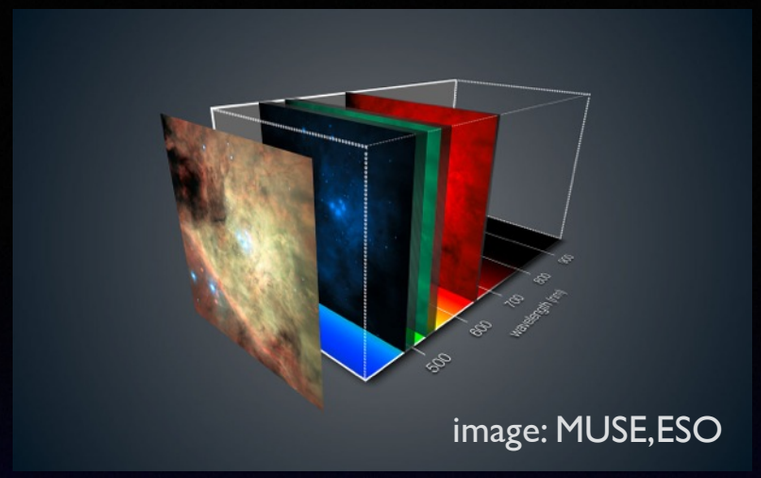
# Focus Session on Multi-dimensional Data

## Introduction

Mark Allen, Joe Lazio
IVOA Interoperability Meeting,
ESAC, Madrid, May 20, 2014

CoSADIE Project

Science Priority Areas




# Multi-dimensional Data

Radio astronomy, Integral Field Spectroscopy, high energy, polarization, simulation, data mining datasets + ...

- Need to ensure that these are accessible and useable within the VO

# Science Drivers

- Uniform discovery and access to multi-d data

Use Cases : e.g. Search for water maser features in a star formation region
Need:  3-D image cube consisting of 2 space and 1 frequency/velocity axes, with ability to search in frequency/velocity at every spatial pixel

Show me a list of data that satisfies:
I. Datatype=cube with 3 dimensions
II. Axes include Frequency
III. Axes include RA
IV. Axes include DEC
V. Frequency range includes 22 GHz

- Interoperability of multi-d data
  - compare and combine at different levels, e.g. compare coverage, combine measurement axes
- Visualisation - big cubes, combined data

# Context

- Focus Sessions (Heidelberg May 2013)
  - engagement with projects, minimal requirements
- Prototype demos (Hawaii Sept 2013)
  - Multiple approaches, ~agreement on what stds. needed
- 1st draft stds. to satisfy minimal requirements
- Follow-up Focus Session (Madrid, May 2014)
  - Status, maintain engagement, next steps

# Projects engaged

- ALMA
- LOFAR
- SKA - ASKAP, MWA, MeerKAT
- JVLA / NRAO
- MUSE
- CALIFA
- LSST
- CRTS
- CTA
- JIVE / VLBI
- JWST
- + liaisons via VO projects

# Minimal requirements

Multi-dimensional Data Access minimal requirements:

- Data Discovery (Query)
  - A service shall be able to receive queries regarding its data collection(s) from a client, with the client placing one or more of the following constraints:
    - RA,Dec
    - Frequency/wavelength
    - Polarization states
    - Spatial size
    - Angular resolution
    - Integration time
    - Time of observation
  - A service shall return to the client a list of observations, and the corresponding metadata for each observation, meeting the user-imposed constraints. In the event that the user places no constraints, the entire list of observations, and the corresponding metadata for each data set, shall be returned. In the event that no data meet the user's constraints, the service shall indicate the absence of any matches.
- Data Access
  - Once a user has the list of observations that satisfy the constraints, they select all or a subset of the observations and:
    - Download the complete science data for each of the selected observations (the service shall return the complete multi-dimensional science data and metadata for each selected observation) or;
    - Download simple cutouts of the science data for each of the selected observations (the service shall be able to extract and return a user-specified subset of the complete multi-dimensional science data and metadata for each selected observation).
- Simple Cutout
  - For a simple cutout, the user-specified subset is restricted to be a contiguous interval within each dimension of the multi-dimensional science data. The user should *not* be allowed to specify subsets with "gaps" or resampling or anything like that.
    - Spatial: (a coordinate and a radius)
    - Energy: one interval (from energy1 to energy2)
    - Time: one interval (from time1 to time2)
    - Polarization: a list

# Schedule

| Time | Speaker | Topic | Materials |
|---|---|---|---|
| **Tuesday 10h-11h30** | | | |
| 10h00 | Mark Allen | Introduction | |
| 10h10 | Séverin Gaudet | IVOA approach to multi-d data | |
| 10h25 | Joe Lazio | Prototypes and Next Steps | |
| 10h40 | Brian Glendenning | NRAO | |
| 10h50 | Mark Kettenis | JIVE/VLBI | |
| 11h00 | Lindsay Magnus | SA^3, MeerKAT | |
| 11h10 | Ruben Garcia-Benito | CALIFA | |
| 11h20 | Willem-Jan Vriend | MUSE | |
| | | | |
| **Tuesday 15h-16h30** | | | |
| 15h00 | Rachel Osten (skype) | JWST | |
| 15h10 | Michael Wise | LOFAR | |
| 15h20 | Panel Discussion | | |

# Presentations

- What data products do your projects plan to deliver?
- Are there plans to do this in a VO-compatible manner?
- Is there intent to provide users with the capability to modify project-provided data before downloading it?

# Panel Discussion

- Do standards and prototypes match expectations for 1st steps?
- What are the paths to implementation of IVOA standards? What are the impediments?
- What added functions are needed?
- What goes into the next set of requirements?

# Follow-on

- Code Repositories Session ()
- DAL WG Session: Data cubes (17h-18h30)
- Applications Sessions (Thursday)
- Informal demos