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IVOA TDIG Group

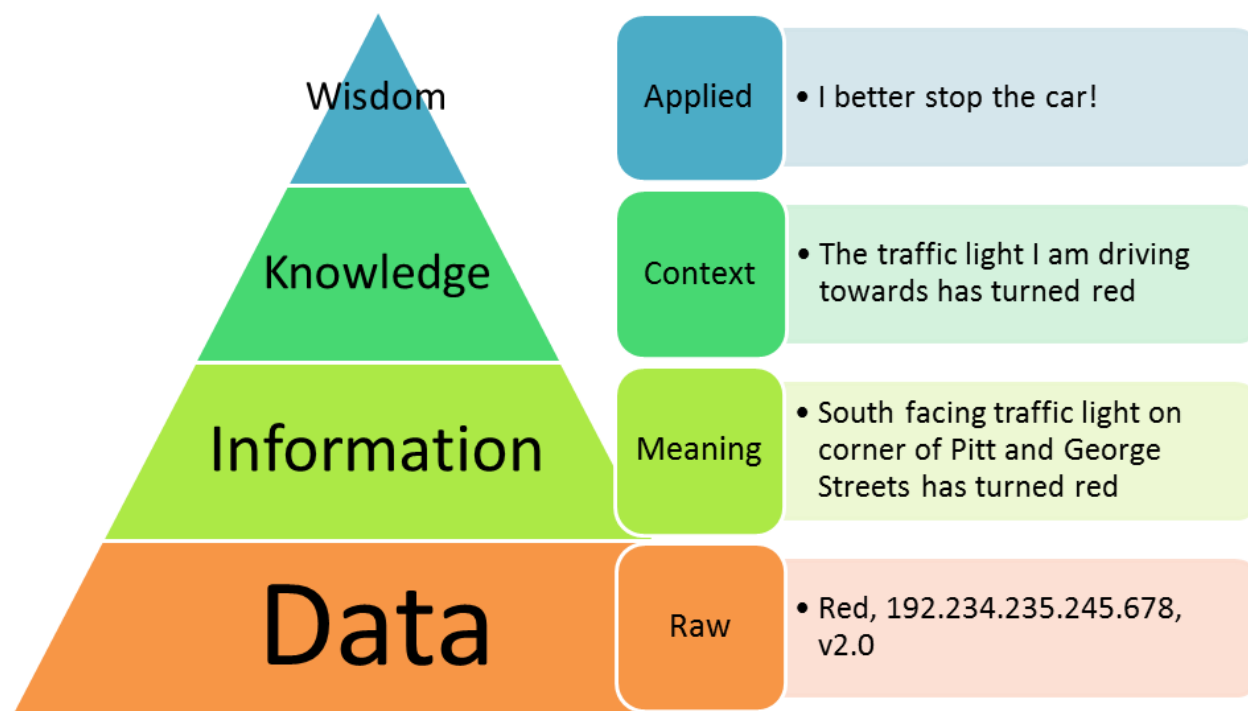
IVOA DM Group

supported by grant LD-15113 of Czech Ministry
of Education Youth and Sports

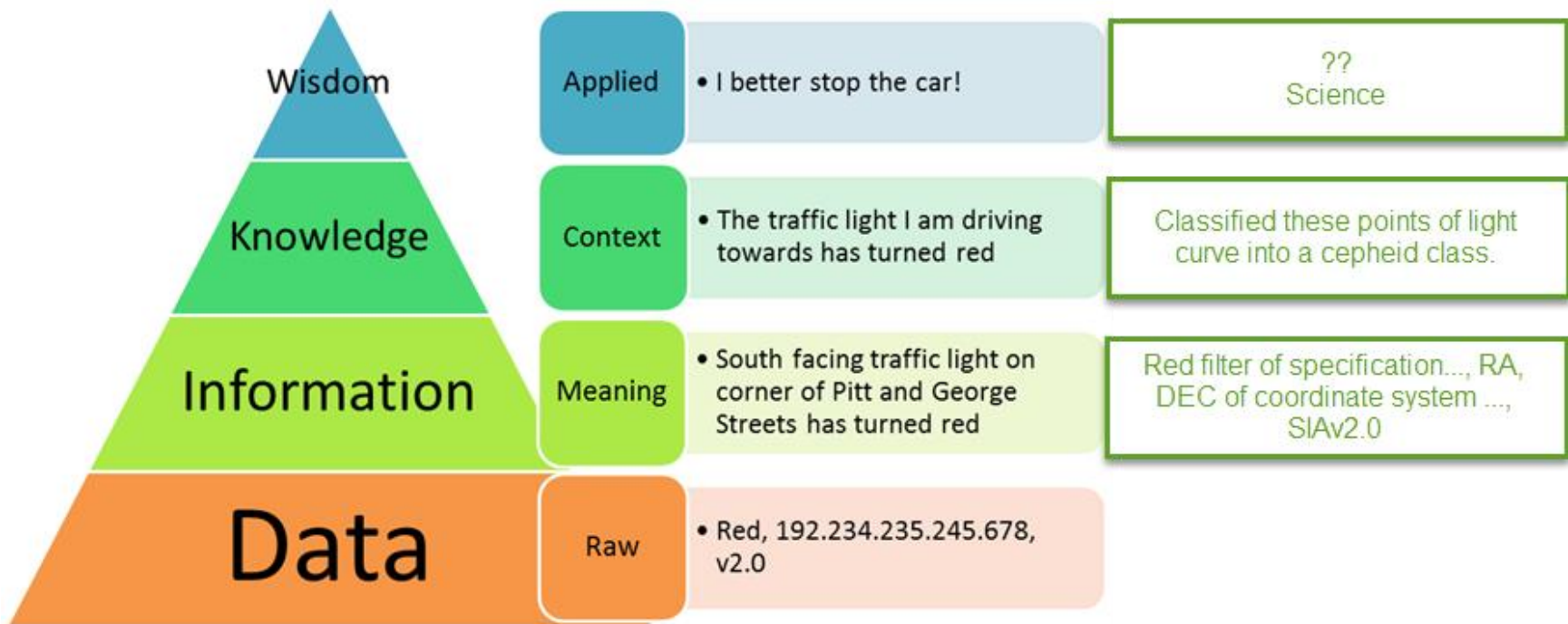
Outline

1. What is TS cube
2. Time Series Cube structure
3. Discovering TS Cube
4. Cutouting TS Cube
5. Open Questions

Separation of Data vs. Information



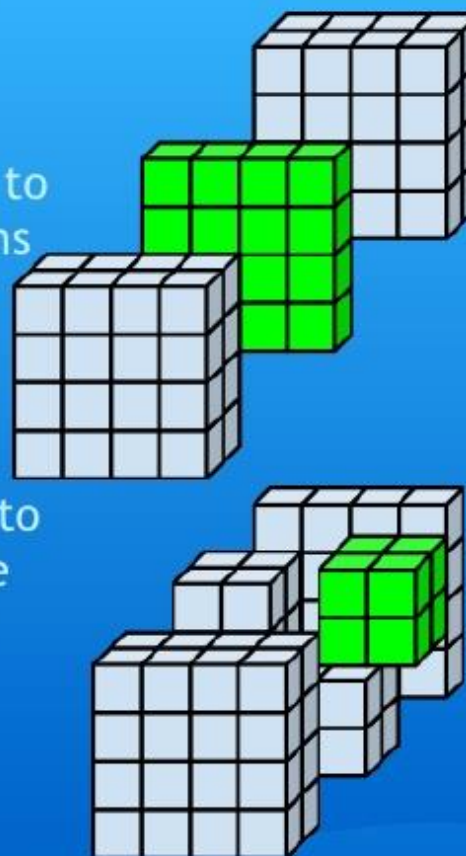
Separation of Data vs. Information



What is a data cube

OLAP Cubes - operations

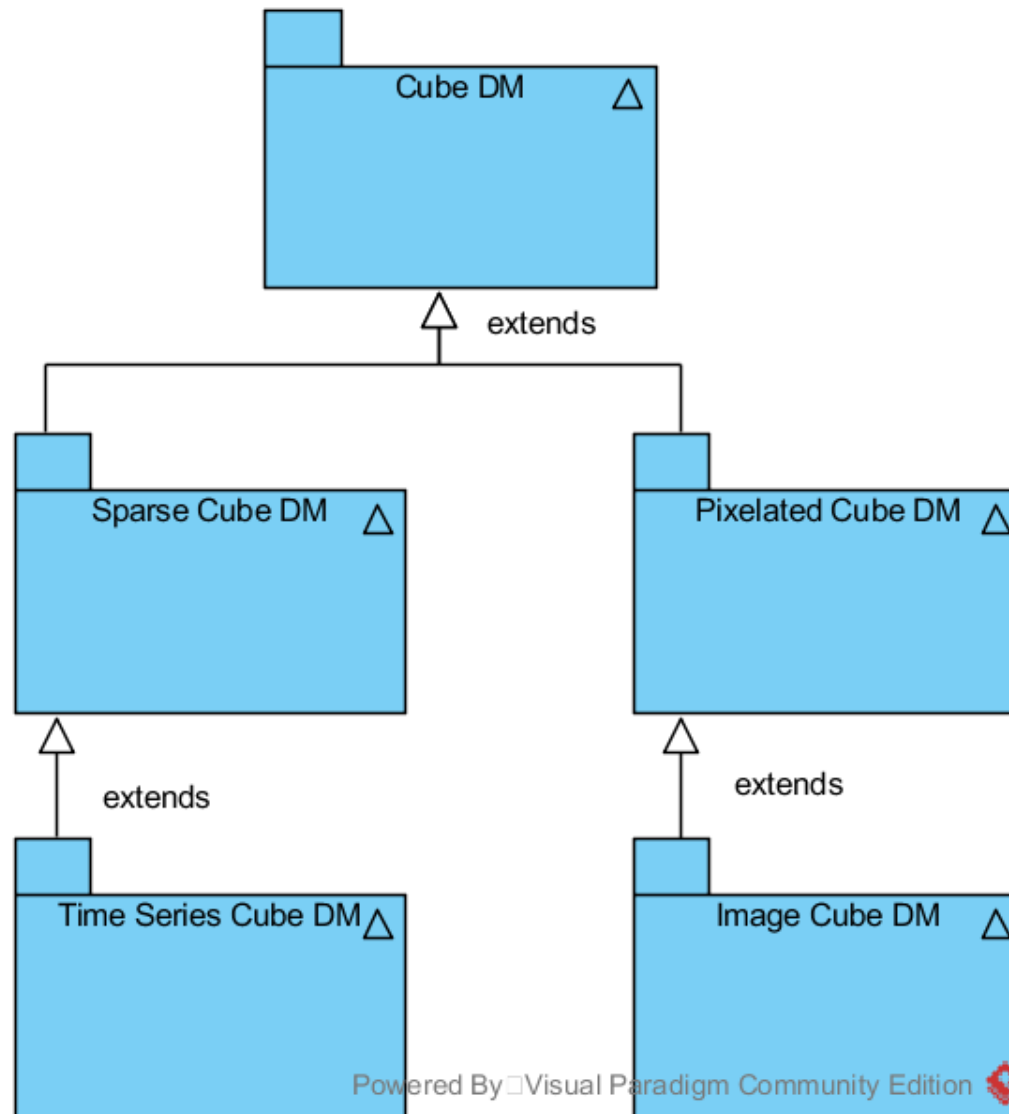
- **Slice** = choose values corresponding to ONE value on one or more dimensions
- **Dice** = choose values corresponding to one slice or a number of consecutive slices on more than 2 dimensions of the cube



Sparse Cube DM

- Can describe any time series axes.
- Is flexible
- Is extensible

Time Series Cube DM



Data + Information in Time Series Cube DM



Separation of Data vs. Information

- Describing meaning (**information layer**) for any possible data in the Cube DM will create a god object
- Cube DM can still describe information about its axes (**data layer**) without needing to know every physical domain model
- Changes to physical domain models (STC, Phot DM, Provenance) won't require Cube DM to change

Time Series Cube UML

- Through **Time Series Cube class** I can find the axes (data) of the cube
- In the **Quantity class**, I store statistical metadata about my data
- **Axis domain DMs (frame)** metadata of already existing models (STC, Phot DM) or potential new models. If these change, it doesn't matter to the Cube DM.

Advantages of Cube

- Adding new filters during the survey
- Adding new data sources (instruments) to the survey
- -> **No change to the VOTable**

Advantage of Time Series Cube

- Time Series Cube DM does not wait for STC v2.0, Phot DM, Gravitation wave DM, ...
- Domain-specific clients (Spectral, Photometry, etc.) can still use cube **without change**. Cube is just adding metadata about the data
- Discovery of “pure” cube metadata -> Time Series Cube can cutout itself without knowing about physical meaning of the data, just statistical distributions
- **Ability** to partially describe non-standardized frames (gravitational waves, hardness ratio, etc.) without the need to understand **everything** that can be stored within Cube DM

Science use Cases for Time Series

- [Use cases - \(2012-10-20, Enrique Solano\)](#)
- 3 groups of requirements
 - Group A: Combine photometry and light curves of a given object/list of objects in the **same photometric band**
 - Group B: Combine photometry and light curves of a given object/list of objects in **different photometric bands**
 - Group C: Time series **other** than light curves

ObsCore discovery

File Help

Simple search **ADQL search**

Back OK

```
SELECT TOP 100 dataproduct_type, target_name,
s_xel1, t_xel, em_xel, pol_xel, t_min, t_max, em_min,
em_max from ivoa.Observe WHERE
dataproduct_type='timeseries' and
1=CONTAINS(POINT('ICRS', s_ra, s_dec),
CIRCLE('ICRS',
12.846083333333333, -72.77333333333333, 8.3e-4
))
```

Clear Send Query

Tags

+ -

ObsCore Servers

short name ^	title
localhost tap	
vos2 tap	

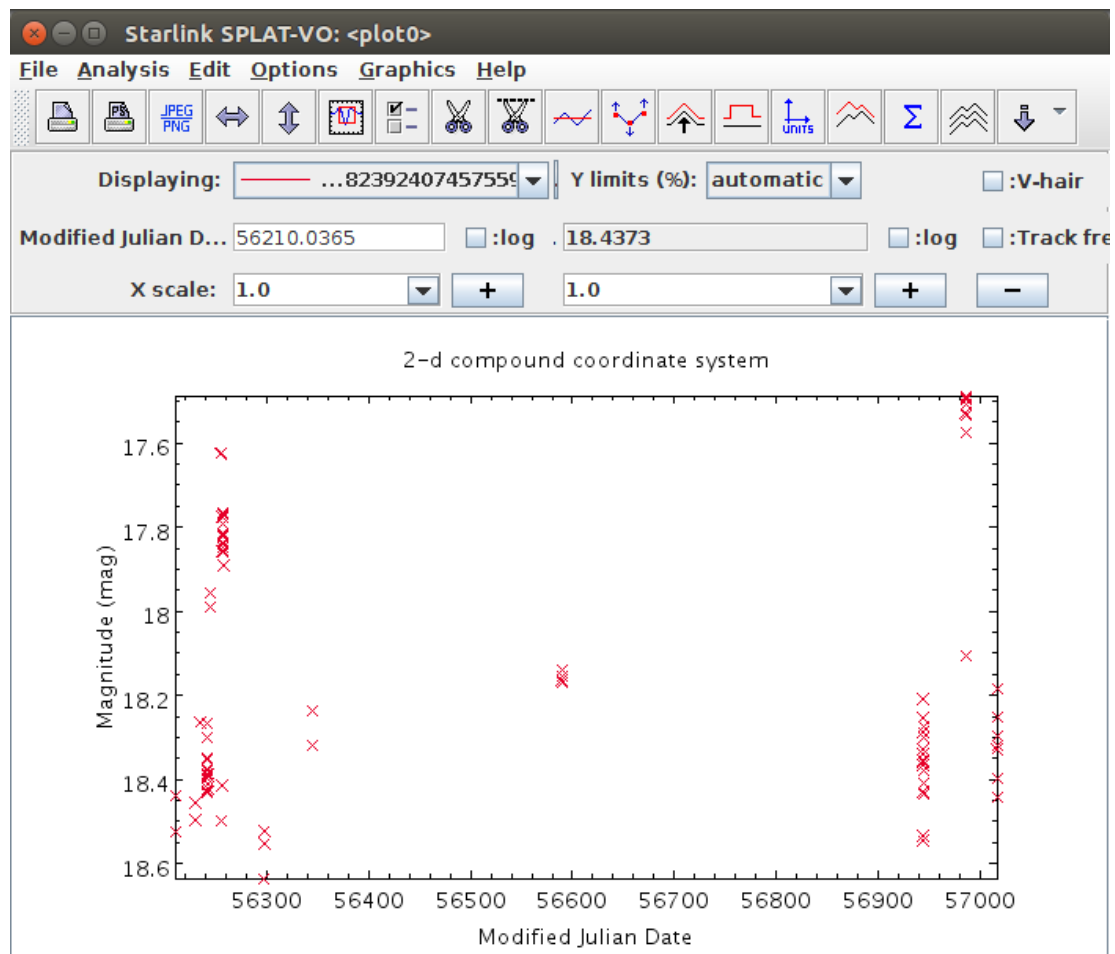
Query results

vos2 tap

In...	dataproduct_type	em_min	em_max	target_name	t_min	t_max	s_xel1	t_xel	em_xel	pol_xel
1	timeseries	5.800000E-7	8.500000E-7	ASU CAS 2344482392407457...	56209.99316	57016.23509	324	324	1	0
2	timeseries	7.020000E-7	1.102000E-6	ASU CAS 2344482392407457...	56210.05358	56298.04055	67	67	1	0
3	timeseries	3.600000E-7	5.600000E-7	ASU CAS 2344482392407457...	56210.03645	57016.18691	90	90	1	0
4	timeseries	4.850000E-7	6.700000E-7	ASU CAS 2344482392407457...	56210.04179	57016.23369	165	165	1	0
5	timeseries	5.800000E-7	8.500000E-7	ASU CAS 2344482392472620...	56641.08493	56641.15412	2	2	1	0
6	timeseries	3.600000E-7	5.600000E-7	ASU CAS 2344482392439918...	56589.11515	56589.11942	2	2	1	0
7	timeseries			ASU CAS 2344482392407457...						
8	timeseries			ASU CAS 2344482392407457...						
9	timeseries			ASU CAS 2344482392407457...						
10	timeseries			ASU CAS 2344482392407457...						
11	timeseries			ASU CAS 2344482392472620...						
12	timeseries			ASU CAS 2344482392439918...						

Display selected
Display all
Download selected
Download all
Deselect table
Deselect all

Light curve



Datalink

Parameters for Server-Generated data processing

DATE_MIN : 56500 [5.62E4..5.7E4] d
 DATE_MAX : 57000 [5.62E4..5.7E4] d
 FLX_SIGMA : 0 / 1 [0..5] m
 MAX_MAGERR : [0.0..5E-1] mag

Clear parameters Set parameters

Dec: -72:46:24
 MAXREC:

None
 None
 None

SSAP Servers

short name	title
localhost extra...	
voarchive ccd700	
voarchive heros	
voarchive lamo...	
vos2 ccd700	
vos2 extract jul...	
vos2 heros	
vos2 lamost	
vos2 lamost_dr1	
vos2 lamost_dr3	

Select all Deselect all
 Query regis... Add New Ser...

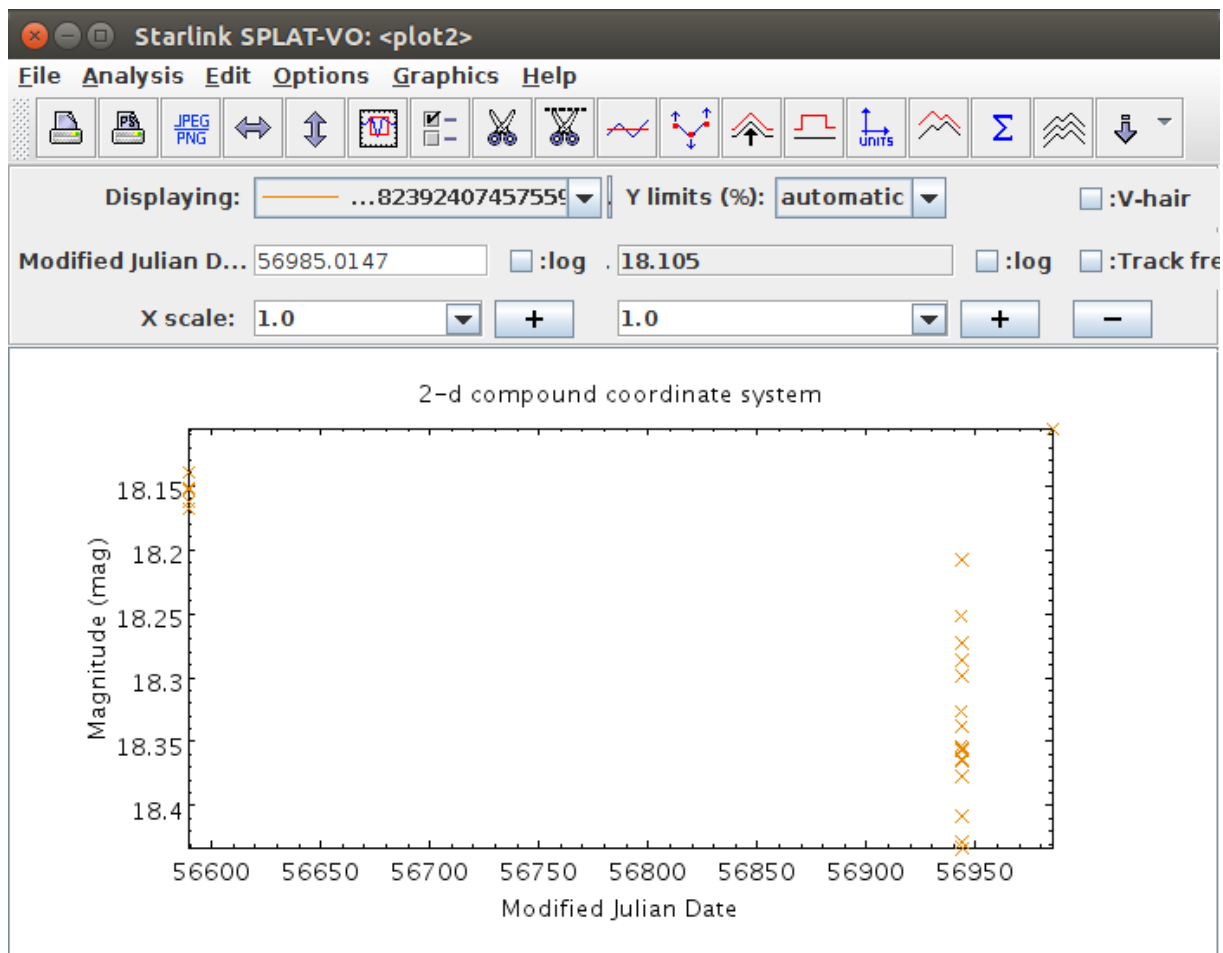
Query: `SERVER_MESSAGES=queryData&POS=12.846083333333333,-72.77333333333333&SIZE=8.333333333333334E-4` SEND QUERY

Query results:

vos2 extract jul16

l...	ssa_specstart	ssa_specend	ssa_dstitle	ssa_targname	max date	ssa_timeExt	ssa_snr	ssa_length	accref	mime
1			Light curve constructed for ob...	ASU CAS 2344482392407457...	57016.23509			324	http://vos2.asu.cas.cz/getpro...	application/x-vote
2			Light curve constructed for ob...	ASU CAS 2344482392407457...	56298.04055			67	http://vos2.asu.cas.cz/getpro...	application/x-vote
3			Light curve constructed for ob...	ASU CAS 2344482392407457...	57016.18691			90	http://vos2.asu.cas.cz/getpro...	application/x-vote
4			Light curve constructed for ob...	ASU CAS 2344482392407457...	57016.23369			165	http://vos2.asu.cas.cz/getpro...	application/x-vote
5			Light curve constructed for ob...	ASU CAS 2344482392472620...	56641.15412			2	http://vos2.asu.cas.cz/getpro...	application/x-vote
6			Light curve constructed for ob...	ASU CAS 2344482392439918...	56589.11942			2	http://vos2.asu.cas.cz/getpro...	application/x-vote

Cutouted data



Multiple bands of one light curve

File Options Resolver Interop Help

Service selection options
Data Source
 Observed data Theore

Wave Band
 Radio Millimeter
 Optical UV
 X-ray Gamma-ray

Tags

SSAP Servers

short name	title
localhost extra...	
voarchive ccd700	
voarchive heros	
voarchive lamo...	
vos2 ccd700	
vos2 extract_jul...	
vos2 heros	
vos2 lamost	
vos2 lamost_dr1	
vos2 lamost_dr3	

Select all Deselect all
Query regis... Add New Ser...

Search parameters:
Simple Query
Object: ogle smc-sc5 311656
 RA: 00:51:23.06 Dec: -72:46:24
 Radius: 0.05 MAXREC:
 Band:
 Time:
 Query Format: None
 Wavelength calibration: None
 Flux calibration: None

Optional Parameters

Use	Name	Value	UCD
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Select all Deselect all Update

Query: <SERVER>?REQUEST=queryData&POS=12.846083333333333,-72.77333333333333&SIZE=8.333333333333334E-4

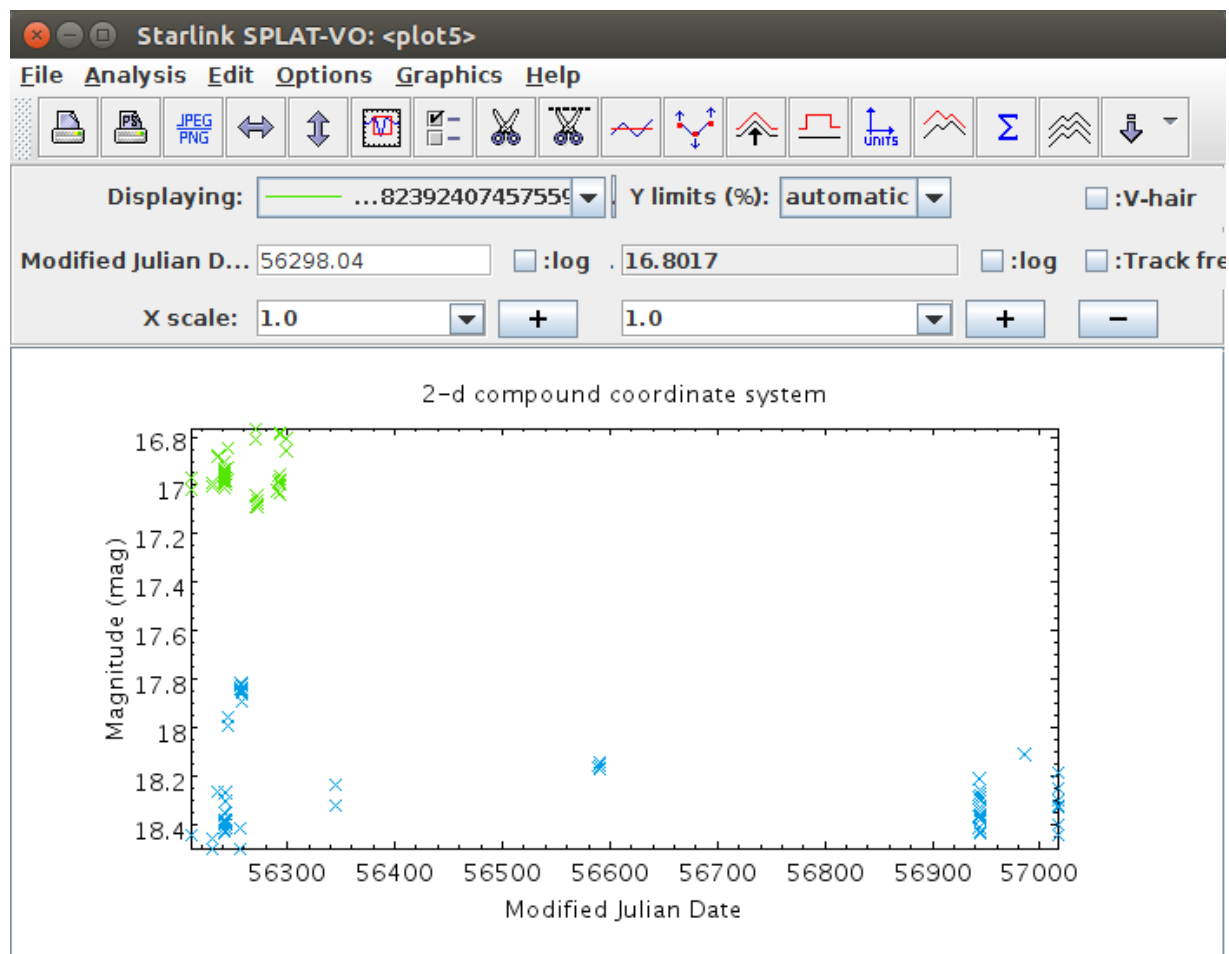
Query results:
vos2 extract_jul16

l...	ssa_specstart	ssa_specend	ssa_dstitle	ssa_targname	max date	ssa_timeExt	ssa_snr	ssa_length	accref	mime
1			Light curve constructed for ob...	ASU CAS 2344482392407457...	57016.23509			324	http://vos2.asu.cas.cz/getpro...	application/x-vote
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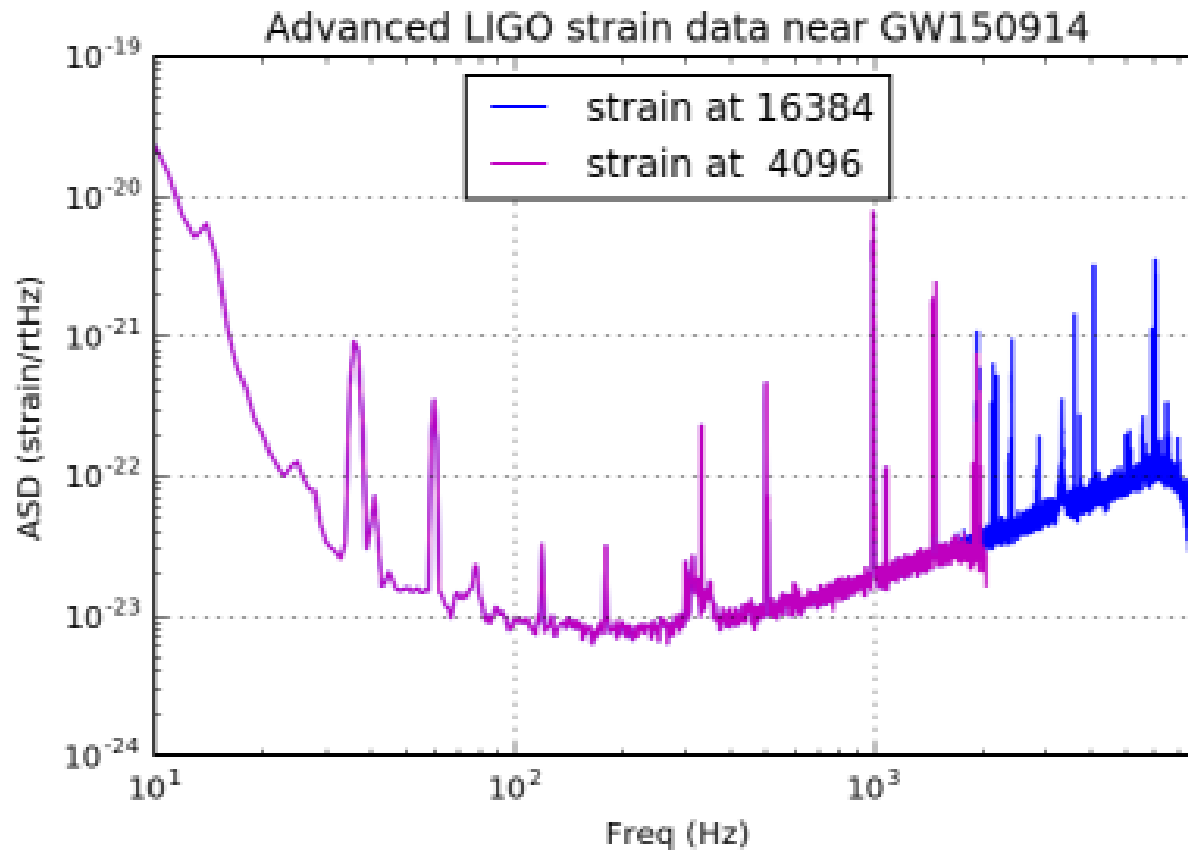
Display selected Display all Download selected Download all Deselect table Deselect all DataLink Services

Save query results Restore query results Close

Light curves (Group A, Group B)



Gravitational wave data (Group C)



Obscure discovery

File Help

Simple search ADQL search

Back OK

```
SELECT TOP 100 dataproduct_type, target_name,
access_url, s_xel1, t_xel, em_xel, pol_xel, t_min,
t_max, em_min, em_max from ivoa.Observe WHERE
dataproduct_type='timeseries' and
1=CONTAINS(POINT('ICRS', s_ra, s_dec),
CIRCLE('ICRS',
12.846083333333333, -72.77333333333333, 8.3e-4
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Clear Send Query

Tags

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short name ^	title
localhost tap	
vos2 tap	

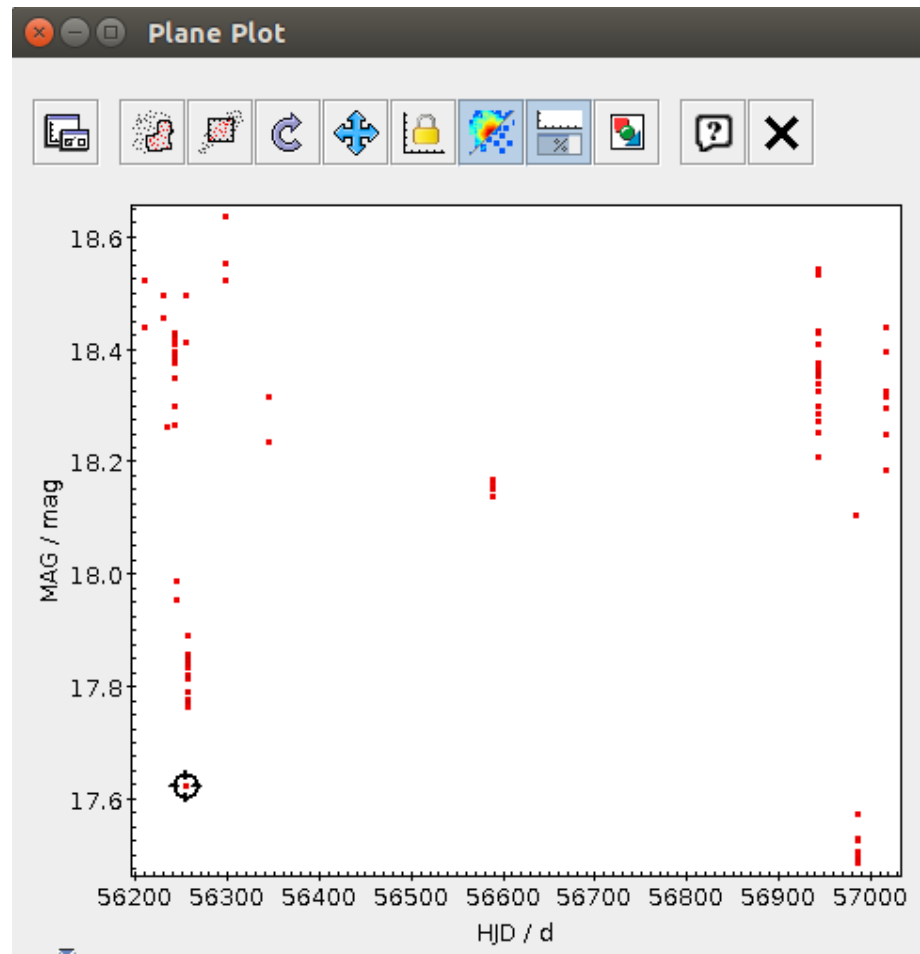
Query results

vos2 tap

dataproduct_type	em_min	em_max	target_name	t_min	t_max	access_url	s_xel1	t_xel	em_xel	pol_xel
timeseries	5.800000E-7	8.500000E-7	ASU CAS 2344482392407457...	56209.99316	57016.23509	http://vos2.asu.cas.cz/extract...	324	324	1	0
timeseries	7.020000E-7	1.102000E-6	ASU CAS 2344482392407457...	56210.05358	56298.04055	http://vos2.asu.cas.cz/extract...	67	67	1	0
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timeseries			ASU CAS 2344482392407457...			http://vos2.asu.cas.cz/getpro...				
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timeseries			ASU CAS 2344482392407457...			http://vos2.asu.cas.cz/getpro...				
timeseries			ASU CAS 2344482392472620...			http://vos2.asu.cas.cz/getpro...				
timeseries			ASU CAS 2344482392439918...			http://vos2.asu.cas.cz/getpro...				

Display selected Display all Download selected Download all Deselect table Deselect all

Topcat plotting + action function



Clicking point leads to cutout in Aladin

R.OSPS 2012-10-29T06:00:14 15506

15"

1.061' x 19.06"

Search

Other use cases

- Plot light curves from multiple data sources
- Looking for stars with more than N photometric points 5 sigma higher than the mean value.
- Fermi has detected a flaring blazar. It has a certain error ellipse, say a few arc-minutes. An optical counterpart is not known. How can one get **light curves for all objects in the error-ellipse** to look for variability and thus possible counterparts to the blazar?
- Retrieve all catalogues which have measurements for a given date (e.g., date of a Gaia observation)

Open Questions

- Add datalink to ObsCore
- What to put into Quantity DM
 - Underlying statistical distribution of values beneath each axis of the cube
 - Underlying statistical distribution of each point in the cube
- Two kinds of models
 - Real world model for data cubes
 - Application data model used for publishing the data (view on the real world model)
- What do I need to discover about the data cube
- Datalink for cutouts of cubes (time series) seems like the best option
- Use cases!

