

ObsCore extension for Radio Astronomy interferometry



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Discovering Interferometry data – visibility data

- Differ from science data due to complex correspondance
- raw data
 - ◀-> science data
- Method 1 : DataLink response attached to science data / progenitor (see Alma, Astron)
 - no actual description
 - indirect (2-step) discovery
- Method 2 : ObsTAP (or SIAP2) service. Metadata for description used for discovery.
 - ATCA, ASKAP, MWA, JIVE
 - → Not that obvious.



ObsCore description of visibility data : issues

- Frequency better adapted than wl for spectral axis description
 - f_min, f_max, char level 2
- Observations may contain
 - several fields
 - various spectral resolutions
 - complex structure of spectral axis
- ->Observation splitted into several datasets.
 - Several possible « point of view » according to data and scientific requirements will drive different splitting choices (see JIVE/CDS discussion inside ESCAPE)



ObsCore description of visibility data : issues

- From visibility data to science cubes : no unique solution. ->
 - Spatial, time, spectral characterization are ranges not fixed values
 - For example there is a fov dependancy to the frequency
 - Could be also affected by a sensitivity / resolution compromise
 - Attempt to give typical rough values
 - More accurate min / max (fov, resolution)
 - Access to sensitivity / response maps and plots
 - **Better « characterization » of spatial axis, characterisation of uv axis required.**



ObsCore extensions

ObsCore mandatory : minimal interoperable dataset description

Within a specific domain : more information is needed for discovery/description

Create an extension (additional attributes)

In TAP : add the table to ivoa schema, and provide joints (or not)

- Exemple : obscure optional (but this is generic)
- Exemple 2 : CAOM
- Exemple 3 : TimeSeries Extension (see Louys et al interop november 2020 and DAL talk « TimeSeries discovery and access »)
- Exemple 4 : Radio Interferometry.

The basic ObsCore is always there. TAP Queries for this part always work.

Work with Extension table will work only in the domain (explicit joins or via views)



ObsCore description of visibility data : estimation/additions

- Spatial axis :
 - s_{fov} typical value as λ/D
 - Ranges : s_{fov_min} , s_{fov_max}
 - $s_{resolution}$ estimated from longest baseline ?
 - $s_{resolution_min}$, $s_{resolution_max}$
 - Beside $s_{resolution}$, add $s_{max_angular_scale}$ (estimated from shortest baseline)
 - *Access to Primary beam and synthesized beam, dirty beam (sensitivity maps)*
 - *Non queryable but help for choosing datasets*



ObsCore description of visibility data : issues

- Attempt to characterize the Fourier space uvw ?
 - In practice only uv
 - Instrumental details / may give an idea of uv coverage
 - Typical numbers summarizing uv coverage ?
 - Ranges ?
 - *Maps and plots*



ObsCore description of visibility data : proposals with additions

- Uv plane characterization
 - `uv_distance_min`, `uv_distance_max` (*parametrisation of uv coverage representation : char level 2*)
 - `uv_distribution_exc`, `uv_distribution_fill` (*prametrisation of uv coverage representation : char level 3*)
 - proposal Astron, Mattia Mancini
 - Acces to uv coverage maps or plots (*char level 4*)
 - *Not queryable*
- Instrumental :
 - Telescope/antennae location(s) (`data_link?`)
 - Number of antennae (`instrument_ant_number`)
 - Distances between antennae (`instrument_max_dist`, `instrument_min_disc`)
- ***Are those additions a complement or an alternative to spatial additions ?***



Spatial characterization

Obscure Radio extension keyword	Definition TD	Utype	ucd	rec. units	Mandatory	default
extension keywords		datamodelpath			/optional	
<i>% spatial charcterisation (ICRS)</i>						
<u>s_ra</u>	Position (within a certain area)	Char.SpatialAxis.Coverage.RefVal.	pos.eq.ra	deg	man	ICRS
<u>s_dec</u>	Position (within a certain area.	Char.SpatialAxis.Coverage.RefVal	pos.eq.dec	deg	man	
<u>s_resolution</u>	Angular resolution interval (distance) longest baseline dependent	Char.SpatialAxis.Resolution.RefVal	pos.AngResol	arcsec	man	
<u>s_resolution_min</u>	Angular resolution interval / min / frequency dependant	Char.SpatialAxis.Resolution.Bounds.Limits.LoLim	pos.AngResol;stat.min	arcsec	opt	
<u>s_resolution_max</u>	Angular resolution interval /max /frequencu dependant	Char.SpatialAxis.Resolution.Bounds.Limits.HiLim	pos.AngResol;stat.max	arcsec	opt	
<u>s_xel</u>		Char.spatialAxis.Coverage.numbins???	meta.number	null	opt	1
<u>s_max_angular_scale</u>	max scale in dataset/shortest baseline dependent	Char.SpatialAxis.Coverage.Resolution.Scale.HiLim	phys.angSize;stat.max	deg	opt	
<u>s_fov</u>	field of view diameter / antenna diameter dependant	Char.SpatialAxis.Coverage.Bounds.Extent.diameter	phys.angSize;instr.fov	deg	man	
<u>s_fov_min</u>	field of view diameter / min value / frequency dependant	Char.SpatialAxis.Coverage.Bounds.Extent.LoLim	phys.angSize;instr.fov;stat.min	deg	opt	
<u>s_fov_max</u>	field of view diameter / min value / frequency dependant	Char.SpatialAxis.Coverage.Bounds.Extent.HiLim	phys.angSize;instr.fov;sta.max	deg	opt	




Spectral characterization +

<i>%target</i>						
target_name	Name of Target	Target.name	meta.id;src	null	opt	
<i>%Observable</i>						
<i>% Physical nature of observable</i>						
o_ucd	Physical nature attached to observable	Char.ObservableAxis.ucd	meta.ucd	null	man	stat.Fourier
	Fourier coeff in visibilty as amplitude , phase depending on u,v					
<i>%introduce visibility on Observable axis</i>						
<i>% spectral coverage</i>						
em_min	spectral interval (min)	Char.SpectralAxis.Coverage.Bounds.Limits.LoLim	em.interval;stat.min	m	man	m
em_max	spectral interval	Char.SpectralAxis.Coverage.Bounds.Limits.HiLim	em.interval;stat.max	m	man	m
<i>% Must be qualified by a ucd em.freq if spectral axis is in Frequency</i>						
em_ucd	Wavelength/ Frequency/ Energy in data	Char.SpectralAxis.ucd	meta.ucd	null	opt	
em_unit	Unit along the spectral axis in data	Char.SpectralAxis.unit	meta.unit	null	opt	
f_min	spectral coverage (min) in frequency	Char.SpectralAxis.Coverage.Bounds.Limits.LoLim	em.freq;stat.min	Mhz or f_min/max _unit ?	man	MHz
f_max	spectral coverage (max) in frequency	Char.SpectralAxis.Coverage.Bounds.Limits.HiLim	em.freq;stat.max	Mhz or f_min/max _unit ?	man	MHz
f_min/max_unit ?	unit for f_min and f_max ???	Char.SpectralAxis.unit	meta.unit	null	opt	




Time characterization +

<i>% Polarisation states</i>						
<i>pol_states</i>	Polarization state list	Char.Polarization.List	meta.class	null	opt	
<i>%time features</i>						
<i>t_min</i>	Time start of the sequence (min)	Char.TimeAxis.Coverage.Bounds.Limits.LoLim	time.start;obs.sequence	s	man	
<i>t_max</i>	Time end of the sequence	Char.TimeAxis.Coverage.Bounds.Limits.HiLim	time.end;obs.sequence	s	man	
% NB: the time span , or elapsed time for the sequence is then t_max-t_min						
<i>t_exptime</i>	Exposure time (sum of multiple exposures)	Char.TimeAxis.Coverage.Support.Extent	time.duration;obs.exposure	s	man	
<i>t_exp_min</i>	Exposure time of samples (min integration time)	Char.TimeAxis.Sampling.Extent.LoLim	time.duration;obs.exposure;stat.ma	s	man	
<i>t_exp_max</i>	Exposure time of samples (max)	Char.TimeAxis.Sampling.Extent.HiLim	time.duration;obs.exposure;stat.ma	s	man	
<i>t_resolution</i>	minimal interpretable time difference	Char.TimeAxis.Resolution.Refval	time.resolution	s	opt	
<i>%nb of sample along the time axis</i>						
<i>t_xel</i>	nb of time intervals in dataset	Char.TimeAxis.numBins	meta.number	null	man	
<i>%uv plane characterization</i>						



Uv plane characterization + instrumental

%uv plane characterization						
uv_distance_min	minimal distance in uv plane	Char.UVAxis.Coverage.Bounds.Limits.LoLim	stat.fourier;pos;stat.min	m	opt	
uv_distance_max	maximal distance in uv plane	Char.UVAxis.Coverage.Bounds.Limits.HiLim	stat.fourier;pos;stat.max	m	opt	
uv_distribution_exc	excentricity of uv distribution	Char.UVAxis.Coverage.Bounds.Excentricity	stat.fourier;pos	null	opt	
uv_distribution_fill	filling factor of uv distribution	Char.UVAxis.Coverage.Bounds.FillingFactor	stat.fourier;pos	null	opt	
%instrumental characterization						
instrument_ant_number	 number of antennae in array	Provenance.ObsConfig.Instrument.Array.AntNumber	instr.baseline;meta.number	null	opt	
instrument_min_dist	minimal distance between antennae in array	Provenance.ObsConfig.Instrument.Array.MinDist	instr.baseline;stat.min	m	opt	
instrument_max_dist	maximal distance between anetnnae in array	Provenance.ObsConfig.Instrument.Array.MaxDist	instr.baseline;stat.max	m	opt	

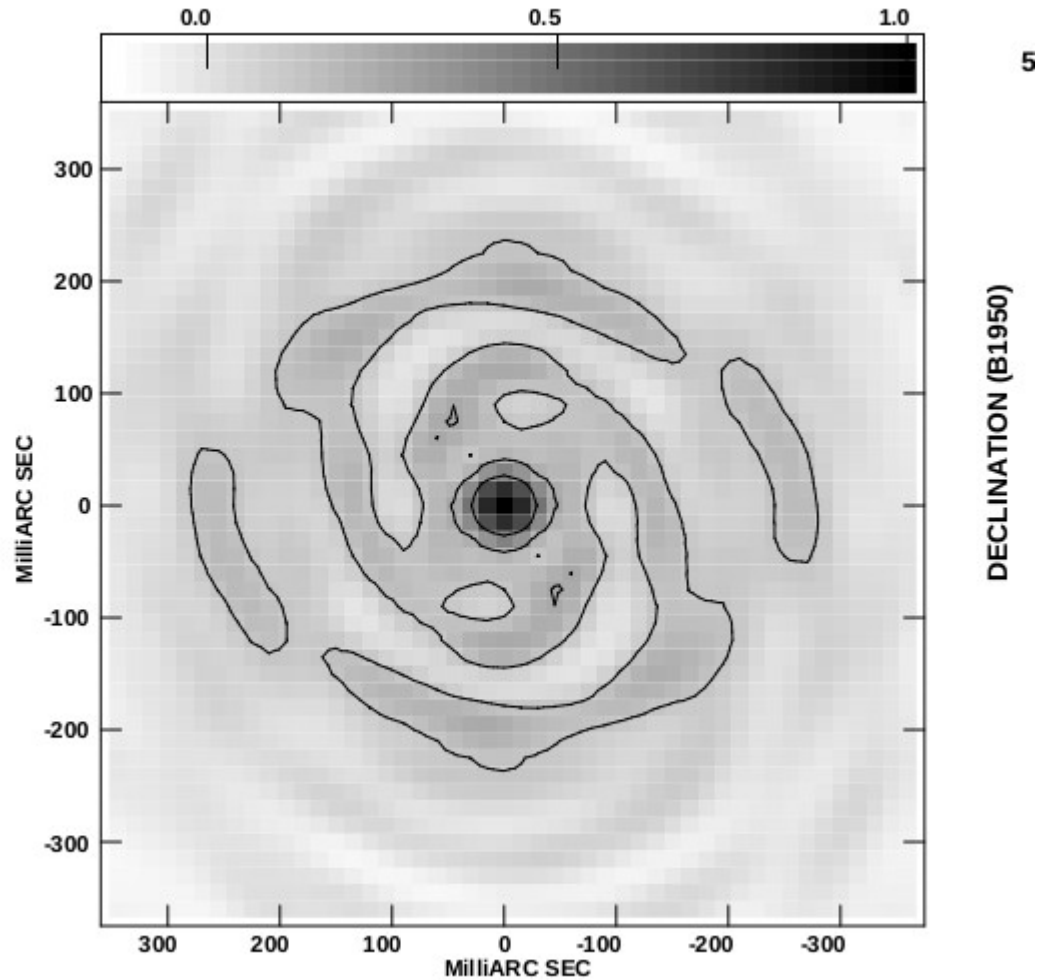


ObsCore description of visibility data : what to do next ?

- extension of ObsCore
 - Radio only ? Or Interferometry (also optical)?
 - See also proposal for an extension for Time Domain (M.Louys, DM, November 18th or DAL session this meeting May 26th)
 - Endorsed Note ? Actual specification ?
- Maps, plots via DataLink
 - Don't have attribute in ObsCore (but could have a characterization vodml-id)
 - Semantics in DataLink
 - This is another discussion



Dirty beam : « resolution » level 4



UV coverage plot

