ALFALFA Data Access
VO and ALFALFA: Why worry about it?

- At least 20,000 detections expected with
  - Positions, redshifts, fluxes, velocity widths, etc.
- Easy cross referencing with other databases and surveys is desirable given that:
  - It is platform independent…
  - A “smart” data format that can be read by any program of choice, and that can describe itself and its contents to any future programs.
  - Applications are easy to write in any language!
Virtual Observatory

What in the galaxy is it?

- Initiative to create standards for the ever-increasing amount astronomical data
- Specify a well-defined framework for all possible astronomical quantities and their unit systems.
- Develop platform independent system of software tools and applications that utilize the framework and standards.
Enter VOTable...

- Important part of VO framework
- Uses the very common XML (eXtensible Markup Language) to tabulate data, but also describe the contents, quantities and units via metadata from UCDs (Unified Content Descriptors).
- The XML format is advantageous as it can read by many programs, which can automatically sort and recognize the contents based on the data descriptions.
- XML files can be easily formatted to display in web browsers, spreadsheets, and data analysis programs – ie HTML, Excel, IDL, VOplot, Aladin.
VOTable: Why use it?

• VOTable (and XML/XSLT stylesheets in general) can be *directly* used to cross reference with other existing databases. Vizier, SDSS, 2MASS, and all major astro website and large surveys allow VOTable output...as should ALFALFA!
### VOTable tree structure

```xml
<VOTABLE>
  <DESCRIPTION>
    Arecibo Legacy Fast ALFA Survey http://egg.astro.cornell.edu/precursor/
  </DESCRIPTION>
  <RESOURCE>
    <TABLE>
      <FIELD datatype="char" name="sourcename" ucd="meta.id" arraysize="*"/>
      <FIELD unit="degrees" datatype="float" name="ra" ucd="pos.eq.ra"/>
      <FIELD unit="degrees" datatype="float" name="dec" ucd="pos.eq.dec"/>
      <FIELD unit="km/s" datatype="short" name="vhelio" ucd="spect.veloc"/>
      <FIELD unit="km/s" datatype="int" name="velwidth" ucd="spect.line.width"/>
      <FIELD unit="mJy" datatype="float" name="rms" ucd="stat.stdev"/>
      <FIELD unit="Jy km/s" datatype="char" name="flux" ucd="phot.count" arraysize="*"/>
    </TABLE>
    <DATA>
      <TABLEDATA>
        <TR>
          <TD>HII001709.7+271616</TD>
          <TD>4.29042</TD>
          <TD>27.2711</TD>
          <TD>3.707</TD>
          <TD>150</TD>
          <TD>3.10000</TD>
          <TD>1.42000</TD>
        </TR>
        <TR>
          <TD>HII022115.8+263218</TD>
          <TD>5.31583</TD>
          <TD>26.3883</TD>
          <TD>9210</TD>
          <TD>158</TD>
          <TD>2.02000</TD>
          <TD>1.06000</TD>
        </TR>
        <TR>
          <TD>HII02312.5+272644</TD>
        </TR>
      </TABLEDATA>
    </DATA>
  </RESOURCE>
</VOTABLE>
```
Tools with VO accessibility

• VOPlot –
  via Java download or implemented as a plugin through a webBrowser
• Aladin – via CDS
• TOPCAT
• Mirage
• And many others!
A database in the Structured Query Language is easily queried by many languages (C, Java, Python, PHP), and database interfaces are easily designed to suit the user’s purpose.
Database cross match

- VOTable can be read into OpenSkyQuery or SDSS CasJOBS and SQL queries can run between the datasets and return desired quantities.
- Results can be pushed directly to any VO ready program, or saved for later analysis.
USER SCENARIOS
User 1: IDL

Browsing data on a local system

- Solution: IDL can be used to view data in raw or catalog form – browser can be created to view source detections. View catalog information on object, as well as DSS image.
User 2: Web access

User can query a database via convenient web form.

- SQL database is created from ALFALFA detections. Web page allows catalog browsing and query actions.
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- DSS and 2MASS image are displayed, as well as spectra and postscript files.
• SQL database is created from ALFALFA detections. Web page allows catalog browsing and query actions.

• Image galleries also available.
User 3: Science exploration

Staring at pictures and spectra is nice, but I want to do data exploration with other resources!

• Data is available in a VOTable format.
• Aladin can be used to cross reference with many catalogs and surveys, including SDSS, NED, Skyview, etc.
• VOPlot can plot results and histograms via a stand alone application, or as a Java browser plugin.
User 3: Application

NED match with Aladin

- VOTable is loaded directly from the ALFALFA website. As the UCDs can be read by Aladin, it can recognize coordinates and overplot NED entries within a specified radius of a queried position.
User 3: Application
Cross match with multiple databases

- Using OpenSkyQuery, the user can match ALFALFA sources against a number of databases, and choose the information about the results that should be returned. A form of SQL is used, but premade queries exist, or the user can drag and drop the desired entries.
Resources

- Virtual Observatory: http://www.ivoa.net/
- VO Table: http://www.us-vo.org/VOTable/
- VO Libraries: http://www.ivoa.net/twiki/bin/view/IVOA/VOTableSoftware
- VO Tools: http://www.us-vo.org/projects/tools.cfm
- ALFALFA precursor data: http://egg.astro.cornell.edu/precursor/
- OpenSkyQuery: http://openskyquery.net/Sky/skysite/