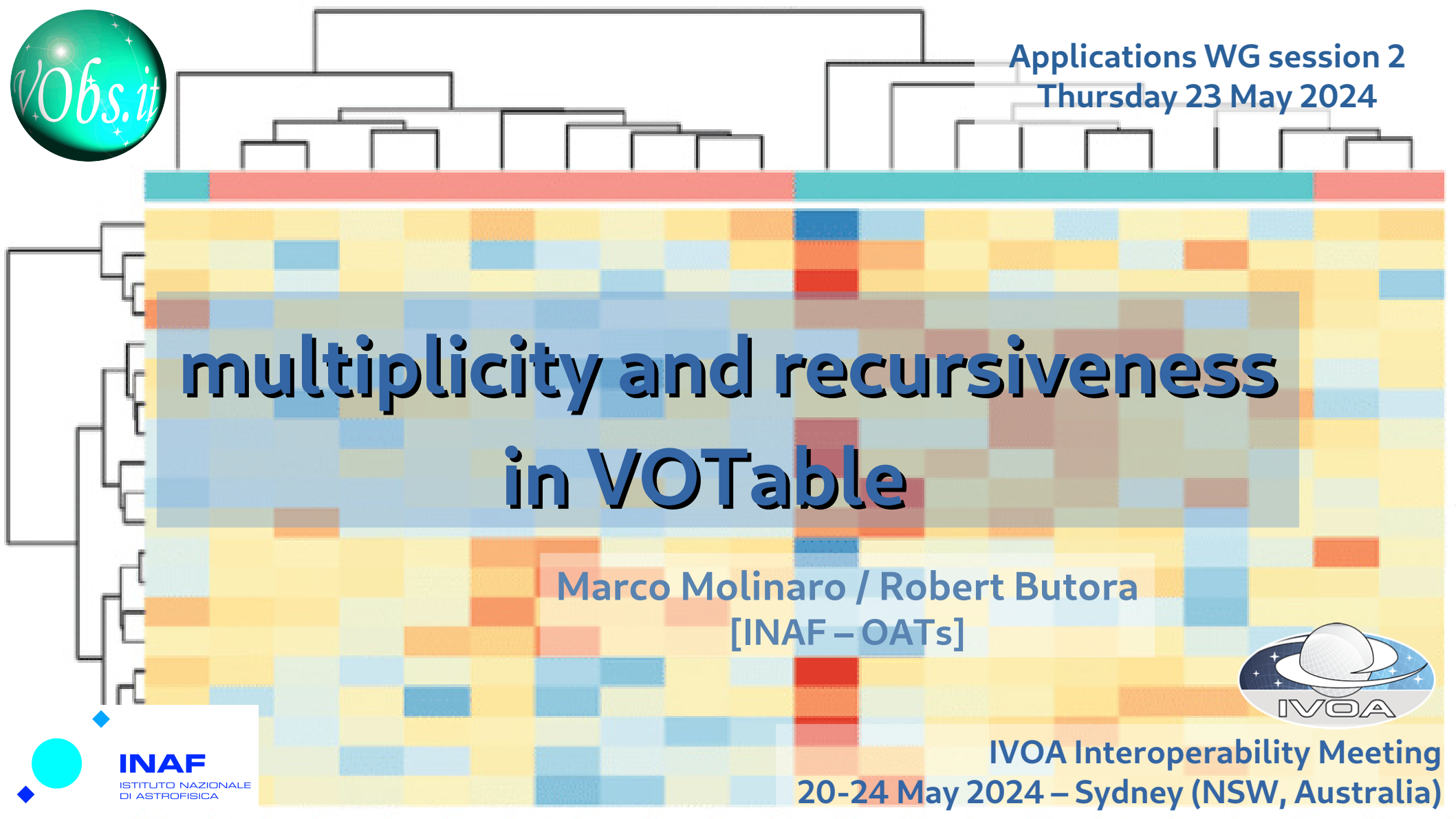

Applications WG session 2
Thursday 23 May 2024

multiplicity and recursiveness in VOTable

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[INAF – OATs]

IVOA Interoperability Meeting
20-24 May 2024 – Sydney (NSW, Australia)

Context

- custom discovery service for galactic astrophysics archive
  - mostly driven by velocity data cubes
  - multiple collections (“surveys”)
    - and sub-collections
      - “sub-surveys” (species and transition :: observable spectral band)
  - galactic coordinates
- currently porting to SIAP/DAP
  - obscore metadata driven (done)
- dedicated client
  - query/response specific features
    - based on scientific users’ requirements
  - moving towards VO interfaces

custom - overview

name	species	transition
Mopra GPS	12CO	1-0
Mopra GPS	13CO	1-0
Mopra GPS	C17O	1-0
CHIMPS	C18O	3-2
CHaMP	HCO+	1-0
HOPS	H2O	6-1-6_5-2-3
HOPS	NH3	1-1_1-1
HOPS	NH3	2-2_2-2
	13CO	1-0
MALT90	N2H+	1-0
MALT90	13CS	2-1
MALT90	H	41a
MALT90	CH3CN	51-41
MALT90	HC3N	10-9
MALT90	13C34S	2-1
MALT90	HNC	1-0
MALT90	HC13CCN	10-9_9-8
MALT90	HCO+	1-0
MALT90	HCN	1-0
MALT90	HNCO	413-312
MALT90	HNCO	404-303
MALT90	C2H	1-0_3/2-1/2_2-1
MALT90	HN13C	1-0
MALT90	SiO	2-1
MALT90	H13CO+	1-0
	12CO	1-0
ThrUMMS	13CO	1-0
ThrUMMS	C18O	1-0
ThrUMMS	CN	1-2-3_0-1-2
NANTEN GPS	12CO	1-0
OGS	12CO	1-0
OGS	13CO	1-0
COHRS	12CO	3-2
VGPS	HI	21 cm
CGPS	HI	21 cm
SGPS	HI	21 cm

subsurvey
(sub-)collection

survey/collection

The 3 values actually compose the obs_collection values in the obscore table

SIA (ongoing) development

- Galactic coordinates apart, besides VO standardisation, the dedicated client is used to consume (sub-)survey grouped responses.
- Is it possible to keep this behaviour in VOTables?
  - actually, the client already parses XML responses similar to VOTables
- We are trying to investigate multiple VOTable responses based on
  - VOTable §3.6
    - The RESOURCE is ***recursive*** …
    - The main component of a RESOURCE is typically ***one or more TABLE*** elements …
- How does the client asks a specific one, if we serve multiple?
  - … so far we are hacking RESPONSEFORMAT=application/x-votable+xml;mode={...}

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1 RESOURCE – 1 TABLE

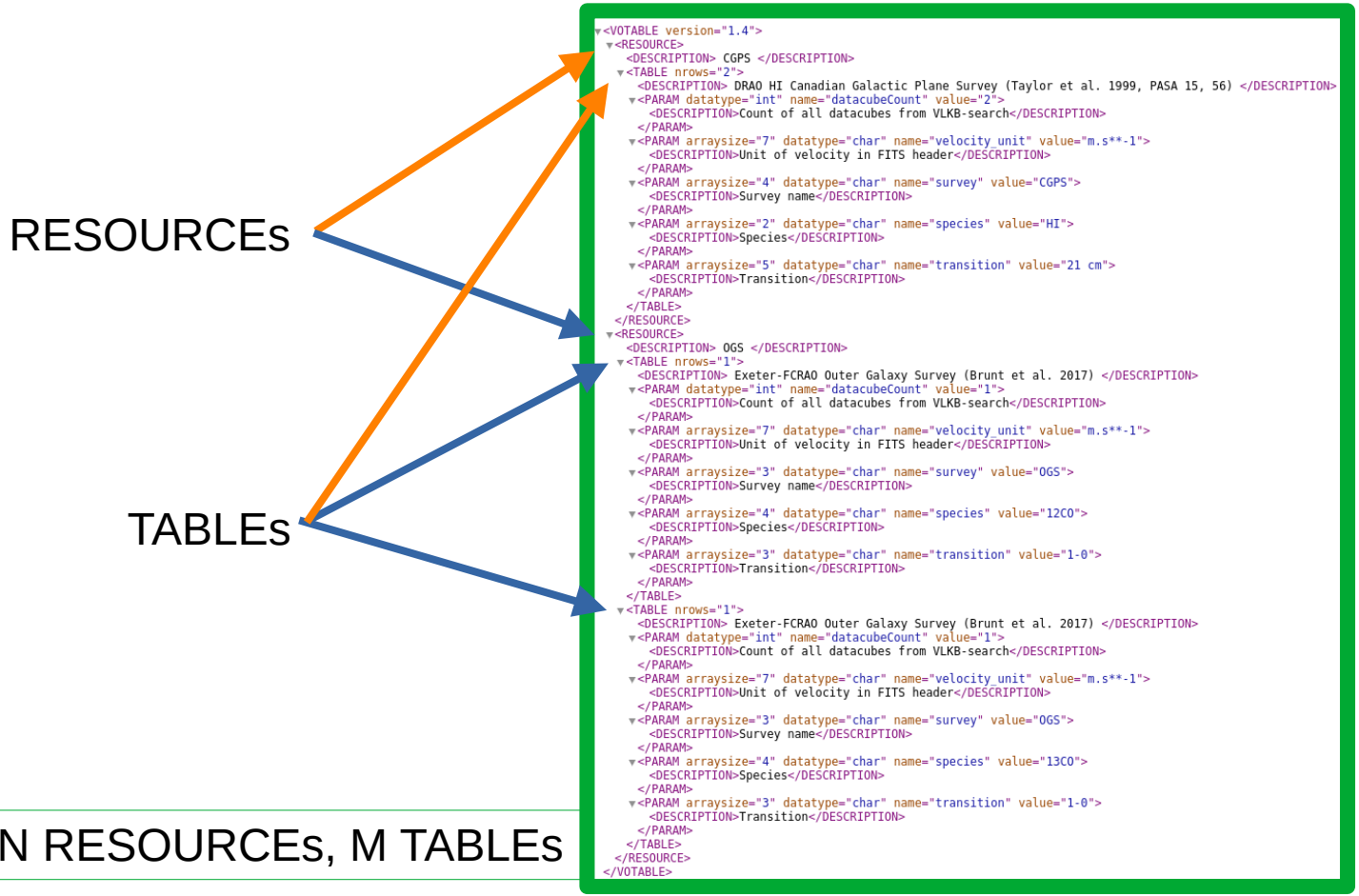
```
▼<VOTABLE version="1.4">
  ▼<RESOURCE>
    ▼<TABLE nrows="15">
      ▼<PARAM datatype="int" name="subsurveyCount" value="14">
         <DESCRIPTION>Count of subsurveys with found datacube(s)</DESCRIPTION>
       </PARAM>
      ▼<PARAM datatype="int" name="datacubeCount" value="15">
         <DESCRIPTION>Count of all datacubes from VLKB-search</DESCRIPTION>
       </PARAM>
      ▼<FIELD arraysize="*" datatype="char" name="dataproduct_type">
         <DESCRIPTION>Dataproduct Type (image|cube)</DESCRIPTION>
       </FIELD>
```

standard ObsTAP response

1 - M

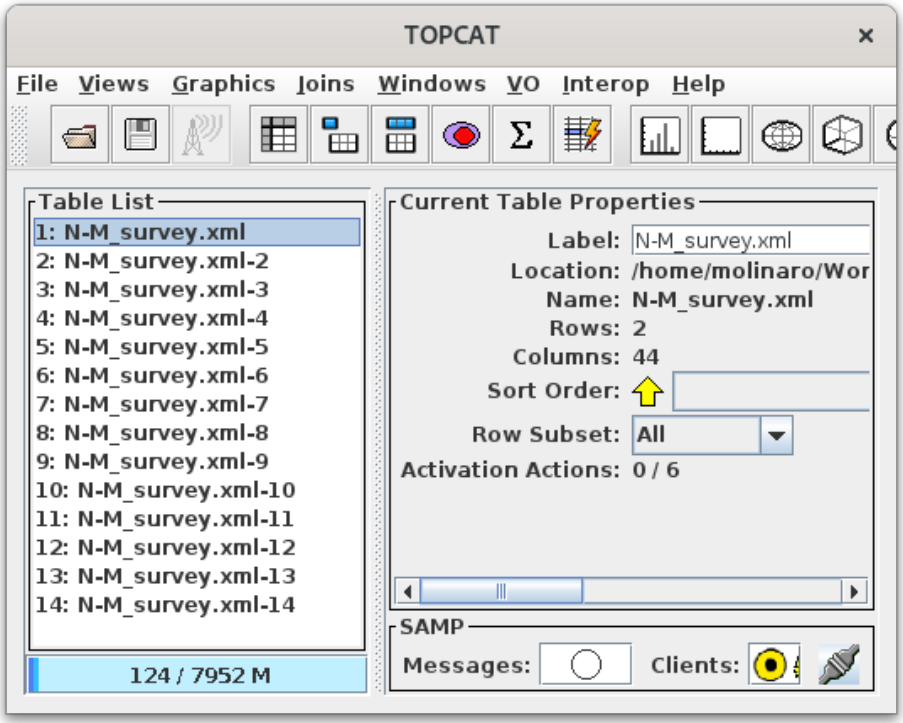

RESOURCE
TABLEs
1 RESOURCE – 1 TABLE
<VOTABLE version="1.4">
<RESOURCE>
<TABLE nrows="2">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
...
</TABLE>
<TABLE nrows="1">
<DESCRIPTION> Exeter-FCRAO Outer Galaxy Survey (Brunt et al. 2017) </DESCRIPTION>
<PARAM datatype="int" name="subsurveyCount" value="14">
<DESCRIPTION>Count of subsurveys with found datacube(s)</DESCRIPTION>
</PARAM>

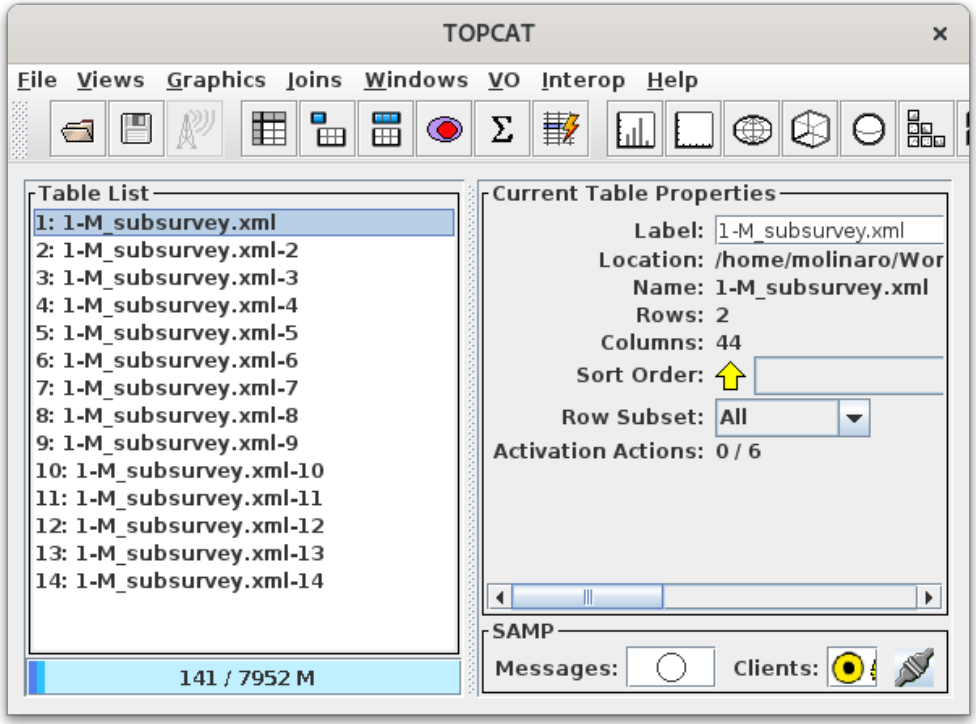
N - M



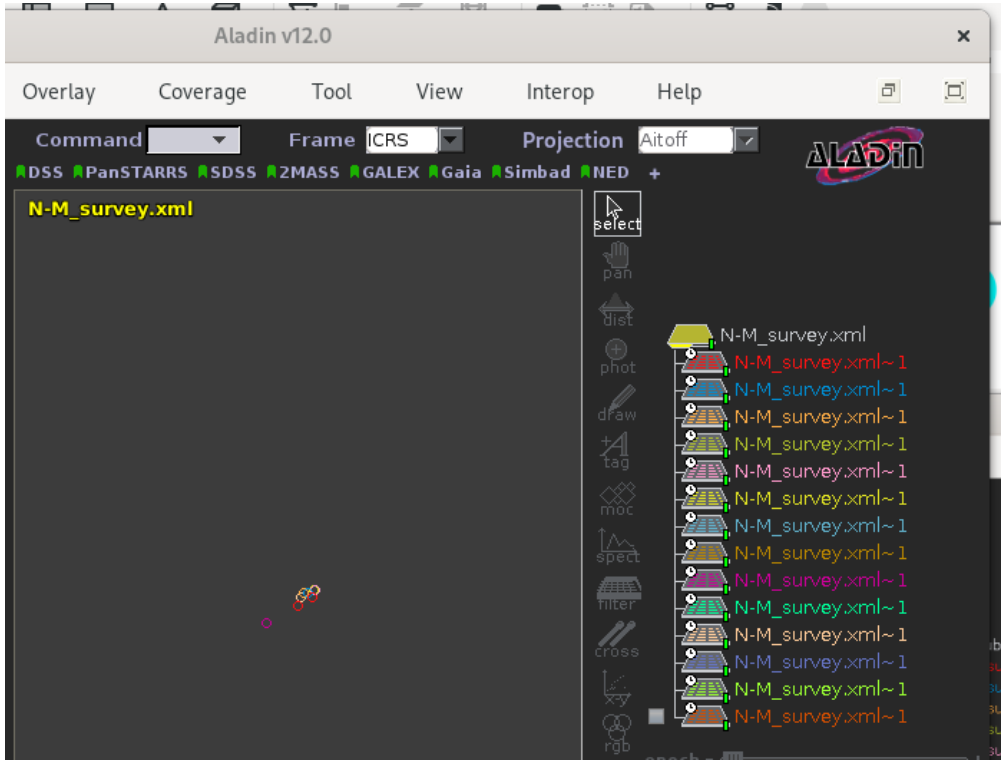

```
<VOTABLE version="1.4">
 <RESOURCE>
  <DESCRIPTION> CGPS </DESCRIPTION>
  <TABLE nrows="2">
   <DESCRIPTION> DRAO HI Canadian Galactic Plane Survey (Taylor et al. 1999, PASA 15, 56) </DESCRIPTION>
   <PARAM datatype="int" name="datacubeCount" value="2">
    <DESCRIPTION>Count of all datacubes from VLKB-search</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="7" datatype="char" name="velocity_unit" value="m.s**-1">
    <DESCRIPTION>Unit of velocity in FITS header</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="4" datatype="char" name="survey" value="CGPS">
    <DESCRIPTION>Survey name</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="2" datatype="char" name="species" value="HI">
    <DESCRIPTION>Species</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="5" datatype="char" name="transition" value="21 cm">
    <DESCRIPTION>Transition</DESCRIPTION>
   </PARAM>
  </TABLE>
 </RESOURCE>
 <RESOURCE>
  <DESCRIPTION> OGS </DESCRIPTION>
  <TABLE nrows="1">
   <DESCRIPTION> Exeter-FCRAO Outer Galaxy Survey (Brunt et al. 2017) </DESCRIPTION>
   <PARAM datatype="int" name="datacubeCount" value="1">
    <DESCRIPTION>Count of all datacubes from VLKB-search</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="7" datatype="char" name="velocity_unit" value="m.s**-1">
    <DESCRIPTION>Unit of velocity in FITS header</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="3" datatype="char" name="survey" value="OGS">
    <DESCRIPTION>Survey name</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="4" datatype="char" name="species" value="12CO">
    <DESCRIPTION>Species</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="3" datatype="char" name="transition" value="1-0">
    <DESCRIPTION>Transition</DESCRIPTION>
   </PARAM>
  </TABLE>
  <TABLE nrows="1">
   <DESCRIPTION> Exeter-FCRAO Outer Galaxy Survey (Brunt et al. 2017) </DESCRIPTION>
   <PARAM datatype="int" name="datacubeCount" value="1">
    <DESCRIPTION>Count of all datacubes from VLKB-search</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="7" datatype="char" name="velocity_unit" value="m.s**-1">
    <DESCRIPTION>Unit of velocity in FITS header</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="3" datatype="char" name="survey" value="OGS">
    <DESCRIPTION>Survey name</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="4" datatype="char" name="species" value="13CO">
    <DESCRIPTION>Species</DESCRIPTION>
   </PARAM>
   <PARAM arraysize="3" datatype="char" name="transition" value="1-0">
    <DESCRIPTION>Transition</DESCRIPTION>
   </PARAM>
  </TABLE>
 </RESOURCE>
</VOTABLE>
```

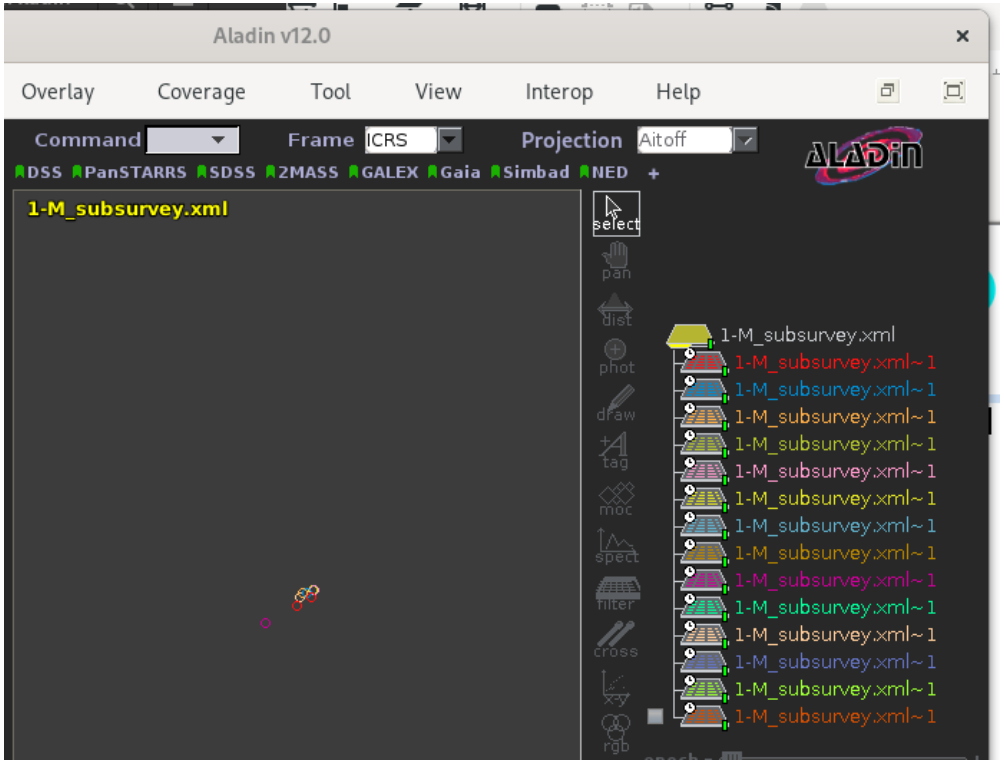
Client behaviour – TOPCAT





Client behaviour – Aladin





Client behaviour – astropy/PyVO

```
votable_subs = parse("1-M_subsurvey.xml")

for resource in votable_subs.resources:
    print("RESOURCE")
    for table in resource.tables:
        print("TABLE", table.nrows)
```

```
RESOURCE
TABLE 2
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
TABLE 1
```

```
pyvo.dal.SIAResults(votable_subs)
```

```
<Table length=2>
dataproduct_type calib_level ... r
     object         int32     ...
---------------- ----------- ... -
            cube           2 ...
            cube           2 ...
```

```
for resource in votable_surv.resources:
    print("RESOURCE")
    for table in resource.tables:
        print("TABLE", table.nrows)
```

```
RESOURCE
TABLE 2
RESOURCE
TABLE 1
RESOURCE
TABLE 1
TABLE 1
RESOURCE
TABLE 1
TABLE 1
TABLE 1
TABLE 1
RESOURCE
TABLE 1
TABLE 1
RESOURCE
TABLE 1
TABLE 1
TABLE 1
TABLE 1
```

```
pyvo.dal.SIAResults(votable_surv)
```

```
<Table length=2>
dataproduct_type calib_level ... m
     object         int32     ...
---------------- ----------- ... -
            cube           2 ...
            cube           2 ...
```

Converting to/from an `astropy.table.Table`

The VOTable standard does not map conceptually to an `astropy.table.Table`. However, a single table within the `VOTable` file may be converted to and from an `astropy.table.Table`:

`SIAResults` is essentially a wrapper around an Astropy **`votable.TableElement`** instance where the columns contain the various metadata describing the images. One can access that VOTable directly via the **`votable`** attribute.

Summary

- quite obvious client behaviour, peculiar use case
- too much flexibility in the standard?
- … or lack of scope in the elements?
  - minor: client-server information exchange
- not really an issue in modeling the response content
  - more similar to normalising/denormalising a relational set
  - or hierarchically structuring a complex set of information
  - … but maybe data models can cover also this

```
<VOTABLE version="1.4">
 <RESOURCE>
  <RESOURCE>
   <RESOURCE>
    <RESOURCE>
     <RESOURCE>
      <RESOURCE>
       <RESOURCE>
        <RESOURCE>
         <RESOURCE>
          <TABLE nrows="1">
```

Thanks!