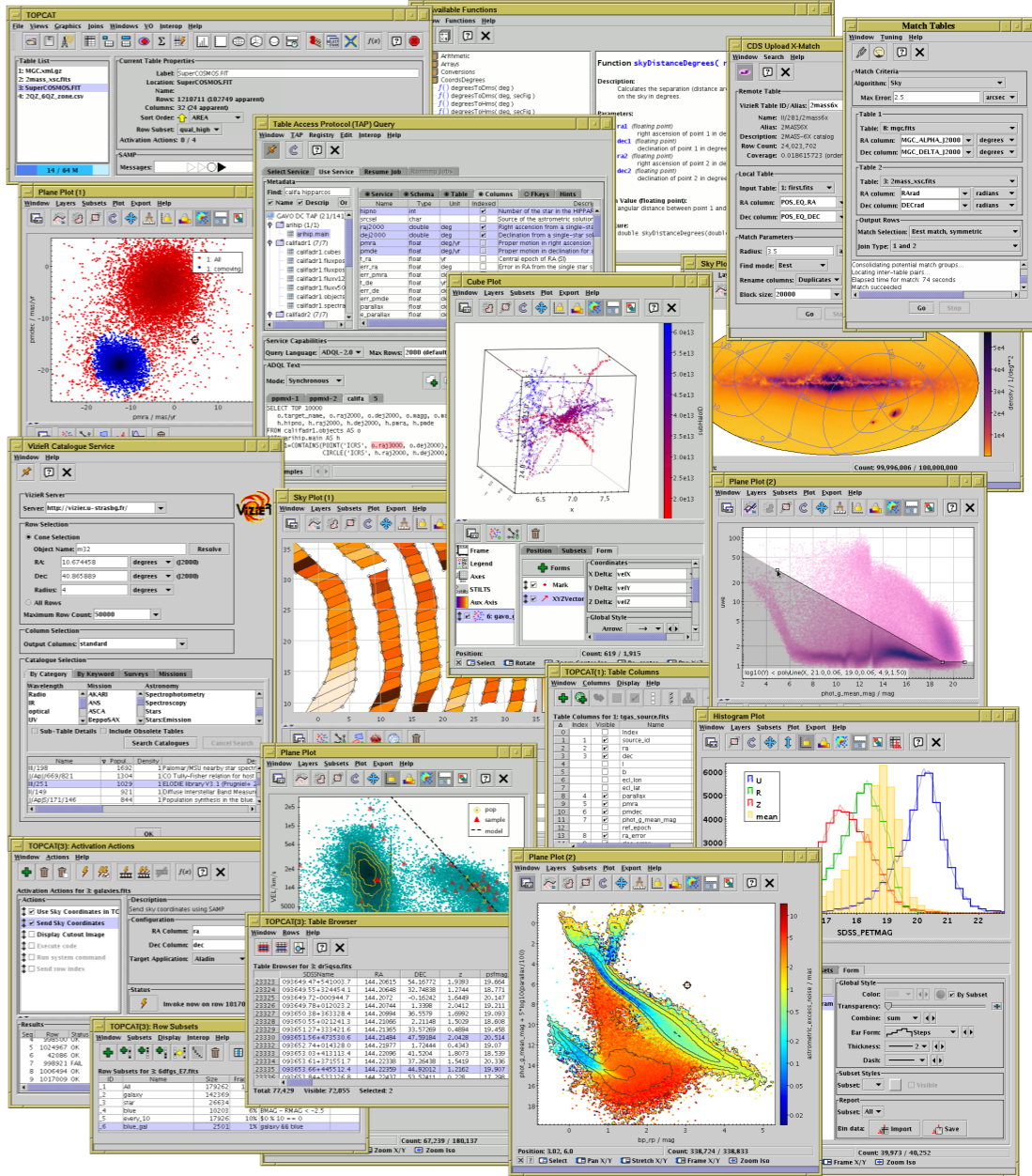
TOPCAT = Tool for OPERations on Catalogues And Tables

Capabilities:

- Does things with tables:
 - ▶ I/O, viz, selections, calculations, matching, ...
- Few Gaia-specific features ...
- ... but talks to the *Virtual Observatory*

See also STILTS

- Command-line/scriptable access to all TOPCAT capabilities (and more)



Data Access

There are lots of ways to get Gaia data!

Accessing DR3 data products from TOPCAT:

- Main `gaia_source` table:
 - ▷ Database query: TAP window
 - ▷ Positional query: Cone search window
 - ▷ Join with local data: X-Match window
- Other tables in database:
 - ▷ Database query: TAP window
 - ▷ Full table download (small-ish tables): Vizier window
- Ancillary tables:
 - ▷ DataLink access: Activation window
 - ▷ Database query (some services): TAP window

... or download externally, then load into TOPCAT

- ESA TAP web interface
- Bulk ECSV downloads

Full Database Access: TAP/ADQL



TOPCAT TAP window

- Browse column/table metadata
- Results loaded directly into topcat
- ADQL syntax highlighting
- ADQL editing features (multi-tab, undo/redo)
- Integrated table upload (`TAP_UPLOAD.t<n>` syntax)

DR3 has lots of tables!

Available TAP services:

- ESA Gaia catalogue
- ARI-Gaia
- GAVO DC
- VizieR
- ... and many more with (and without) Gaia data

The screenshot shows the 'Table Access Protocol (TAP) Query' window. The 'Metadata' section is active, displaying a list of tables on the left and a detailed view of the 'gaiadr3.gaia_source' table on the right. The table view includes columns for Name, Type, Unit, and Desc. Below the metadata, the 'Service Capabilities' section shows 'Query Language: ADQL-2.0', 'Max Rows: 3000000 (default)', and 'Uploads: 100Mb'. The 'ADQL Text' section contains a query: `SELECT TOP 100000 designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag, phot_g_mean_mag+5*log10(parallax/100) AS mag_g FROM gaiadr3.gaia_source WHERE parallax > 10 AND parallax_over_error > 10 AND astrometric_excess_noise < 1`. A 'Run Query' button is visible at the bottom.

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Table Access Protocol (TAP) Query

Window TAP Registry Edit Interop Help

Select Service Use Service Resume Job Running Jobs

Metadata

Find:

Name Descrip Or

Service	Schema	Table	Columns	FKeys	Hints
		Name	Type	Δ Unit	Desc
		rv_template_fe_h	float	'dex'	[Fe/H] of the template used
		mh_gspphot	float	'dex'	Iron abundance from GSP-PH
		mh_gspphot_lower	float	'dex'	Lower confidence level (16%
		mh_gspphot_upper	float	'dex'	Upper confidence level (84%
		phot_g_mean_flux	double	'electron'.s**1	G-band mean flux
		phot_g_mean_flux_error	float	'electron'.s**1	Error on G-band mean flux
		phot_bp_mean_flux	double	'electron'.s**1	Integrated BP mean flux
		phot_bp_mean_flux_error	float	'electron'.s**1	Error on the integrated BP m
		phot_rp_mean_flux	double	'electron'.s**1	Integrated RP mean flux
		phot_rp_mean_flux_error	float	'electron'.s**1	Error on the integrated RP m
		rv_template_teff	float	K	Teff of the template used to
		teff_gspphot	float	K	Effective temperature from G
		teff_gspphot_lower	float	K	Lower confidence level (16%
		teff_gspphot_upper	float	K	Upper confidence level (84%
		rv_time_duration	float	d	Time coverage of the radial v
		ra	double	deg	Right ascension

Service Capabilities

Query Language: ADQL-2.0 Max Rows: 3000000 (default) Uploads: 100Mb

ADQL Text

Mode: Synchronous

```
SELECT TOP 100000
  designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
  phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
  AND parallax_over_error > 10
  AND astrometric_excess_noise < 1
```

Run Query

Full Database Access: TAP/ADQL



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The screenshot shows the 'Table Access Protocol (TAP) Query' window. It features a menu bar (Window, TAP, Registry, Edit, Interop, Help) and a toolbar with icons for search, refresh, help, and close. Below the menu is a tabbed interface with 'Select Service', 'Use Service', 'Resume Job', and 'Running Jobs'. The 'Metadata' section is active, displaying a tree view of tables on the left and a table of columns on the right. The columns table has columns for Name, Type, Unit, and Desc. Below the metadata is the 'Service Capabilities' section, which includes 'Query Language: ADQL-2.0', 'Max Rows: 3000000 (default)', and 'Uploads: 100Mb'. The 'ADQL Text' section shows a query in a text area with a toolbar above it. The query is:

```
SELECT TOP 100000
  designation, source_id, ra, deg, parallax, bp_rp, phot_g_mean_mag,
  phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
  AND parallax_over_error > 10
  AND astrometric_excess_noise < 1
```

 At the bottom of the window is a 'Run Query' button.

Full Database Access: TAP/ADQL



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Table Access Protocol (TAP) Query

Window TAP Registry Edit Interop Help

Select Service Use Service Resume Job Running Jobs

Metadata

Find: gold

Name Descrip Or

GAIA (6/227)

- gaiadr3 (6/88)
 - gaiadr3.gold_sample_carbon_stars
 - gaiadr3.gold_sample_fgkm_stars
 - gaiadr3.gold_sample_oba_stars
 - gaiadr3.gold_sample_solar_analogues
 - gaiadr3.gold_sample_spss
 - gaiadr3.gold_sample_ucd

Service	Schema	Table	Columns	FKeys	Hints
		Name	Type	Unit	Description
		source_id	long		Unique source identifier (unique)
		teff_gspphot	float	K	Effective temperature from GSP-Phot
		logg_gspphot	float	log(cm.s**-2)	Surface gravity from GSP-Phot
		mh_gspphot	float	'dex'	Global metallicity from GSP-Phot
		ag_gspphot	float	mag	Extinction in G band from GSP-Phot
		ebpminrp_gspphot	float	mag	Reddening E(BP-RP) from GSP-Phot
		alphafe_gspspec	float	'dex'	Median abundance of alpha-elements
		teff_gspspec	float	K	Median value of the effective temperature
		logg_gspspec	float	log(cm.s**-2)	Median value of logarithm of the surface gravity
		mh_gspspec	float	'dex'	Median global metallicity [M/H] from GSP-Spec
		radius_flame	float	solRad	Radius of the star derived from FLAME
		lum_flame	float	solLum	Luminosity of the star from FLAME
		mass_flame	float	solMass	Mass of the star from FLAME using
		age_flame	float	Gyr	Age of the star from FLAME using
		evolstage_flame	int		Evolutionary stage of the star derived
		radius_flame_spec	float	solRad	Radius of the star from FLAME using

Service Capabilities

Query Language: ADQL-2.0 Max Rows: 3000000 (default) Uploads: 100Mb

ADQL Text

Mode: Synchronous

```
1
SELECT TOP 100000
  designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
  phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
  AND parallax_over_error > 10
  AND astrometric_excess_noise < 1
```

Examples Info

Run Query

Full Database Access: TAP/ADQL



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GAIA (6/227)

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 - gaiadr3.gold_sample_carbon_stars
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 - gaiadr3.gold_sample_spss
 - gaiadr3.gold_sample_ucd

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source_id	long		Unique source identifier (unique)		
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alphafe_gspspec	float	'dex'	Median abundance of alpha-elements		
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mass_flame	float	solMass	Mass of the star from FLAME using		
age_flame	float	Gyr	Age of the star from FLAME using		
evolstage_flame	int		Evolutionary stage of the star derived		
radius_flame_spec	float	solRad	Radius of the star from FLAME using		

Service Capabilities

Query Language: ADQL-2.0 Max Rows: 3000000 (default) Uploads: 100Mb

ADQL Text

Mode: Synchronous

```
SELECT TOP 100000
  designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
  phot_g AS mag_g,
  (parallax/100) AS mag_g
FROM gaiadr3.g
WHERE parallax > 0
AND parallax < 100000
AND astromet
```

- Basic
- Upload
- Service-Provided
 - TAP_SCHEMA
 - ObsTAP
 - RegTAP

- Cone search sorted by angular separation
- Cone search in galactic coordinates + DataLink filter
- Selection of rectangular sky region + 2MASS pre-computed cross-match
- Bright sources in Gaia DR2 and (E)DR3
- Basic positional cross-match: Hipparcos vs Gaia
- Advanced positional cross-match
- Positional cross-match + proper-motion propagation
- Retrieve average quantities per HEALPix level 8 in the Galactic anticentre
- Extinction-corrected CMD diagram (histogram)
- Exploration of the interstellar medium with Gaia RVS diffuse interstellar bands

Sky Region Access: Cone Search



TOPCAT Cone Search window

- Loads all Gaia sources in a given part of the sky
- Operation:
 - ▷ **VO|Cone Search** menu item
 - ▷ **Keywords:** “gaia” → **Find Services**
 - ▷ Select service **ARI-Gaia**
 - ▷ Fill in:
 - **Object Name** or **RA/Dec**
 - **Radius**
 - ▷ **Verbosity** selector controls which columns are included

The screenshot shows the 'Cone Search' window in TOPCAT. The 'Available Cone Services' section is active, displaying search results for 'gaia dr3'. The 'Cone Parameters' section is also visible, showing search criteria for object 'ngc346' with RA 14.771207, Dec -72.1759, and a radius of 0.75 degrees.

Available Cone Services

Registry: <http://reg.g-vo.org/tap> **RegTAP**

Keywords: **And**

Match Fields: Short Name Title Subjects ID Publisher Descr

Accept Resource Lists **Cancel** **Find Services**

Short Name	Title	
ARI-Gaia	ARI's Cone Search Service for the last Gaia Data Release (DR3)	Gaia B
ARI-Gaia	ARI's Cone Search Service for Gaia EDR3	Gaia B
GAIA DR3	Gaia DR3 at ESA	Gaia,
GAIA EDR3	Gaia EDR3 at ESA	Gaia,
I/355	Gaia DR3 Part 1. Main source	
I/356	Gaia DR3 Part 2. Extra-galactic	
I/357	Gaia DR3 Part 3. Non-single stars	

AccessURL	Description	Version
https://gaia.ari.uni-heidelbe...		

Resource Count: 13

Cone Parameters

Cone URL: <https://gaia.ari.uni-heidelberg.de/cone/search?>

Object Name: **Resolve**

RA: **degrees** (J2000) Accept Sky Positions

Dec: **degrees** (J2000)

Radius: **degrees**

Verbosity: **2 (normal)**

OK

Data Access: Match Catalog X against Gaia

TOPCAT CDS Upload X-Match window

- Load X , then use **CDS X-Match** window
- Very fast, millions of rows while you wait
- Most, but not all columns from DR3 returned (some renamed)
- Understand match epoch (see [CDS X-Match service documentation](#))

TAP Upload match in TOPCAT TAP window

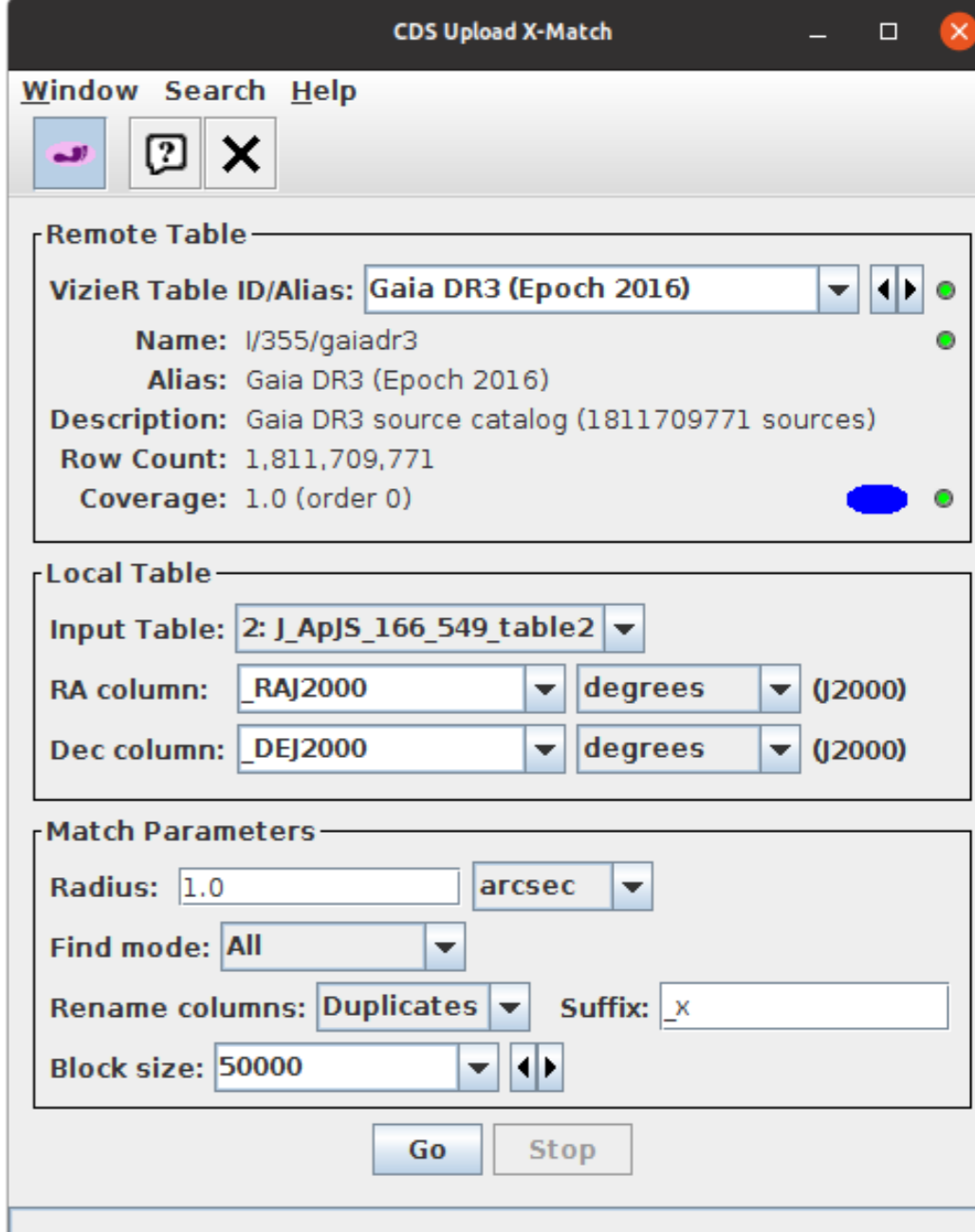
- Load X , then use `TAP_UPLOAD.t<n>` in ADQL
- Very flexible
- Upload table size limits apply

TOPCAT Pair Match window

- Load Gaia and X in same region, then match
- Suitable for matches in the same (sky?) region, \lesssim few million sources

Use pre-calculated archive match tables via TAP

- High-quality matches already done for large tables
- AllWISE, RAVE, SDSS DR13, APASS DR9, Pan-STARRS1, GSC 2.3, 2MASS, ...



CDS Upload X-Match

Window Search Help

Remote Table

VizieR Table ID/Alias: Gaia DR3 (Epoch 2016)

Name: I/355/gaiadr3

Alias: Gaia DR3 (Epoch 2016)

Description: Gaia DR3 source catalog (1811709771 sources)

Row Count: 1,811,709,771

Coverage: 1.0 (order 0)

Local Table

Input Table: 2: J_ApJS_166_549_table2

RA column: _RAJ2000 degrees (J2000)

Dec column: _DEJ2000 degrees (J2000)

Match Parameters

Radius: 1.0 arcsec

Find mode: All

Rename columns: Duplicates Suffix: _x

Block size: 50000

Go Stop

Data Access: Ancillary Tables (*DataLink*)

Background

- Ancillary data products are not all in the database
- Can't (mostly) access via TAP/ADQL, needs [DataLink](#)
 - ▷ sampled/continuous XP spectra, RVS spectra, epoch photometry, epoch RVs, GSPPhot/MSC MCMC samples
- Each row in the catalogue points to a [DataLink table](#) listing additional resources (via `designation/source_id` column)



TOPCAT Activation Window







- Configures {something} to happen when row/point clicked
 - ▷ Lots of options: load/plot table, view image/spectrum, message other tool, run command, ...
 - ▷ Includes **Invoke Service & View Datalink Table** (as long as `designation` column is SELECTed)
 - ▷ Various options from DataLink: load, plot, download, send tables
- Operates on ancillary data from one source at a time

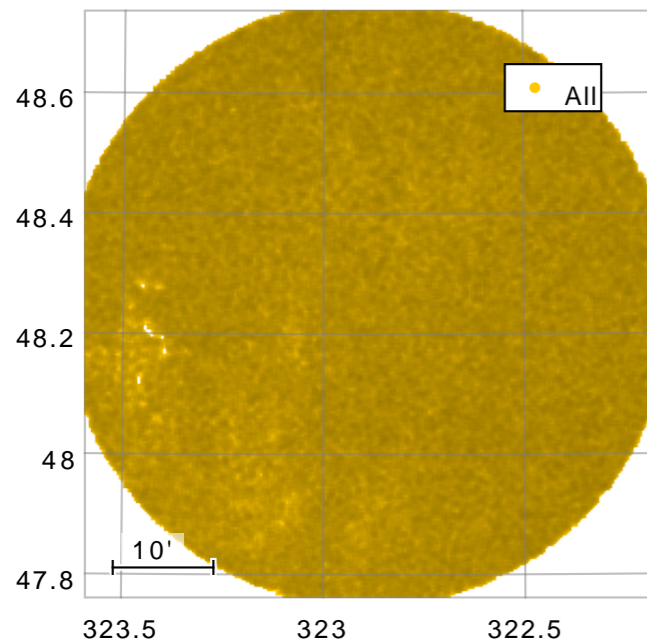
Seq	Row	Status	Message
5	80084	OK	https://gea.esac.esa.int/data-server/data?ID=Gaia+DR3+4122597029
6	80089	OK	https://gea.esac.esa.int/data-server/data?ID=Gaia+DR3+4122667123
7	123123	OK	https://gea.esac.esa.int/data-server/data?ID=Gaia+DR3+6133931765
8	85086	OK	https://gea.esac.esa.int/data-server/data?ID=Gaia+DR3+4373306541

semantics	description	content_type	content_length	ID
1 #this	MCMC MSC, source Gaia DR3 4...	application/x-votable+xml		Gaia DR3 43733065
2 #this	XP mean sampled spectra, so...	application/x-votable+xml		Gaia DR3 43733065
3 #this	XP mean continuous spectra, ...	application/x-votable+xml		Gaia DR3 43733065
4 #this	MCMC GSP-Phot, source Gaia ...	application/x-votable+xml		Gaia DR3 43733065

Example: Cluster identification using Proper Motions







Identify members of open cluster NGC 7092 by proper motion clustering

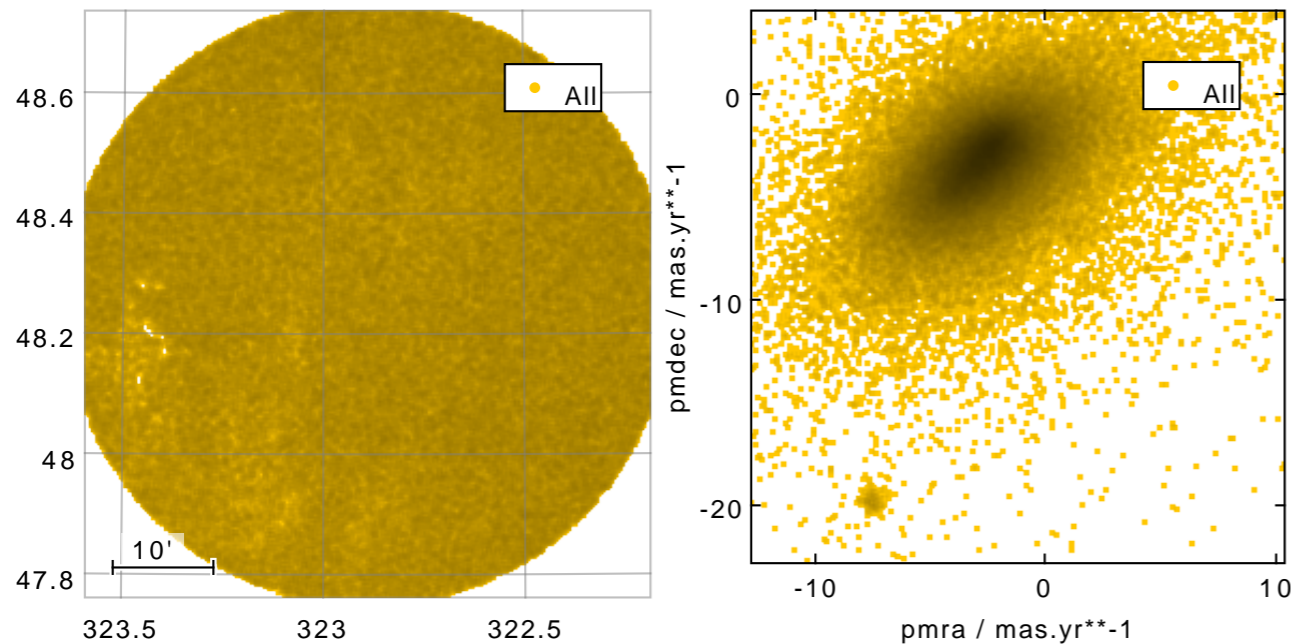
-  Cone Search NGC7092, $r=0.5^\circ$; returns $\sim 112\,000$ rows
-  Proper Motion space plot $pmra$ vs. $pmdec$
-  Make graphical selection of comoving objects
-  Sky Plot, see cluster positions (**Subsets** tab)
-  Colour-Magnitude diagram bp_rp vs. $phot_g_mean_mag$, view selection
-  Plot cluster $parallax$ histogram & Gaussian fit to determine mean distance ($\varpi \approx 3.3 \text{ mas} \Rightarrow r \approx 303 \text{ pc}$)



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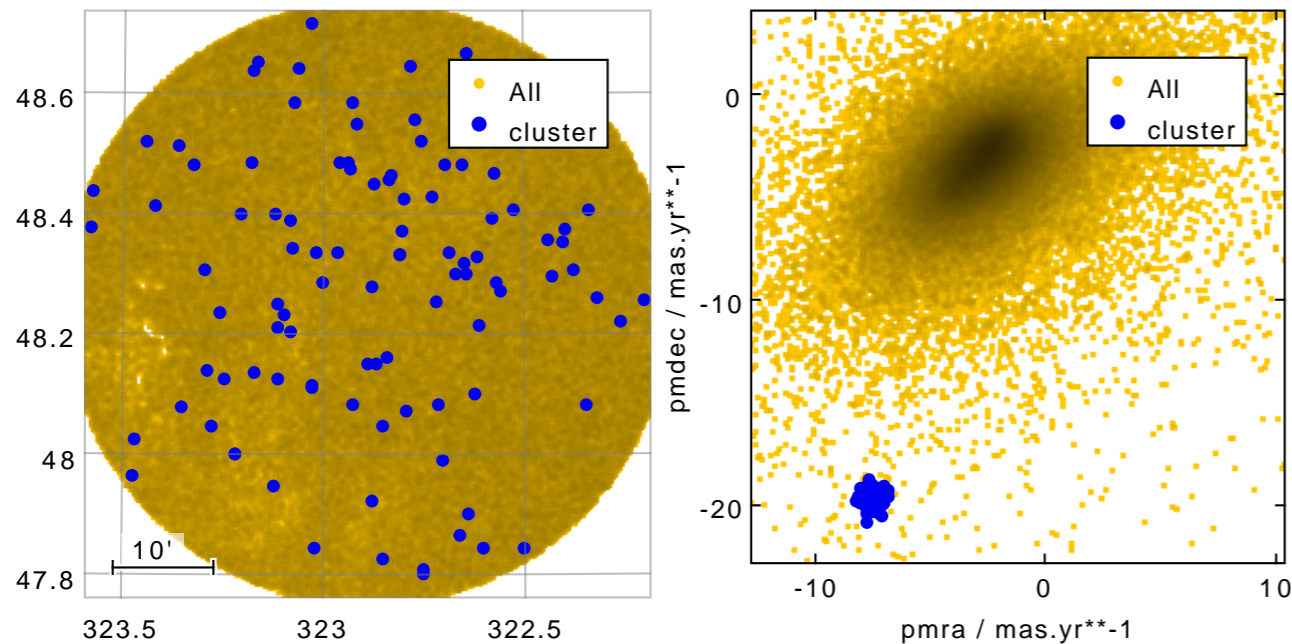
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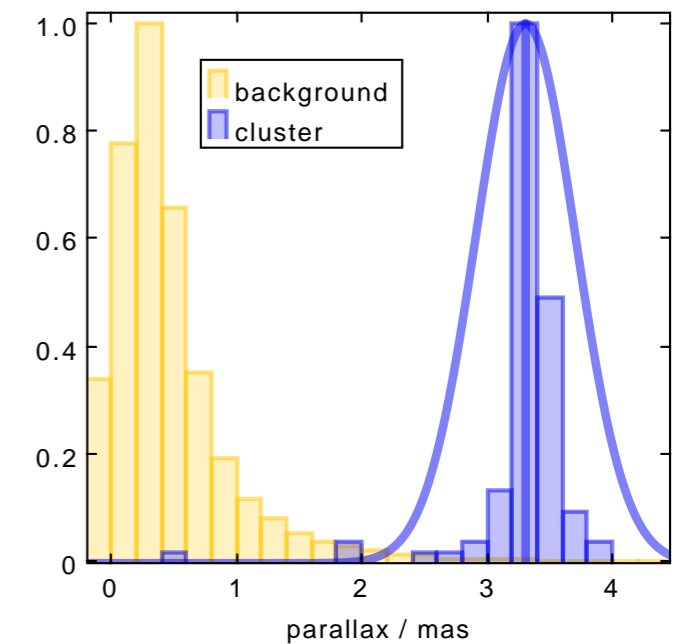
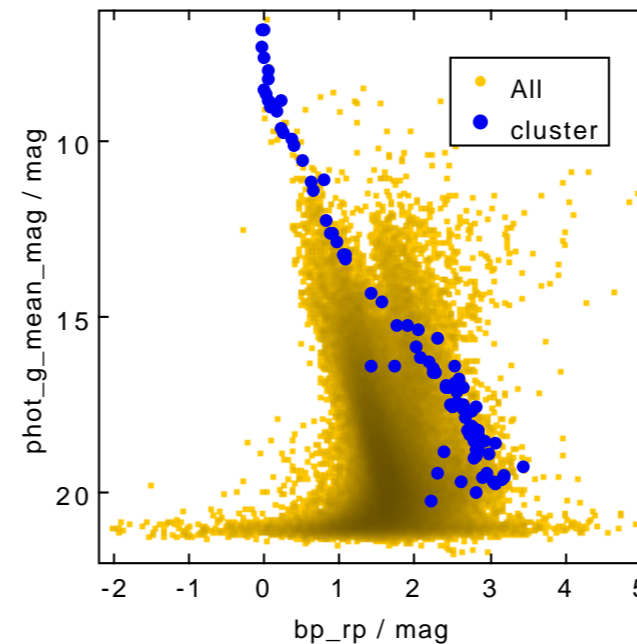
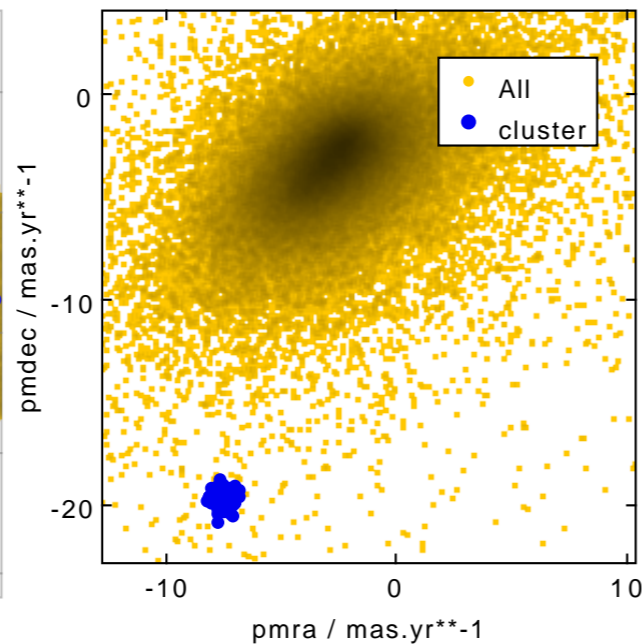
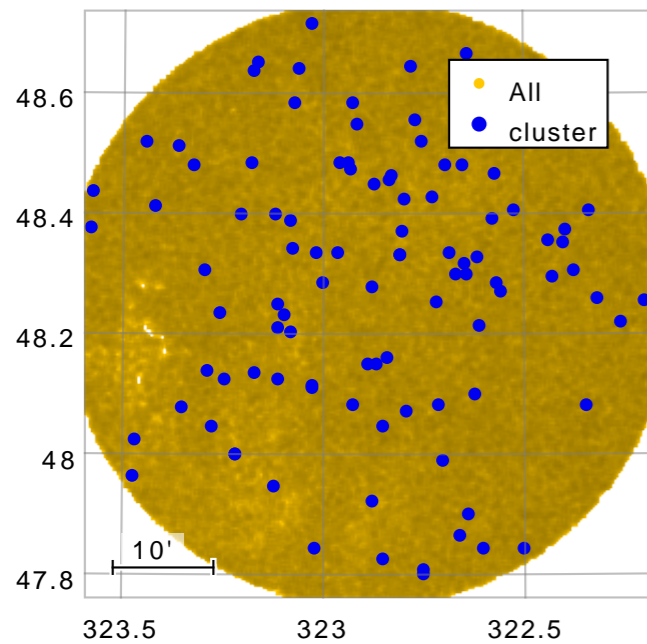
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-  Colour-Magnitude diagram bp_rp vs. $phot_g_mean_mag$, view selection
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Example: Galactic Extinction Map

Apsis calculates extinction maps (Delchambre et al. (2022), “Gaia DR3 Apsis III”)

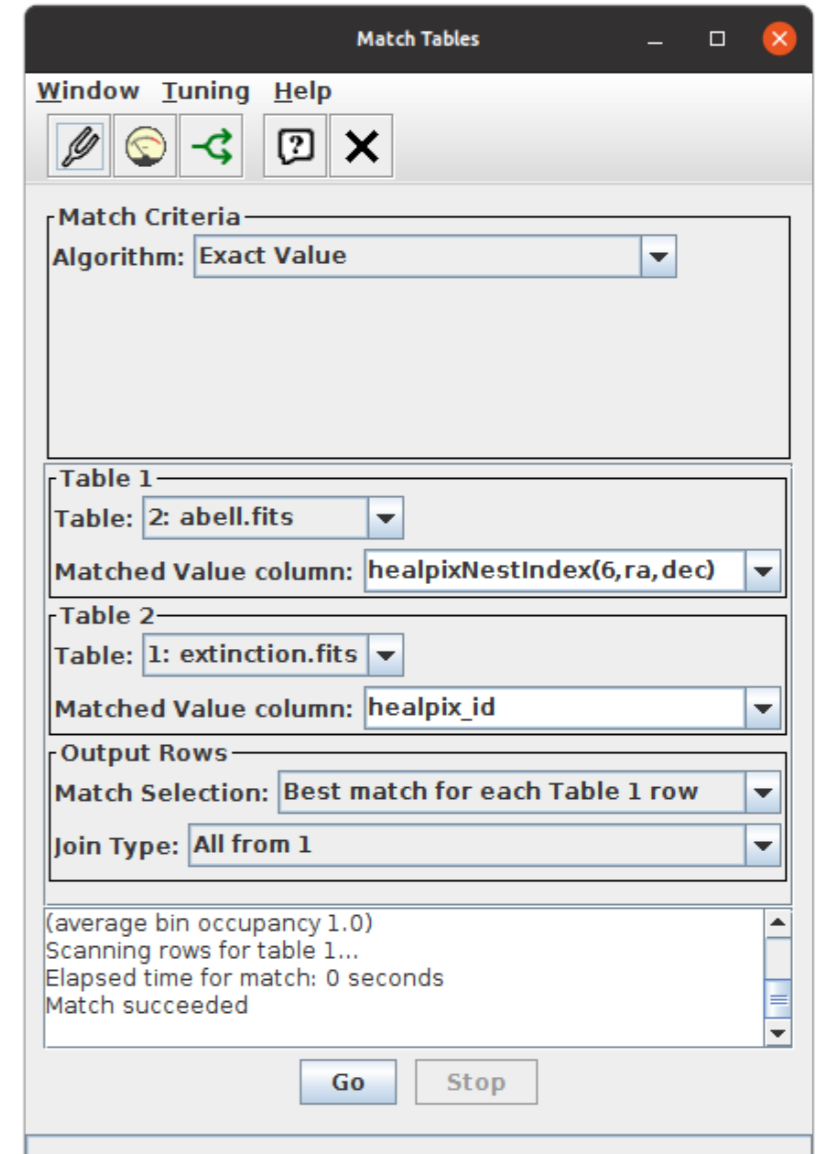
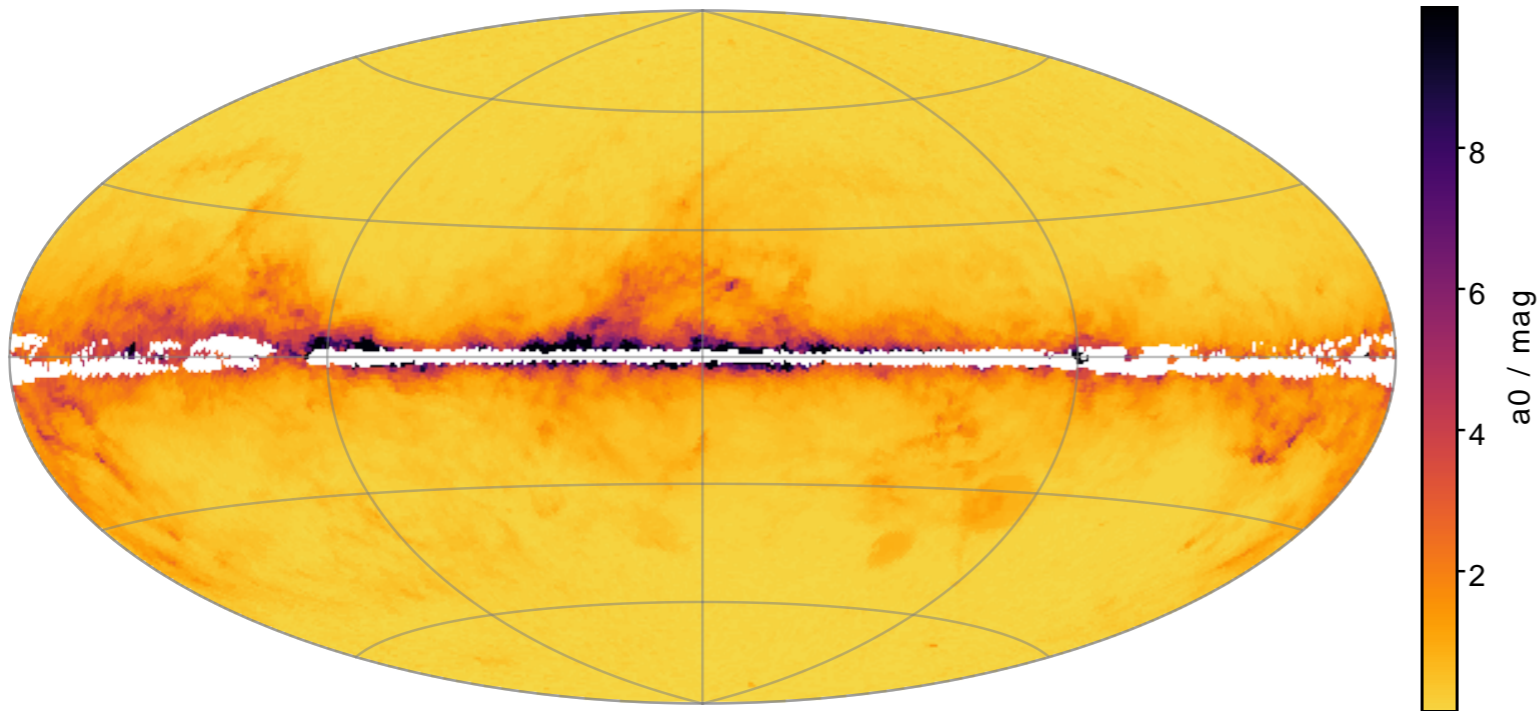
 Retrieve all HEALPix level 6 pixels from `total_galactic_extinction_map` ($49\,152 = 12 \times 4^6$ rows)

```
SELECT healpix_id, a0
FROM gaiadr3.total_galactic_extinction_map
WHERE healpix_level = 6
```

 Plot using HEALPix Layer Control

 Match HEALPix pixels against user table to find source extinction

- **Exact Value** match, `healpixNestIndex(6,RA,DEC)` vs. `healpix_id`



Match Tables

Window Tuning Help

Match Criteria

Algorithm: Exact Value

Table 1

Table: 2: abell.fits

Matched Value column: healpixNestIndex(6,ra,dec)

Table 2

Table: 1: extinction.fits

Matched Value column: healpix_id

Output Rows

Match Selection: Best match for each Table 1 row

Join Type: All from 1

(average bin occupancy 1.0)
Scanning rows for table 1...
Elapsed time for match: 0 seconds
Match succeeded

Go Stop

Example: QSO Candidates

See [Bailer-Jones et al. \(2022\)](#), “Gaia DR3: The Extragalactic Content”



Query `qso_candidates` table; need to join with `gaia_source` to get RA & Dec

```
SELECT g.ra, g.dec, q.redshift_qsoc,  
       q.gaia_crf_source, q.host_galaxy_flag, q.classlabel_dsc_joint, q.vari_best_class_name  
FROM gaiadr3.gaia_source AS g  
JOIN gaiadr3.qso_candidates AS q USING (source_id)
```

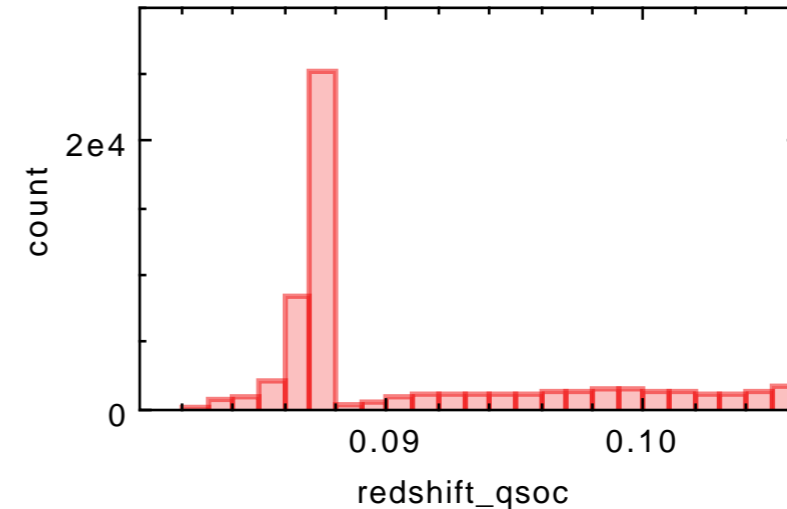
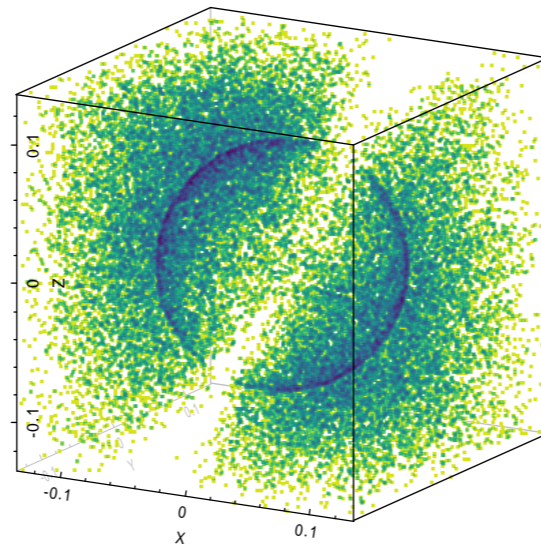
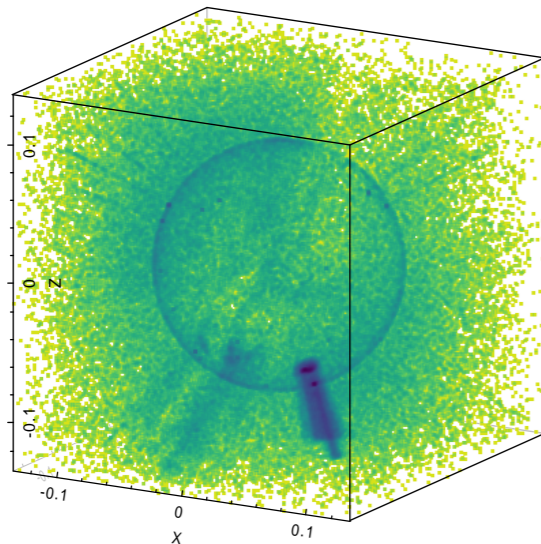


Plot in spherical polar coordinates using `ra`, `dec`, `redshift_qsoc`



Apply purity selection (Table 10 from Bailer-Jones et al., converting ADQL → TOPCAT expression language):

```
gaia_crf_source || host_galaxy_flag<6 || classlabel_dsc_joint=="quasar" || vari_best_class_name=="AGN"
```



Example: XP Sampled Spectra via DataLink

View XP Sampled spectra for points in a plot of interest



Query `gaiadr3.gaia_source` table to plot HR diagram:

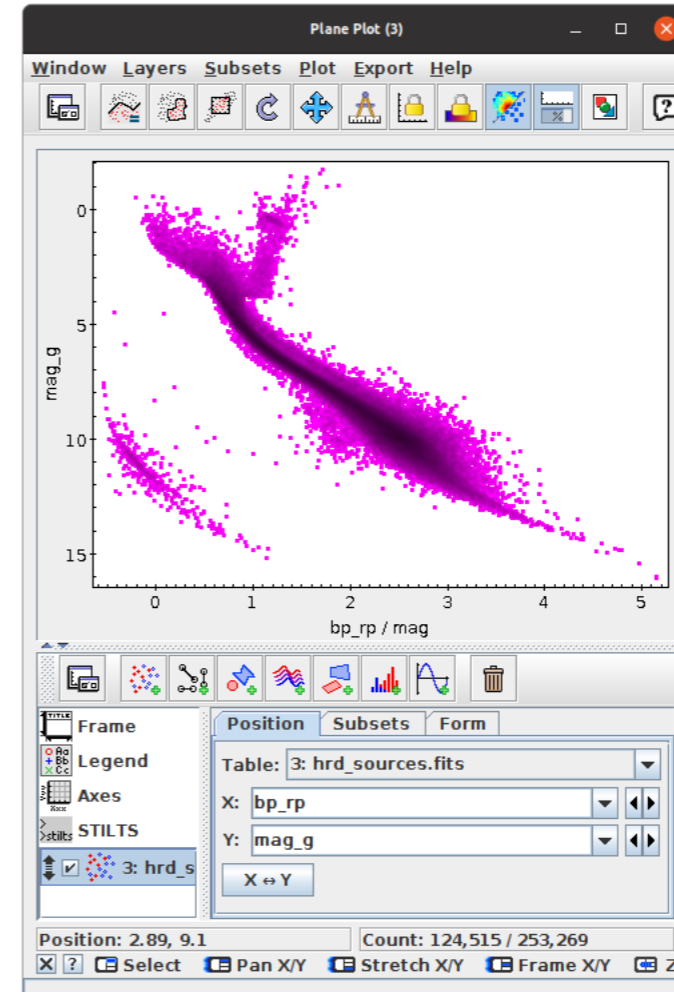
```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
      AND phot_bp_mean_flux_over_error > 10
      AND phot_rp_mean_flux_over_error > 10
      AND astrometric_excess_noise < 1
      AND has_xp_sampled = 'true'
```

- ▶ Select on `has_xp_sampled` to ensure spectra are available
- ▶ Must **SELECT** `designation` (or sometimes `source_id`) to link rows with DataLink



Set up **Activation Action**

- ▶ Select checkbox for **Invoke Service**
- ▶ Service **Action** is **View DataLink Table**
- ▶ Select **XP mean sampled spectra** row of DataLink table
- ▶ Configure to **Plot Table** on DataLink load and **Auto-Invoke**
- ▶ Set up plot to taste
 - clicking on point in plot displays spectrum (works best with TOPCAT v4.8-6 or later)



Example: XP Sampled Spectra via DataLink

View XP Sampled spectra for points in a plot of interest



Query `gaiadr3.gaia_source` table to plot HR diagram:

```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
      AND phot_bp_mean_flux_over_error > 10
      AND phot_rp_mean_flux_over_error > 10
      AND astrometric_excess_noise < 1
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→ clicking on point in plot displays spectrum
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The screenshot shows the TOPCAT software interface. In the background, a 'Plane Plot (3)' window displays a Hertzsprung-Russell diagram with mag_g on the y-axis and bp_rp on the x-axis. Points are colored in shades of purple and blue. A mouse cursor is hovering over a point. In the foreground, the 'TOPCAT(5): Activation Actions' window is open, showing configuration for 'TAP 4 gaiadr3.gaia_source, gaiadr3.gcns_main_1'. The 'Actions' list includes 'Invoke Service' (checked), 'Send Sky Coordinates', 'Display HiPS cutout', 'Send HiPS cutout', 'Delay', and 'Execute code'. The 'Configuration' section shows 'Action: View DataLink Table' and 'Name: ancillary'. Below this, a 'DataLink Table' window is open, displaying a table with columns: semantics, description, content_type, content_length, and ID. The table contains four rows of data, with the second row selected. Below the table, the 'Row Link Type' is 'Fixed Access URL' and the 'Row Detail' section shows the access_url, content_type, content_length, description, and semantics for the selected row. At the bottom, the 'URL' is shown as 'https://gea.esac.esa.int/data-server/data?ID=Gaia+DR3+4373306541703685248&RETRIEVAL_TYPE=XP_S', and the 'Type' is 'TABLE', 'Guess' is checked, 'Action' is 'Plot Table', and 'Auto-Invoke' is checked.

semantics	description	content_type	content_length	ID
1 #this	MCMC MSC, source Gaia DR3 4...	application/x-votable+xml		Gaia DR3 43733065
2 #this	XP mean sampled spectra, so...	application/x-votable+xml		Gaia DR3 43733065
3 #this	XP mean continuous spectra, ...	application/x-votable+xml		Gaia DR3 43733065
4 #this	MCMC GSP-Phot, source Gaia ...	application/x-votable+xml		Gaia DR3 43733065

Row Detail
access_url: https://gea.esac.esa.int/data-server/data?ID=Gaia+DR3+4373306541703685248&RETRIEVAL_TYPE=XP_S
content_type: application/x-votable+xml
content_length:
description: XP mean sampled spectra, source Gaia DR3 4373306541703685248
semantics: #this

Example: XP Sampled Spectra via DataLink

View XP Sampled spectra for points in a plot of interest



Query `gaiadr3.gaia_source` table to plot HR diagram:

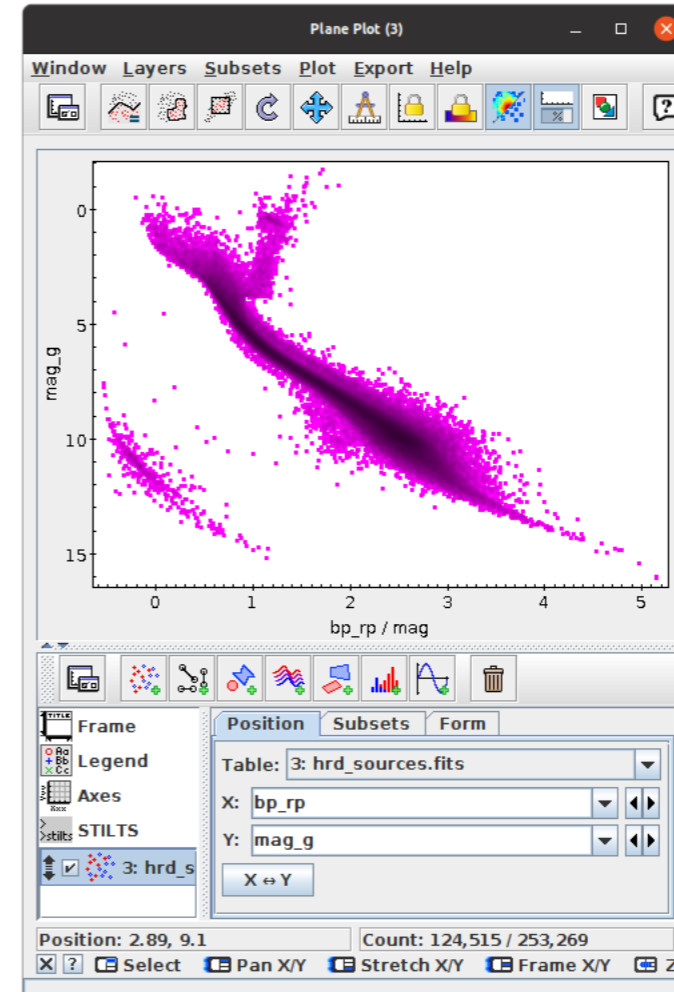
```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
      AND phot_bp_mean_flux_over_error > 10
      AND phot_rp_mean_flux_over_error > 10
      AND astrometric_excess_noise < 1
      AND has_xp_sampled = 'true'
```

- ▶ Select on `has_xp_sampled` to ensure spectra are available
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View XP Sampled spectra for points in a plot of interest



Query `gaiadr3.gaia_source` table to plot HR diagram:

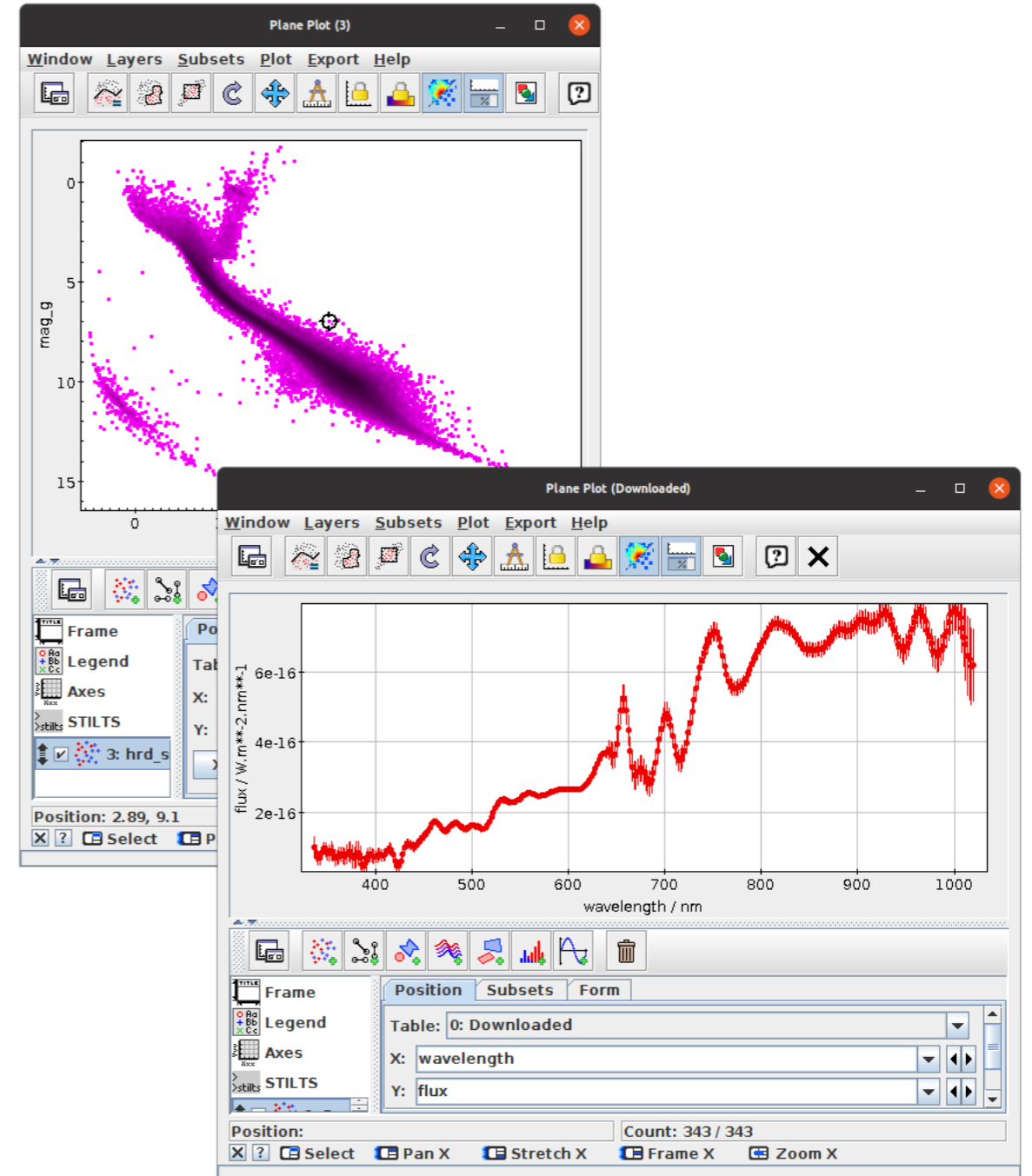
```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
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      AND phot_rp_mean_flux_over_error > 10
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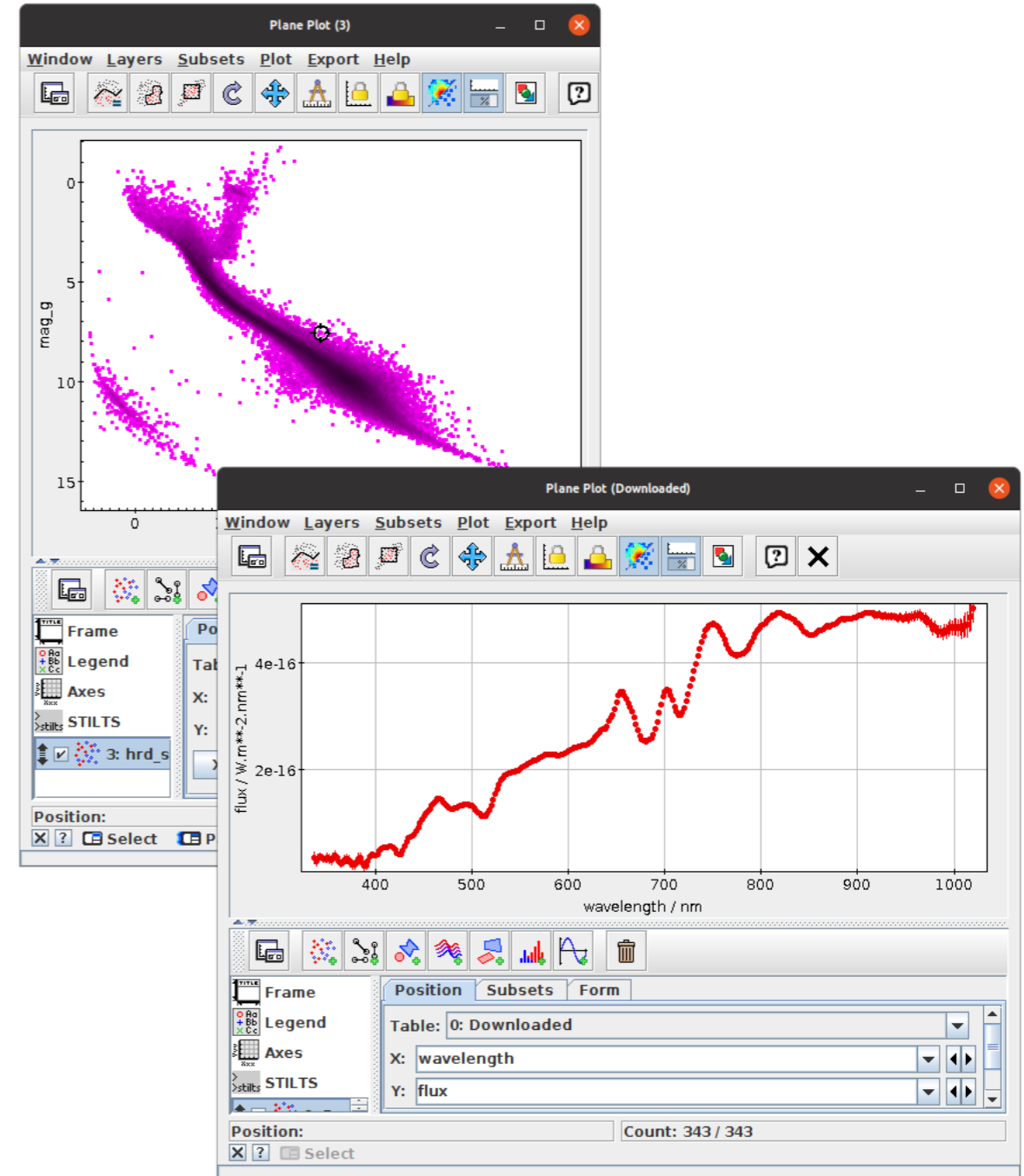
```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
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Example: XP Sampled Spectra via DataLink

View XP Sampled spectra for points in a plot of interest



Query `gaiadr3.gaia_source` table to plot HR diagram:

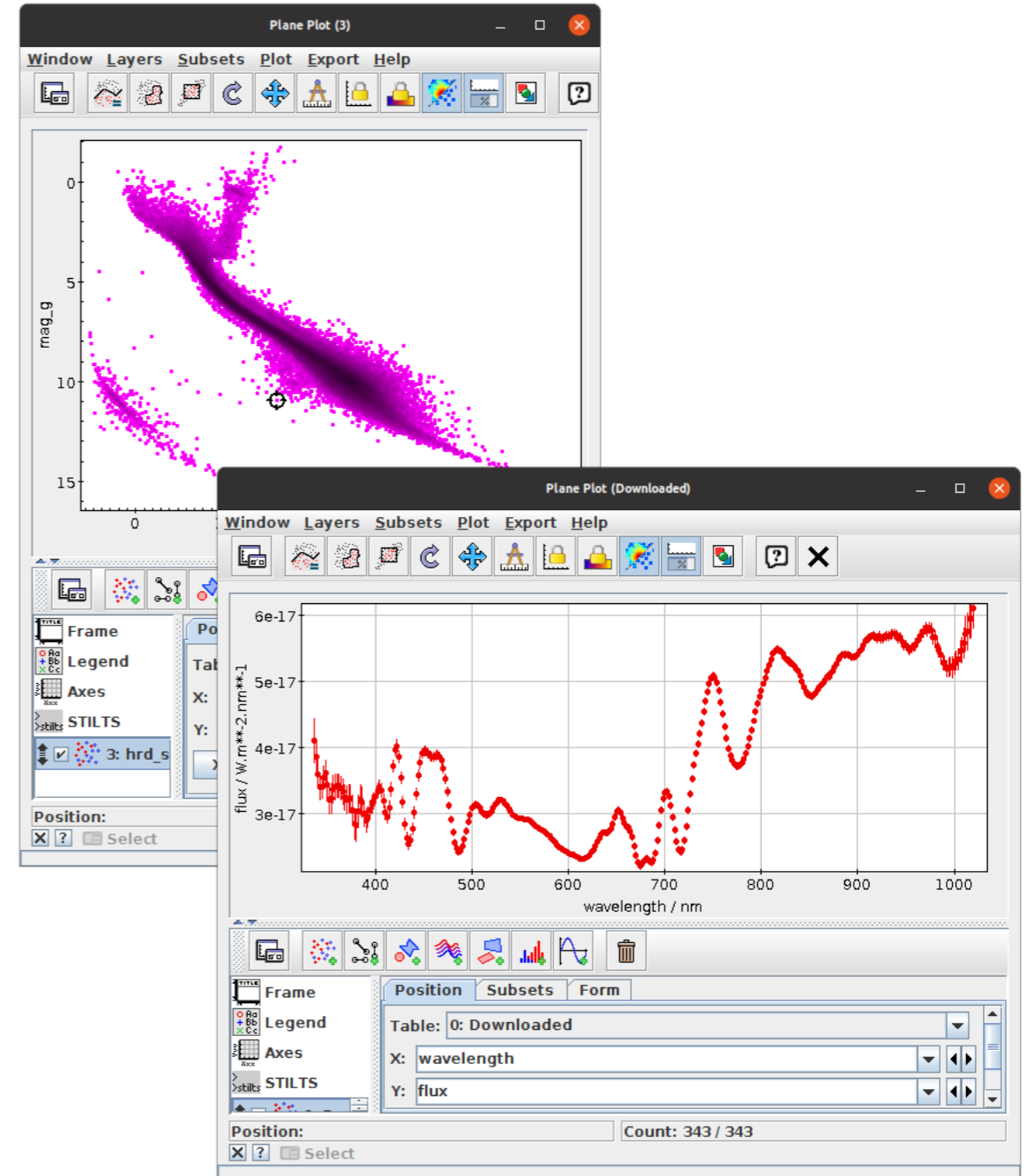
```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
      AND phot_bp_mean_flux_over_error > 10
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View XP Sampled spectra for points in a plot of interest



Query `gaiadr3.gaia_source` table to plot HR diagram:

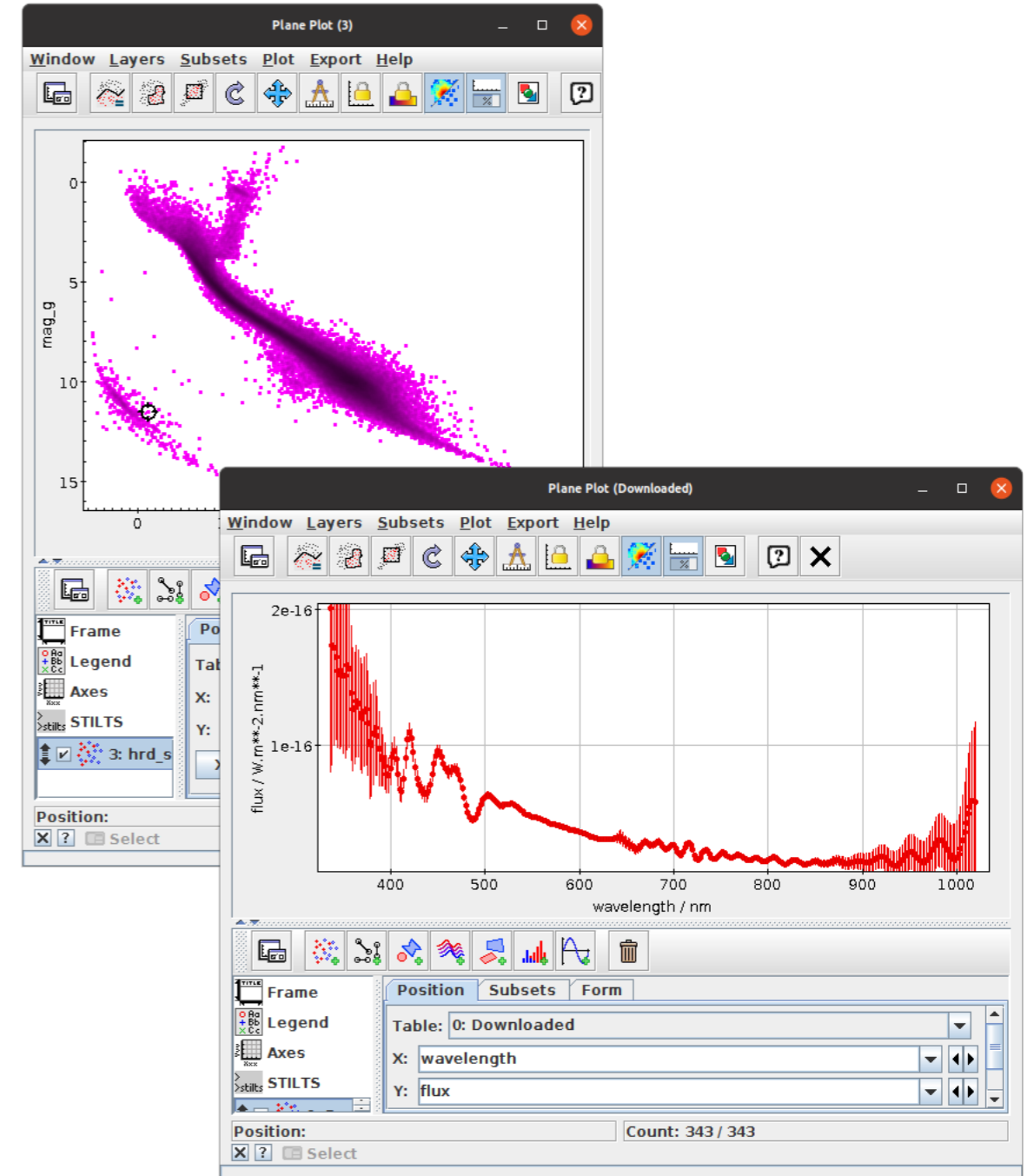
```
SELECT designation, source_id, ra, dec, parallax, bp_rp, phot_g_mean_mag,
       phot_g_mean_mag+5*log10(parallax/100) AS mag_g
FROM gaiadr3.gaia_source
WHERE parallax > 10
      AND parallax_over_error > 10
      AND phot_bp_mean_flux_over_error > 10
      AND phot_rp_mean_flux_over_error > 10
      AND astrometric_excess_noise < 1
      AND has_xp_sampled = 'true'
```

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Example: XP Sampled Spectra as Arrays



Get some White Dwarf spectra

```
SELECT source_id, bp_rp, phot_g_mean_mag+5*log10(parallax/100) AS g_abs
FROM gaiadr3.gaia_source
WHERE parallax > 10 AND parallax_over_error > 10
  AND phot_bp_mean_flux_over_error > 10 AND phot_rp_mean_flux_over_error > 10
  AND astrometric_excess_noise < 1
  AND has_xp_sampled = 'true'
  AND bp_rp BETWEEN -0.63 AND 1.21
  AND phot_g_mean_mag+5*log10(parallax/100) BETWEEN 7.4 AND 15.5
```

```
stilts arrayjoin in=wd_hrd.fits icmd=progress out=wd_spectra.fits \
  atable='"https://gea.esac.esa.int/data-server/data?RETRIEVAL_TYPE=XP_SAMPLED&RELEASE=Gaia+DR3&ID="+source_id'
```



View them using the XYArray plot

- Use array functions to normalise them
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- Linked views using subsets
- To highlight activated row, use **Activated** subset
- To select single/multiple rows from plot, use **Handles** layer

(most of these features require recent versions)

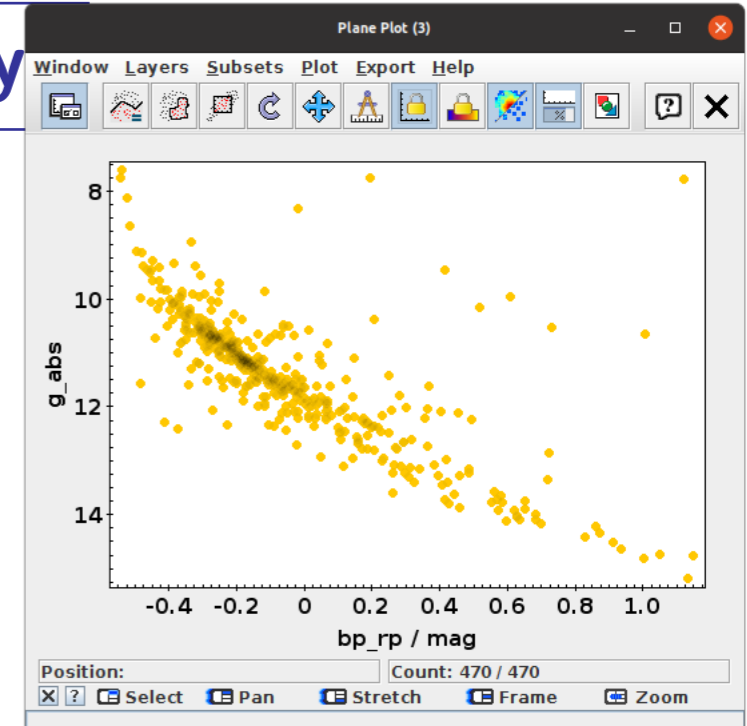
Example: XP Sampled Spectra as Array



Get some White Dwarf spectra

```
SELECT source_id, bp_rp, phot_g_mean_mag+5*log10(parallax/100) AS g_abs
FROM gaiadr3.gaia_source
WHERE parallax > 10 AND parallax_over_error > 10
  AND phot_bp_mean_flux_over_error > 10 AND phot_rp_mean_flux_over_error > 10
  AND astrometric_excess_noise < 1
  AND has_xp_sampled = 'true'
  AND bp_rp BETWEEN -0.63 AND 1.21
  AND phot_g_mean_mag+5*log10(parallax/100) BETWEEN 7.4 AND 15.5
```

```
stilts arrayjoin in=wd_hrd.fits icmd=progress out=wd_spectra.fits \
  atable='"https://gea.esac.esa.int/data-server/data?RETRIEVAL_TYPE=XP_SAMPLED&RELEASE=Gaia+DR3&ID="+source_id'
```



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Example: XP Sampled Spectra as Array



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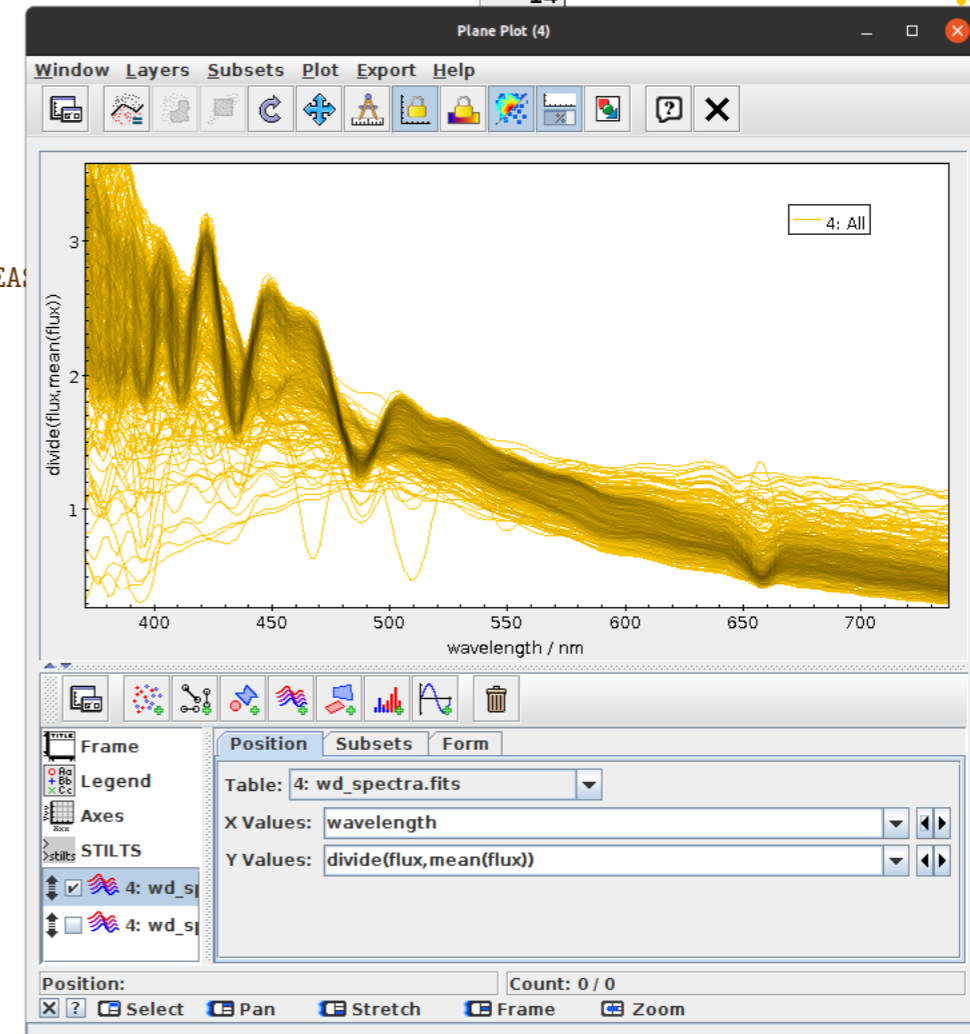
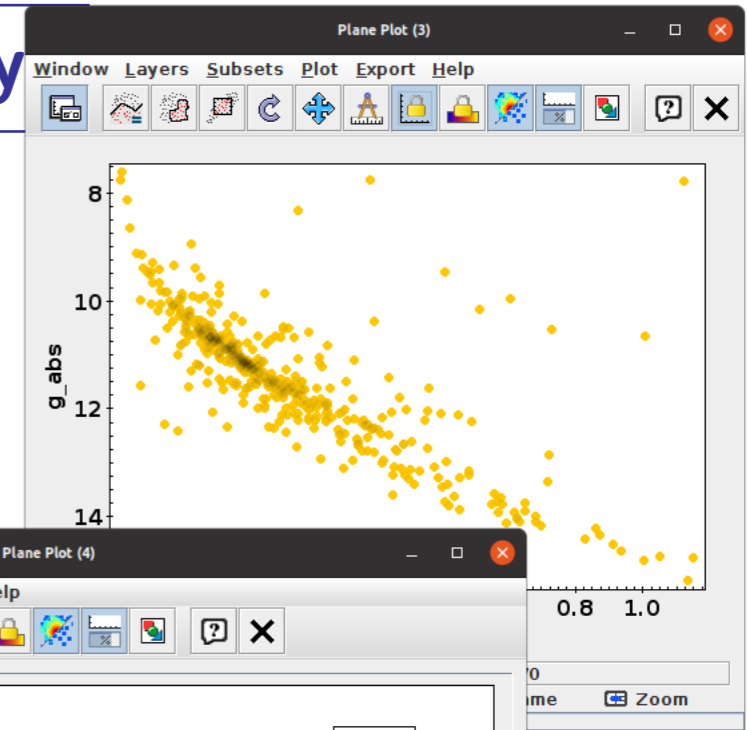
```
SELECT source_id, bp_rp, phot_g_mean_mag+5*log10(parallax/100) AS g_abs
FROM gaiadr3.gaia_source
WHERE parallax > 10 AND parallax_over_error > 10
AND phot_bp_mean_flux_over_error > 10 AND phot_rp_mean_flux_over_error > 10
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AND phot_g_mean_mag+5*log10(parallax/100) BETWEEN 7.4 AND 15.5
```

```
stilts arrayjoin in=wd_hrd.fits icmd=progress out=wd_spectra.fits \
atable='"https://gea.esac.esa.int/data-server/data?RETRIEVAL_TYPE=XP_SAMPLED&RELEASE'"
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Get some White Dwarf spectra

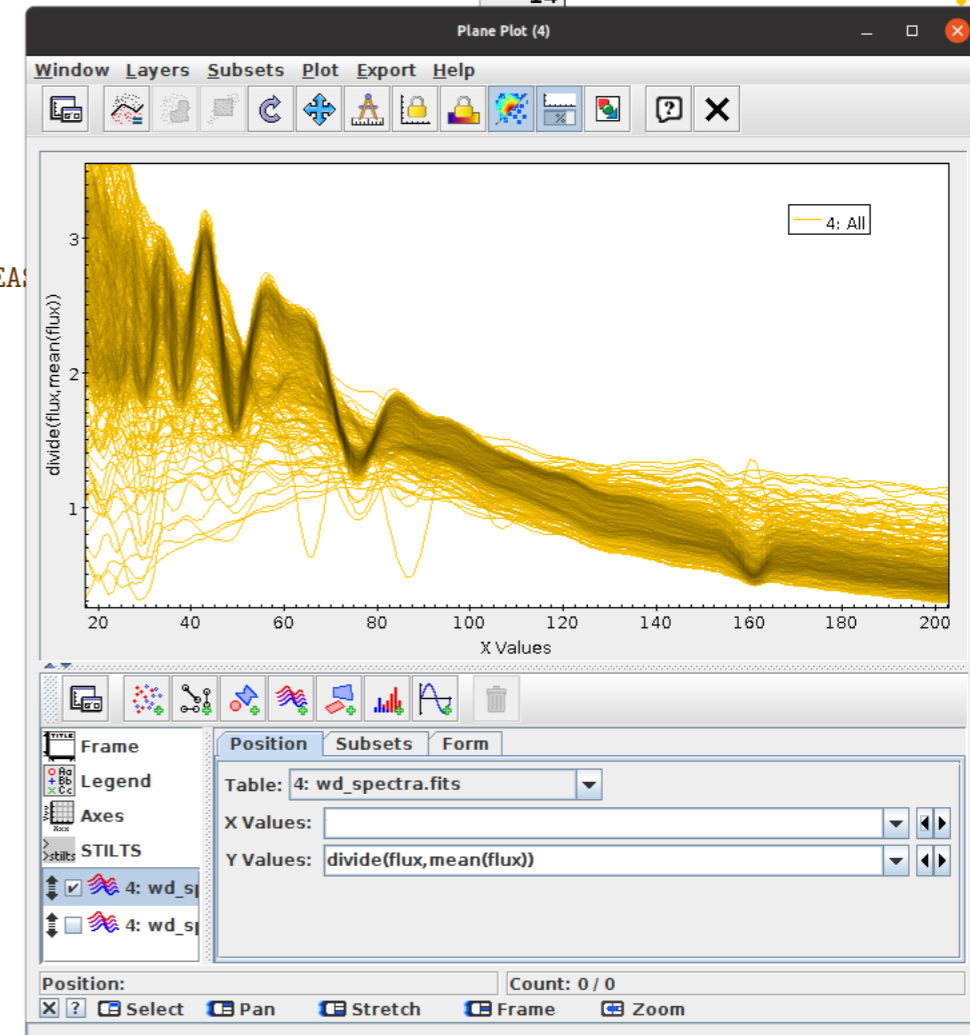
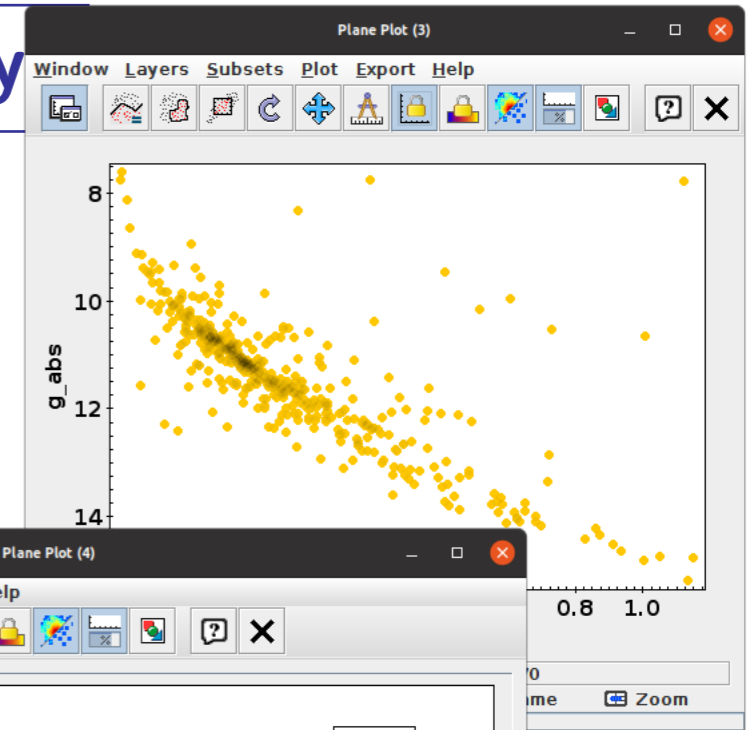
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Get some White Dwarf spectra

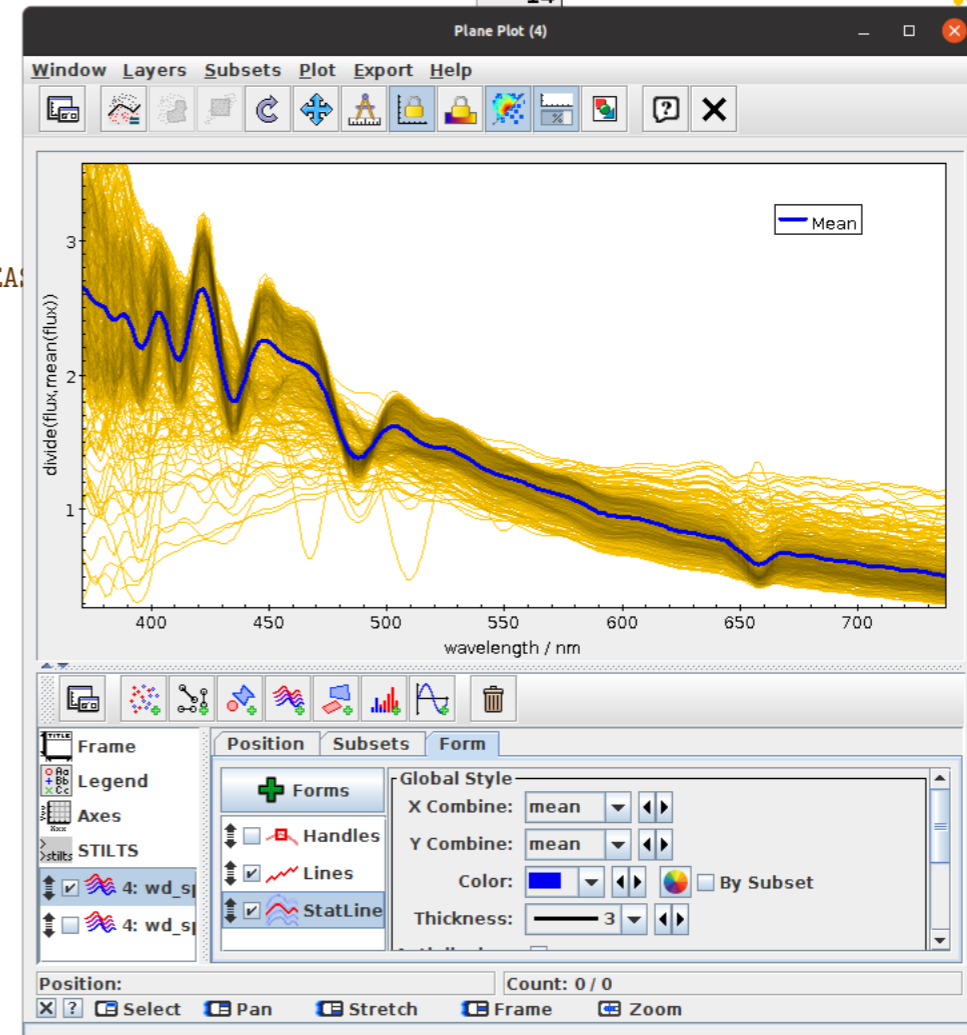
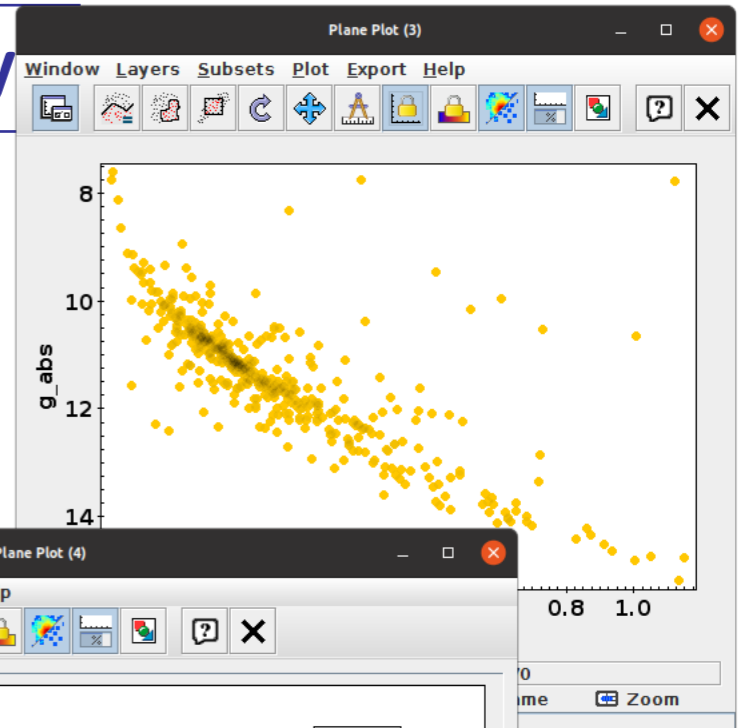
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```



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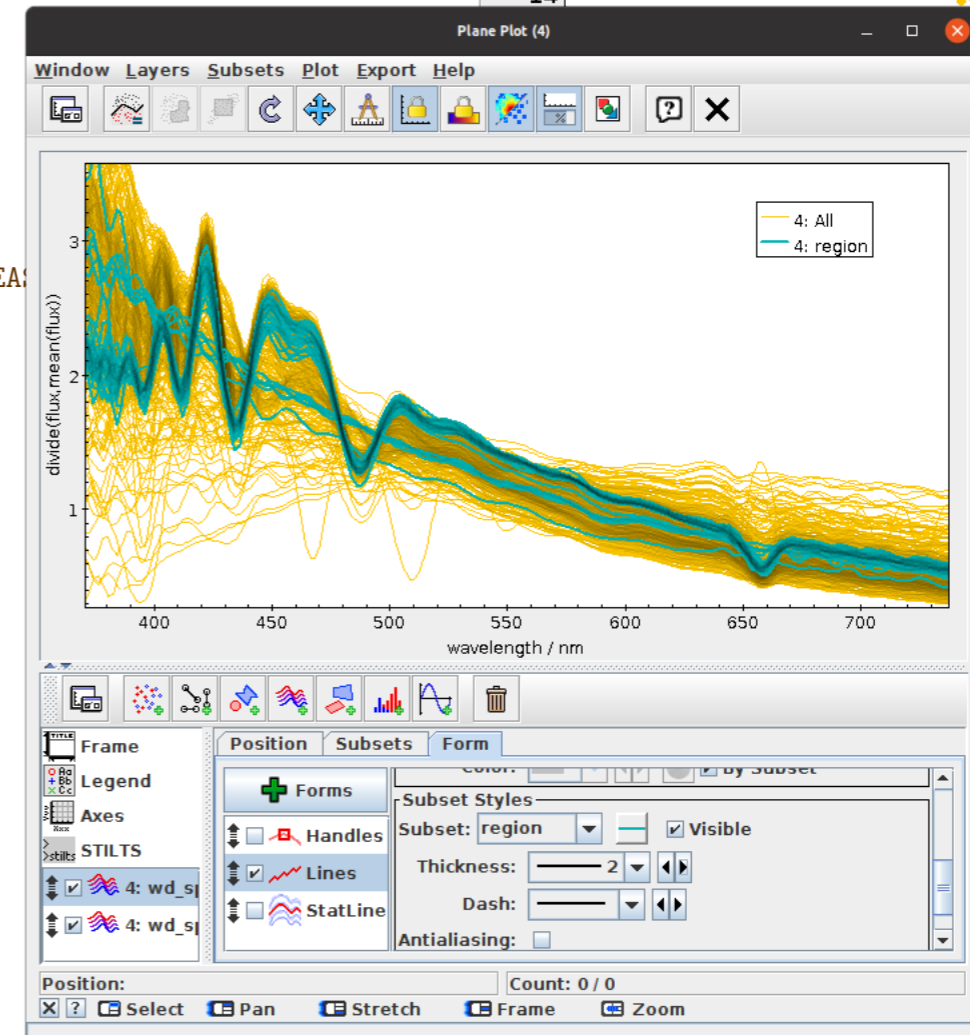
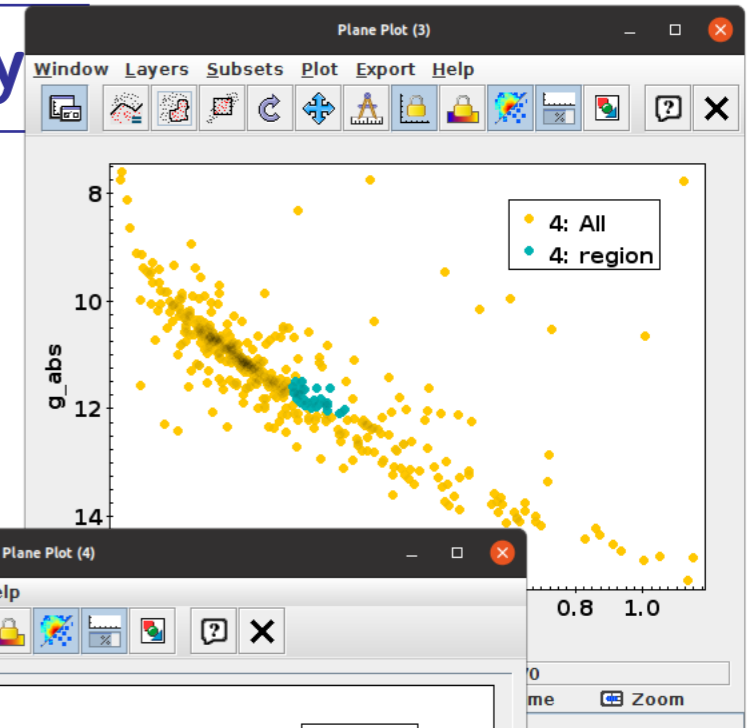
```
SELECT source_id, bp_rp, phot_g_mean_mag+5*log10(parallax/100) AS g_abs
FROM gaiadr3.gaia_source
WHERE parallax > 10 AND parallax_over_error > 10
AND phot_bp_mean_flux_over_error > 10 AND phot_rp_mean_flux_over_error > 10
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Get some White Dwarf spectra

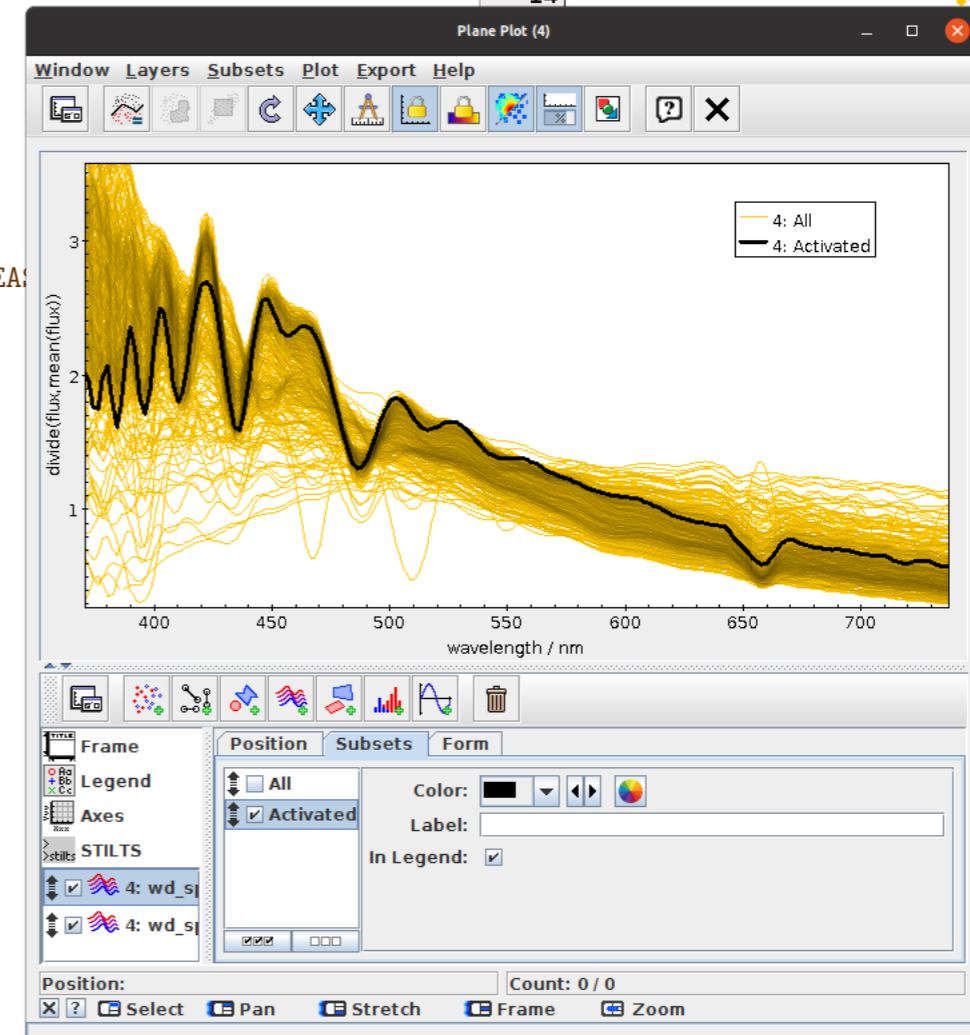
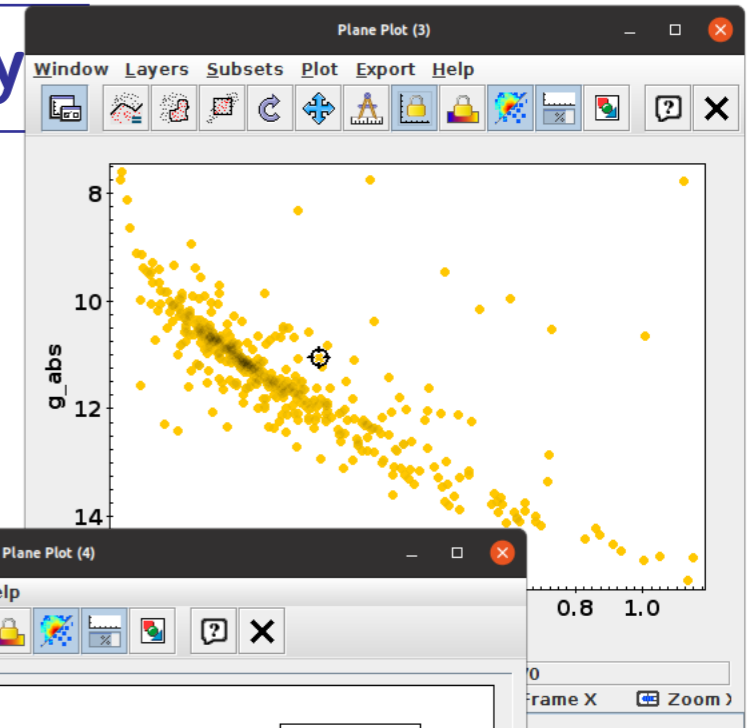
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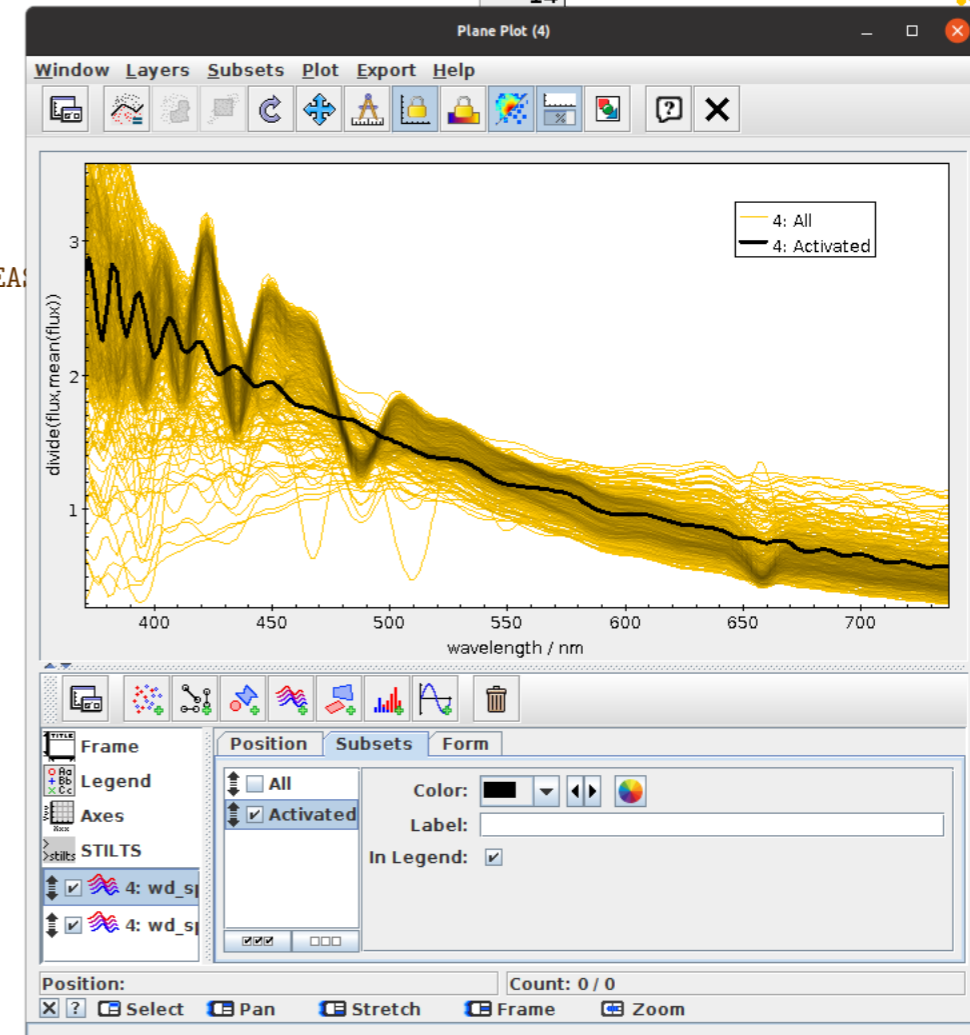
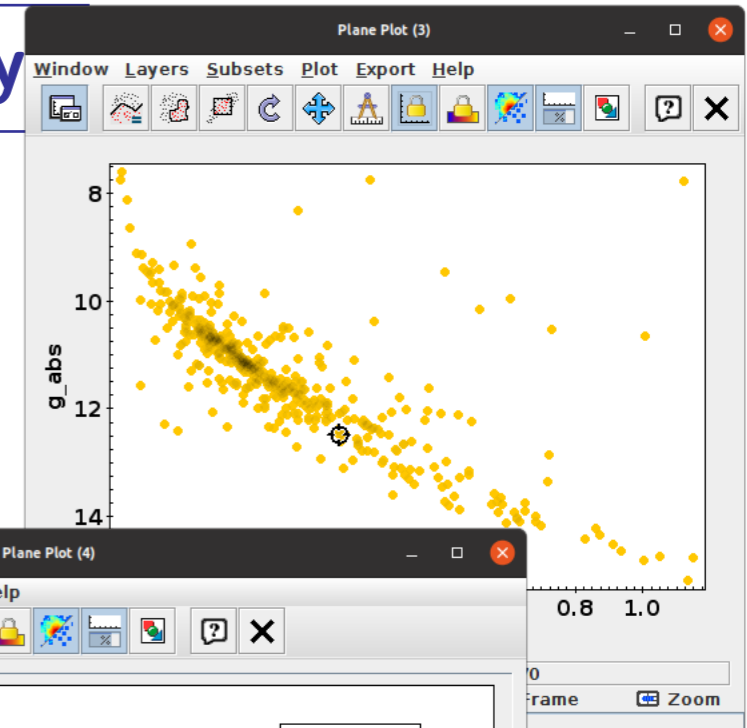
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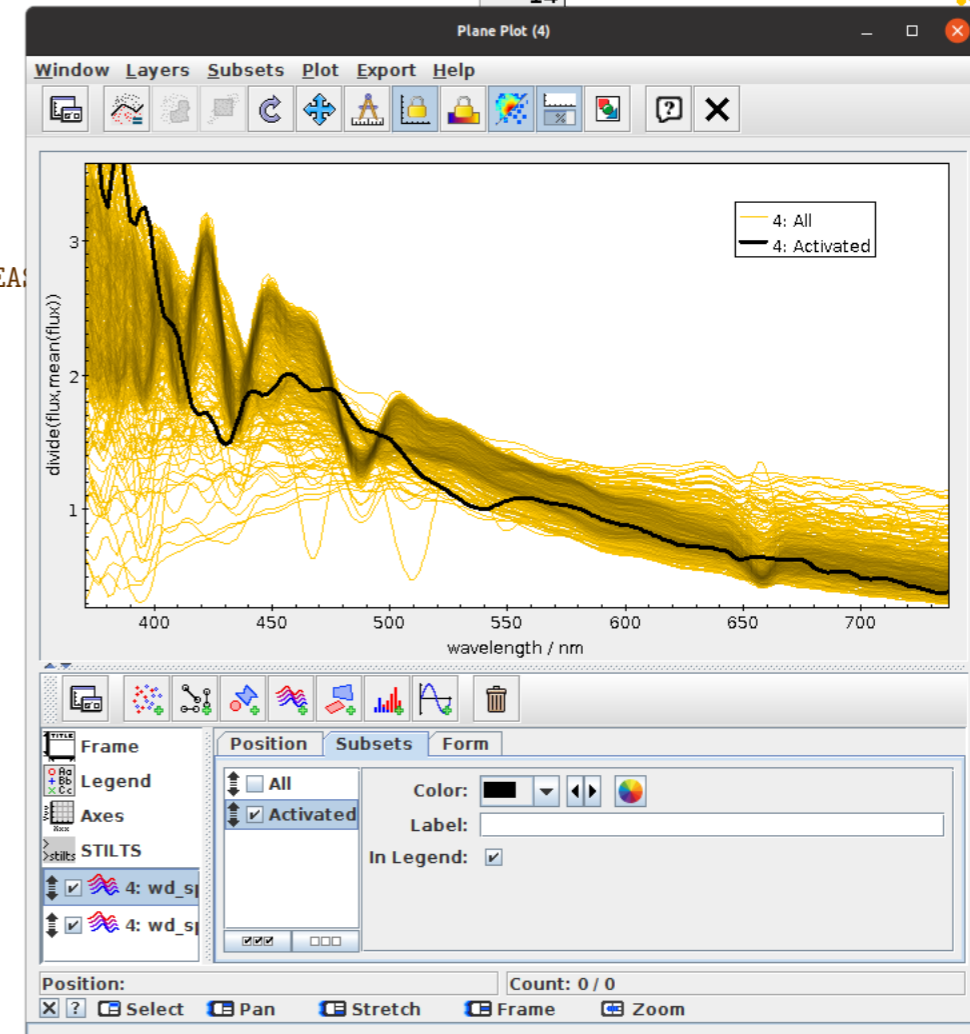
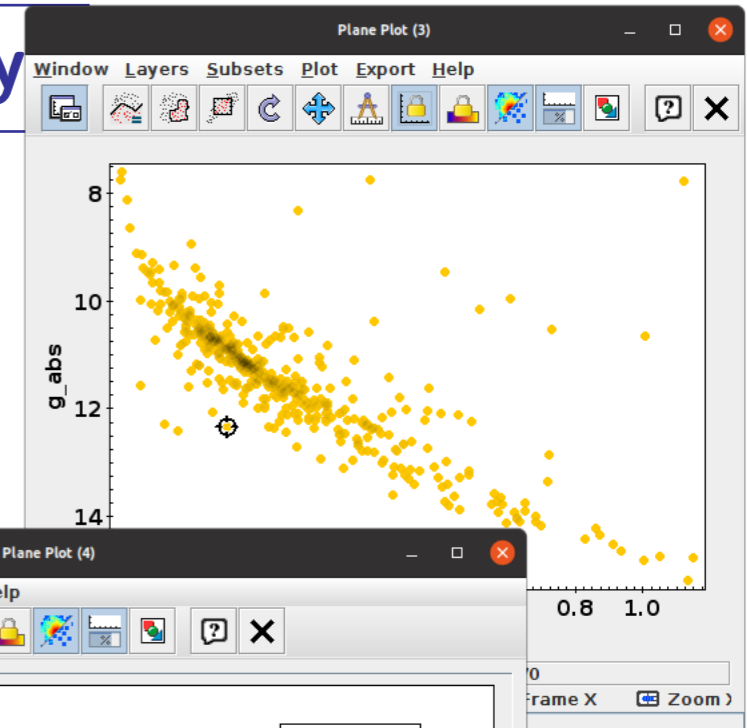
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  AND astrometric_excess_noise < 1
  AND has_xp_sampled = 'true'
  AND bp_rp BETWEEN -0.63 AND 1.21
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stilts arrayjoin in=wd_hrd.fits icmd=progress out=wd_spectra.fits \
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Get some White Dwarf spectra

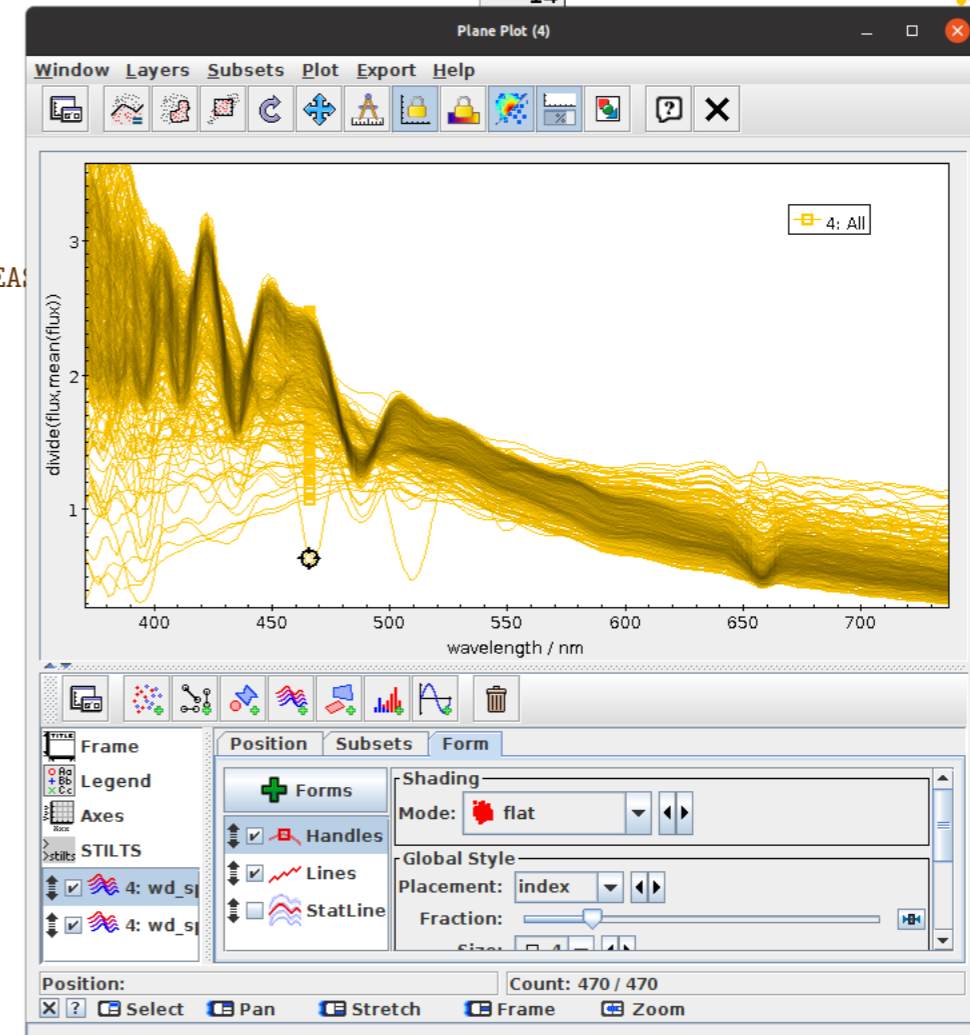
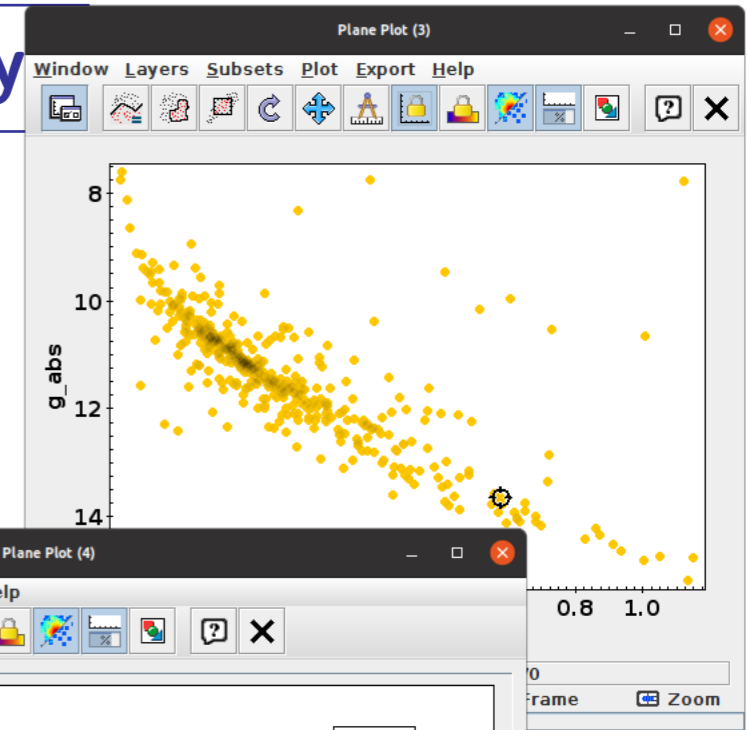
```
SELECT source_id, bp_rp, phot_g_mean_mag+5*log10(parallax/100) AS g_abs
FROM gaiadr3.gaia_source
WHERE parallax > 10 AND parallax_over_error > 10
  AND phot_bp_mean_flux_over_error > 10 AND phot_rp_mean_flux_over_error > 10
  AND astrometric_excess_noise < 1
  AND has_xp_sampled = 'true'
  AND bp_rp BETWEEN -0.63 AND 1.21
  AND phot_g_mean_mag+5*log10(parallax/100) BETWEEN 7.4 AND 15.5
```

```
stilts arrayjoin in=wd_hrd.fits icmd=progress out=wd_spectra.fits \
  atable='"https://gea.esac.esa.int/data-server/data?RETRIEVAL_TYPE=XP_SAMPLED&RELEASE"
```



View them using the XYArray plot

- Use array functions to normalise them
- If X Values are blank, array index is used instead
- Plot mean spectra etc using **StatLine**/**StatMark** form
- Linked views using subsets
- To highlight activated row, use **Activated** subset
- To select single/multiple rows from plot, use **Handles** layer
(most of these features require recent versions)




Summary

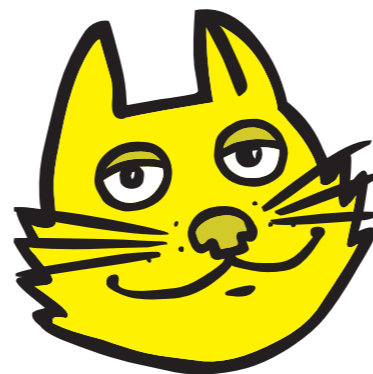
TOPCAT's a good tool for working with Gaia DR3 data

- getting hold of it
- exploring it, analysing it
- comparing it to other data

Gaia DR3 is a fantastic data set to work with

Lots of features of both I didn't show here!

- Comprehensive [HTML](#) / [PDF](#) user manual
- **Help for Window**  button on every window
- Email support:
 - ▷ on list: topcat-user@bristol.ac.uk
 - ▷ in person: m.b.taylor@bristol.ac.uk
- Acknowledgement: [2005ASPC..347...29T](#)



<http://www.starlink.ac.uk/topcat/>

- Downloads
- Documentation
- Tutorials (*including extended version of this one*)

Enjoy Gaia DR3!