

# TOPCAT & STIL(TS)

## TOPCAT Java GUI

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

## STIL library for dealing with tabular data

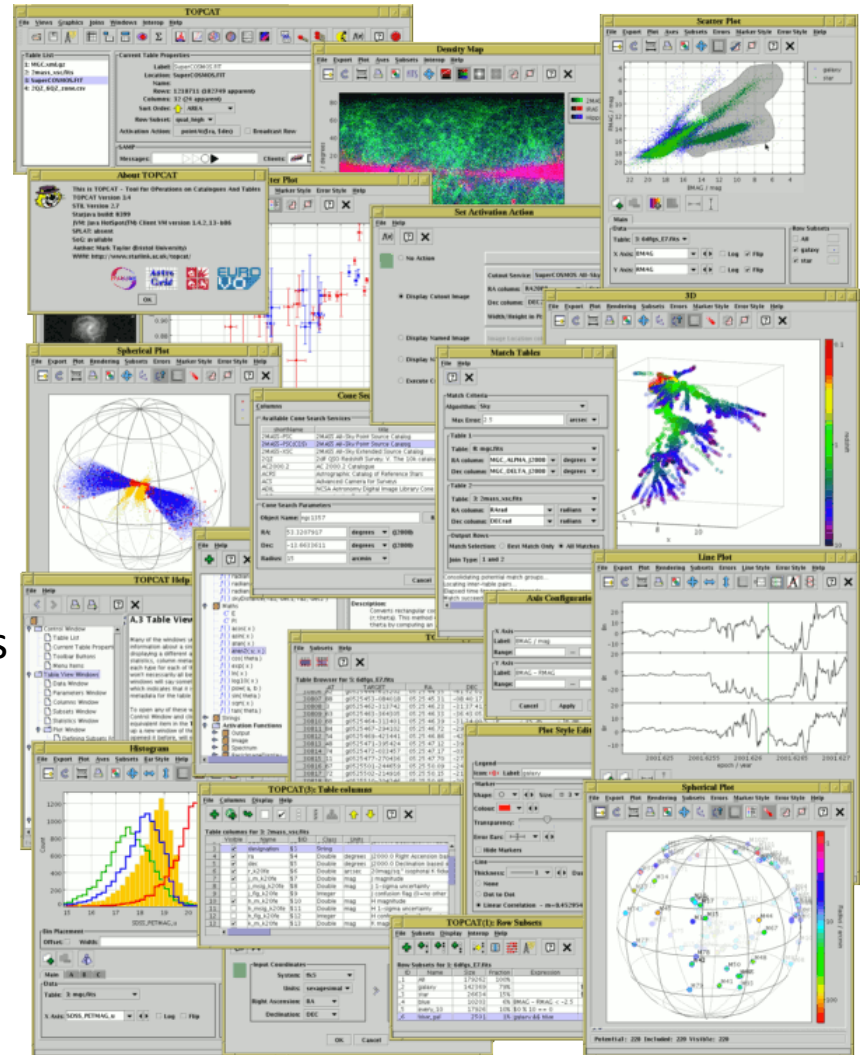
<http://www.star.bristol.ac.uk/~mbt/stil>

## STILTS command-line tool

<http://www.star.bristol.ac.uk/~mbt/stilts/>

## Key features:

- Import/export catalogs in various formats
- Cross-matching and merging
- Plotting and manipulating data
- Search and retrieve data from archives



# TOPCAT : VO retrieval

The screenshot displays the Cone Search application window. The main window is titled "Cone Search" and has a menu bar with "File", "Columns", "Registry", "Interop", and "Help". Below the menu bar are three icons: a pushpin, a question mark, and a close button. The interface is divided into several sections:

- Available Cone Search Services:** A dropdown menu for "Registry" is set to "http://registry.astrogrid.org/astrogrid-registry/services/RegistryQueryv1\_0". A "Keywords" field contains "iphas". Match fields are checked for "Short Name", "Title", "Subjects", and "ID". There are "Cancel Query" and "Submit Query" buttons.
- Search Results Table:** A table with columns "Short Name", "Title", and "IPHAS". The results are:

Short Name	Title	IPHAS
J/A+A/480/409	IPHAS symbiotic stars candidates (Corradi+, 2008)	Binari
J/A+A/504/291	Candidate Planetary Nebulae in IPHAS catalog (Viironen+, 2009)	Phot
J/MNRAS/384/1277	H(alpha) emission line sources from IPHAS (Witham+, 2008)	Phot
J/MNRAS/397/1685	Galactic plane IPHAS-POSS1 proper motion survey (Deacon+, 2009)	Proper
	IPHAS IDR: service	IPHAS
- Cone Search Parameters:** A "Cone Search URL" field contains "http://vizier.u-strasbg.fr/viz-bin/votable/-A?-source=J/MNRAS/384/1277&". An "Object Name" field contains "KR Aur". RA is "93.933" degrees (J2000), Dec is "28.585722" degrees (J2000), and Radius is "50" degrees. There is a "Resolve" button and a checked "Accept Sky Positions" checkbox.

At the bottom of the main window is an "OK" button. To the left, a partial view of another window shows a "Table List" with "12 / 910 M" items.

# Table Data

add custom columns

TOPCAT(1): Table Columns

File Columns Display Help

Table Columns for 1: KR Aur-J\_MNRAS\_384\_1277-50d

Visible	Name	ID	Class	Units	Description	UCD
<input type="checkbox"/>	Index	\$0	Long		Table row index	
<input checked="" type="checkbox"/>	_r	\$1	Double	deg	Distance from center (RA)2000=+06 15 43.92, DEJ2000=+28 35 08.6)	POS_ANG_DIST_GENERA
<input checked="" type="checkbox"/>	_RAJ2000	\$2	Double	deg	Right ascension (FK5) Equinox=J2000. (computed by VizieR, not part of the original data)	POS_EQ_RA_MAIN
<input checked="" type="checkbox"/>	_DEJ2000	\$3	Double	deg	Declination (FK5) Equinox=J2000. (computed by VizieR, not part of the original data)	POS_EQ_DEC_MAIN
<input checked="" type="checkbox"/>	IPHAS	\$4	String		IPHAS source designation, JHHMMSS.ss+DDMMSS.s (1)	ID_MAIN: 1
<input checked="" type="checkbox"/>	r'mag	\$5	Float	mag	Sloan r' band magnitude	PHOT_SDSS_R
<input checked="" type="checkbox"/>	e_r'mag	\$6	Float	mag	Sloan r' band magnitude error	ERROR
<input checked="" type="checkbox"/>	r'-i'	\$7	Float	mag	Sloan r'-i' colour index	PHOT_SDSS_R-I
<input checked="" type="checkbox"/>	e_r'-i'	\$8	Float	mag	Sloan r'-i' colour index error	ERROR
<input checked="" type="checkbox"/>	r'-Ha	\$9	Float	mag	Sloan r'-H(alpha) colour index	PHOT_CI_R-HALPHA
<input checked="" type="checkbox"/>	e_r'-Ha	\$10	Float	mag	Sloan r'-H(alpha) colour index error	ERROR
<input checked="" type="checkbox"/>	Flag	\$11	String		[cksmo ] Photometry/Cross-match flag (2)	CODE_MISC
<input checked="" type="checkbox"/>	KW99	\$12	String		Details from Kohoutek & Wehmeyer (1999, Cat. III/205)	DATA_LINK
<input checked="" type="checkbox"/>	RAJ2000	\$13	String	"h:m:s"	Right ascension (J2000.0)	POS_EQ_RA

TOPCAT(1): Table Browser

File Subsets Help

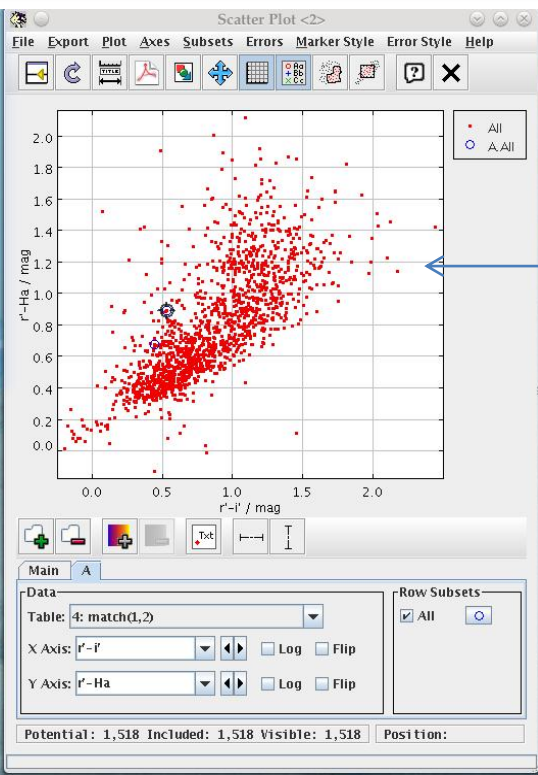
Table Browser for 1: KR Aur-J\_MNRAS\_384\_1277-50d

	_r	_RAJ2000	_DEJ2000	IPHAS	r'mag	e_r'mag	r'-i'	e_r'-i'	r'-Ha	e_r'-Ha	Flag
1	49.89964	34.39933	56.81556	J021735.84+564856.0	17.912	0.016	0.863	0.021	0.715	0.02	
2	49.98747	34.41121	57.44617	J021738.69+572646.2	18.432	0.025	1.013	0.031	0.913	0.03	
3	49.864	34.52233	57.02453	J021805.36+570128.3	16.709	0.007	0.748	0.01	0.492	0.01	
4	49.87278	34.56196	57.22292	J021814.87+571322.5	17.899	0.016	0.978	0.021	0.796	0.02	
5	49.76696	34.72971	57.11914	J021855.13+570708.9	17.222	0.01	0.816	0.013	0.639	0.013	s
6	49.75811	34.74792	57.12506	J021859.50+570730.2	18.657	0.028	0.996	0.034	0.85	0.034	s
7	49.88995	34.8	58.10786	J021912.00+580628.3	18.013	0.01	0.111	0.031	0.13	0.023	
8	49.65691	34.80183	56.64975	J021912.44+563859.1	16.785	0.007	0.702	0.01	0.518	0.01	
9	49.70676	34.89779	57.30825	J021935.47+571829.7	16.83	0.008	0.109	0.014	0.138	0.012	s
10	49.53083	35.03762	56.66333	J022009.03+563948.0	18.585	0.024	1.012	0.03	1.016	0.028	
11	49.80962	35.27662	59.02044	J022106.39+590113.6	17.029	0.009	1.008	0.011	0.946	0.011	
12	49.92993	35.5885	60.37658	J022221.24+602235.7	17.896	0.016	1.032	0.019	0.634	0.021	
13	49.17729	35.78283	56.96867	J022307.88+565807.2	18.349	0.028	0.915	0.036	0.926	0.034	
14	49.96145	35.89017	61.16406	J022333.64+610950.6	15.933	0.005	0.905	0.006	0.621	0.006	
15	49.75364	35.90437	60.26744	J022337.05+601602.8	14.	0.002	0.585	0.003	0.489	0.003	
16	49.2297	35.92779	57.70722	J022342.67+574226.0	18.611	0.054	1.02	0.062	1.14	0.061	
17	49.54987	35.93512	59.37764	J022344.43+592239.5	13.967	0.002	0.575	0.003	0.415	0.003	
18	49.7565	36.09854	60.69911	J022423.65+604156.8	16.253	0.006	0.828	0.008	0.519	0.008	
19	49.99653	36.35683	62.19936	J022525.64+621157.7	18.692	0.031	1.359	0.035	1.062	0.04	
20	49.1897	36.4893	62.60735	J022558.78+582636.1	15.173	0.004	0.515	0.006	0.408	0.006	

# TOPCAT Example

3 tables loaded

The TOPCAT main window displays a 'Table List' on the left with three tables: 1: KR Aur-J\_MNRAS\_384\_127, 2: KR Aur-IX\_10A-50d, and 4: match(1,2). The 'Current Table Properties' panel shows details for the selected table 'match(1,2)', including its location, name, and sort order.



scatter plot

The 'Match Tables' dialog box is used for defining match criteria. It includes fields for 'Algorithm' (set to 'Sky') and 'Max Error' (set to '15.0 arcsec'). Below, two tables are listed for matching: Table 1 (KR Aur-J\_MNRAS\_384\_1277-50d) and Table 2 (KR Aur-IX\_10A-50d), with their respective RA and Dec columns. The 'Match Selection' is set to 'Best Match Only' and 'Join Type' is '1 and 2'. A 'Go' button is at the bottom.

table matching

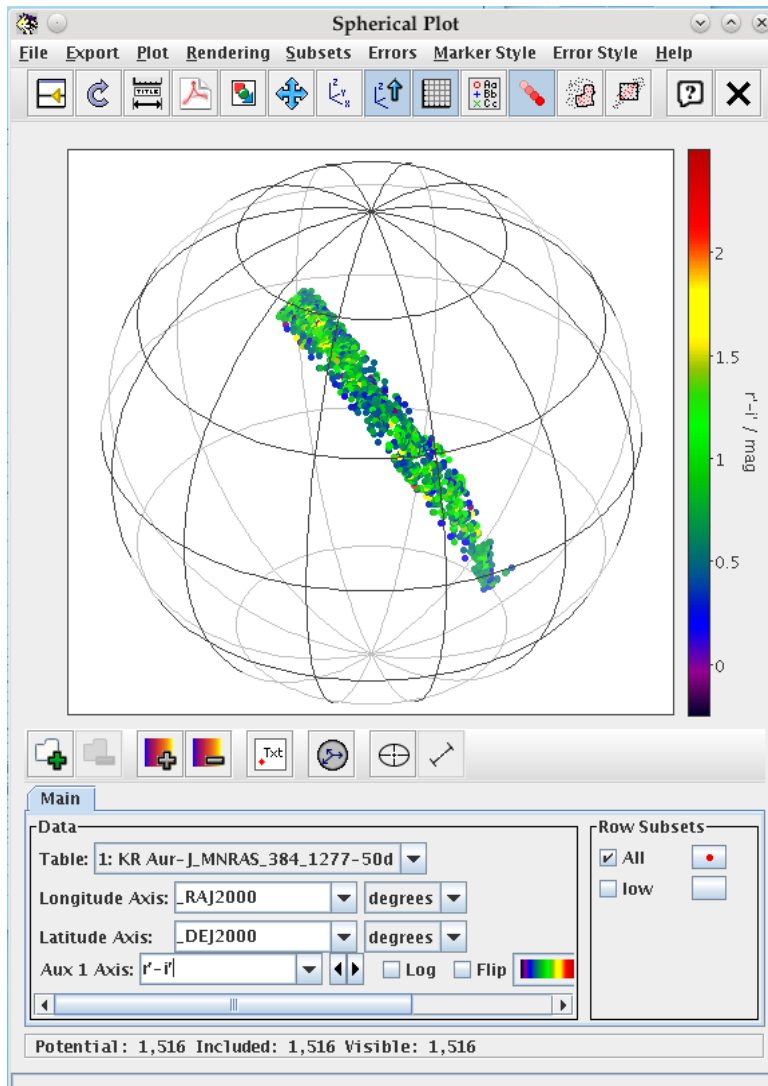


The 'TOPCAT(4): Table Browser' window displays a table of matched pairs. The table has columns for various parameters including RA, Dec, IPHAS, and magnitudes in different filters.

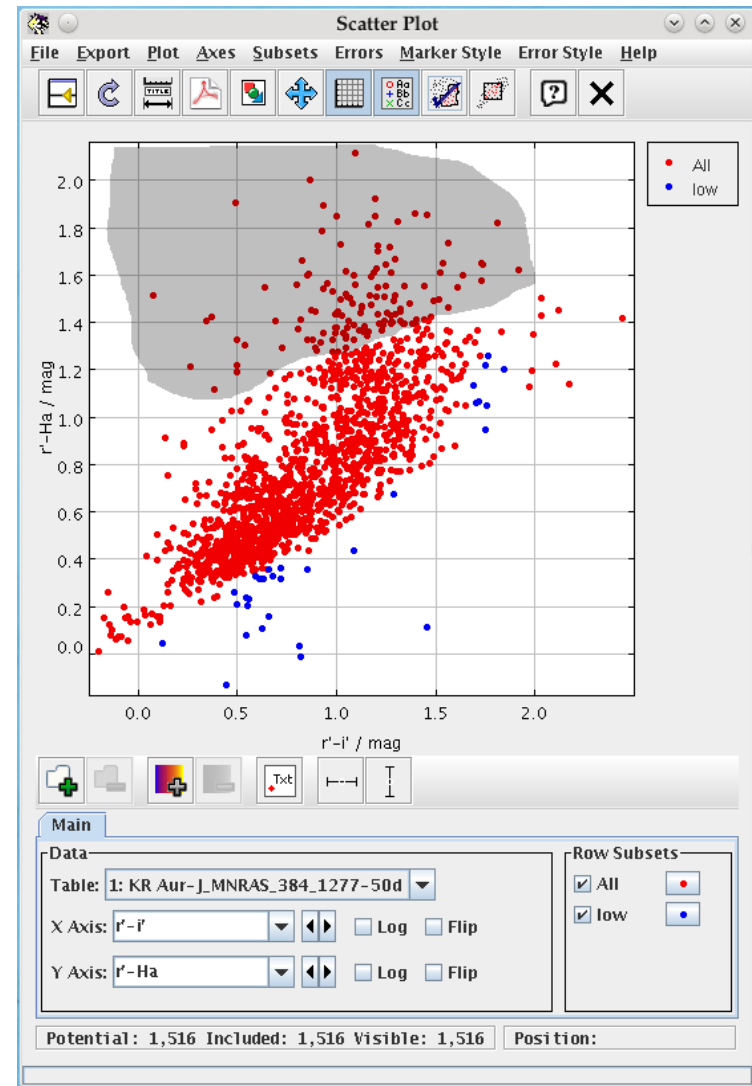
	r_1	_RAJ2000_1	_DEJ2000_1	IPHAS	r'mag	e_r'mag	r'-I'	e_r'-I'	r'-Ha	e_r'-Ha	Flag
1	6.12958	86.9515	28.58647	J054748.36+283511.3	15.797	0.005	0.447	0.007	0.669	0.006	s
2	13.18456	94.18008	15.40314	J061643.22+152411.3	15.627	0.002	0.528	0.004	0.887	0.004	s

sky matched pairs

# TOPCAT



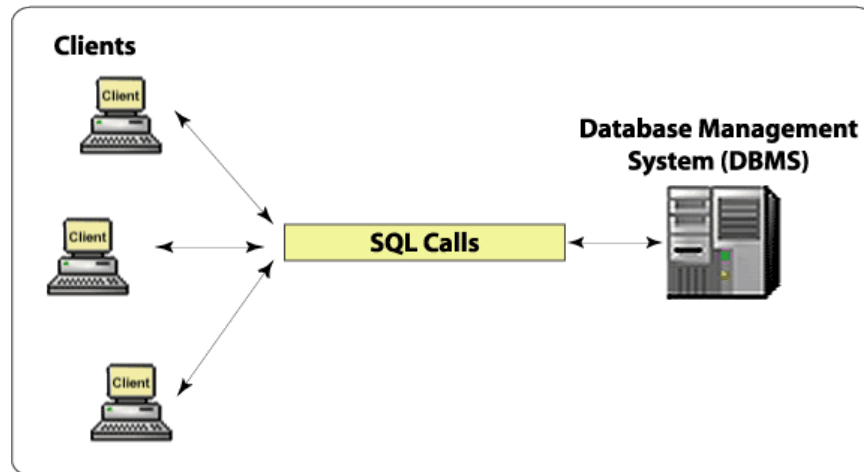
sky plot, colour coded



subsets

# SQL Queries

- **SQL** refers to query syntax allowing you to search and interact with large databases stored by a SQL-compatible server
- The **Structured Query Language** is very popular, originating outside of astronomy, and can handle very large databases plus many clients (commercial and open source implementations available)



- Many astronomical databases powered by SQL even if you may query it by other means (a webform or VO query)
- When simpler frontends fail, or once tables involved become very large, you may need to resort to performing your own SQL queries

# Database lingo

- Tables with rows and columns = Database with records and fields

ID	Source Class	Magnitude	Filter
1	1	12.34	1
2	3	16.89	2

- Records in separate tables may be connected to each other:

Class ID	Value
1	Star
2	Galaxy
3	Unknown

*Relational database*

Filter ID	Value
1	U
2	B
3	V
4	R

# SQL Queries : SDSS

- SDSS prime and early example of a large astronomical data resource that offered multiple ways of retrieving data, including custom SQL queries
- Tutorial covering performing SQL queries on SDSS data:  
<http://skyserver.sdss3.org/dr8/en/help/howto/search/>



The screenshot shows the Sloan Digital Sky Survey / SkyServer DR8 website. The page is titled "SQL Tutorial" and features a navigation menu with options like Home, Data, Schema, Education, Astronomy, SDSS, Contact Us, Download, Site Search, and Help. The main content area includes a "SQL Tutorial" section with a "Back to Help" link and a list of 11 items: 1. Introduction, 2. A Simple Query, 3. Common Searches, 4. More Samples, 5. Multiple Tables, 6. Aggregate Fcns., 7. Group By, 8. Order By, 9. Views, 10. Functions, and 11. Conclusion. A "NEXT" button is visible at the bottom right of the page.



# Table browser

Sloan Digital Sky Survey / SkyServer

DR8

Home Data Schema Education Astronomy SDSS Contact Us Download Site Search Help

## Schema Browser

FieldProfile  
FileGroupMap  
FIRST  
Frame  
galSpecExtra  
galSpecIndx  
galSpecInfo  
galSpecLine  
HalfSpace  
History  
IndexMap  
Inventory  
LoadHistory  
Mask  
MaskedObject  
Neighbors  
PartitionMap  
PhotoObjAll  
PhotoObjDR7  
PhotoPrimaryDR7  
PhotoProfile  
Photoz  
PhotozRF  
PhotozRFTemplateCoeff  
PhotozTemplateCoeff  
Plate2Target  
PlateX  
ProfileDefs  
ProperMotions  
PubHistory  
RC3  
RecentQueries  
Region  
Region2Box  
RegionArcs  
RegionPatch  
Rmatrix  
ROSAT  
Run  
RunShift  
SDSSConstants  
sdssImagingHalfSpaces  
sdssPolygon2Field  
sdssPolygons  
sdssTargetParam  
sdssTileAll  
sdssTiledTargetAll  
sdssTilingGeometry  
sdssTilingInfo  
sdssTilingRun  
Sector  
segueTargetAll  
SiteConstants  
SiteDBs  
SiteDiagnostics  
SpecDR7

TABLE **PhotoObjAll**

The full photometric catalog quantities for SDSS imaging.

This table contains one entry per detection, with the associated photometric parameters measured by PHOTO, and astrometrically and photometrically calibrated.

The table has the following views:

- **PhotoObj**: all primary and secondary objects; essentially this is the view you should use unless you want a specific type of object.
- **PhotoPrimary**: all photo objects that are primary (the best version of the object).
  - **Star**: Primary objects that are classified as stars.
  - **Galaxy**: Primary objects that are classified as galaxies.
  - **Sky**: Primary objects which are sky samples.
  - **Unknown**: Primary objects which are noOne of the above
- **PhotoSecondary**: all photo objects that are secondary (secondary detections)
- **PhotoFamily**: all photo objects which are neither primary nor secondary (blended)

The table has indices that cover the popular columns.

name	type	length	unit	ucd	description
objID	bigint	8			Unique SDSS identifier composed from [skyVersion, rerun, run, camcol, field, obj].
skyVersion	tinyint	1			Layer of catalog (currently only one layer, 0; 0-15 available)
run	smallint	2			Run number
rerun	smallint	2			Rerun number
camcol	tinyint	1			Camera column
field	smallint	2			Field number
obj	smallint	2			The object id within a field. Usually changes between reruns of the same field
mode	tinyint	1			1: primary, 2: secondary, 3: other
nChild	smallint	2			Number of children if this is a composite object that has been deblended. BRIGHT (in a flags sense) objects also have nchild == 1, the non-BRIGHT sibling.
type	smallint	2			Type classification of the object (star, galaxy, cosmic ray, etc.)
clean	int	4			Clean photometry flag (1=clean, 0=unclean).
probPSF	real	4			Probability that the object is a star. Currently 0 if type == 3 (galaxy), 1 if type == 6 (star).
					Flag to indicate whether object is inside a mask and

## Schema Browser

Need to know what Tables are available and which fields are stored in those tables

# Basic Query

---

**SELECT**

ra, dec

which fields do you want returned?

**FROM**

specObj

from which table?

**WHERE**

ra BETWEEN 140 and 141

**AND**

dec BETWEEN 20 and 21

**AND**

class='STAR'

boolean constraints  
on fields that records  
must satisfy

# Relational Query

---

## SELECT

```
specObj.fiberID,  
PhotoObj.modelMag_u,  
PhotoObj.modelMag_g,  
PhotoObj.modelMag_r,  
PhotoObj.modelMag_i,  
PhotoObj.modelMag_z,  
PhotoObj.ra, PhotoObj.dec,  
specObj.z, PhotoObj.ObjID
```

which fields do you want returned?  
[Table.Field]

## FROM

```
PhotoObj, specObj
```

from which tables?

## WHERE

```
specObj.bestObjid = PhotoObj.ObjID
```

need to ensure we  
compare same object

## AND

```
specObj.class = 'qso'
```

## AND

```
specObj.zWarning = 0
```

## AND

```
specobj.z between 0.3 and 0.4
```

boolean constraints  
on fields that records  
must satisfy

[Table.field = Value]

# Result

Your SQL command was:

```
SELECT
specObj.fiberID, PhotoObj.modelMag_u, PhotoObj.modelMag_g,
PhotoObj.modelMag_r, PhotoObj.modelMag_i, PhotoObj.modelMag_z,
PhotoObj.ra, PhotoObj.dec, specObj.z, PhotoObj.ObjID
FROM
PhotoObj, specObj
WHERE
specObj.bestObjid = PhotoObj.ObjID
AND
specObj.class = 'qso'
AND
specObj.zWarning = 0
AND
specObj.z between 0.3 and 0.4
```

fiberID	modelMag_u	modelMag_g	modelMag_r	modelMag_i	modelMag_z	ra	dec	z	ObjID
225	21.608122	20.919027	20.106173	19.625843	19.161301	215.97274128	-0.96643655	0.391129	1237648720172745195
640	20.437267	20.066856	19.869516	19.683071	19.237711	195.66483383	0.40463547	0.374446	1237648674510995921
221	14.929588	12.896034	12.344924	12.255587	13.574942	6.40105152	-0.46343099	0.383457	1237657190371164165
218	20.620367	19.742416	18.909544	18.444504	17.982805	6.55951741	-0.98912516	0.372924	1237657189834358887
512	17.007906	16.777861	16.785234	16.746496	16.370136	23.57580286	0.26019863	0.399601	1237657071157444676
189	18.119993	17.833719	17.874315	17.677757	17.250725	33.24829998	-0.50817531	0.394522	1237657070087962632
151	20.841267	20.093006	18.863449	18.384741	17.953033	337.42612345	-0.71003756	0.374328	1237656567586095748
192	19.786795	19.552595	19.321449	19.210716	18.773647	233.74375738	2.70391221	0.389854	1237654879671550196
332	19.542379	19.182779	18.850351	18.602491	18.349787	143.53824274	2.5436351	0.381111	1237654599949942970
513	18.413069	18.271866	18.284575	18.26753	17.632139	145.17885592	2.26594343	0.385768	1237653665256767497
85	20.295122	19.745787	19.058146	18.573439	18.002174	166.94072826	60.1539464	0.397834	1237653616398696678
42	20.057171	19.952911	19.487123	19.267277	18.884089	348.67848826	-10.51547783	0.377506	1237653436008759550
382	19.270554	19.143511	18.722548	18.43214	18.025404	49.6711526	-6.67914789	0.390237	1237652901306499242
601	20.580416	20.056355	19.482079	19.14917	18.849903	45.02323702	-7.20430752	0.374826	1237652901304467725
585	20.303259	19.847921	19.321499	19.023911	18.627033	28.93484124	-8.68499508	0.381934	1237652901297520731

# Powerful Queries

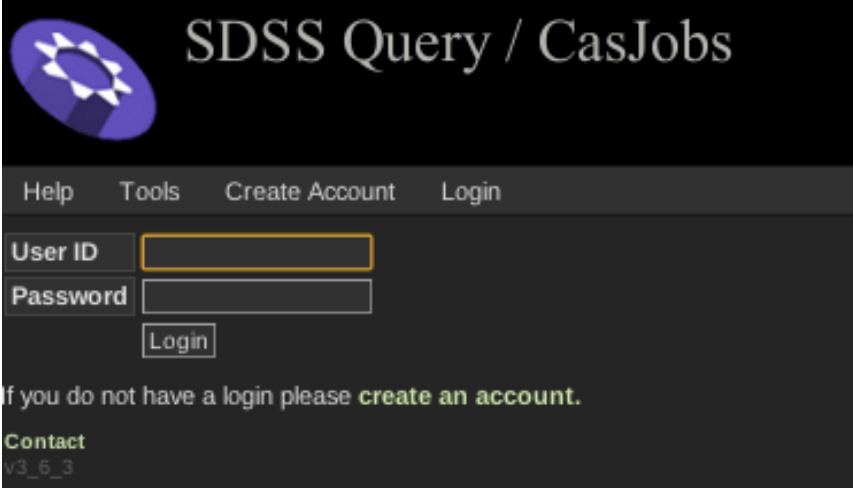
---

```
SELECT TOP 10
run,camCol,rerun,field,objID,ra,dec
FROM Galaxy
WHERE ( ( flags & (dbo.fPhotoFlags('BINNED1')
| dbo.fPhotoFlags('BINNED2')
| dbo.fPhotoFlags('BINNED4')) ) > 0
and ( flags & (dbo.fPhotoFlags('BLENDED')
| dbo.fPhotoFlags('NODEBLEND')
| dbo.fPhotoFlags('CHILD')) ) != dbo.fPhotoFlags('BLENDED')
and ( flags & (dbo.fPhotoFlags('EDGE')
| dbo.fPhotoFlags('SATURATED')) ) = 0
and petroMag_i > 17.5
and (petroMag_r > 15.5 or petroR50_r > 2)
and (petroMag_r > 0 and g > 0 and r > 0 and i > 0)
and ( (petroMag_r-extinction_r) < 19.2
and (petroMag_r - extinction_r <
(13.1 + (7/3) * (dered_g - dered_r) + 4 * (dered_r - dered_i)
- 4 * 0.18) )
and ( (dered_r - dered_i - (dered_g - dered_r)/4 - 0.18) < 0.2)
and ( (dered_r - dered_i - (dered_g - dered_r)/4 - 0.18) > -0.2)
-- dered_ quantities already include reddening
and ( (petroMag_r - extinction_r +
2.5 * LOG10(2 * 3.1415 * petroR50_r * petroR50_r)) < 24.2) )
or ( (petroMag_r - extinction_r < 19.5)
and ( (dered_r - dered_i - (dered_g - dered_r)/4 - 0.18) > (0.45 - 4 *
(dered_g - dered_r)) )
and ( (dered_g - dered_r) > (1.35 + 0.25 * (dered_r - dered_i)) ) )
and ( (petroMag_r - extinction_r +
2.5 * LOG10(2 * 3.1415 * petroR50_r * petroR50_r) ) < 23.3 ) )
```

# CasJobs

---


- No limit on number of records returned or the time it takes for your Query to run
- You can also upload and create your own Tables, then join those in SQL queries



The screenshot shows the SDSS Query / CasJobs interface. At the top left is a logo consisting of a purple circle with white arrows pointing outwards. To the right of the logo, the text "SDSS Query / CasJobs" is displayed in a light grey font. Below the logo and title is a navigation bar with four links: "Help", "Tools", "Create Account", and "Login". Underneath the navigation bar are two input fields: "User ID" and "Password". The "User ID" field is highlighted with a yellow border. Below the "Password" field is a "Login" button. At the bottom of the form, there is a line of text: "If you do not have a login please [create an account](#)." and a "Contact" link. The version number "v3\_6\_3" is visible at the bottom left of the interface.

- Note: it is very easy to write a very complex Query so appreciate what you are asking from the server
- The SDSS/SQL model is used by others, such as GALEX, MAST, VISTA etc

# Other example ; UKIDSS @ WFAU

Home | Overview | Browser | Access | Login | Cookbook | nonSurvey 

**WFCAM**  
Science Archive

WSA Home  
Start Here  
Data Overview  
Known Issues  
the Surveys  
Schema browser  
Data access  
Login  
Archive Listing  
GetImage  
ColourImage  
MultiGetImage  
Region  
Menu query  
Freeform SQL  
CrossID  
Analysis services  
SQL Cookbook  
Q&A  
Glossary  
Release History  
non-Survey  
Gallery  
Publications  
Monitor  
Downtime  
Links

Status: Not logged in.  
Please reload this page if you have logged in and are not seeing the correct login status.

*The GPS and UDS are not publically accessible in UKIDSSDR7plus. Users wishing to access GPS/UDS data should use the DR6plus/DR5plus databases respectively.*

## Freeform SQL Query

This form allows you to submit an SQL query to the WSA database ([notes and tips](#)).

An [enhanced version of this form](#) allows the upload of a file to a temporary database table. This table (#userTable) can then form part of the query being executed.

Database release to use: **UKIDSSDR7PLUS**

Upload SQL query from file into this form:  No file chosen

or enter  
SQL statement:

ensure one of the file formats is selected below if you want to save your results.

Email Address:  the results of long running queries will be sent by email.

Data Format:

- HTML table summary (results are NOT saved to file)
- ASCII FILE (downloadable with HTML table summary on-screen)
- FITS FILE (downloadable with HTML table summary on-screen)
- VOTable FILE (downloadable with HTML table summary on-screen)

*( The number of rows written to the downloadable files is subject to an upper limit see data access )*

File Compression:  (none)  GZIP

IFA ROE

THE UNIVERSITY OF  
WARWICK

# TOPCAT Assignment

---

- Retrieve a 5' cone of data from the SDSS DR7 photometry (`sdsdr7-sda` service, `PhotoObjAll` catalog) centered on 01:30:56, +43:55:49
- Merge the resulting table with 2MASS (`2mass-psc`) using a sky matching radius of 2''
- Make a scatter plot of SDSS (u-g) colour versus 2MASS (J-K) colour, limited to sources brighter than SDSS  $g=20$
- Consider the source that is most red in the near-infrared and comment on its optical colour relative to other sources in the field