

Advanced TOPCAT-STILTS

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TOPCAT & STILTS

- Both do basically the same things but
 - TOPCAT
 - Easier to learn.
 - Good for interactive use, especially exploring data to get a feel for what's there.
 - STILTS
 - Better for reproducible work (it can be scripted).
 - Steeper learning curve.

TOPCAT & STILTS

- Which is the best format?

- Small table (<1000 rows): **doesn't matter.**
- Medium-sized (rows*cols) < 20million): **FITS.**
- Big (millions of rows, especially with lots of columns): **colfits.**

- [4.1.1.1 FITS](#)
- [4.1.1.2 Column-oriented FITS](#)
- [4.1.1.3 VOTable](#)
- [4.1.1.4 CDF](#)
- [4.1.1.5 ASCII](#)
- [4.1.1.6 IPAC](#)
- [4.1.1.7 Comma-Separated Values](#)
- [4.1.1.8 GBIN](#)
- [4.1.1.9 Tab-Separated Table](#)
- [4.1.1.10 SQL Database Queries](#)
- [4.1.1.11 World Data Center](#)

- If the input file is not in this format you can convert it using STILTS:

- *stilts tpipe in=xxx.csv ifmt=csv out=xxx.fits*

TOPCAT & STILTS

- Output in Latex

The image shows a composite screenshot of the TOPCAT software interface and an Emacs editor window. The TOPCAT window displays the 'Current Table Properties' for a table named 'TAP_3_gaiadr1.tgas_source,extcat.hipparcos', showing 50 rows and 5 columns. The Emacs window shows the LaTeX code for a table with 5 columns, with the first column containing the table ID and the next four columns containing columns of data.

TOPCAT Current Table Properties:

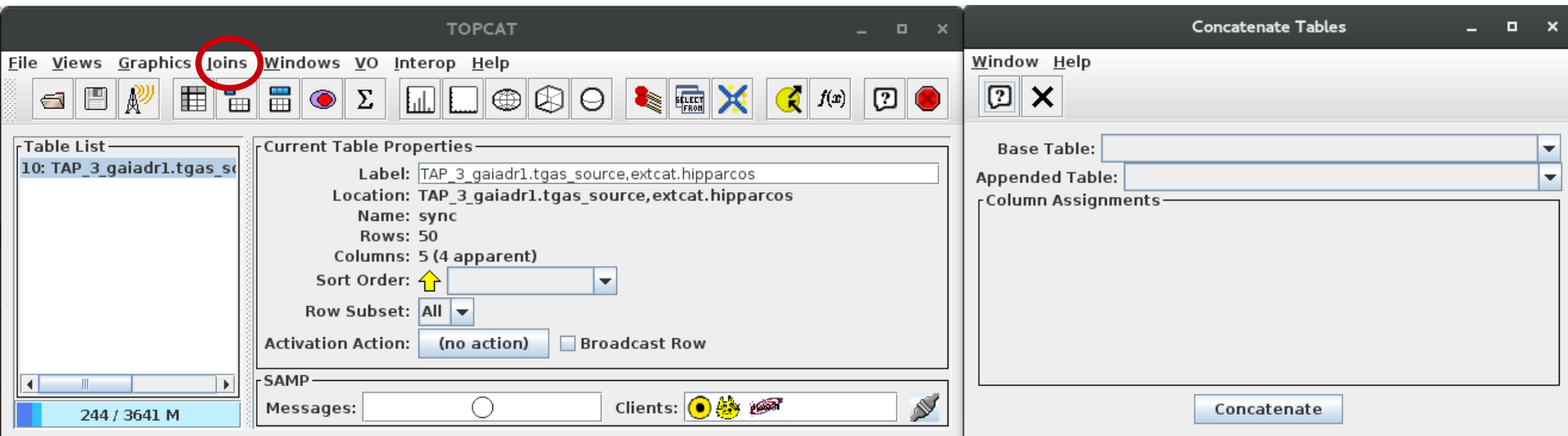
- Label: TAP_3_gaiadr1.tgas_source,extcat.hipparcos
- Location: TAP_3_gaiadr1.tgas_source,extcat.hipparcos
- Name: sync
- Rows: 50
- Columns: 5
- Sort Order: ↑
- Row Subset: All

Emacs LaTeX Code:

```
\documentclass{article}
\begin{document}
\begin{table}
\begin{tabular}{|r|r|r|r|r|}
\hline
\multicolumn{1}{|c|}{hip} &
\multicolumn{1}{|c|}{g_mag_abs_gaia} &
\multicolumn{1}{|c|}{g_mag_abs_hip} &
\multicolumn{1}{|c|}{b_v} \\
\hline
95905 & 2.90110612385656 & 3.08139684809066 & 0.394 \\
95838 & 3.36666243484313 & 3.60007543840966 & 0.707 \\
95662 & 4.21575480915181 & 4.96691320323364 & 0.683 \\
96089 & 3.67412200337596 & 3.99711049720092 & 0.609 \\
97946 & 3.95220466256254 & 3.93122863291356 & 0.495 \\
98189 & 4.08580555128650 & 3.90903495748743 & 0.639 \\
\hline
\end{tabular}
\end{table}
\end{document}
```

TOPCAT & STILTS

- Concatenating tables in TOPCAT



- Only two tables at a time.

TOPCAT & STILTS

- Concatenating multiple tables in STILTS

B.24.2 Examples

Here are some examples of `tcat`:

```
stilts tcat ifmt=ascii in=t1.txt in=t2.txt in=t3.txt out=table.txt
```

Concatenates the three named ASCII format tables to produce an output table. All three must have compatible numbers and types of columns.

```
stilts tcat ifmt=ascii in="t1.txt t2.txt t3.txt" out=table.txt
```

Has exactly the same effect as the previous example.

```
stilts tcat ifmt=ascii in=@inlist.lis out=table.txt
```

This will have the same effect as the previous two examples if a file name "inlist.lis" in the current directory contains three lines, "t1.txt", "t2.txt" and "t3.txt".

- Same input format → `tcatn`
- Similar columns (in number and class).

TOPCAT & STILTS

- Concatenating multiple tables in STILTS

```
stilts tcatn nin=2 in1=survey.vot.gz ifmt2=csv in2=more_data.csv
      icmd1='addskycoords fk5 galactic RA2000 DEC2000 GLON GLAT' \
      icmd1='keepcols "OBJ_ID GLON GLAT"' \
      icmd2='keepcols "ident gal_long gal_lat"' \
      loccol=FILENAME
      omode=topcat
```

In this case we are trying to concatenate results from two tables which are quite dissimilar to each other. In the first place, one is a VOTable (no `ifmt1` parameter is required since VOTables can be detected automatically), and the other is a comma-separated-values file (for which the `ifmt2=csv` parameter must be given). In the second place, the column structure of the two tables may be quite different. By pre-processing the two tables using the `icmd1` & `icmd2` parameters, we produce in each case an input table which consists of three columns of compatible types and meanings: an integer identifier and floating point galactic longitude and latitude coordinates. The second table contains such columns to start with, but the first table requires an initial step to convert FK5 J2000.0 coordinates to galactic ones. `tcatn` joins the two doctored tables together, to produce a table which contains only these three columns, with all the rows from both input tables, and sends the result directly to a new or running instance of TOPCAT. An additional column named `FILENAME` is appended to the table before sending it; this contains "survey.vot.gz" for all the columns from the first table and "more_data.csv" for all the columns from the second one.

TOPCAT & STILTS

- Functions in TOPCAT

The image shows two windows from the TOPCAT software. The left window is titled 'Define Synthetic Column' and contains a form with the following fields: 'Name', 'Expression', 'Units', 'Description', 'UCD' (with a dropdown menu set to 'no UCD'), and 'Index' (with a spinner box set to 47). There are 'OK' and 'Cancel' buttons at the bottom. The right window is titled 'Available Functions' and displays a tree view of function categories. The 'Arithmetic' category is expanded, showing a list of functions. The function 'julianToMjd(julianEpoch)' is highlighted in blue. To the right of the function list, a detailed description is provided for the selected function.

Function `julianToMjd(julianEpoch)`

Description:
Converts a Julian Epoch to Modified Julian Date. For approximate purposes, the argument of this routine consists of an integral part which gives the year AD and a fractional part which represents the distance through that year, so that for instance 2000.5 is approximately 1 July 2000.

Parameters:
`julianEpoch` (floating point)
julian epoch

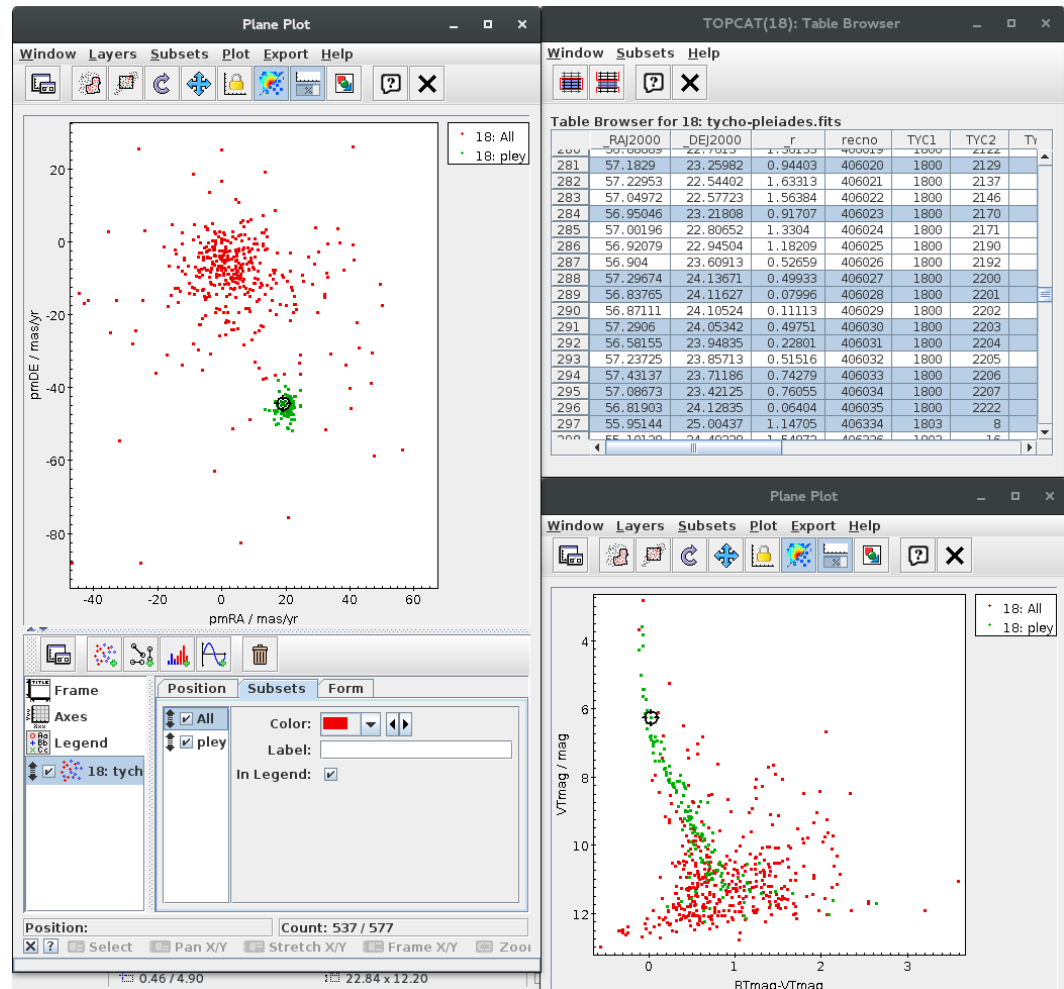
Return Value (floating point):
modified julian date

Example:
`julianToMjd(2000.0) = 51544.5`

Signature:
`double julianToMjd(double)`

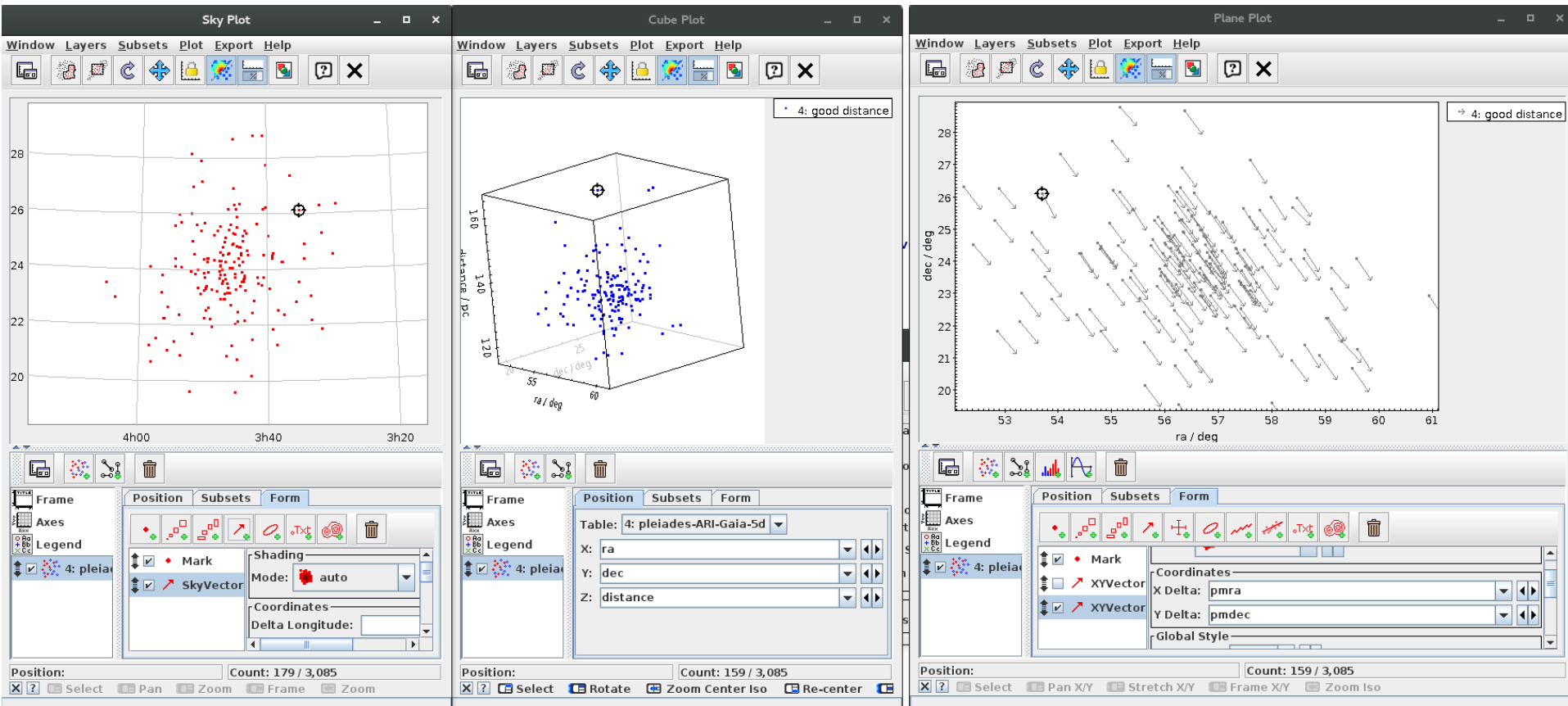
TOPCAT & STILTS

- Linked views



TOPCAT & STILTS

- Linked views



TOPCAT & STILTS

- Crossmatching



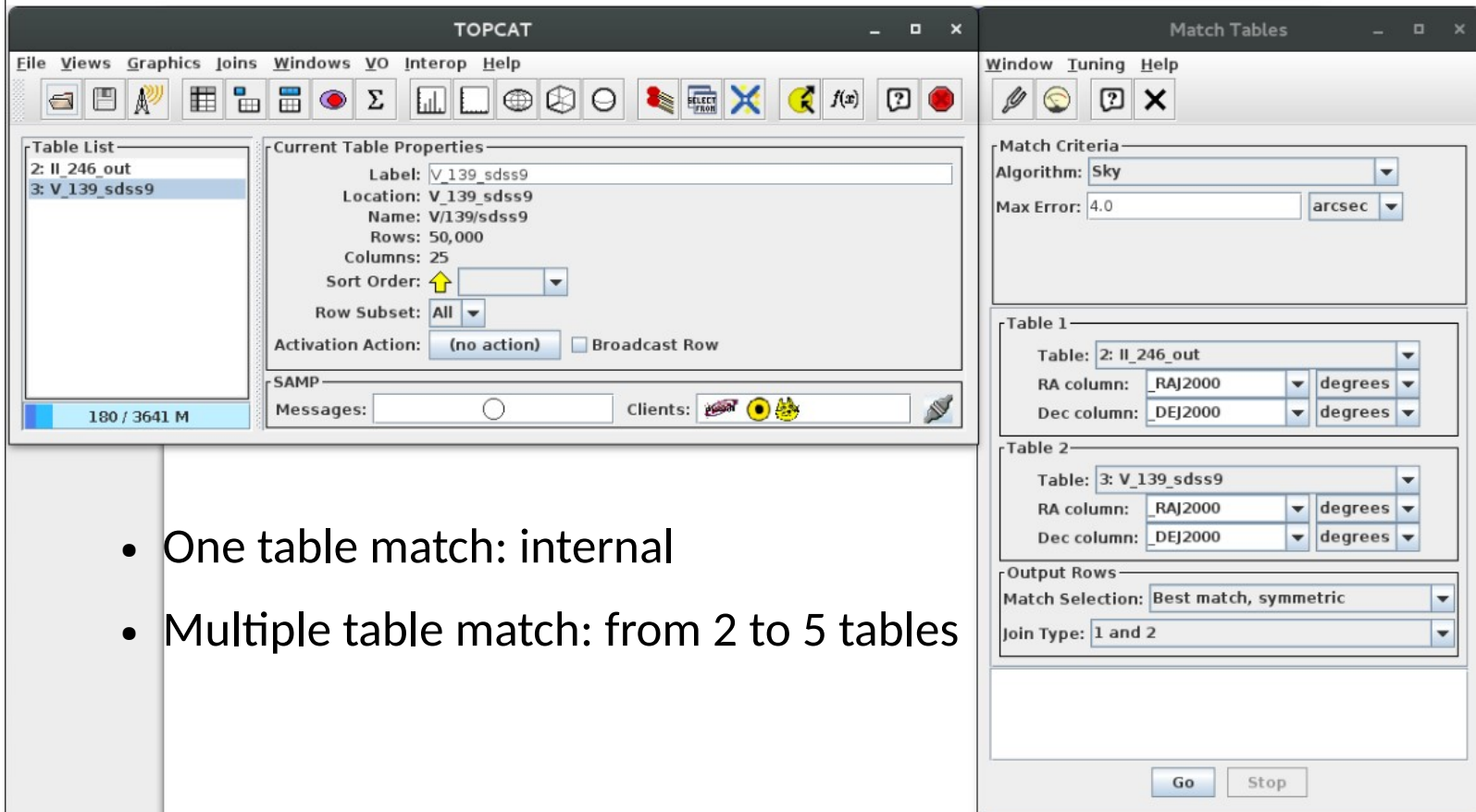
```
stilts tskymatch2 \  
  in1=tycho-pleiades.fits ra1=_RAJ2000 dec1=_DEJ2000 \  
  in2=2mass-pleiades.fits ra2=_RAJ2000 dec2=_DEJ2000 \  
  join=1and2 find=best error=1 \  
  out=tycho-2mass.fits \  
  \
```

- There are lots of different match types (Algorithm selector), not just Sky.
- Think about the output options. Especially in crowded fields, the default Best Match, Symmetric can give surprising results.
- For large tables (> million rows) , the crossmatch can run out of memory.
 - Tip: Increase heap memory (run with `java -jar -Xmx2048M topcat-full.jar`) or use the `java -disk` option.

TOPCAT & STILTS

- **Crossmatching**  - How to x-match two **medium-size** catalogues?

TOPCAT → Joins / Pair match



The screenshot displays the TOPCAT software interface. The main window is titled 'TOPCAT' and shows a 'Table List' on the left with two tables selected: '2: II_246_out' and '3: V_139_sdss9'. The 'Current Table Properties' panel shows details for the selected table 'V_139_sdss9', including its label, location, name, number of rows (50,000), and columns (25). The 'Match Tables' dialog box is open on the right, showing the 'Match Criteria' section with 'Algorithm' set to 'Sky' and 'Max Error' set to 4.0 arcsec. The 'Table 1' section is configured with 'Table: 2: II_246_out', 'RA column: RAJ2000', and 'Dec column: DEJ2000'. The 'Table 2' section is configured with 'Table: 3: V_139_sdss9', 'RA column: RAJ2000', and 'Dec column: DEJ2000'. The 'Output Rows' section shows 'Match Selection' set to 'Best match, symmetric' and 'Join Type' set to '1 and 2'. The 'Go' and 'Stop' buttons are visible at the bottom of the dialog.

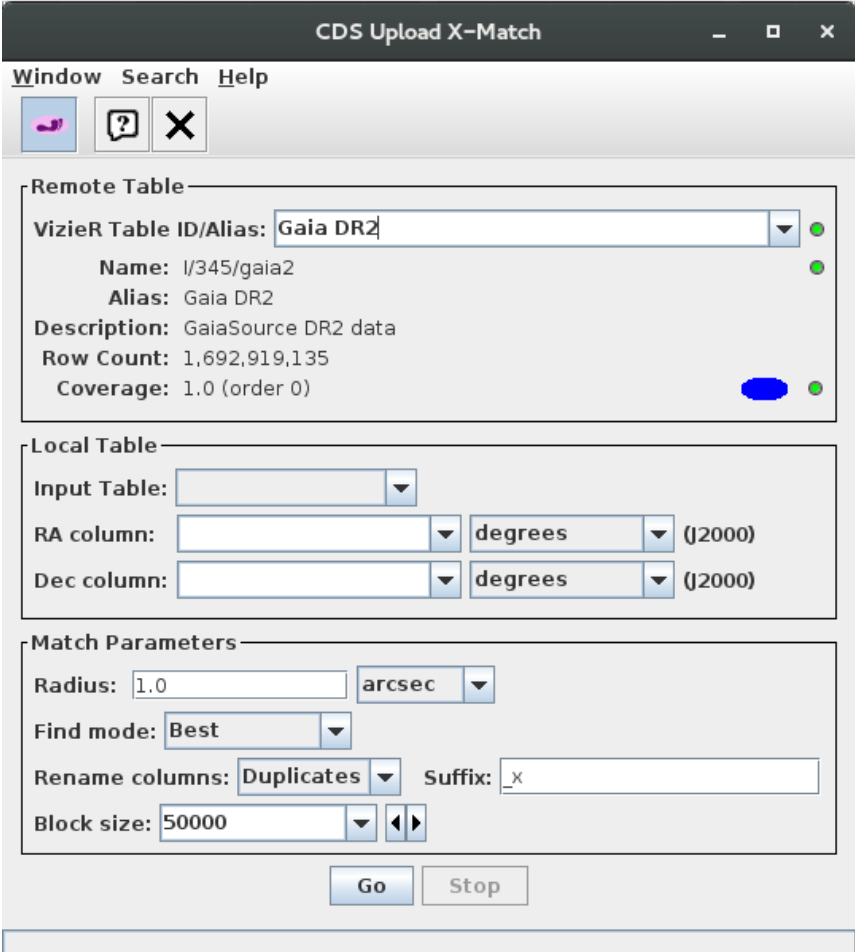
- One table match: internal
- Multiple table match: from 2 to 5 tables

TOPCAT & STILTS

- **Crossmatching**  - How to x-match my catalogue with a **large catalogue** (in CDS) ?

TOPCAT → Joins → CDS Upload X-Match

- **Advantages:** Efficiency
- **Disadvantages:**
 - Only CDS catalogues
 - Only default columns



CDS Upload X-Match

Window Search Help

Remote Table

VizieR Table ID/Alias: Gaia DR2

Name: I/345/gaia2

Alias: Gaia DR2

Description: GaiaSource DR2 data

Row Count: 1,692,919,135

Coverage: 1.0 (order 0)

Local Table

Input Table:

RA column: degrees (12000)

Dec column: degrees (12000)

Match Parameters

Radius: 1.0 arcsec

Find mode: Best





Rename columns: Duplicates Suffix: _x

Block size: 50000

Go Stop

TOPCAT & STILTS

- **Crossmatching**  - How to x-match my catalogue with a **large catalogue** (in CDS) ?

Radmm     Hot Stuff for One Year (HSOY) (Altmann+, 2017) [2017A&A...600L...4A](#) [ReadMe+ftp](#) [Similar Catalogs](#)

I/339 [Post annotation](#)

1.I/339/hsoy The HSOY catalogue (583001653 sources) (original column names in green) (583001653 rows)

Simple Constraint **List Of Constraints**

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

Standard Original

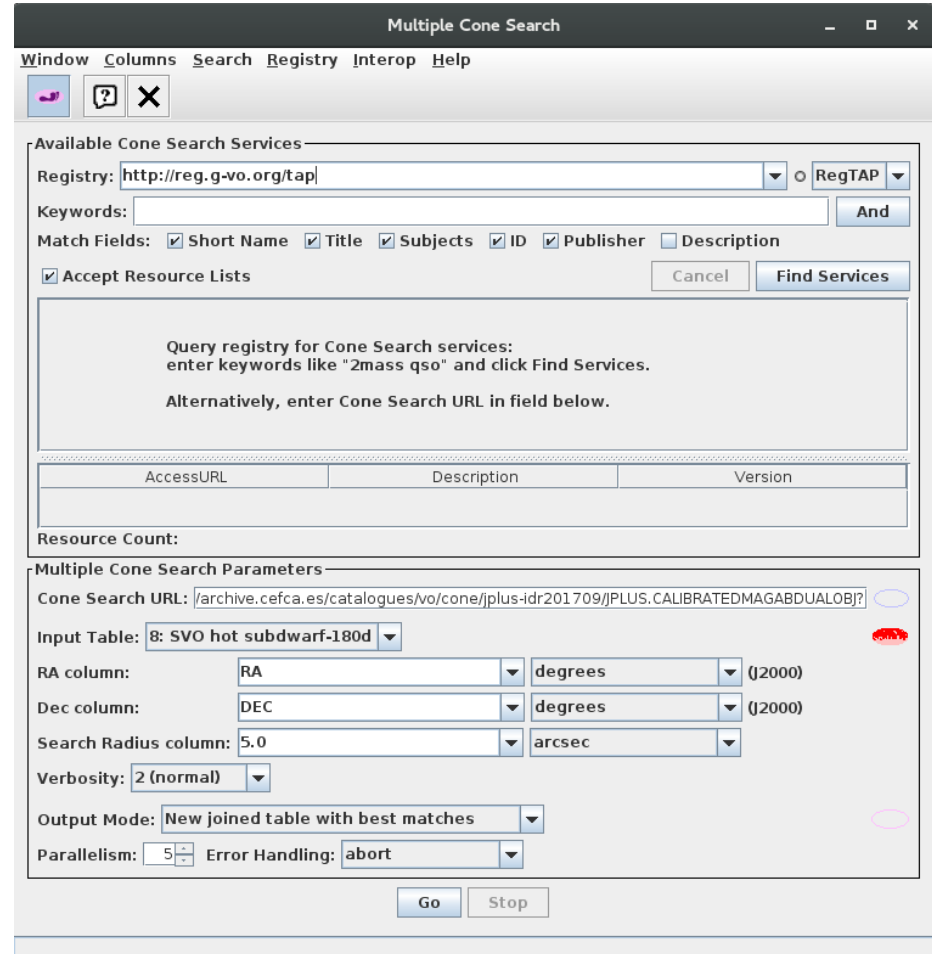
Show	Sort	Column	Clear	Constraint	Explain (UCD)
<input checked="" type="checkbox"/>	<input type="radio"/>	RAJ2000	<input type="text"/>	deg	(i) Right ascension, J2000.0, at epoch 2000 (raj2000) (pos.eq.ra;meta.main)
<input checked="" type="checkbox"/>	<input type="radio"/>	DEJ2000	<input type="text"/>	deg	(i) Declination, J2000.0, at epoch 2000 (dej2000) (pos.eq.dec;meta.main)
<input checked="" type="checkbox"/>	<input type="radio"/>	ipix	<input type="text"/>		(n)(i) PPMXL object identifier (ipix) (Note 1) (meta.id;meta.main)
<input checked="" type="checkbox"/>	<input type="radio"/>	comp	<input type="text"/>		[0/4] Disambiguation counter (where multiple DR1 objects match one PPMXL object) (comp) (Note 1) (meta.code.multip)
<input type="checkbox"/>	<input type="radio"/>	e_RAJ2000	<input type="text"/>	mas	Mean error: RA*cos(DE) at mean epoch EpRA (e_ra) (stat.error;pos.eq.ra)
<input type="checkbox"/>	<input type="radio"/>	e_DEJ2000	<input type="text"/>	mas	Mean error: DE at mean epoch EpDE (e_de) (stat.error;pos.eq.dec)
<input checked="" type="checkbox"/>	<input type="radio"/>	pmRA	<input type="text"/>	mas/yr	Proper motion in RA, pmRA*cos(DE) (pmra) (pos.pm;pos.eq.ra)
<input checked="" type="checkbox"/>	<input type="radio"/>	pmDE	<input type="text"/>	mas/yr	Proper motion in DE (pmde) (pos.pm;pos.eq.dec)
<input type="checkbox"/>	<input type="radio"/>	e_pmRA	<input type="text"/>	mas/yr	Mean error in pmRA (e_pmra) (stat.error;pos.pm;pos.eq.ra)
<input type="checkbox"/>	<input type="radio"/>	e_pmDE	<input type="text"/>	mas/yr	Mean error in pmDE (e_pmde) (stat.error;pos.pm;pos.eq.dec)

TOPCAT & STILTS

- Crossmatching  - How to x-match my catalogue with a **large catalogue** (in CDS) ?

TOPCAT → VO → Multicone

- Disadvantages:
 - slow



The screenshot shows the 'Multiple Cone Search' window. It has a menu bar with 'Window', 'Columns', 'Search', 'Registry', 'Interop', and 'Help'. Below the menu bar are three icons: a red 'X', a question mark, and a magnifying glass. The main area is divided into several sections:

- Available Cone Search Services:** A text box for 'Registry' containing 'http://reg.g-vo.org/tap'. To its right is a dropdown menu set to 'RegTAP'. Below this is a 'Keywords:' text box with an 'And' button. A 'Match Fields:' section has checkboxes for 'Short Name', 'Title', 'Subjects', 'ID', 'Publisher', and 'Description', with 'Short Name', 'Title', 'Subjects', and 'ID' checked. There is also a checkbox for 'Accept Resource Lists' which is checked. 'Cancel' and 'Find Services' buttons are at the bottom right of this section.
- Query registry for Cone Search services:** A text box containing the instruction: 'Query registry for Cone Search services: enter keywords like "2mass qso" and click Find Services. Alternatively, enter Cone Search URL in field below.'
- Table Headers:** A table with three columns: 'AccessURL', 'Description', and 'Version'. The table is currently empty.
- Resource Count:** A label indicating the number of resources found.
- Multiple Cone Search Parameters:** A section for configuring the search. It includes a 'Cone Search URL:' text box with the value '/archive.cefca.es/catalogues/vo/cone/jplus-ldr201709/JPLUS.CALIBRATEDMAGABDUALOBJ?'. Below this is an 'Input Table:' dropdown set to '8: SVO hot subdwarf-180d'. There are three rows for column selection: 'RA column:' with 'RA' and 'degrees' (J2000), 'Dec column:' with 'DEC' and 'degrees' (J2000), and 'Search Radius column:' with '5.0' and 'arcsec'. There is also a 'Verbosity:' dropdown set to '2 (normal)'. At the bottom of this section are 'Output Mode:' (set to 'New joined table with best matches') and 'Parallelism:' (set to '5') and 'Error Handling:' (set to 'abort').

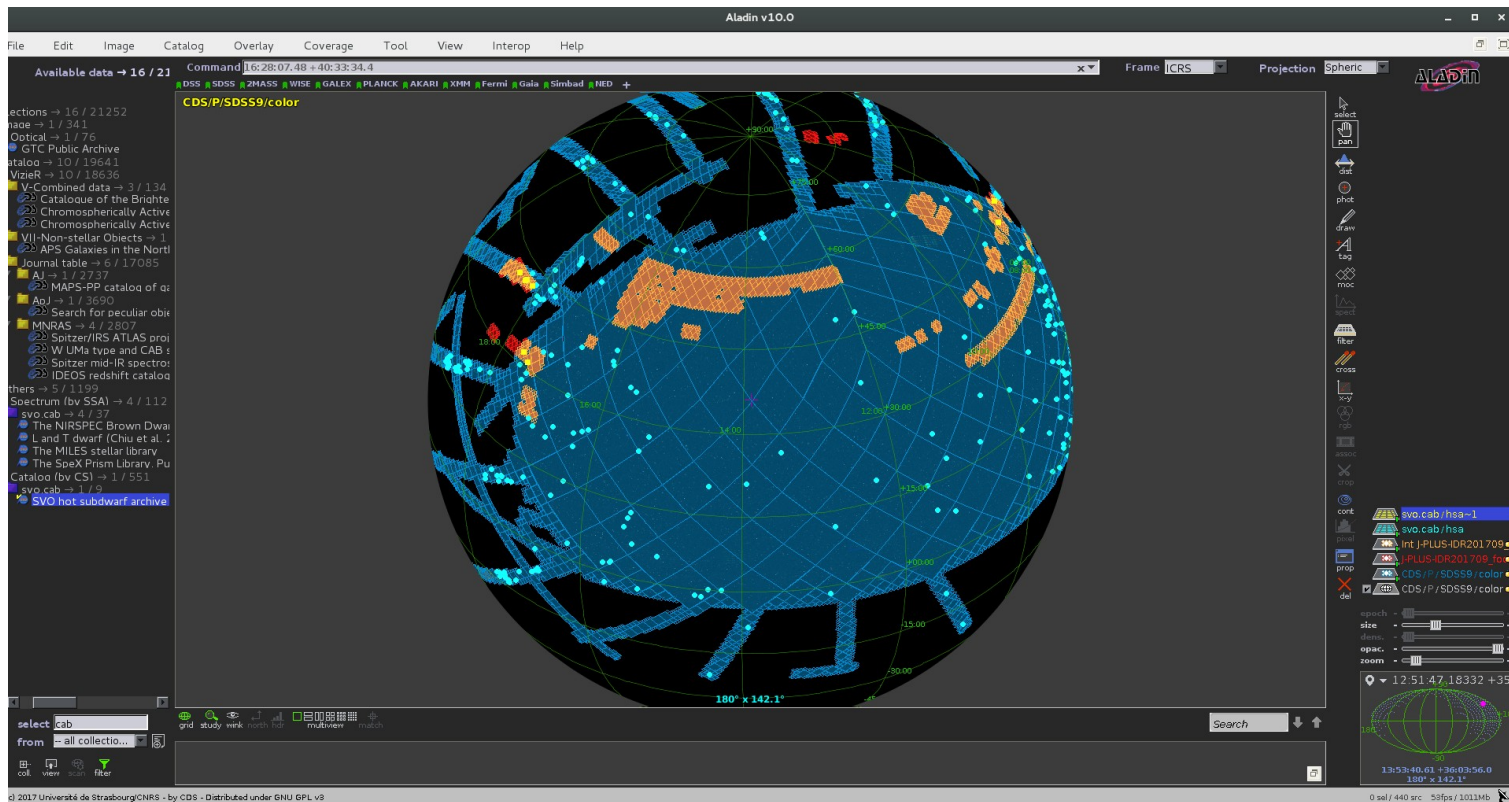
At the bottom of the window are 'Go' and 'Stop' buttons.

TOPCAT & STILTS

- **Crossmatching**  - How to x-match my catalogue with a **large catalogue** (in CDS) ?

Alternative (for non all-sky surveys)

- Filter a table by MOC → X-match the filtered table



TOPCAT & STILTS

- Crossmatching  - How to x-match two large catalogues (in CDS) ?

- Disadvantages:

- No filtering
→ Large outputs

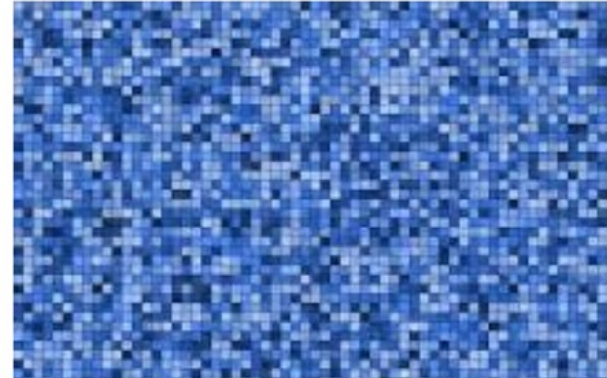


The screenshot shows the CDS X-Match Service interface. At the top, there is a navigation bar with links for Portal, Simbad, VizieR, Aladin, X-Match, Other, and Help. Below this, the main heading is "CDS X-Match Service" with sub-links for X-match, Tables management, and Documentation. The main content area is titled "Choose tables to cross-match". It features two input fields: "Gala DR2" and "PanSTARRS DR1". Below each field are buttons for "VizieR", "SIMBAD", and "My store". Underneath the input fields are two table cards. The first card is for "Gaia DR2 (Gaia Collaboration, 2018)" with 1,692,919,135 rows and a thumbnail image. The second card is for "The Pan-STARRS release 1 (PS1) Survey - DR1 (Chambers+, 2016)" with 1,919,106,885 rows and a thumbnail image. A "Show options" dropdown menu is located below the table cards. A "Begin the X-Match" button is positioned below the "Show options" menu. At the bottom of the interface, there is a section titled "Visualize and manage your cross-match jobs" which contains a table with columns for Table 1, Table 2, Options, Begin, Status, and Actions. The table currently shows "No job in list". A "Delete" button is located at the bottom right of the interface.

TOPCAT & STILTS

- Crossmatching  • - How to x-match two large catalogues (in CDS) ?
(Alternative)

- STILTS



- Cross-match

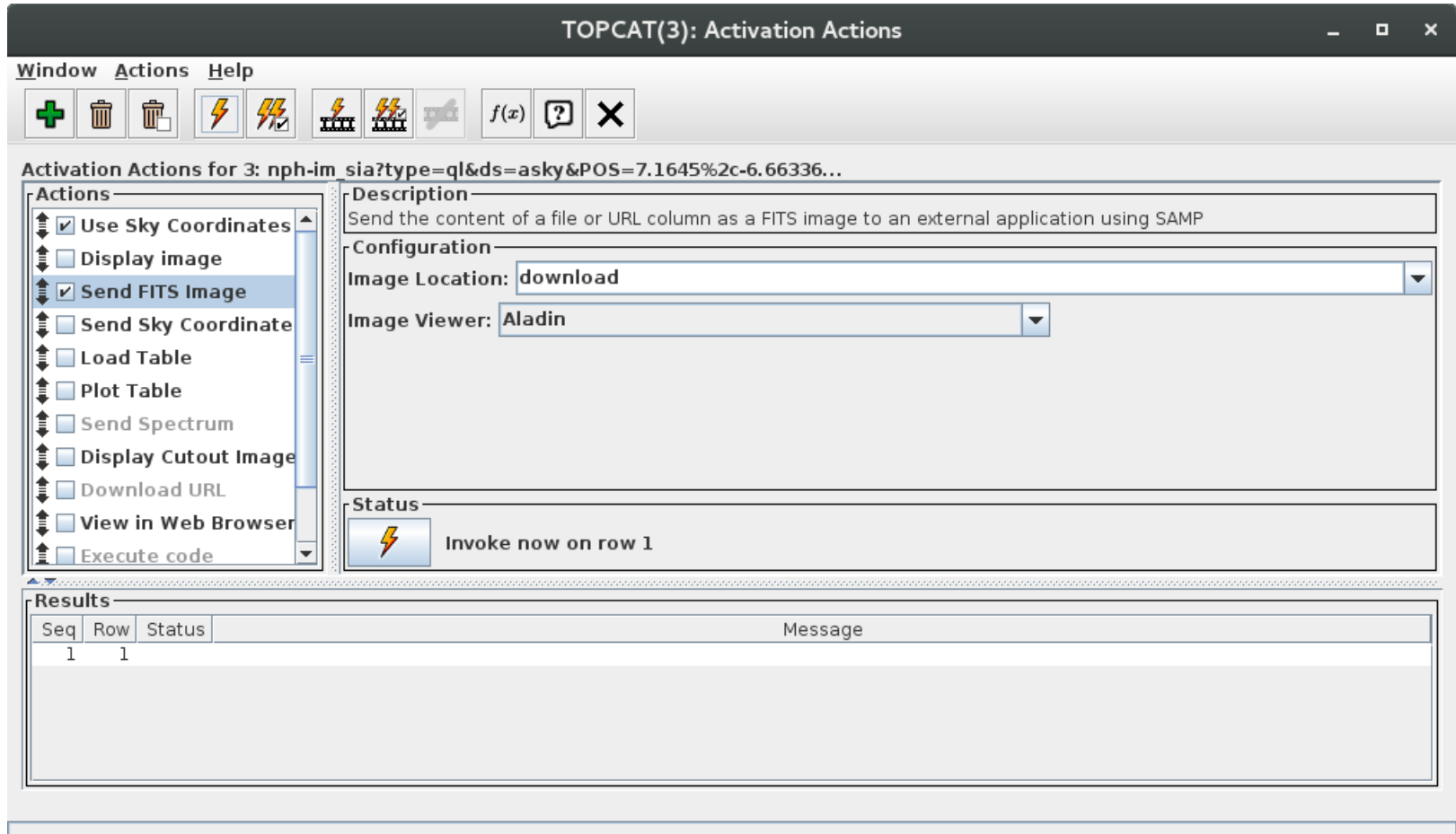
```
java -jar stilts.jar tskymatch2 ifmt1=votable in1=2mass.xml ifmt2=votable  
in2=sdss.xml ra1="RAJ2000" dec1="DEJ2000" ra2="RAJ2000" dec2="DEJ2000"  
error=10 find=all out=cross.xml ofmt=votable'
```

- Filtering

```
java -jar stilts.jar tpipe ifmt=votable in=cross.xml cmd="select  
zmag>12&&zmag<19.5&&rmag-kmag>(zmag+0.5)/2.5&&(rmag-  
kmag)<(zmag+10.5)/2.5&&e_Kmag>0" out=rmkz.xml ofmt=votable
```

TOPCAT & STILTS

- Activation actions and activation window



TOPCAT & STILTS

- Activation actions and activation window

Starlink SPLAT-VO: A Spectral Analysis Tool

Global list of spectra: /tmp/SPLAT29423673260732607

Properties of current spectra:

Short name: /tmp/SPLAT294236732607326303.fits
Full name: http://sdc.cab.inta-csic.es:80/cqi-ines/SingleDownload?filename=LWP12752LL.FIT
Format: TABLE

Columns: WAVELENGTH, FLUX, SIGMA

Colour: Save Reset

Composite: 100%

Line type: polyline

Line width: 1

Starlink SPLAT-VO: <plotO>

Displaying: /tmp/SPLAT294236732607326303.fit Remove Y limits (%): automatic :V-hair

Wavelength: 3239.469 log Data count: 1.446742E-16 log Track free

X scale: 1.0 Y scale: 1.0

2-d compound coordinate system

Data count (erg/cm²/s/Å)

Wavelength (Angstrom)

TOPCAT

Table List

29: ll_246_out
31: ssas(29)

Current Table Properties

Label: ssas(29)
Location: ssas(29)
Name:
Rows: 34
Columns: 50
Sort Order:
Row Subset: All
Activation Action: spectrum(Spectrum) Broadcast Row

SAMP

Messages: Clients:

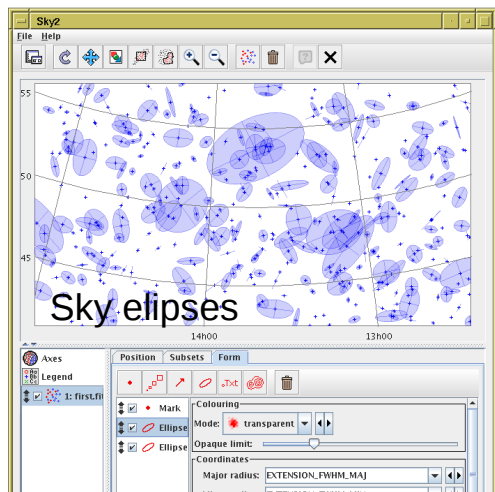
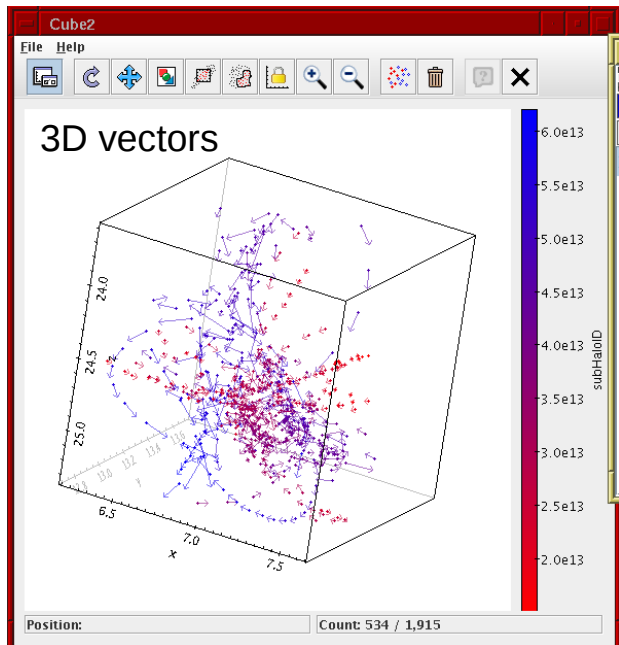
TOPCAT(31): Table Browser

Window Subsets Help

	AXES	UNITS	DIMEQ
1	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
2	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
3	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
4	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
5	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
6	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
7	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
8	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
9	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
10	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
11	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
12	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
13	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
14	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
15	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
16	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
17	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3
18	WAVELENGTH FLUX SIGMA QUALITY	ANGSTROM ERG/CM2/S/A ERG/CM2/S/A n/a	L ML-1T-3 ML-1T-3

Go Stop

TOPCAT: Visualization



TOPCAT
Density Map
Scatter Plot
See Activation Action
Cone Set
Match Tables
Line Plot
A.3 Table View
Histogram
Table Columns
Row Subsets
Axis Configure
Spherical Plot

TOPCAT & STILTS

- More at:

- TOPCAT v 4.6-1

<http://www.star.bris.ac.uk/~mbt/topcat/sun253/sun253.html>

- STILTS v 3.1-4

<http://www.star.bris.ac.uk/~mbt/stilts/sun256/sun256.html>

- TOPCAT/STILTS advanced tutorial

<http://andromeda.star.bris.ac.uk/topcat/tutorial-asterics1/>