

Exploiting Virtual Observatory and Information Technology: Techniques for Astronomy

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Lecture #2 Goal:
Data Centres and
Databases
Discovery, access,
federating

Summary: Lecture #2

- Introduction
- Science Archives
 - MetaCentres
 - Missions
- Databases
 - XML and Registries
 - Queries, SQL
- Federating Databases
 - Cross matching
 - Open Sky Query/ Open Sky Nodes/ Data Set Access
- Science Example
 - Hunting for Brown Dwarfs

Introduction: Catalogue Access

- Data exists in many globally located archives
 - In addition to data on your tapes
- How to find and access that data
 - Issues of types of data
 - Issues of types of databases and access to data
 - Issues of data description
- Virtual Observatory standards to address these
 - VOTable, UCD, Registry, VOQL
- Technologies
 - XML, SQL
- Note: many of the concepts and standards referred to here are rapidly evolving, so information in this lecture may soon be out of date!

Missions & Data Centres: Overview

Creating the digital sky...

Traditional Data Centres: USA

- Radio:
 - NRAO: <http://e2e.nrao.edu/archive/>
- InfraRed:
 - IPAC @ CalTech: <http://www.ipac.caltech.edu/>
- Optical:
 - MAST @ STScI: <http://archive.stsci.edu/mast.html>
 - Observatories: SDSS <http://www.sdss.org>, NOAO <http://www.archive.noao.edu/nsa/>, Keck <http://www2.keck.hawaii.edu/koa/koa.php>
- UV/X-Ray:
 - HEASARC @ GSFC: <http://heasarc.gsfc.nasa.gov/>
 - Chandra @ SAO: <http://cxc.harvard.edu/cda/>
- γ -Ray: Swift @ HEASARC
- Solar: see NSO @ <http://vso.nascom.nasa.gov/cgi-bin/search>

Data Centres: UK

- Radio:
 - Jodrell Bank/Merlin: <http://www.merlin.ac.uk/archive/>
- InfraRed/ Optical:
 - CASU @ IoA, Cambridge: <http://archive.ast.cam.ac.uk/>
 - WFAU @ ROE, Edinburgh: <http://www.roe.ac.uk/ifa/wfau/>
 - UK ISO: <http://jackal.bnsc.rl.ac.uk/isouk/> (ends 2006)
- Xray & γ -Ray:
 - LEDAS @ Leicester: <http://ledas-www.star.le.ac.uk/>
- Solar:
 - RAL: <http://trace.solararchive.rl.ac.uk/soho/>
 - MSSL: http://www.mssl.ucl.ac.uk/www_solar/surfindex.html
- STP:
 - RAL WDC: <http://www.wdc.rl.ac.uk/>
 - Lancaster: <http://www.dcs.lancs.ac.uk/iono/data/>

Data Centres: EU

- Radio: see also Radionet @ <http://www.radionet-eu.org/>
 - JIVE: <http://archive.jive.nl/scripts/listarch.php>
 - ESO: will host ALMA sub-mm archive
- IR/ Optical: see also Opticon @ <http://www.astro-opticon.org/>
 - ESO (ground): <http://archive.eso.org/>
 - OmegaCen @ Groningen: <http://www.astro.rug.nl/~omegacen/>
 - Terapix (CFHT/MegaCam):
http://terapix.iap.fr/rubrique.php?id_rubrique=169
- ESA (space missions):
 - <http://www.rssd.esa.int/index.php?project=SA>
- High Energy
 - XMM: http://xmm.vilspa.esa.es/external/xmm_data_acc/xsa/
- Solar/ STP: no one major collection (except see ESA)

Data Centres: Other

- ADC @ NAOJ <http://dbc.nao.ac.jp/>
 - Subaru @ SMOKA <http://smoka.nao.ac.jp/>
- CFHT @ CADC
 - <http://cadwww.dao.nrc.ca/cfht/>
- Gemini @ CADC
 - <http://cadwww.hia.nrc.ca/gemini/>

Meta Centres

- NED: <http://nedwww.ipac.caltech.edu/>
- CDS: <http://cdsweb.u-strasbg.fr/>
 - VizieR: Catalogues
 - Simbad:
 - Aladin: Integration and Visualisation
- Planetary Data Centre: <http://pds.jpl.nasa.gov/>
- CADC: <http://cadwww.dao.nrc.ca/>
- Astro-ph: <http://uk.arxiv.org/archive/astro-ph>
 - Pre-print server
- ADS: <http://ukads.nottingham.ac.uk/>
 - Publications
- Google: <http://www.google.com>
 - Google Scholar <http://www.scholar.google.com/>

Athens, the Library, Computing Course

- Eduserv Athens: Useful resource
 - Login @ <http://www.athensams.net/myathens/>
 - Entry way to Blackwell, Ingenta, ISI Web of Science
- Cambridge Library
 - IoA: <http://www.ast.cam.ac.uk/~ioalib/homepage.html>
 - Database links: <http://www.ast.cam.ac.uk/~ioalib/databases.html>
 - Newton: <http://newton.lib.cam.ac.uk:7603/>
- IoA Graduate Computing Course
 - Recap: Jeremy Saunders computing course
 - Notes @ http://www-xray.ast.cam.ac.uk/~jss/lecture/grad_training/notes/
 - Resources @ http://www-xray.ast.cam.ac.uk/~jss/lecture/grad_training/

NED: A resource for 8 Million ExtraGalactic Objects

<http://nedwww.ipac.caltech.edu/>

NASA/IPAC
EXTRAGALACTIC
DATABASE

- ▶ [Diameter Data](#)
- ▶ [News - Contents and Capabilities](#)
- ▶ [Frames](#)



| OBJECTS | DATA | LITERATURE | TOOLS | INFO |
|----------------------------------|--|--|--|------------------------------|
| By Name | Images By Object Name or By Region | References | Coordinate Transformation & Extinction Calculator Velocity Calculator | FAQ |
| Near Name | Photometry & SEDs | Author Name | Cosmology Calculators Extinction-Law Calculators | Introduction |
| Near Position | Redshifts | Text Search | FTP | Features |
| Advanced All-Sky | Positions | Knowledgebase <small>caltech LEVEL 5</small> | Glossary & Lexicon | Team |
| IAU Format | Notes | Abstracts | Batch Jobs | Comment |
| By Refcode | Catalogs | Thesis Abstracts | Skyplot | Web Links |
| | Diameters <small>NEW</small> | | | |

Interface last updated: 14 Dec 2004

- * 7.6 million objects
- * 11.6 million multiwavelength object cross-IDs
- * 122 thousand associations (candidate cross-IDs)
- * Redshifts for 484 thousand objects
- * 21.4 million photometric measurements

Database last updated: 14 Dec 2004

- * 3.6 million diameter measurements
- * 2.6 million objects linked to 59,000 refereed journal articles
- * 2.0 million images, maps and external links
- * 60 thousand notes
- * 36 thousand abstracts

If your research benefits from the use of NED, we would appreciate the following acknowledgement in your paper: *This research has made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.*



CDS: <http://cdsweb.u-strasbg.fr/>

The image displays three overlapping browser windows from the CDS website:

- Top Left Window (SIMBAD):** Titled "SIMBAD Astronomical Database". It features navigation links for "CDS", "Simbad", "VizieR", "Aladin", "Catalogues", "Nomenclature", "Biblio", and "Tutorial". Below these are two main sections: "Queries" (with sub-links "by identifier" and "by coordinates") and "Documentation" (with sub-links "Presentation" and "Main functionalities").
- Top Right Window (VizieR):** Titled "VizieR Service". It includes navigation links for "CDS", "Simbad", "VizieR", "Aladin", "Catalogues", "Nomenclature", "Biblio", "Tutorial", and "Developer's corner". It highlights "NEW" releases: "UCAC2 Catalog", "DENIS 2nd Release", and "2MASS All-Sky Release". Other links include "Browsing through Catalogues", "Output Preferences", "FAQ", and "More about VizieR".
- Bottom Window (Aladin):** Titled "Aladin sky atlas". It shows a search interface with a "Position" field containing "J2000" and a "Pixel in file" field. A toolbar includes "Load...", "Links...", "Tools...", "Help...", and "Detach". A "Server selector" window is open, showing "Aladin image database" with a "Target" field set to "m 31" and a "Radius" field set to "0 arcmin". Below this is a table of data servers:

| SURVEY | COLOR | SIZE | OBS ID |
|--------------------------------|---------|--------------|------------------|
| <input type="checkbox"/> 2MASS | H(IR H) | 8.6 'x17.1 ' | 971024N_HI008003 |

Additional elements on the right side of the Aladin window include a "Find Catalogue" button, a "Find Data around Target" button, and a "Target radius" field set to "10 arcmin". There are also checkboxes for "Use LISTS of Targets", "Show all columns", and "Show column UCDs".

The SIMBAD cross-identification outside the scope of SIMBAD can be used as a selection criteria (filters) Links to some

Acknowledge If the Simbad data is not the following

©ULP/CNRS

<http://simbad.u-strasbg.fr/>

among 4465 available

out: ALL columns
c J2000 B1950
r and x,y are the distance to the Target, Position is in the same coordinate system as Target

on, the current page, completed with your input, will be reloaded to be

Date: Images/Spectra



How to find and query data with VOs

- **Problem:** there is obviously a lot of data available at individual archive sites
- But, how does one find relevant data for say an individual object, a patch of sky, a set of galaxies with a certain morphological class?
- How does one avoid having to access each of these individual archives, one at a time.
- **Solution:** the Virtual Observatory, and its underpinning interoperability standards
 - A 'one stop' solution ...
- But first, XML, Registries, and SQL ...

XML: Structured Information

- Extensible Markup Language for Documents and Data
- Readable and verbose
- Schema which set structure, used for data models
- Transformable (using XLST)
 - XML, HTML, PDF and so forth
- Tools to create and debug readily available
 - Parsers: Java, C++, Perl ...
 - Browsers and Editors
 - Databases in XML
 - Exist (used by AstroGrid): <http://exist.sourceforge.net/>
 - Bindings > APIs

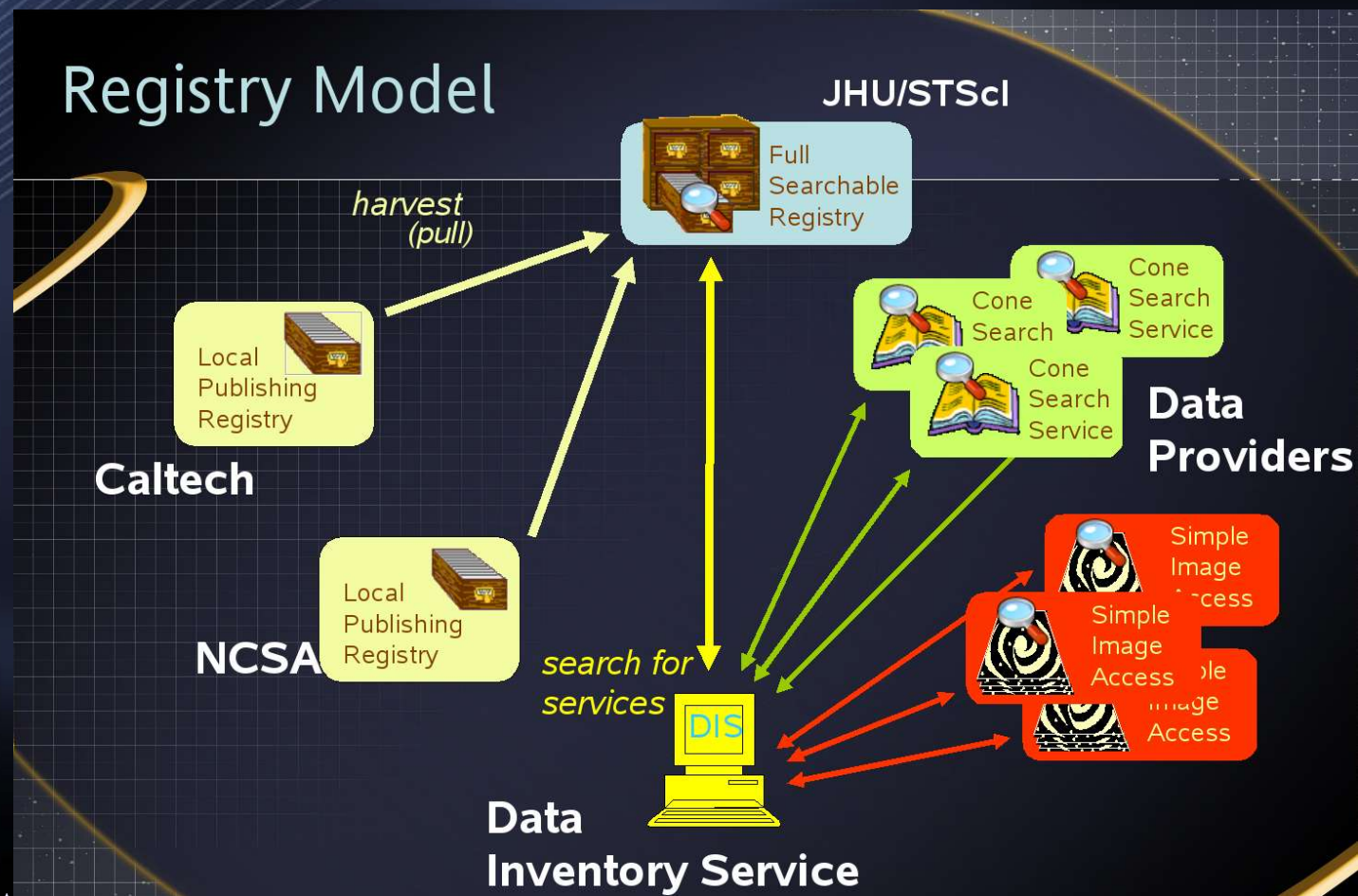
<http://xml.oreilly.com>

Locating Relevant Data

- As an astronomer – how do you find the data that you require?
- Are their multiple resources available?
- How do you decide which of the resources is actually relevant?
- Resources can be:
 - Data
 - Information (e.g. Paper references)
 - Applications or other programmes
 - Compute/ disk etc
- VO registries provide a solution to these questions

Registries: what are they?

- Used to discover and locate resources
- A list of resource descriptions, described by structured metadata: enables automated searching and processing
- Resource metadata
 - XML schemas



AstroGrid's Registry

- Types of Registries:— Full, Publish, Special
- Registry is the main focal point for all Astrogrid components
- Agreed Standards with IVOA
 - Search and harvest interface
 - OAI (a digital library) standard for harvest interface
- Types of resource
 - Generic services, web services, applications, ...
 - Data collections
 - AstroGrid-specific resources (e.g. MySpace servers)
- Use of XQuery language with eXist XML database.
- Harvesting (Jan 05)
 - US NVO, CDS-VizieR

The screenshot shows the AstroGrid Portal search interface. At the top, there are navigation buttons: Home, MySpace, Resources, Queries, Workflows, Jobs, Help, and Logout. Below this is a 'Resource browser' section with a 'Search for:' label and three buttons: 'Catalog Search', 'Task Search', and 'Browse filestores'. To the right of these buttons is a 'General Constraints' form with fields for 'Resource name', 'Resource publisher', 'Resource title', and 'Description'. The 'Description' field has 'elais' entered. There are also radio buttons for 'and', 'or', and 'or c'. Below the form is a 'Search by:' section with radio buttons for 'constrains AND wavelength AND mission' and 'constraints OR wavelength OR mission'. The main content area displays a search result for 'Title: ELAIS: final band-merged catalogue (Rowan-Robinson+, 2004) - Final ELAIS Ca'. The description follows: 'Description: The catalog represents the final band-merged European Large-Area ISO (ELAIS) Catalogue at 6.7, 15, 90 and 175{mu}m, and the associated data at U, g', r, J, H, K and 20cm. Details about the origin of the survey, the observations, data reduction and optical identification are described in the paper. In addition to fluxes in the infrared and optical passbands, spectroscopic redshifts are tabulated, where available. The N1 and N2 areas, the Isaac Newton Telescope ugriz Wide Field Survey permits photometric redshifts to be estimated for galaxies and quasars.' Below the description are fields for 'AuthorityID: CDS', 'ResourceKey: VizieR/J/MNRAS/351/1290/catalog', 'Type: Catalog', 'Subject: Galaxies, Redshifts', and 'Content level: Research'. At the bottom of the result are tabs for 'curation', 'table/column', and 'xml'. The 'table/column' tab is selected, showing a list of columns with their names and descriptions, such as 'Column: recno Desc: Record number within the original table (starting from 1) Type: UCD: ID_MAIN:1'.

VO registries

- NVO registry
- AstroGrid registry
- Euro-VO registry (based on AstroGrid implementation)
- CDS registry
- Japan-VO registry

All now harvesting each other: thus querying any one returns full list of globally held resources.

VOResource XML Schema:

<http://www.ivoa.net/xml/VOResource/v0.10>

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.ivoa.net/xml/VOResource/v0.10"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:vr="http://www.ivoa.net/xml/VOResource/v0.10"
  xmlns:vm="http://www.ivoa.net/xml/VOMetadata/v0.1"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified"
  version="0.10">

<xs:include schemaLocation="VOResourceRelType-v0.10.xsd"/>

<xs:complexType name="Resource">
  <xs:annotation>
    <xs:documentation>
      Any entity that is describable and identifiable by a IVOA Identifier.
    </xs:documentation>
  </xs:annotation>
  <xs:sequence>
    <xs:element name="title" type="xs:string">
      <xs:annotation>
        <xs:appinfo>
          <vm:dcterms>Title</vm:dcterms>
        </xs:appinfo>
        <xs:documentation>
          the full name given to the resource
        </xs:documentation>
      </xs:annotation>
    </xs:element>
```

Web Page to Registry: Use of Schemas

Searchable Registry
National Virtual Observatory : NVO Registry

Read only view of data.

| Title? | Spitzer First Look Survey (FLS) -- NOAO ELAIS N1 -- R | | | | | | | | | | | | |
|---------------------|---|-------------------|---|--|------|-------|------------|-----------|--------|---|-----------|-----|--|
| Harvested From | http://nvo.ncsa.uiuc.edu/cgi-bin/nvo/oai_v10.pl?verb=ListRecords&metadataPrefix=ivo_vor&from=2 | | | | | | | | | | | | |
| Shortname? | FLS_ELAISN1_R | Identifier? | ivo://irsa.ipac/FLS_ELAISN1_R | | | | | | | | | | |
| ContactName? | Anastasia Alexov | ContactEmail? | aalexov@ipac.caltech.ec | | | | | | | | | | |
| Creator? | Fadda, D., Jannuzi, B., Ford, A., & ... | Publisher? | NASA/IPAC Infrared Science A | | | | | | | | | | |
| Contributor? | NOT PROVIDED | Subject? | | | | | | | | | | | |
| ResourceType | SIAP | | | | | | | | | | | | |
| Description? | The Spitzer First Look Survey has obtained several pointings with the NOAO MOSAIC camera on the Kitt Peak 4m telescope covering the ELAIS N1 region in the R-band. This region is also part of the SWIRE project. Available to the public are image FITS files, bad pixel maps, exposure maps and source catalogs of each | | | | | | | | | | | | |
| Related Resources | | | | | | | | | | | | | |
| Type? | Project | Instrument? | NOT PROVIDED | | | | | | | | | | |
| Date? | 1/1/2000 12:00:00 AM | Version? | NOT PROVIDED | | | | | | | | | | |
| ReferenceURL? | http://irsa.ipac.caltech.edu/data/SPITZER/FLS_ELAISN1_R | ServiceURL? | http://irsa.ipac.caltech.edu/cgi-bin/ | | | | | | | | | | |
| CoverageSpatial? | CoordRange | CoverageTemporal? | NOT PROVIDED | | | | | | | | | | |
| RegionOfRegard? | 0 | CoverageSpectral? | Optical | | | | | | | | | | |
| ContentLevel? | Research | Facility? | NOT PROVIDED | | | | | | | | | | |
| ModificationDate | 4/5/2004 1:07:22 PM | | | | | | | | | | | | |
| Interfaces | <table border="1"><thead><tr><th>Number</th><th>Type</th><th>QType</th><th>ResultType</th><th>AccessURL</th></tr></thead><tbody><tr><td>Params</td><td>0</td><td>PARAMHTTP</td><td>GET</td><td>text/xml http://irsa.ipac.caltech.edu/cgi-bin/Atlas/nph-atlas?mission=FLS</td></tr></tbody></table> | | | Number | Type | QType | ResultType | AccessURL | Params | 0 | PARAMHTTP | GET | text/xml http://irsa.ipac.caltech.edu/cgi-bin/Atlas/nph-atlas?mission=FLS |
| Number | Type | QType | ResultType | AccessURL | | | | | | | | | |
| Params | 0 | PARAMHTTP | GET | text/xml http://irsa.ipac.caltech.edu/cgi-bin/Atlas/nph-atlas?mission=FLS | | | | | | | | | |
| Footprint | | | | | | | | | | | | | |
| Simple Image Access | | | | | | | | | | | | | |
| Format | | | | | | | | | | | | | |
| VOTableColumns | | | | | | | | | | | | | |
| ImageServiceType | MaxqueryRegionSizeLat | 0 | MaxqueryRegi | | | | | | | | | | |

- Registry Schema define structure
- This example shows a resource described using the VOResource schema
- Registry populated via a mixture of automatic and manual entry of resource information

VOTable: An interchange format

Source: VOTable 1.1: <http://www.ivoa.net/Documents/REC/VOTable/VOTable-20040811.html>

The VOTable format is an XML standard for the interchange of data represented as a set of tables. In this context, a table is an unordered set of rows, each of a uniform format, as specified in the table *metadata*. Each row in a table is a sequence of table cells, and each of these contains either a primitive data type, or an array of such primitives. VOTable is derived from the Astrores format [1], itself modeled on the FITS Table format [2]; VOTable was designed to be closer to the FITS Binary Table format.

VOTable supports separating of data from metadata and the streaming of tables, and other ideas from modern distributed computing. It bridges two ways to express structured data: XML and FITS. It tries (through the UCD - see [below](#)) to express formally the semantic content of a parameter or field. It has the hierarchy and flexibility of XML: using `GROUP` elements introduced in version 1.1, columns in a VOTable can be grouped in arbitrarily complex hierarchies; and the ID attribute can be used in XML to enable what are essentially pointers. FITS does not handle Unicode (extended alphabet) characters.

- Full metadata representation
- A hierarchy of RESOURCES containing PARAMs and TABLEs
- Use of UCDs to express the content of a parameter
- Metadata first (XML) then the data (XML, binary, FITS)
 - Streaming allowed with binary data

VOTable: An Example

```
<?xml version="1.0"?>
<VOTABLE version="1.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="http://www.ivoa.net/xml/VOTable/VOTable/v1.1">
  <COOSYS ID="J2000" equinox="J2000." epoch="J2000." system="eq_FK5"/>
  <RESOURCE name="myFavouriteGalaxies">
    <TABLE name="results">
      <DESCRIPTION>Velocities and Distance estimations</DESCRIPTION>
      <PARAM name="Telescope" datatype="float" ucd="phys.size;instr.tel"
        unit="m" value="3.6"/>
      <FIELD name="RA" ID="col1" ucd="pos.eq.ra;meta.main" ref="J2000"
        datatype="float" width="6" precision="2" unit="deg"/>
      <FIELD name="Dec" ID="col2" ucd="pos.eq.dec;meta.main" ref="J2000"
        datatype="float" width="6" precision="2" unit="deg"/>
      <FIELD name="Name" ID="col3" ucd="meta.id;meta.main"
        datatype="char" arraysize="8"/>
      <FIELD name="RVel" ID="col4" ucd="src.veloc.hc" datatype="int"
        width="5" unit="km/s"/>
      <FIELD name="e_RVel" ID="col5" ucd="stat.error;src.veloc.hc"
        datatype="int" width="3" unit="km/s"/>
      <FIELD name="R" ID="col6" ucd="phys.distance" datatype="float"
        width="4" precision="1" unit="Mpc">
        <DESCRIPTION>Distance of Galaxy, assuming H=75km/s/Mpc</DESCRIPTION>
      </FIELD>
      <DATA>
        <TABLEDATA>
          <TR>
            <TD>010.68</TD><TD>+41.27</TD><TD>N 224</TD><TD>-
297</TD><TD>5</TD><TD>0.7</TD>
          </TR>
          <TR>
            <TD>287.43</TD><TD>-63.85</TD><TD>N
6744</TD><TD>839</TD><TD>6</TD><TD>10.4</TD>
          </TR>
          <TR>
            <TD>023.48</TD><TD>+30.66</TD><TD>N 598</TD><TD>-
182</TD><TD>3</TD><TD>0.7</TD>
          </TR>
        </TABLEDATA>
      </DATA>
    </TABLE>
  </RESOURCE>
</VOTABLE>
```

UCDs: <http://www.ivoa.net/twiki/bin/view/IVOA/IvoaUCD>

• Unified Content Descriptors: Controlled vocabulary for Astronomy

In the semantic web community, knowledge is represented through triples of well-defined words, representing *a property of an instance of a concept and its value*. For example in the statement: "The velocity of the M31 galaxy is 120 km/sec", we have a property (velocity), a concept (galaxy), an instance of the concept (the M31 galaxy), and the value (120 km/sec).

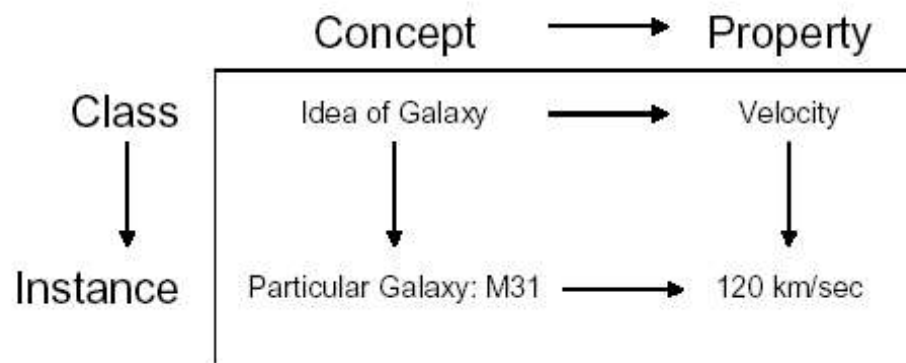


Figure 1: How concepts, properties, classes and instances are related

The UCD system is an attempt to describe simply the most commonly used quantities that astronomers want to exchange. It gives *standard names to properties of instances of concepts* (read this sentence twice). In Figure 1, we have:

The primary word of the UCD refers to a property, e.g.

- `meta.Id`
- `meta.note`
- `phot.Flux`
- `phys.mass`

Secondary words can indicate either:

- A concept that the property refers to:
 - * `meta.Id;src`
 - * `meta.Id;Inst.telescope`
- Another property that the primary word refers to:
 - * `stat.error;pos.eq.ra`
- Or information related to the primary word:
 - * `phot.Flux;em.opt.V.Johnson`

SQL

- **Structured Query Language:** an ANSI standard language designed for manipulation of relational databases. Initially developed by Codd at IBM, early 1970's.
- **Latest ANSI standard is SQL2003**
 - Various flavours of SQL: IBM DB2, MySQL, Oracle Database 10g, PostgreSQL, Microsoft SQL Server 2000
 - All 'more or less' implement SQL2003, but with varying syntaxes and additional Statements and (especially) Functions

```
/* MySQL */
```

```
SELECT CURRENT_TIMESTAMP;  
'2001-12-15 23:50:26'
```

```
/* DB2 */
```

```
VALUES CURRENT_TIMESTAMP  
'2001-12-15 23.50.26.000000'
```

- **Simple syntax:** `SELECT <cols> FROM <table> WHERE <conditions>`
- **Joins for multiple tables:** `SELECT g.*, n.type FROM galaxy g, name n WHERE g.id=n.id AND g.i>20.3`

ADQL: <http://www.ivoa.net/twiki/bin/view/IVOA/IvoaVOQL>

- Used in querying of single databases
- SQL92 with additional extensions specific for astronomy
 - Mathematical Functions
 - REGION keyword:
 - e.g. `REGION('Circle J2000 195.1 -0.34 2.3')`
 - XMATCH keyword:
 - e.g. `XMATCH(o, t, 3.5)` (o and t are alias's)
 - XMATCH will be more fully covered in Lecture 4
- ADQL has two formats: /s (string) for us, and /x (xml)
 - Services to translate between formats (e.g. AstroGrid and NVO)
 - ADQL-0.7.4 services at <http://openskyquery.net/adqltranslator/>
- Latest version: ADQL-0.9 (2004-11-03)
 - http://www.ivoa.net/internal/IVOA/IvoaVOQL/WD_ADQL-0.9.pdf
 - Caution: most services still using ADQL-0.7.4!

ADQL /s and /x

```
select * FROM twomass_psc AS T1 WHERE CIRCLE('J2000', 12.34, -1.23, 0.01)
```

```
<Select xmlns='http://www.ivoa.net/xml/ADQL/v0.7.4'
xmlns:xsi='http://www.w3.org/2001/XMLSchema-instance'
xmlns:xsd='http://www.w3.org/2001/XMLSchema' >
  <SelectionList>
    <Item xsi:type='allSelectionItemType' ></Item>
  </SelectionList>
  <From>
    <Table xsi:type='tableType' Name='twomass_psc' Alias='twomass_psc' ></Table>
  </From>
  <Where>
    <Condition xsi:type='regionSearchType' >
      <Region xmlns:q1='urn:nvo-region' xsi:type='q1:circleType' coord_system_id='' >
        <q1:Center ID='' coord_system_id='' >
          <Pos2Vector xmlns='urn:nvo-coords' >
            <Name>Ra Dec</Name>
            <CoordValue>
              <Value>
                <double>12.34</double>
                <double>-1.23</double>
              </Value>
            </CoordValue>
          </Pos2Vector>
        </q1:Center>
        <q1:Radius>0.01</q1:Radius>
      </Region>
    </Condition>
  </Where>
</Select>
```

Note Schema: this is
ADQL 0.7.4

Same query: the /s version is
shorter and easier for us to read.
But the XML /x version is better
for computers!

SkyQuery: <http://openskyquery.net>

- Addresses the issue of sending a query to **MULTIPLE** databases
 - NVO implementation to date
 - AstroGrid implementation: UK databases accessible shortly
- Process
 - Webservice
 - Takes ADQL, returns VOTable
 - Analyse the query
 - Generate 'cost' estimates
 - Derive an execution plan
 - Perform x-matches
 - From small to large
 - propagate required attributes
 - VOTable returns

```
SELECT o.objId, o.r, o.type,
       t.objId, t.j_m
FROM SDSS:PhotoPrimary o,
     TWOMASS:PhotoObj t
WHERE XMatch(o,t)<3.5
      AND Region('CIRCLE J2000...')
      AND (o.i-t.j_m)>2
      AND o.type=3
```

VOQL

- Extension of SQL/ ADQL to allow richer high level queries of a wider variety of data, so images and not just catalogues
- SIAP to be covered in lecture 3

Integration of SkyNode and SIAP node

We need to make standards not only for query language but also supported protocol, the way of metadata query and specification of the returned VOTable.

| | SIAP Node | SkyNode | UnifiedSkyNode |
|----------------|---|---|---|
| Data | Image | Catalog | Catalog/Image/Spectrum/... |
| Query Language | Parameter , name of the parameters are defined. | SQL , no restriction to the name of column | SQL , define a guideline for , syntax |
| Protocol | Http/Get/Parameter | Http/Put/Soap | Http/Put/Soap ? |
| Metadata Query | " FORMAT = METADATA " returns supported parameters and columns it will return. | Tables and Columns interface are defined. | Define standard metadata table which have metadata of table and column. Query is described with SQL. |
| Query Output | VOTable, Some metadata must be included. | VOTable, no specification for the content | VOTable , FIELD element should have metadata stored in the metadata table. |

<http://www.ivoa.net/internal/IVOA/InterOpSep2004VOQL/VOQLSyntax-yshirasa.pdf>

Database Queries

A.V.O demonstration prototype v2.000

Load... Save... Plugins... Print...

Position J2000 00:42:45.05 + Pix

J/ApJ/504/113

Server selector

Image servers: Aladin, VOdemo, SSS...

Retrieve data from the Virtual Observatory - Mozilla

InterOpSep200... Retrieve data fr... http://o...nslator/ Open SkyQuery IVOA Document... Astronomical D...

Home MySpace Resources **Queries** Workflows Jobs Help Logout

Retrieve data from the Virtual Observatory

Data Query Builder (in (s)ADQL)

AS T1 WHERE

5
10
20
30
40
50

Clear

Save to MySpace Execute Query ?

Search (roe) Example 3 Example 4

pers

| | | | | | | |
|-----|------|-------|---------|----------|---------|-----|
| ... | sin | ... | asin | ... | abs | ... |
| ... | cos | ... | acos | ... | ceiling | ... |
| d | tan | ... | atan | ... | floor | ... |
| ... | cot | ... | atan2 | ... | exp | ... |
| t | log | ... | log10 | ... | power | ... |
| max | ... | sigma | ... | sum | ... | ... |
| c | ... | desc | ... | distinct | ... | ... |
| ... | like | ... | notlike | ... | ... | ... |

Table: J/MNRAS/351/1290/

FROM: J/MNRAS/351/1290/catalog

AS: T1 C&P

| | |
|------------|----------|
| recno | ELAIS |
| RAJ2000 | DEJ2000 |
| S20cm | e_S20cm |
| S175um | e_S175um |
| S/N175 | Off175 |
| S90um | e_S90um |
| S/N90 | Off90 |
| S15um | S/N15 |
| S6.7um | e_S6.7um |
| q_S6.7um | Flag1 |
| Flag2 | Jmag |
| e_Jmag | Hmag |
| e_Hmag | Kmag |
| e_Kmag | r_Jmag |
| RAo | DEo |
| Umag | g'mag |
| r'mag | i'mag |
| Zmag | e_Umag |
| e_g'mag | e_r'mag |
| e_i'mag | e_Zmag |
| S/GU | S/Gg' |
| S/Gr' | S/Gi' |
| S/GZ | r'magS |
| e_r'magS | S/G |
| OffTot | OffRA |
| OffDE | Prob |
| Rel | typ |
| log(1+zpb) | ptwa |

Open SkyQuery

Home Query Import Tutorial Help

National Virtual Observatory

Build Edit Submit

Query Status

Query is complete

RESULTS View Plot

Devel ExecPlan

Nodes: Colors?

Node: SDSSDR2

Node: TWOMASS

Samples

Version: v1_0_9 US-VO.org

Sigmas Region Clear

Nodes

- Rosat
- GALEX
- DLS
- RC3
- SDSS
- SDSSDR2
- TwoDf
- Twoqz
- USNOB
- GOODS
- HDFN
- HDFS
- UDF
- TWOMASS
- IRAS
- PSCz
- ADIL
- FIRST
- NVSS
- NDWFS
- NVORegistry
- sxds_skynode

```

SELECT o.objid, o.ra,
       o.dec, o.type, t.objid,
       t.j_m, o.z
FROM
  SDSSDR2:PhotoPrimary o, TWOMASS:PhotoPrimary t
WHERE XMATCH(o, t) < 2.5 AND
      Region('CIRCLE J2000 16.031 -0.891 30') AND
      (o.z - t.j_m) > 2
    
```

Welcome to the Open SkyQuery Interactive query builder. You should see a parsed, clickable version of your entered query in the pane directly above this one.

If instead you see 'Query is empty', this means that builder needs a node or two to get started. You can add nodes to the builder by clicking the desired node's '+' icon in the left panel.

Once you have some sql in the above panel, you can then click on a token in that query to pull up a menu with options appropriate for that specific token. For example, one way to select an additional column from a mythical 'mytable' is to click on 'mytable' and then chose 'Add Selection', then pick the desired column from the given choices.

You can switch between 'edit' and 'build' modes at any time by using the tabs at the top of the query panel. Your changes from one will carry over to the other. Most menu options have additional mouse-over info.

Science Example

Putting the technology to use ...

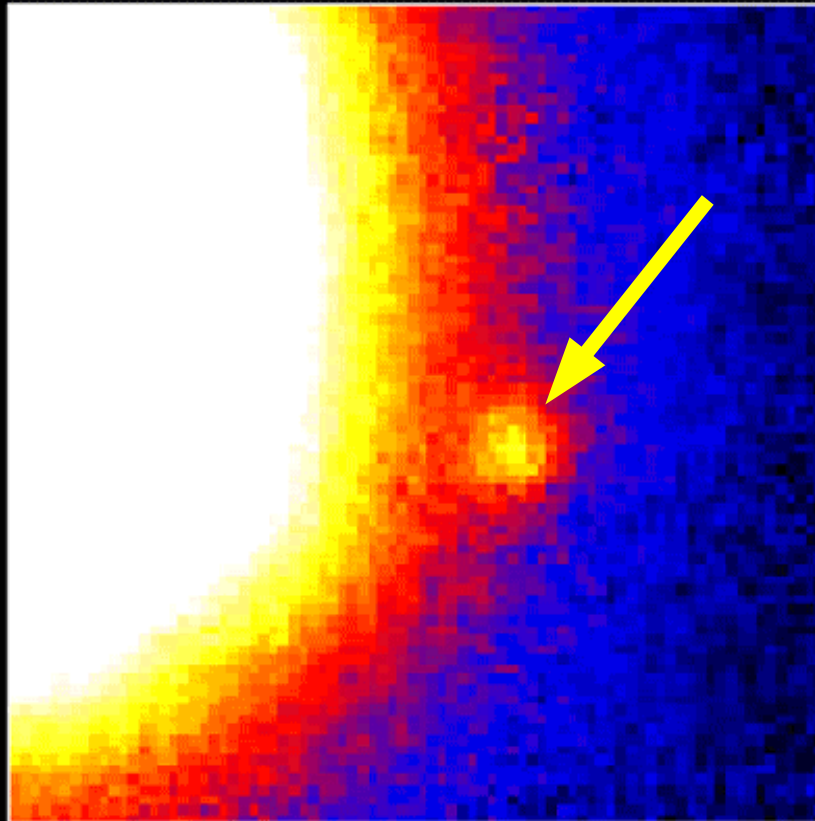
Science Case: Identifying Brown Dwarfs

- Very low-mass stars
 - L-type (neutral alkali and hydride lines) and T-type (methane)
 - Cool: about 1350-2350 K
 - Inefficient nuclear fusion (mostly of deuterium)
 - Bridge the gap between stars and planets?
 - Theoretical mass range $0.012\text{-}0.08 M_{\odot}$
 - *But* 'desert' - no v. large planets/small Brown Dwarfs known
 - Selection effect?
 - Different formation processes?
 - Do Brown Dwarfs form by direct cloud collapse v. planets in circumstellar discs?
 - How numerous are Brown Dwarfs ?
- Hard to find - very dim, first confirmed detection 1995

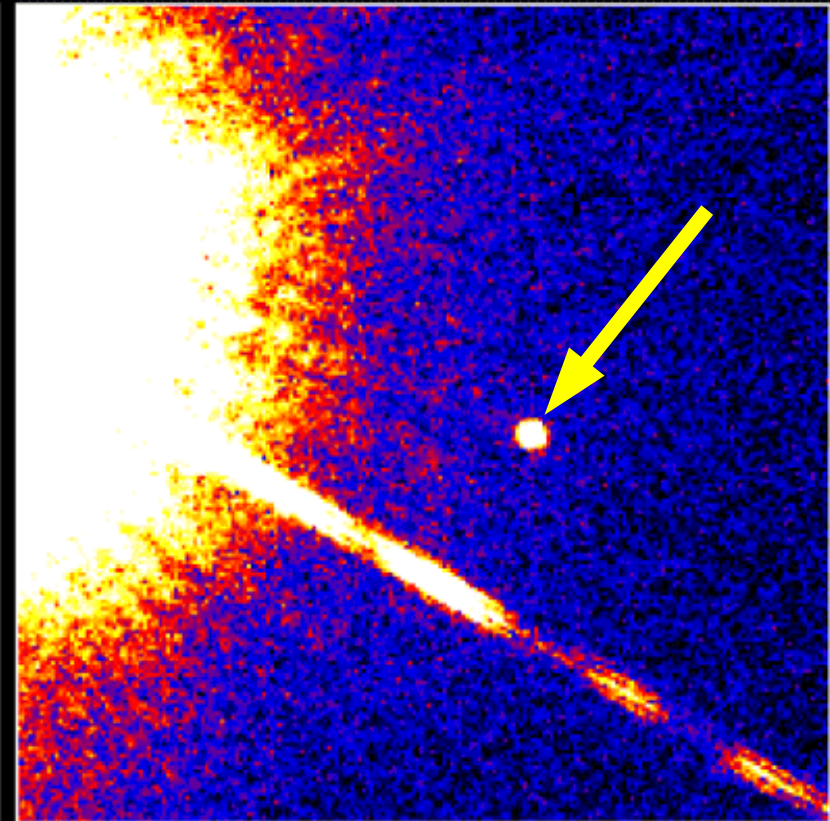
Gliese 229 B

- Oldest known Brown Dwarf, most extreme colours!

Brown Dwarf Gliese 229B



Palomar Observatory
Discovery Image
October 27, 1994



Hubble Space Telescope
Wide Field Planetary Camera 2
November 17, 1995

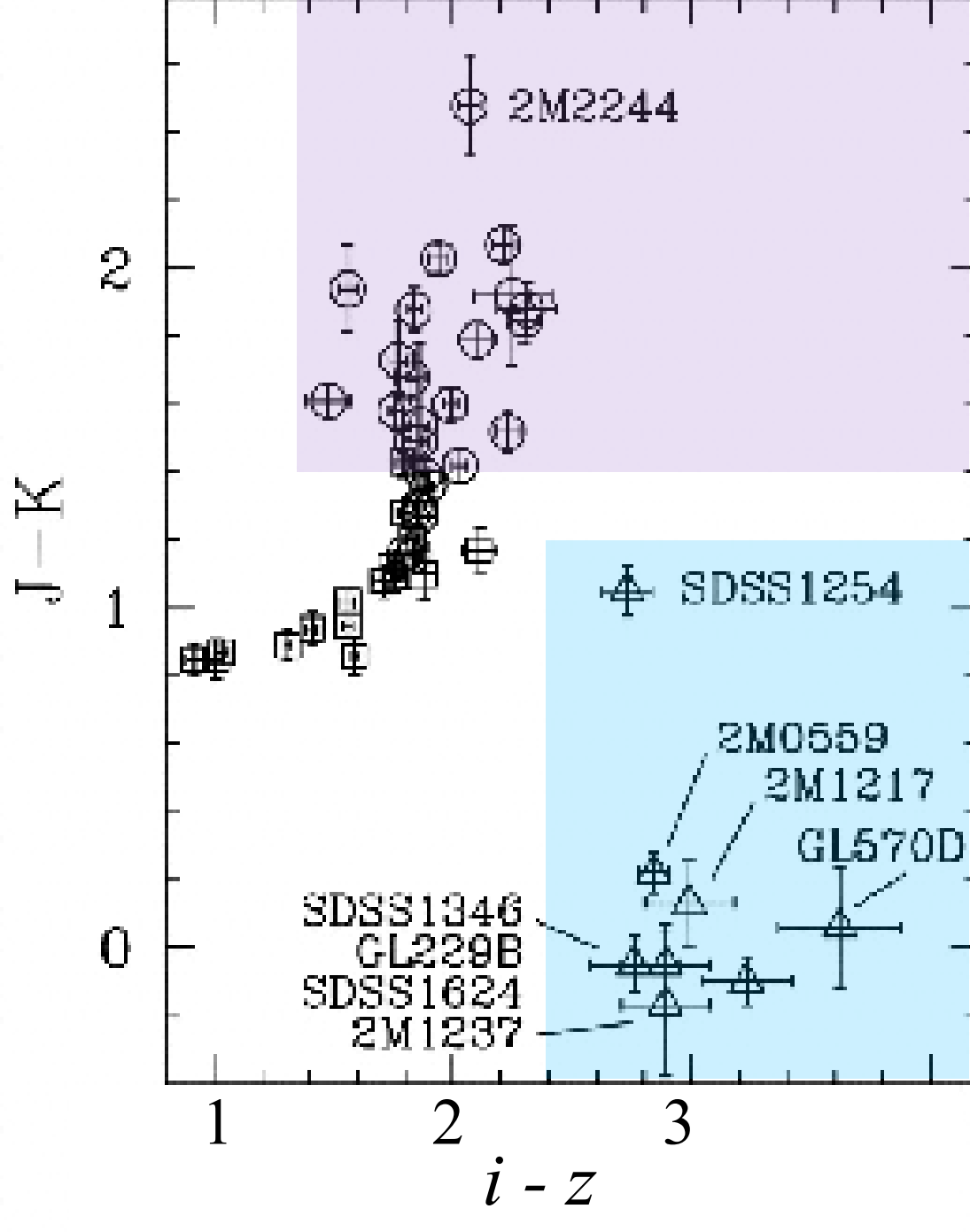
PRC95-48 · ST ScI OPO · November 29, 1995

T. Nakajima and S. Kulkarni (CalTech), S. Durrance and D. Golimowski (JHU), NASA

Recognising very cool stars

- Most known Brown Dwarfs are identified as
 - Faint (so distance must be known)
 - Possessing distinctive spectral lines (so slow spectroscopy)
- Colours (ratios of flux density in different bands) give
 - Distance-independent temperature estimates
 - Easily obtained from large-scale surveys
- INT-WFS images give *i*, *z* ($\sim 770, 950$ nm) bands
 - Measure *z*-band sources and *i*-band flux density at *z*-band position since upper limits are useful
- 2MASS data catalogue gives J, K ($1.2, 2.2 \mu\text{m}$) bands

Brown Dwarf colour-colour plot



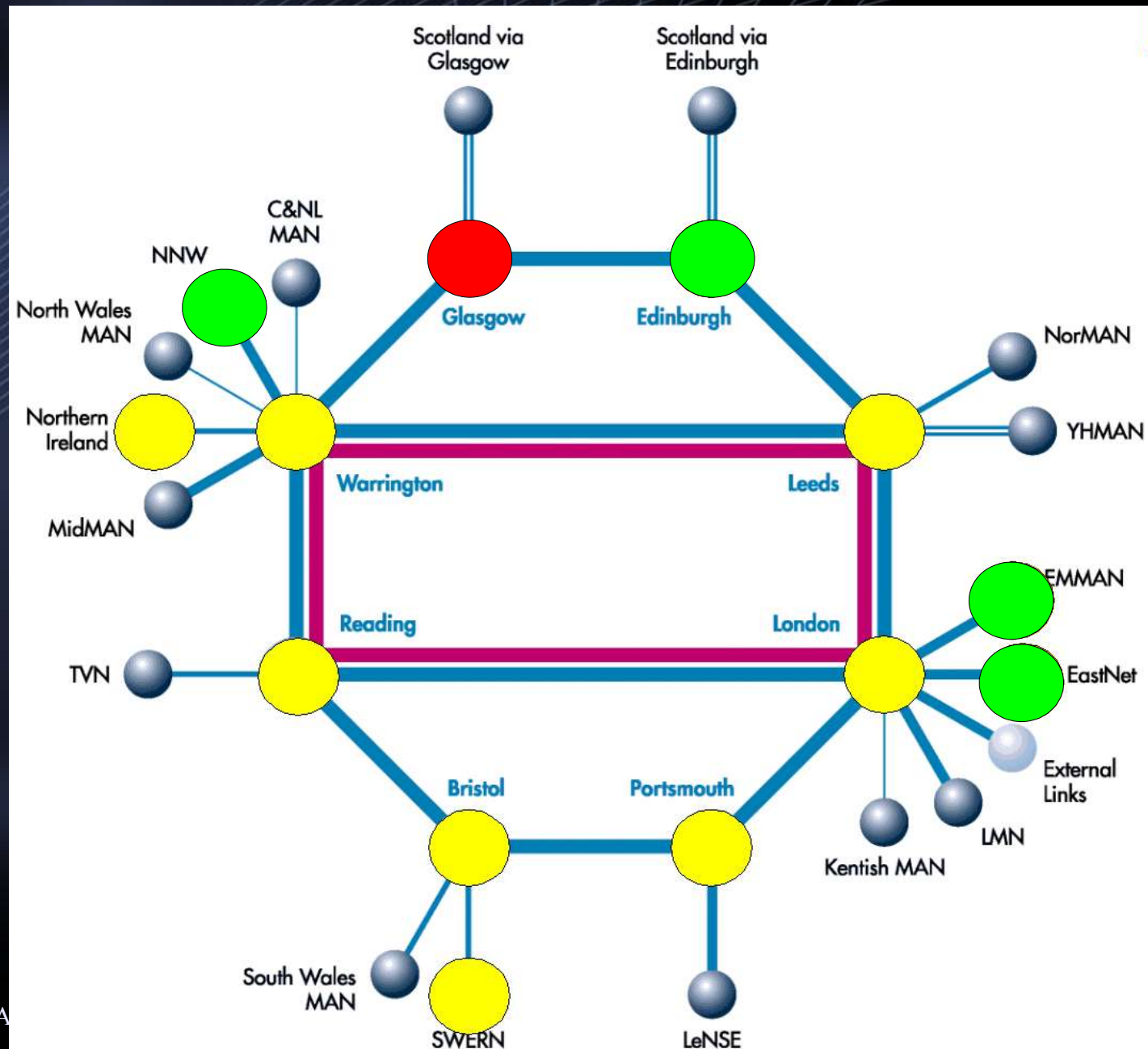
- Dahn et al. (2002)
- Dobbie et al. (2002)
 - adjust to INT-WFS filters
- \oplus Mostly L-dwarfs
 - $i-z > 1.4$
 - $J-K > 1.4$
- \triangle T-dwarfs
 - $i-z > 2.4$
 - $J-K < 1.2$
- \square M-dwarfs

Accessing & processing distributed data

- Select INT-WFS Observing Log entries for Pleiades in i and z bands with small photometric and pointing errors
 - Cross-match to get i and z observations of same fields
- Extract Zero-point, Seeing, Exposure time from Logs
- Construct image URLs for Simple Image Access server at Cambridge
- Feed images to SExtractor hosted at JBO [Covered in Lecture 3]
- Cone search 2MASS catalogue at ROE for Pleiades region
- Cross-match lists of extracted i and z sources and 2MASS sources, all held in MySpace at Leicester
- Use TopCat tool to access MySpace files and make colours

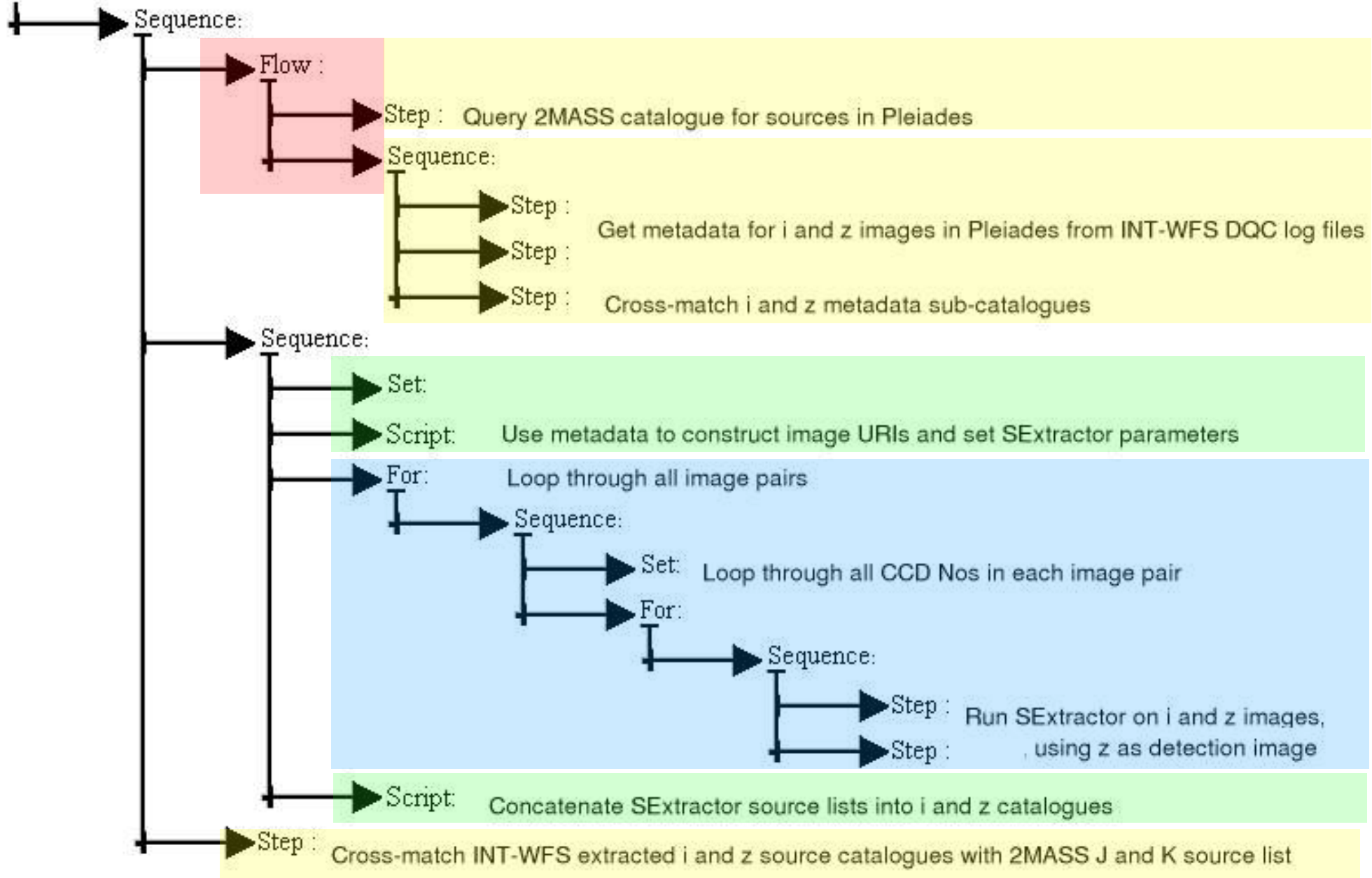
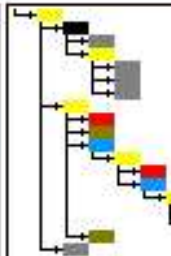
Colour cut using distributed resources

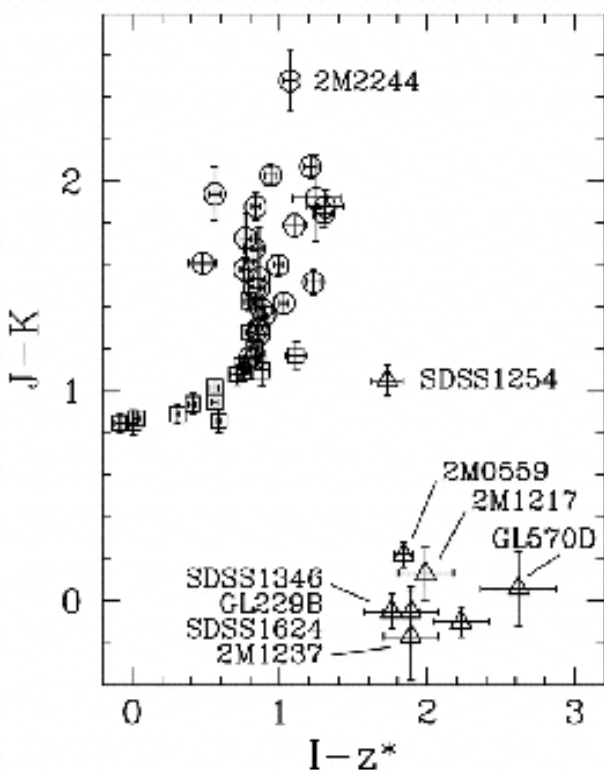
- Query 2MASS catalogue at ROE
- Query INT-WFS Log at Cambridge
- Feed images to SExtractor at JBO
- Cross-match source lists in MySpace at Leicester
- Use TopCat on MySpace files, display in Glasgow



| | |
|--------------|---|
| Name: | Pleiades colour cut |
| Description: | Pleiades colour cut using INT-WFS i and z (from images) and 2MASS J and K (catalogue) |

[update workflow details](#)



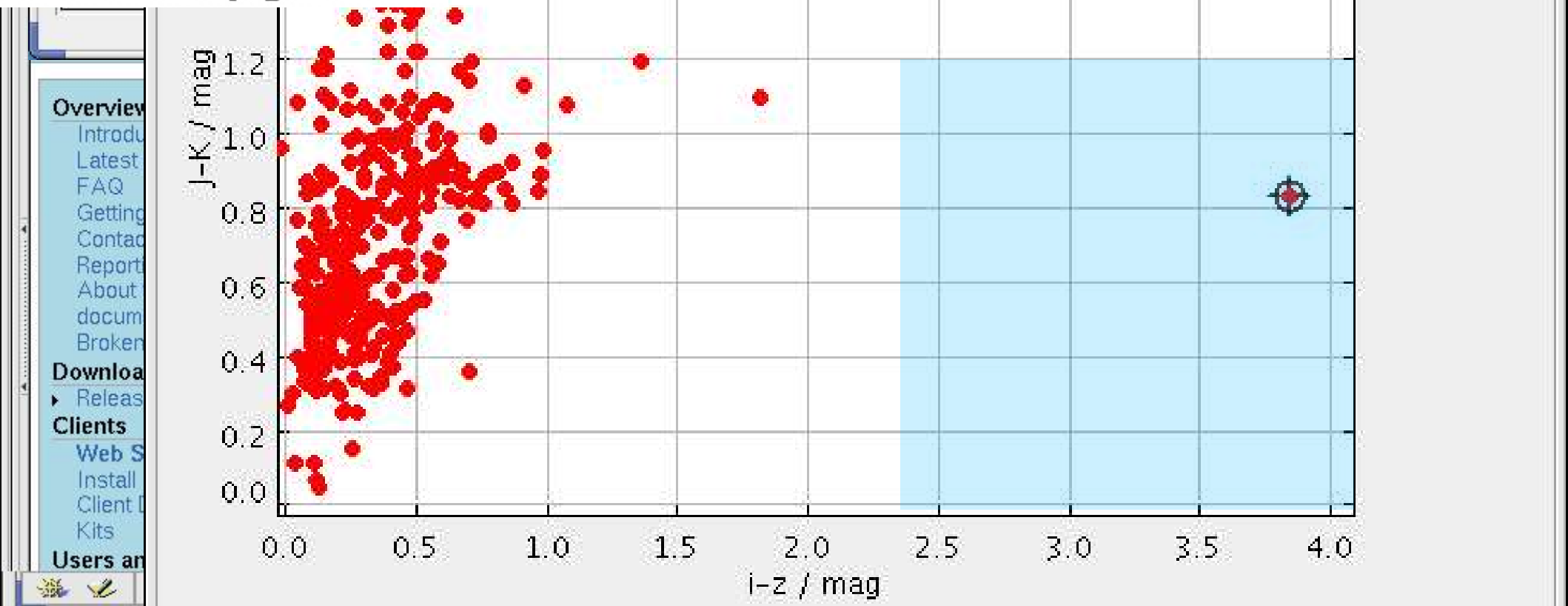


Plotter

Marker Types Points Regression Help

Icons: Grid, Refresh, Scatter, Legend, Help, Close

STARLINK



Overview

- Introduction
- Latest
- FAQ
- Getting
- Contact
- Report
- About
- document
- Broken

Download

- Releases

Clients

- Web S
- Install
- Client I
- Kits

Users and

Brown Dwarf summary

- $>200 \times \sim 2$ arcmin (8×10^6 pixel) x i, z INT-WFS fields
 - ~ 2000 sources extracted per field (half a million possible sources)
- ~ 5000 2MASS sources
- 0 to 10 INT-WFS/2MASS cross-matches per field
- So far, average one L-dwarf candidate per field
- Any T-dwarfs? Still to be found.
- Future: Data mine for
 - distances,
 - proper motions,
 - Li/CH₄ lines
- *Method could also find free-floating planets (Lucas et al.)*

Lecture 2: Acknowledgements

- Brown dwarf science example – slides 31 to 39 - adapted from Anita Richards: Brown Dwarf science case developed for the AstroGrid Dec 2004 demo – see <http://wiki.astrogrid.org/bin/view/Astrogrid/AgDemoDec2004Galactic>
- Skyquery slide 27 adapted from Tamas Budavari: <http://www.us-vo.org/summer-school/proceedings/presentations/Budavari-VoStandards.ppt>
- IVOA standards – see <http://www.ivoa.net/forum/>

Next Lecture: Images, Applications and Workflows