The NVO Data Discovery Portal

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Portal Summary

• Astronomer access to VO:
  – Address science right away without worrying about downloads, data models, formats, protocols, ....
• Quick and convenient
• Comprehensive
• Lead users to other VO resources
  – Transition to CLI and GUI tools
• Distributed implementation among NVO organizations

All elements publicly available: Portal home page currently at http://heasarc.gsfc.nasa.gov/vo/portal
The NVO Data Discovery tools enable you to find and query datasets throughout the Virtual Observatory, to examine data of interactively through your web browser, and to retrieve catalogs and data for local analysis. You can begin your investigation at one of several starting points depending on what information you already have in hand: types of objects or phenomena (Registry), a specific list of objects or positions on the sky (Inventory, VIM), or a particular object or position (DataScope, Simple Query). Tabular data can be converted to VO-friendly formats with the Table Converter, and data discovery and retrieval services can be invoked and built into scripts with the VOClient command line interface.

**Search:**

- Find data collections and catalogs by searching their descriptions [Registry]
- Query catalogs and collections by position [Simple Query]
- Count matches between catalog entries and given positions [Inventory]
- Integrate data from multiple positions and datasets [VIM]
- Collect all data at a given position [DataScope]
- Query the VO from the command line [VOClient]

**Tools:**

- View, sort and filter tables [Table Viewer]
- Convert tables to standard VO formats [Table Converter]

For information on how to get started, try our [help page](http://iraf-nvo.noao.edu/vo-cli/).
So why haven’t we promoted it?

- Registry V1.0 transition
  - Adapting to protocols
  - Issues with new resources
- Reliability
  - Portal elements themselves
  - Services invoked
- Interoperability of elements
- Complexity
  - Balance between power and usability
  - User comprehension

Building something simple is hard.
Registry transition

- Many more data resources registered with standardized interfaces (factor of 10 increase)
- Distinctions between resource and interface
- Known issues become more significant, new problems emerge.
- Complexity of new registry interface
  - New VOTable based format for conveying registry information.
Reliability

- **Portal services**
  - Graceful failure modes.
  - Handling of large requests.
  - Formal testing
- **External services**
  - Finding actual failure modes
    - Often fail in ways not specified in standard
  - Failures due to overloading
  - Services down
    - Cannot always wait in an interactive environment
    - Service monitoring
Interoperability of Portal Elements

- What information should be passed around?
  - List of positions
  - List of resources
  - Provenance
  - Where to send results

- Syntax
  - Mini-standard

- Propagate ideas to registry group.
Complexity

• Hide complexity of VO
  - Jargon
  - Inconsistent terminology and interfaces

• Guide user expectations
  - Make intuitive what is possible
  - Make manifest what is unfeasible

• Address scaling of user requests
  - How many sources, how many resources?

• “Where can I go from here?”

• Documentation
Future

New NVO home page concept
FOLLOWING SLIDES FROM NVO SUMMER SCHOOL PORTAL TALK
Portal elements

- What kind of data is there? (registry)
- Poke around in a resource. (simple query)
- What resources are there at my positions? (inventory)
- Everything known about a given source (DataScope)
- How can I use my data in the VO ?(table converter and wizard)?
- How can I combine information from multiple resources? (Vim)
- But I don’t want to have to use the web! (voclient)
The NVO Data Discovery tools enable you to find and query datasets throughout the Virtual Observatory, to examine data interactively through your web browser, and to retrieve catalogs and data for local analysis. You can begin your investigation at one of several starting points depending on what information you already have in hand: types of objects or phenomena (Registry), a specific list of objects or positions on the sky (Inventory, VIM), or a particular object or position (DataScope, Simple Query). Tabular data can be converted to VO-friendly formats with the Table Converter, and data discovery and retrieval services can be invoked and built into scripts with the VOClient command line interface.

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Examples and Help

Specific Examples

- How many image services currently provide data for the GOODS survey?
- Where can you get an HST 4350A image of the center of the Hubble Deep Field?
- How many Bautz-Morgan type II Abell clusters are within 20 degrees of the south pole?
- How many of them are in the ROSAT FSC (within 10')?
- How many chromospherically active binaries are EUV sources... seen by the ROSAT WFC? ...seen by EUVE?
- How many stars with known exoplanets have been observed by ST? [Where you have a list of stars with exoplanets]
- How can I write a script that will show the rough number of HST, Chandra and Spitzer observations at a given location?

Suggested portal threads.

Try selecting the entry below which most indicates the kind of information you are starting with. A corresponding set of possible outputs will popup. If you click on one of these, the page will show a suggested path to that outcome.

What do you have to start with?

- An idea of the kind of data I am interested in.
- Name of a table
- A list of objects.
- A single source or position
- Multiple sets of targets
What kind of data is out there?

Find Astronomical Data Resources

cataclysmic binaries

Advanced

Search  Reset

Examples: HEASARC, GALEX, redshift, Optical, far ultraviolet, M51
The active response page

**Find Astronomical Data Resources**

**cataclysmic binaries**

Save All Results as CSV ▼ Save

Filter

- Output selection
- Browse/query
- Categories
- shortName
- title
- description
- publisher

Results 1-20 of 74

- Show 20 ▼ results per page
- Next, Send Results to ▼ ▼ Send

- Select
- Search
- Requery
- Save
- Sort
- Page

- Examples: HEASARC, GALEX, redshift, Optical, far ultraviolet, M51
Registry Advanced Search

Find Astronomical Data Resources
Available VO Resource Metadata tags are listed here.

- title like 'galex'

- AND/OR-

**Capability Type**
- Cone Search
- Simple Image Access (SiAP)
- Simple Spectral Access (SSAP)
- Open Sky Node
Poke around.

• Pick searchable service and click search button.
• Do all sky search if appropriate, or limited positional search.
• Filter results
Send results to the table viewer (SimpleQuery)
Another active results screen

<table>
<thead>
<tr>
<th>unique_id</th>
<th>name</th>
<th>ra</th>
<th>dec</th>
<th>vmax</th>
<th>spect_type</th>
<th>orbital_period</th>
<th>Search_Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>5 CET</td>
<td>0.08:11</td>
<td>-22:52</td>
<td>6.07</td>
<td>WF/K1III</td>
<td>96.439</td>
<td>191.545</td>
</tr>
<tr>
<td>57</td>
<td>33 PSC</td>
<td>0.05:20</td>
<td>-54:20</td>
<td>4.01</td>
<td>K0III</td>
<td>72.93</td>
<td>351.645</td>
</tr>
<tr>
<td>52</td>
<td>13 CET A</td>
<td>0.35:14</td>
<td>-33:53</td>
<td>5.2</td>
<td>(FTV/JG4V)</td>
<td>2.08200</td>
<td>570.635</td>
</tr>
<tr>
<td>43</td>
<td>BD CET</td>
<td>0.22:46</td>
<td>-9:43</td>
<td>7.69</td>
<td>K1III</td>
<td>35.100</td>
<td>649.955</td>
</tr>
<tr>
<td>73</td>
<td>S2 PSC</td>
<td>23.13:23</td>
<td>2.40:32</td>
<td>7.1</td>
<td>F8Iv/K1IV</td>
<td>3.905860</td>
<td>710.998</td>
</tr>
<tr>
<td>68</td>
<td>AZ PSC</td>
<td>22:58:52</td>
<td>0:13:57</td>
<td>7.3</td>
<td>K0III</td>
<td>47.121</td>
<td>917.015</td>
</tr>
<tr>
<td>64</td>
<td>AV CET</td>
<td>1:16:36</td>
<td>-23:01</td>
<td>5.47</td>
<td>WD/5III</td>
<td>56.824</td>
<td>1158.437</td>
</tr>
<tr>
<td>77</td>
<td>UV PSC</td>
<td>1:16:55</td>
<td>6:45:42</td>
<td>8.99</td>
<td>G4-Sv/K0-2V</td>
<td>0.851048</td>
<td>1221.437</td>
</tr>
<tr>
<td>71</td>
<td>BI CET</td>
<td>1:22:50</td>
<td>0:42:42</td>
<td>8.08</td>
<td>G5v/G5V</td>
<td>0.51782</td>
<td>1243.277</td>
</tr>
<tr>
<td>89</td>
<td>IM PEG</td>
<td>22:53:02</td>
<td>16:50:27</td>
<td>5.6</td>
<td>K2II-III</td>
<td>24.65</td>
<td>1414.399</td>
</tr>
<tr>
<td>106</td>
<td>ZETA AND</td>
<td>0:47:20</td>
<td>24:16:01</td>
<td>4.06</td>
<td>K1III</td>
<td>17.7692</td>
<td>1510.478</td>
</tr>
<tr>
<td>128</td>
<td>II PEG</td>
<td>23:55:04</td>
<td>28:38:00</td>
<td>7.2</td>
<td>K2-3V-IV</td>
<td>0.724183</td>
<td>1719.475</td>
</tr>
<tr>
<td>118</td>
<td>KU PEG</td>
<td>23:05:29</td>
<td>25:00:33</td>
<td>7.9</td>
<td>G8II</td>
<td>1411.0</td>
<td>1748.477</td>
</tr>
<tr>
<td>63</td>
<td>FF AOR</td>
<td>22:00:35</td>
<td>-2:44:33</td>
<td>9.34</td>
<td>SDO-B/G6IV-III</td>
<td>9.207755</td>
<td>1798.048</td>
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<tr>
<td>120</td>
<td>BD-25 161</td>
<td>1:04:07</td>
<td>28:35:12</td>
<td>8.4</td>
<td>G2V</td>
<td>91.9</td>
<td>1844.459</td>
</tr>
<tr>
<td>28</td>
<td>UV PEG</td>
<td>1:48:41</td>
<td>24:58:48</td>
<td>7.02</td>
<td>K1IV</td>
<td>18.06</td>
<td>2117.990</td>
</tr>
</tbody>
</table>
Chromospherically Active Binaries with G stars brighter than \( v = 8 \)

<table>
<thead>
<tr>
<th>unique_id</th>
<th>name</th>
<th>ra</th>
<th>dec</th>
<th>vmax</th>
<th>spec_type</th>
<th>orbital_period</th>
<th>Search_Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>42 CAP</td>
<td>21:41:32</td>
<td>-14:02:50</td>
<td>&lt;7</td>
<td>G2 IV</td>
<td>13.1740</td>
<td>2221.413</td>
</tr>
<tr>
<td>173</td>
<td>LAMBDA AN</td>
<td>23:37:33</td>
<td>46:27:29</td>
<td>3.7</td>
<td>G8 IV - III</td>
<td>20.5212</td>
<td>2803.091</td>
</tr>
<tr>
<td>75</td>
<td>HR 1023</td>
<td>3:23:38</td>
<td>4:52:55</td>
<td>6.38</td>
<td>G1 I II</td>
<td>287.201</td>
<td>3064.87</td>
</tr>
<tr>
<td>170</td>
<td>AR LAC</td>
<td>22:09:40</td>
<td>45:44:31</td>
<td>6.09</td>
<td>G2 IV - K0 IV</td>
<td>1.93222</td>
<td>3113.424</td>
</tr>
<tr>
<td>70</td>
<td>V711 TAU</td>
<td>3:36:47</td>
<td>0:35:16</td>
<td>5.7</td>
<td>G5 IV - K1 IV</td>
<td>2.83774</td>
<td>3251.955</td>
</tr>
<tr>
<td>51</td>
<td>EI ERI</td>
<td>4:09:40</td>
<td>-7:53:31</td>
<td>6.96</td>
<td>G5 IV</td>
<td>1.947227</td>
<td>3762.162</td>
</tr>
<tr>
<td>172</td>
<td>ALPHA AUR</td>
<td>5:16:41</td>
<td>45:59:53</td>
<td>0.08</td>
<td>G11 I/II</td>
<td>104.0214</td>
<td>4950.097</td>
</tr>
<tr>
<td>181</td>
<td>HR 2054</td>
<td>5:57:04</td>
<td>49:01:46</td>
<td>6.47</td>
<td>G3 III</td>
<td>83.19</td>
<td>5371.233</td>
</tr>
<tr>
<td>4</td>
<td>V824 ARA</td>
<td>17:17:25</td>
<td>-66:58:56</td>
<td>6.63</td>
<td>G5 IV - K0 IV</td>
<td>1.681652</td>
<td>5648.817</td>
</tr>
<tr>
<td>9</td>
<td>HR 4980</td>
<td>13:12:55</td>
<td>-59:49:00</td>
<td>6.16</td>
<td>G0 V/G0 V</td>
<td>4.23342</td>
<td>7111.436</td>
</tr>
<tr>
<td>140</td>
<td>XI UMA B</td>
<td>11:18:10</td>
<td>31:31:45</td>
<td>4.87</td>
<td>G5 V</td>
<td>3.3805</td>
<td>8817.182</td>
</tr>
</tbody>
</table>
Plotting

This component is currently in development.

- Single click to select the nearest point
- Down and drag to select all points within box

Possible features to be implemented...
What’s nearby?

• Go to inventory as result of search.
Inventory

Correlation radius

New inputs

Limit services to be checked

Look at matches
## Inventory results

<table>
<thead>
<tr>
<th>Table</th>
<th>Located At</th>
<th>Archive Subset</th>
<th>Table Record Count</th>
<th>Matched Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>The UCAC2 Bright Star Supplement UCAC Bright Star Supplement</td>
<td>VIZIER</td>
<td>Astrometric</td>
<td>430000</td>
<td>25</td>
</tr>
<tr>
<td>Positions and Proper Motions Catalog</td>
<td>HEASARC</td>
<td>STAR CATALOG</td>
<td>468861</td>
<td>25</td>
</tr>
<tr>
<td>2nd Cat. of Radial Velocities with Astrometric Data The catalogue of radial velocities of galactic stars with high precision astrometric data, the 2nd version (CRVD-2)</td>
<td>VIZIER</td>
<td>Spectroscopic</td>
<td>54907</td>
<td>25</td>
</tr>
<tr>
<td>Master Optical Catalog</td>
<td>HEASARC</td>
<td>MASTER CATALOG</td>
<td>4363156</td>
<td>25</td>
</tr>
<tr>
<td>Catalogue of Stellar Spectral Classifications The catalog of MK Spectral Types</td>
<td>VIZIER</td>
<td>External</td>
<td>283485</td>
<td>25</td>
</tr>
<tr>
<td>Hipparcos Main Catalog</td>
<td>HEASARC</td>
<td>STAR CATALOG</td>
<td>118218</td>
<td>25</td>
</tr>
<tr>
<td>Hipparcos Input Catalog</td>
<td>HEASARC</td>
<td>STAR CATALOG</td>
<td>118209</td>
<td>25</td>
</tr>
<tr>
<td>Chromospherically active binaries Hipparcos astrometric and radial velocity data</td>
<td>VIZIER</td>
<td>Journal/MNRAS</td>
<td>237</td>
<td>25</td>
</tr>
<tr>
<td>Smithsonian Astrophysical Observatory Star Catalog</td>
<td>HEASARC</td>
<td>STAR CATALOG</td>
<td>256944</td>
<td>25</td>
</tr>
<tr>
<td>Bright Star Catalogue, 5th Revised Ed. The main part of the Catalogue</td>
<td>VIZIER</td>
<td>Combined</td>
<td>9110</td>
<td>25</td>
</tr>
<tr>
<td>Bright Star Catalog</td>
<td>HEASARC</td>
<td>STAR CATALOG</td>
<td>9110</td>
<td>25</td>
</tr>
</tbody>
</table>

Select for examination

Size of catalog

Number of inputs matched

Download table as: ASCII Table
Send table to: TableViewer
Select a dataset, then: Find Matching Records
View matches

NVO Inventory Service

Further Processing

Download table as: ASCII Table
Send table to: TableViewer

The table below is a "positional join" of the user's table with the selected catalog. The first set of columns come from the user's table and after the blank column from the selected catalog. It is often the case that one record in the user's table will match multiple entries in the selected catalog, in which case the data from the user's table is replicated in multiple records here. These are both identified by having the same "matchid" and, in the display here, by having the same background color.

<table>
<thead>
<tr>
<th>matchid_u</th>
<th>unique_id_u</th>
<th>name_u</th>
<th>ra_u</th>
<th>dec_u</th>
<th>vmax_u</th>
<th>spect_type_u</th>
<th>orbital_period_u</th>
<th>Search_Offset_u</th>
<th>ra</th>
<th>dec</th>
<th>ID</th>
<th>RAdeg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>57</td>
<td>33 PSC</td>
<td>1.33375</td>
<td>-5.7075</td>
<td>4.61</td>
<td>K0III</td>
<td>72.93</td>
<td>351.646</td>
<td>1.333920</td>
<td>-5.707618</td>
<td>50048661</td>
<td>1.333920</td>
</tr>
<tr>
<td>2</td>
<td>64</td>
<td>AY CET</td>
<td>19.15083</td>
<td>-2.50023</td>
<td>5.47</td>
<td>WD/G5III</td>
<td>56.824</td>
<td>1158.437</td>
<td>10.151200</td>
<td>-2.500369</td>
<td>50052577</td>
<td>19.15119</td>
</tr>
<tr>
<td>2</td>
<td>89</td>
<td>IMPEG</td>
<td>343.2596</td>
<td>10.84111</td>
<td>5.0</td>
<td>K2III-II</td>
<td>24.65</td>
<td>1414.399</td>
<td>343.259441</td>
<td>16.641194</td>
<td>50072798</td>
<td>343.25844</td>
</tr>
<tr>
<td>4</td>
<td>106</td>
<td>ZETA AND</td>
<td>11.82458</td>
<td>24.26722</td>
<td>4.06</td>
<td>K1III</td>
<td>17.792</td>
<td>1510.478</td>
<td>11.834689</td>
<td>24.267178</td>
<td>50073028</td>
<td>11.834689</td>
</tr>
<tr>
<td>5</td>
<td>44</td>
<td>42 CAP</td>
<td>325.38625</td>
<td>-14.0475</td>
<td>5.17</td>
<td>G2IV</td>
<td>13.1740</td>
<td>2221.413</td>
<td>325.386914</td>
<td>-14.047611</td>
<td>50048581</td>
<td>325.38691</td>
</tr>
<tr>
<td>6</td>
<td>134</td>
<td>6 TRI</td>
<td>33.09292</td>
<td>30.30306</td>
<td>4.94</td>
<td>F5/K0III</td>
<td>14.7393</td>
<td>2520.252</td>
<td>33.094019</td>
<td>30.303440</td>
<td>50079932</td>
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</tr>
<tr>
<td>6</td>
<td>134</td>
<td>6 TRI</td>
<td>33.09292</td>
<td>30.30306</td>
<td>4.94</td>
<td>F5/K0III</td>
<td>14.7393</td>
<td>2520.252</td>
<td>33.092834</td>
<td>30.303067</td>
<td>50079981</td>
<td>33.092834</td>
</tr>
<tr>
<td>7</td>
<td>173</td>
<td>LAMERIA AN</td>
<td>354.39125</td>
<td>40.45806</td>
<td>3.7</td>
<td>GRM-III</td>
<td>20.5212</td>
<td>2303.001</td>
<td>354.391110</td>
<td>40.458152</td>
<td>50135384</td>
<td>354.391018</td>
</tr>
</tbody>
</table>
Build up information on a list of sources: VIM

Actions

Current table
Cross-correlate with USNOB

Number of matches for each entry
Some rows match more than one input entry.
Larger scale requests

Status box

Made 23 cutouts with 1 surveys
elapsed time 102 seconds
Image gallery with VIM
What’s known about a given source?

VO DataScope Query

Query VO resources for a given region of a sky

Note: DataScope V2.1 released March 26, 2007 (many cosmetic changes and some bug fixes)

What do we know about a given point or region in the sky?

To find out, just enter a target or position. The NVO DataScope will show you the results from hundreds of resources.

Position: 3c273

Use a target name (e.g., 3c273) or position (e.g., 10 10 10.1, 20 20 20.2)

Size: 0.25

(in degrees, max is 2)

Run query: Submit Query

Reset
Handling user input lists

- User created lists
- Lists downloaded from non-VO sources
Welcome to the NVO Table Import Wizard. You can convert a text-based table to a VOTable that is suitable for Virtual Observatory applications. You can input your own text, or load an example of a text table by clicking on Table Examples, then selecting one of the examples.

To start, paste the text table into the yellow box below, then click Next step. You will be led through a simple process which extracts the data columns from your text table to yield a VOTable.

```
name, ra, dec
s1, 10 10 10, 20 20 20
s2, 20 20 20, 30 30 30.5
s3, 10 11 12, 11 14 15
```
When finished, click on Next step below.

Important: If your table is divided by a separator (eg comma-separated values), Click here to select that character.
The table wizard creates the VOTable for you, but currently you need to manually stripe it into a file or other service to use it.
Table converter

Upload Table / Source List

C:\Users\admin\Documents\test.inp

Upload  Reset

This service converts the user's input into tables (VOTable XML and flat ASCII) that can be used by other VO services. When necessary, name resolution (NED and SIMBAD) and coordinate transformation are applied.
Converter outputs

```
<table>
<thead>
<tr>
<th>name</th>
<th>ra_u</th>
<th>dec_u</th>
<th>ra</th>
<th>dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>s1</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>s2</td>
<td>20</td>
<td>20</td>
<td>30</td>
<td>30.5</td>
</tr>
<tr>
<td>s3</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>14.15</td>
</tr>
</tbody>
</table>
```

Showing first 3 of 3 records
Wizard versus converter

- **Wizard**
  - is interactive
  - lets user see how conversion is done
  - requires data to be striped in and out.

- **Converter**
  - uses files
  - can send data to other services
  - will do name resolution of target names.
  - no interactive input, may get confused by complex files
Off the Web: VOClient

• Three main tasks:
  – VORegistry: query the registry for data resources
  – VOData: Query the data resources
  – VOSesame: Convert names to coordinates

• Can interchange lists of sources and data resources with portal Web pages.
... and it can be used from the Web too!

Available Tasks:

- **VODATA** -- Query and Access VO Images, Catalogs and Tables
- **VOREGISTRY** -- Search and Resolve VO Registry Resources
- **VOSESAME** -- Resolve object names to coordinates

Developed with the support of the National Science Foundation under Cooperative Agreement AST0122449 with The Johns Hopkins University.
VORegistry Example

Query:

Search Term: HST Observations

Options: OR terms, Exact resolution

Mode: Resolve Type: All

Response:

Executing Cmd: voregistry -v HST Observations

Type: CONE
Title: Hubble Ultra Deep Field Catalog
ShortName: UDF
Subject: Survey Source
Identifier: ivo://nasa.heasarc/hubbleudf
ServiceURL: http://heasarc.gsfc.nasa.gov/cgi-bin/vo/cone/cone

Type: Catalog
Title: MIT/Amsterdam M31 Survey
ShortName: M31 Stars/deep
Subject: Star
Identifier: ivo://nasa.heasarc/m31stars2
ServiceURL:
VOData example

Executing Cmd: vodata -v -V -rm 0.1 HST ngc4258

# Service query 'HST' non-unique (2 found)...
# Using CONE Resource HST -> ivo://archive.stsci.edu/hst
# Resolver: ngc4258 -> ngc4258 184.730000 47.310000
# Service: HST
# Title: Hubble Space Telescope
# No. of Objects: 1
# No. of Services: 1
# Search size: 0.001667 (degrees)
#
# Service NRec Typ Resource Title
# --------- ----- --- ---------------
# HST 9 C Hubble Space Telescope
#
# 9 (Records Found)
# 1 (Resources Queried)
# 0 (Failed Requests)
# 1 (Successful Requests)
# (1 Results w/ Data)
#
# Approx Time: 00:00:05 (00:04 Resolution, 00:01 Query, 00:00 Access)

Result Directory Contents and Downloads: vocii32498
VOClient usage

• Use Web pages to see examples and try out usage.
• Use on the command line for repeated and operational use
  – Long commands
• VOClient can create lists for use in simple query, inventory or VIM.
• Download your own copy from: http://iraf-nvo.noao.edu/vo-cli/downloads/index.html
After starting in the portal...

- TOPCAT or VOPlot: Display and manipulate tables of results
- Aladin: Compare images and tables
- Use specialized features of discovered resources
- Data mining in VIM, OpenSkyQuery, WESIX or other tools
- Publish results
- ...