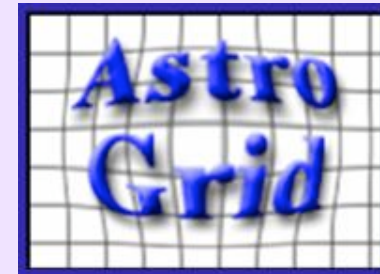


Virtual Observatory 2.0 ?

- VO today
- VO tomorrow





Virtual Observatory recap

The VO vision

The VO vision

- web all docs in the world inside your PC

The VO vision

- web all docs in the world inside your PC
- VO all databases in the world inside your PC

The VO vision

- web all docs in the world inside your PC
 - VO all databases in the world inside your PC
-
- Most astronomy data are already on line
 - So is that all we need ?

Two Problems

- Tower of Babel

- too many different web pages, formats, keywords, table column names, access methods, passwords etc etc
- standardise !!!!

- Data Deluge

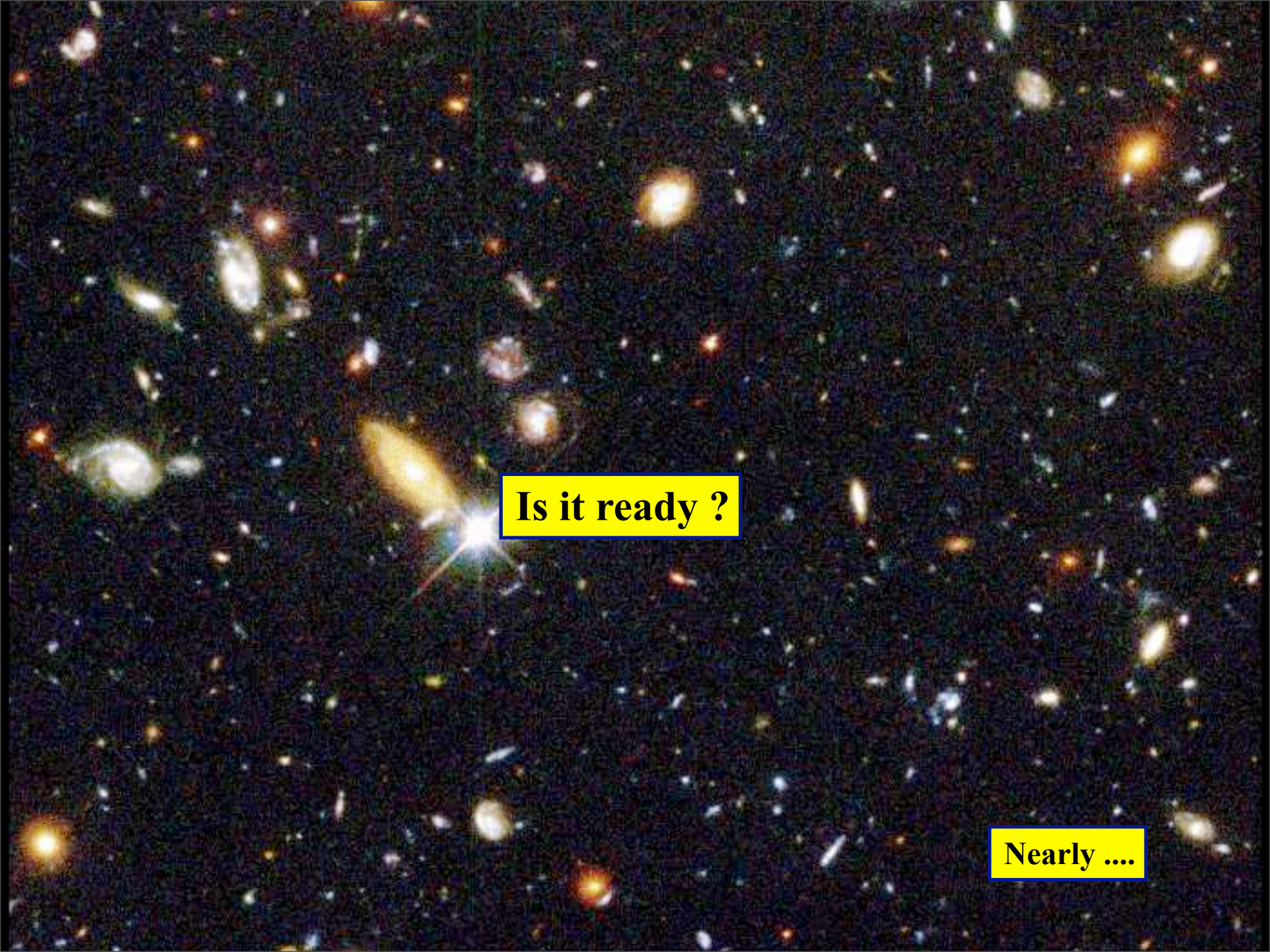
- some modern datasets VAST
- cannot "download and hack"
- need online data *search and analysis services*

So ...we need ...

- ~~heads knocked together~~ *international standards*
- *data services* that follow the rules
- *yellow pages* for data (Registry)
- *VO software* that understands this stuff
 - infrastructure
 - tools
 - a software ecosystem not a "one stop shop" portal



Is it ready ?



Is it ready ?

Nearly

Whats done ?

www.astrogrid.org

- Many (but not all) key standards
- Thousands of datasets
- Yellow pages
- Lots of techy stuff
 - Middleware, API, VOSpace, Identity services ...
- Several good interoperating user tools
 - VO Desktop, Aladin, Topcat, VOSpec ..
- Two related popular tools
 - Google Sky and World Wide Telescope

Whats done ?

www.astrogrid.org

- Many (but not all) key standards
- Thousands of datasets *most of them work...*
- Yellow pages
- Lots of techy stuff
 - Middleware, API, VOSpace, Identity services ...
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Sky Browsing approach

The screenshot displays the Microsoft WorldWide Telescope application window. The title bar reads "Microsoft WorldWide Telescope". The main menu includes "Explore", "Guided Tours", "Search", "Community", "Telescope", "View", and "Settings". Below the menu is a "Collections" bar with icons for "My Collections", "Constellations", "Solar System (Sk...", "All-Sky Surveys", "Spitzer Studies", "Chandra Studies", "Hubble Studies", "Astrophotography", "Radio Studies", and "NOAO Studies". The central area is a large, vibrant image of the Orion Nebula, with a white crosshair cursor positioned in the center. At the bottom, a control panel features a "Look At" dropdown set to "Sky", an "Imagery" dropdown set to "Digitized Sky Survey (Optical)", an "Image Crossfade" slider, a "Context Search Filter" dropdown set to "All", and a "1 of 44" indicator. Below these are eight thumbnail images of celestial objects: Orion Nebula, Orion Nebula, Orion Nebula, Barnard 30, Barnard 30, Abell 520, Abell 520, and Messier 42. To the right of the thumbnails is a circular sky map with a yellow arrow pointing to the current view, and a small inset map of Orion. The sky map shows the current location in the Orion constellation, with RA: 05h35m13s and Dec: -03:16:53. The Windows taskbar at the bottom shows the "start" button, the application name "Microsoft WorldWide ...", and the system tray with the time "2:05 PM".

Yellow Pages Approach

VO Explorer - catalogue searches

Contents of catalogue searches - 11 resources

Filter result: [icon]

| Flag... | Title | Capability | Valida... | Date |
|------------|---------------------------------------------------------|------------|-----------|------------|
| | IRAS Point Source Catalog, Version 2.0 | [icon] | | 2008-12-24 |
| | XMM-Newton Serendipitous Source Catalog (2XMMI Version) | [icon] | | 2008-12-24 |
| | ROSAT All-Sky Survey: Faint Sources | [icon] | | 2008-12-24 |
| | Fermi LAT Bright Source List | [icon] | | 2009-02-17 |
| | SDSS Data Release 5 (DR5) | [icon] | | 2009-08-12 |
| | UKIDSS DR3 | [icon] | | 2009-06-05 |
| | SuperCOSMOS Science Archive (SSA) | [icon] | | 2009-02-16 |
| | UKIDSS DR1 | [icon] | | 2009-11-03 |
| [red flag] | USNO-B1 Catalogue | [icon] | | 2007-04-11 |
| | 2MASS All-Sky Extended Source Catalog | [icon] | | 2008-04-07 |
| | 2MASS All-Sky Point Source Catalog | [icon] | | 2008-04-07 |

Information Table Metadata XML

IRAS Point Source Catalog, Version 2.0 [icon]

Short Name IRASPSC IVOA-ID ivo://nasa.heasarc/iraspcc
Resource Type CatalogService Created 2008-12-24

Content Type catalog Subject survey source Level research

The IRAS Point Source Catalog, Version 2.0, is a catalog of some 250,000 well-confirmed infrared point sources observed by the Infrared Astronomical Satellite (IRAS), i.e., sources with angular extents less than approximately 0.5, 0.5, 1.0, and 2.0 arcminutes in the in-scan direction at 60, and 100 microns (um), respectively. Positions, flux densities, uncertainties, associations with known astronomical objects and various cautionary flags are given for each object in the catalog. Away from confused regions of the sky, the survey is complete to about 0.4, 0.5, 0.6, and 1.0 Janskies (Jy) at 12, 25, 60, and 100 microns, respectively. Typical position uncertainties are about 6 arcseconds in the in-scan direction and about 8 to 16 arcseconds in the cross-scan direction. [Further Information...](#)

Source Reference 1988IRASP.C.....0J
Relationships service-for [NASA/GSFC Exploration of the Universe Division](#)

Waveband Coverage infrared
Spatial Coverage All-Sky

Annotate
 Flag [red flag]
Highlight [dropdown]
Alternative title [input]
Notes [text area]
Tags [input]

Actions
Query
Multi Query
Web interface

About
Selection: CatalogService
Further Info
Email Curator

Yellow Pages Approach

The image shows a screenshot of the VO Explorer software interface, specifically the 'catalogue searches' window. The main window displays a table of search results with columns for 'Flag...', 'Title', 'Capability', 'Valida...', and 'Date'. The first entry is 'IRAS Point Source Catalog, Version 2.0' with a date of '2008-12-24'. A 'New Smartlist' dialog box is open in the foreground, titled 'VO Explorer - New Smartlist'. It shows a search named 'ROSAT image search' with the following conditions: 'Service capability is Image', 'Waveband is X-ray', and 'Title contains ROSAT'. The query text is displayed as '((capability = Image) AND (waveband = X-ray)) AND (title = ROSAT)'. The status bar at the bottom indicates 'Matches 10 of 9220 resources'. On the left side, there is a sidebar with a tree view of resource lists and a panel for the selected 'IRAS Point Source Catalog' resource, showing details like 'Short Name', 'Resource Type', and 'Content Type'.

VO Explorer - catalogue searches

Contents of catalogue searches - 11 resources

| Flag... | Title | Capability | Valida... | Date |
|---------|----------------------------------------|------------|-----------|------------|
| | IRAS Point Source Catalog, Version 2.0 | | | 2008-12-24 |
| | XMM-N | | | |
| | ROSAT | | | |
| | Fermi L | | | |
| | SDSS D | | | |
| | UKIDSS | | | |
| | SuperC | | | |
| | UKIDSS | | | |
| | USNO-1 | | | |
| | 2MASS | | | |
| | 2MASS | | | |

VO Explorer - New Smartlist

The search named: ROSAT image search

Contains resources which match **all** of the following conditions:

- Service capability is Image
- Waveband is X-ray
- Title contains ROSAT

Query Text

```
((capability = Image) AND (waveband = X-ray)) AND (title = ROSAT)
```

Matches 10 of 9220 resources

Update Cancel

Search data services

The screenshot displays the 'Astroscope - 103 Cat. Object Services' web interface. The left sidebar contains search controls, navigation buttons, and action menus. The main area shows a central 'Cat. Objects' node with lines radiating to various data services and their respective result counts.

Search for:
 Cat. Objects Images
 Spectra Timed Data

At:
Position (RA,Dec) or Object Name: 19.271249,-73.446993
Search Radius (degs/arcsecs): 5.100000
 Degrees Sexagesimal

Navigate:
Search, Go To Top, Clear Selection

Process:
Actions: View, Download..., Multi Query, Send tables to Aladin, Send tables to Topcat
About: application/x-votable+xml

Search Results:

- Far Ultraviolet Explorer (FUSE) - 216 results
- Long-term photometry of - 4 results
- ANS UV Catalogue of Point - 3 results
- Hipparcos Input Catalogue, - 234 results
- The FUSE Observation Log - 216 results
- Atlas of warm AGN and - 1 results
- Far-UV Point Sources - 438 results
- 2MASS-selected Flat Galaxy -band - 52 results
- 2MASS-selected Flat Galaxy - 24 results
- BeppoSAX WFC Observation Log - 11 results
- The APM Bright Galaxy - 3 results
- CGRO/BATSE Earth Occultation - 4 results
- HEAO 1 A4 X-ray - 3 results
- ATNF Pulsar Catalog - 28 results
- Ephemerids of eclipsing - 3 results

Pipe results to other apps

TOPCAT(1): Table Browser

Table Browser for 1: [nph-catsearch?CAT=fp_psc&RA=355.0&DEC=0.0&SR=0.1](#)

| | ra | dec | err_maj | err_min | err_ang | designation | j_m |
|----|---------|-----------|---------|---------|---------|------------------|--------|
| 1 | 355.06 | -0.01215 | 0.06 | 0.06 | 90 | 23401429-0000437 | 14.877 |
| 2 | 354.923 | -0.052709 | 0.13 | 0.11 | 1 | 23394151-0003097 | 14.773 |
| 3 | 355.076 | -0.063874 | 0.35 | 0.24 | 4 | 23401820-0003499 | 16.912 |
| 4 | 354.936 | -0.067378 | 0.14 | 0.12 | 1 | 23394461-0004025 | 15.42 |
| 5 | 355.077 | -0.05786 | 0.5 | 0.42 | 80 | 23401840-0003282 | 16.584 |
| 6 | 355.028 | -0.036228 | 0.07 | 0.07 | 90 | 23400675-0002104 | 15.493 |
| 7 | 355.022 | -0.028082 | 0.21 | 0.19 | 79 | 23400527-0001410 | 16.776 |
| 8 | 354.931 | -0.020214 | 0.24 | 0.24 | 11 | 23394355-0001127 | 16.798 |
| 9 | 355.003 | -0.039334 | 0.19 | 0.17 | 7 | 23400066-0002216 | 16.639 |
| 10 | 355.073 | -0.065699 | 0.24 | 0.14 | 1 | 23401750-0003565 | 16.566 |
| 11 | 354.906 | -0.016004 | 0.28 | 0.25 | 9 | 23393748-0000576 | 16.397 |
| 12 | 354.939 | -0.078006 | 0.13 | 0.11 | 0 | 23394540-0004408 | 12.15 |
| 13 | 354.935 | -0.056206 | 0.13 | 0.11 | 1 | 23394435-0003223 | 13.596 |

Pipe results to other apps

TOPCAT(1): Table Browser

Scatter Plot

Table Browser for 1: nph-
ra de

| | | |
|----|---------|--|
| 1 | 355.06 | |
| 2 | 354.923 | |
| 3 | 355.076 | |
| 4 | 354.936 | |
| 5 | 355.077 | |
| 6 | 355.028 | |
| 7 | 355.022 | |
| 8 | 354.931 | |
| 9 | 355.003 | |
| 10 | 355.073 | |
| 11 | 354.906 | |
| 12 | 354.939 | |
| 13 | 354.935 | |

Scatter Plot showing j_snr (Y-axis) versus j_m (X-axis). The plot displays a series of red data points, indicating a decreasing trend of j_snr as j_m increases.

Main

Data

Table: 1: nph-catsearch?CAT=fp_psc&RA=355.

X Axis: j_m Log

Y Axis: j_snr Log

Row Subsets

All

Potential: 55 Included: 55 Visible: 20 Position: (12.34, 1)

Pipe results to other apps

TOPCAT(1): Table Browser

Scatter Plot

Table Browser for 1: nph-
ra de

| | | |
|----|---------|--|
| 1 | 355.06 | |
| 2 | 354.923 | |
| 3 | 355.076 | |
| 4 | 354.936 | |
| 5 | 355.077 | |
| 6 | 355.028 | |
| 7 | 355.022 | |
| 8 | 354.931 | |
| 9 | 355.003 | |
| 10 | 355.073 | |
| 11 | 354.906 | |
| 12 | 354.939 | |
| 13 | 354.935 | |

Aladin v6.0

Location ICRS Pixel 1.842 full

rass3bb.fits

1500
1000
500
0
-500

j_snr

11.5 12.0 12.5

j_m

1° 8.965° x 8.286°

Zoom 2x

10° x 10°

Search

(c)1999-2009 UdS/CNRS - Centre de Donnees astronomiques de Strasbourg

0 sel / 0 src 1Mb

Pipe results to other apps

The image displays a workflow for processing astronomical data. On the left, the TOPCAT(1) Table Browser shows a table with 13 rows of data. The 5th row is highlighted, corresponding to the data point in the scatter plot. The scatter plot, titled 'Scatter Plot', shows the relationship between 'j_m' (X-axis) and 'j_snr' (Y-axis). The data points are red dots, with the 5th point being the most prominent. The Aladin v6.0 interface shows a sky map of the 'rass3bb.fits' file. A red crosshair marks the position of the 5th data point. The map includes a zoomed-in view of the region, a search bar, and various toolbars for navigation and analysis. The status bar at the bottom indicates 'Potential: 55 Included: 55' and '0 sel / 0 src 1Mb'.

| ra | dec |
|----|---------|
| 1 | 355.06 |
| 2 | 354.923 |
| 3 | 355.076 |
| 4 | 354.936 |
| 5 | 355.077 |
| 6 | 355.028 |
| 7 | 355.022 |
| 8 | 354.931 |
| 9 | 355.003 |
| 10 | 355.073 |
| 11 | 354.906 |
| 12 | 354.939 |
| 13 | 354.935 |

TOPCAT(1): Table Browser

Scatter Plot

Table Browser for 1: nph-

ra

dec

1 355.06

2 354.923

3 355.076

4 354.936

5 355.077

6 355.028

7 355.022

8 354.931

9 355.003

10 355.073

11 354.906

12 354.939

13 354.935

Aladin v6.0

Location [] ICRS Pixel 1.842 full

rass3bb.fits

select

pan

zoom

dist

draw

tag

text

filter

cross

rgb

assoc

cont

mqfs

pixel

prop

del

Zoom 2x

10" x 10"

8.965" x 8.286"

1"

Search []

0 sel / 0 src 1Mb

(c)1999-2009 UdS/CNRS - Centre de Donnees astronomiques de Strasbourg

Do Science

Scripting Approach

```
#!/usr/bin/python
"""
Sends a query to WFCAM Science Archive; saves result to file on local disk.

Usage: python wsa_gps.py
will write a file named wsa_gps_res.vot to the current directory.
History: 20071212 Written by E. A. Gonzalez-Solares
"""

from time import sleep
from astrogrid import acr, DSA, MySpace

# Uncomment if automatic login is not enabled
# acr.login('ukidss')

# Define SQL here
# This query selects for each source, the x and y position in the detector as well as the
# size of the detector in which it was detected and the pixel scale. Only sources which are
# more than 10 arcsec away from the chip edges are returned in a search box
#
# NOTE: If the 'top 100' clause is removed then see below and save the output to a file in MySpace.
sql="""SELECT top 100
    s.sourceID, s.ra, s."dec", s.jmhPnt, s.pStar, s.pGalaxy, s.pNoise, s.pSaturated,
    s.jAperMag3, s.jAperMag3Err, s.jClass, s.hAperMag3, s.hAperMag3Err, s.hClass,
    s.k_1AperMag3, s.k_1AperMag3Err, s.k_1Class, d.x, d.y, m.xSize, m.ySize, c.xPixSize,
    c.yPixSize
FROM
    gpsSource AS s, gpsDetection AS d, MultiframeDetector AS m, CurrentAstrometry AS c
WHERE
    s.k_1ObjID = d.objID AND d.multiframeID = m.multiframeID AND d.extNum = m.extNum AND
    d.multiframeID = c.multiframeID AND d.extNum = c.extNum AND
    s.ra between 310.8 AND 313.0 AND s."dec" between 43.14 AND 44.0 AND
    d.x*c.xPixSize>10 AND d.y*c.yPixSize>10 AND
    (m.xSize-d.x)*c.xPixSize>10 AND (m.ySize-d.y)*c.yPixSize>10"""

# Define the endpoint service
dsa=DSA('ivo://wfaou.roe.ac.uk/ukidssDR2-dsa/ceaApplication')

# Write all the SQL in one line
sql = ''.join(sql.split())

# Submit
r=dsa.query(sql)

# For large queries better use a file in MySpace
# r = dsa.query(sql, saveAs='#ukidss/wsa_gps_res.vot')

# Wait until query status is completed
while r.status()<>'COMPLETED':
    sleep(10)

# Save results to file
open('wsa_gps_res.vot','w').write(r.results()[0])

# If the file is saved in MySpace then do
# open('wsa_gps_res.vot','w').write(urllib2.urlopen(r.results()[0]).read())
```

AstroGrid Python script



Is this all a bit old fashioned ?

The wisdom of the crowd ?

- Is this is all too rigid ?
 - life dominated by big missions and data centres
 - the IVOA dictates and you must obey
- Why can't the VO just *emerge* ?
 - all the new postdocs are smarter than the greybeards
- Is there a Web 2.0 style VO ?

Web vs Web 2.0

- Web : world becomes transparent
 - but clear divide between *creators* and *readers*
 - and between *servers* and *clients*
- Web 2.0 : users create, adjust, vote
 - blogs, tagging, wiki, Digging etc
- What is the astro equivalent ?

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Note : most "people power" examples actually rely on infrastructure provided by large corporations...

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Note : most "people power" examples actually rely on infrastructure provided by large corporations...

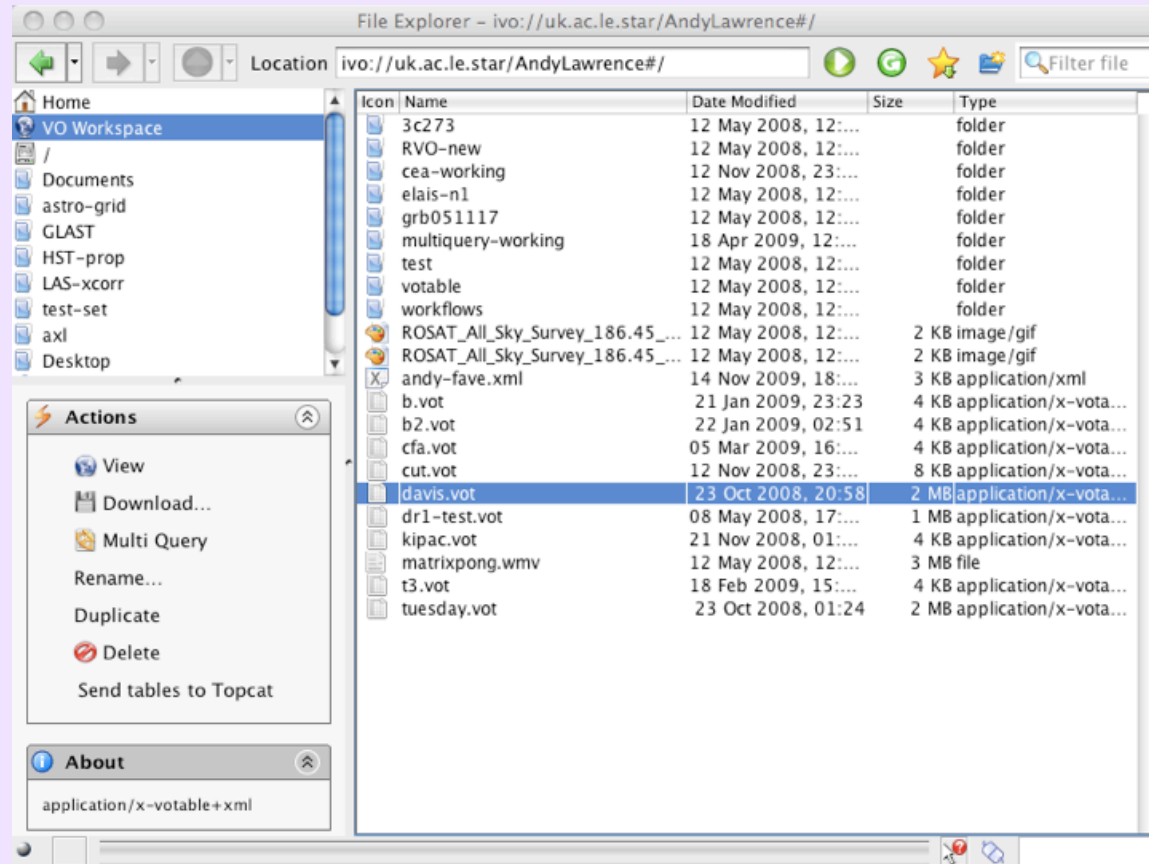
Likewise : astro-social apps will also need a supporting infrastructure.....



Seven Ideas for VO 2.0

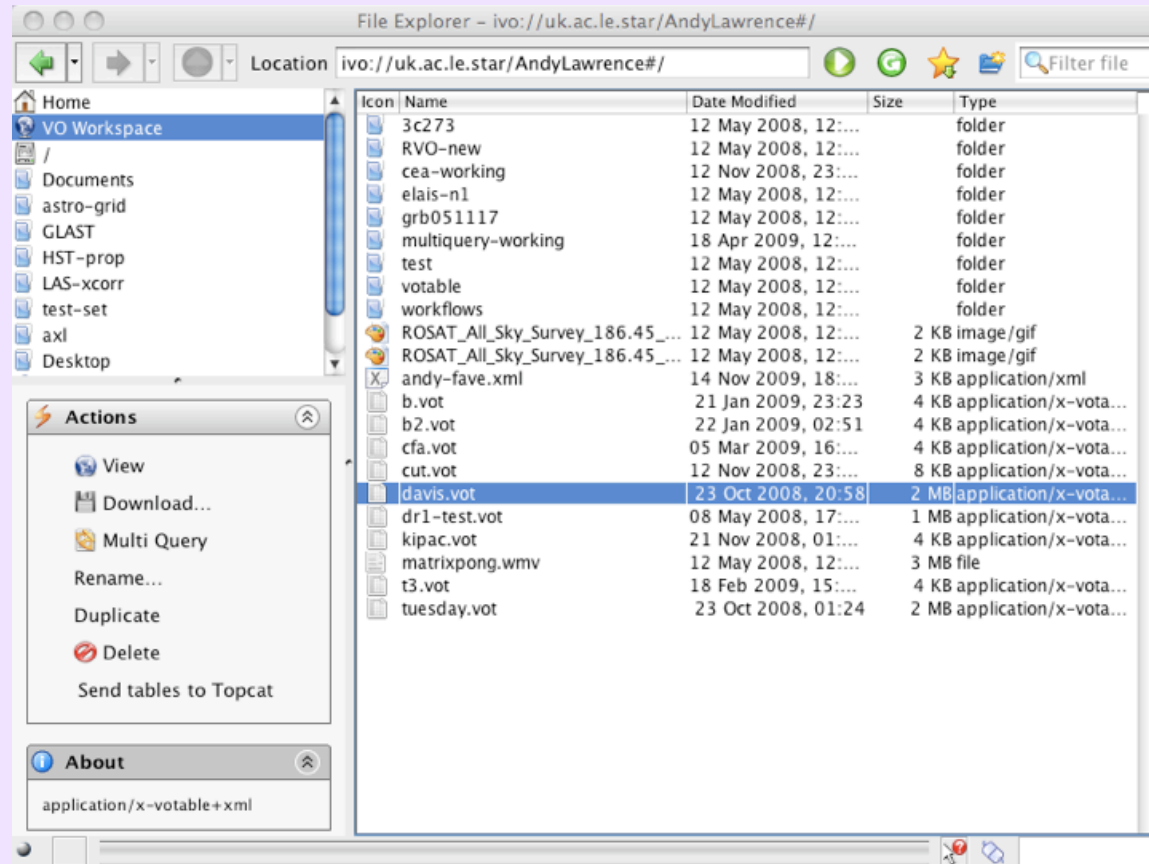
Collaboration Spaces

- Shared filestores
- Arbitrarily defined access lists
- Automated link to appropriate apps
- Editable shared objects - notes, tables, images etc



Collaboration Spaces

- Shared filestores
- Arbitrarily defined access lists
- Automated link to appropriate apps
- Editable shared objects - notes, tables, images etc



This is almost ready ...

Self Publication

- I have 300 FITS files from my VLT run
- How do I put them in the VO ?
- Needs publication tools that automate compliance to VO standards...
- ... and probably data centre hosting

Blogs as public notebooks

- Astroblogs so far one of three things :
 - Outreach magazine
 - Political discussion forum
 - Vanity Press
- Scientists in other disciplines are using them as online Lab-books
- Does that make sense for astronomy ?

Folksonomies

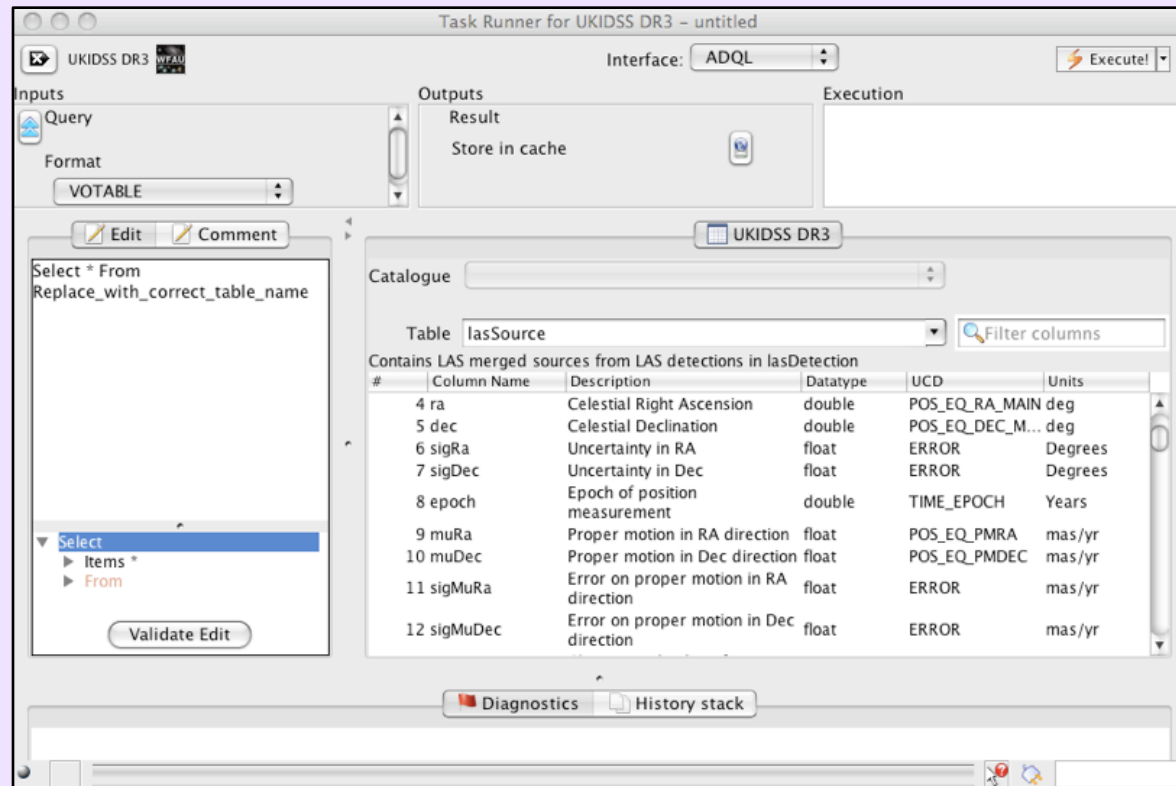
- Much VO effort on *metadata* and *ontologies*
- W2 approach : authors invent their own *tags*
 - Readers can search on these
 - The most popular tags emerge naturally
- Should data centres decide their own metadata ?
- Problems
 - Astro metadata is more structured
 - The metadata is not for people...
 - ...its for applications, so they know what to do with a data object

Annotations

- Users shouldn't *change* public data
- But they can *add value* by annotating it
- Three styles
 - General commentary (cf Google sidewiki)
 - Individual annotations ("this object is a quasar")
 - Mass annotations ("Q13 marks all crossmatches using algorithm-13")
- Annotation service can be detached if contents are standardised

Data model market

- QueryBuilder picks up column names automatically from database
- But user has to look up what they mean
- Can be automated for applications if database follows a known *data model*



The screenshot shows the 'Task Runner for UKIDSS DR3 - untitled' interface. The 'Inputs' section has a 'Query' field with the text 'Select * From Replace_with_correct_table_name' and a 'Format' dropdown set to 'VOTABLE'. The 'Outputs' section has a 'Result' field and a 'Store in cache' checkbox. The 'Execution' section is empty. The 'Catalogue' dropdown is set to 'UKIDSS DR3'. The 'Table' dropdown is set to 'lasSource'. Below the table dropdown is a 'Filter columns' button. The table below contains 12 columns with the following data:

| # | Column Name | Description | Datatype | UCD | Units |
|----|-------------|-----------------------------------------|----------|-----------------|---------|
| 4 | ra | Celestial Right Ascension | double | POS_EQ_RA_MAIN | deg |
| 5 | dec | Celestial Declination | double | POS_EQ_DEC_M... | deg |
| 6 | sigRa | Uncertainty in RA | float | ERROR | Degrees |
| 7 | sigDec | Uncertainty in Dec | float | ERROR | Degrees |
| 8 | epoch | Epoch of position measurement | double | TIME_EPOCH | Years |
| 9 | muRa | Proper motion in RA direction | float | POS_EQ_PMRA | mas/yr |
| 10 | muDec | Proper motion in Dec direction | float | POS_EQ_PMDEC | mas/yr |
| 11 | sigMuRa | Error on proper motion in RA direction | float | ERROR | mas/yr |
| 12 | sigMuDec | Error on proper motion in Dec direction | float | ERROR | mas/yr |

- Current approach is for IVOA to define standard data models
- Alternative is for a *free market of data models* to emerge and database to point at the one it is using

Community Tool Market

- Useful VO tools written by smart grad students
- Key components already there :
 - protocol for apps to play nice with each other (SAMP)
 - library of pre-packaged VO-service routines (Astro Runtime)
 - VO service call handling middleware (Astro Runtime)
- Needs to be much easier
- Needs a publishing framework
 - cf Mac widgets, Google gadgets

A dense field of stars in various colors (yellow, orange, red, blue) with a central yellow box containing the text 'FIN'. The stars are scattered across the frame, with some appearing as bright white or blue points and others as smaller, dimmer spots. The background is a rich, multi-colored mosaic of stellar populations.

FIN