Interface Control Document for Gaia observed spectral libraries

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Abstract

This document defines the content of observed spectral libraries to be validated by CU8 and used by various CUs within the DPAC.

Revision history

Issue	Rev. no.	Date	Author	Comments
1	0	2009-06-18	UH	Final revisions. Issued.
0	7	2009-06-06	UH	Revisions after comments from Coryn and Antonella.
0	6	2009-02-18	UH	More revisions.
0	5	2009-01-28	UH	Major revision. Add QSO table.
0	4	2008-10-23	UH	Minor revisions.
0	3	2008-09-24	FT	add galaxy and asteroid tables.
0	2	2008-05-23	FT	update the tables.
0	1	2008-05-17	UH	Minor revisions.
0	0	2008-05-13	FT	Created.

Acronyms

The following table has been generated from the on-line Gaia acronym list:

Acronym	**Description**
ASCII	American Standard Code for Information Interchange
AU	Astronomical Unit
BAL	Broad Absorption Line (galaxies)
CU	Coordination Unit (in DPAC)
DM	Data Model
DPAC	Data Processing and Analysis Consortium
DPC	Data Processing Centre
FITS	Flexible Image Transport System
GBOG	Ground-Based Observations for Gaia (DPAC)
ICD	Interface Control Document
ICRS	International Celestial Reference System
ISO	International Organisation for Standardisation (Geneva, Switzerland)
IVOA	International Virtual Observatory Alliance
MDB	Main DataBase
MJD	Modified Julian Date (to be avoided; see also JD)
PI	Principal Investigator
QSO	Quasi-Stellar Object
SDSS	Sloan Digital Sky Survey
SNR	Signal-to-Noise Ratio (also denoted SN and S/N)
SPLIB	SPectral LIBraries (synthetic spectral data)

SSO	Solar-System Object
UTC	Coordinated Universal Time
WD	White Dwarf (star)
WR	Wolf-Rayet star
XML	eXtensible Markup Language

Contents

1 Introduction and purpose

To make use of real ground-based spectra of astrophysical objects for the data processing, the CUs need a detailed description of the spectra and the targets. The fundamental parameters of the objects, information on the observations and how they are stored need to be provided. The main purpose of observed spectra and parameters gathered within CU8 is to calibrate the algorithms produced by several parametrizer packages and the synthetic spectra provided by the "Training Data" work package of CU8. The spectra and parameters could also be used in other parts of the DPAC to simulate the data provided by Gaia, as a complement to synthetic spectra.

The current document describes the content of libraries of observed spectra provided or used by work packages within CU8. It defines a number of parameters (e.g. stellar $T_{\rm eff}$, log g, resolution of the spectrograph, chemical element abundances, name of the instruments used to produce the spectra, etc.), which should be included for each object and each observation. The parameter tables try to encompass all possible aspects of the ground-based data obtained for CU8. Of course, not all observations will cover all of the parameters. Currently the parameters are not classified into mandatory and optional. This should be defined in a future version of this ICD, guided by experience with its application.

1.1 Scope

This ICD is applicable to all libraries of observed spectra produced under the coordination of and validated by CU8. Its main purpose is to allow storage of ground-based data obtained for the purpose of Gaia data processing in the Gaia main database.

This document can be seen as a complement to the ICD for computed stellar libraries, FT-002.

Other CUs obtaining ground-based observations are CU3, CU4, CU5, CU6 and CU7. CU5 has defined its own format and content of ground-based spectra. This is described in the ICD for the CU5 Data Model, DWE-009 (Section 10, "SPSS Reference Values"). The remaining CUs will also define their respective data models[1]. Common questions related to ICDs/data models/MDB storage will be discussed within the GBOG working group.

1.2 ICD change

The library content is defined and maintained using the MDB Dictionary Tool[2], see MTL-003. The tables in this ICD are generated automatically with this tool. Changes to this ICD are con-

[1] see `http://www.rssd.esa.int/wikiSI/index.php?title=ICD_summary_table`
[2] `http://gaia.esac.esa.int/maindb/mdbtools/`

trolled by the CU8 configuration control board [3]. Change requests must be made via Mantis[4].

2 Interface specification for observed spectral libraries

The names of the ICD detailed parameter tables for libraries presented in Section 3 are as follows.

StarObserved for observed spectra of all types of stars.

GalObserved for observed spectra of galaxies. All are point source galaxies.

QSOObserved for observed spectra of quasars (QSOs).

AsteroidObserved for observed asteroid spectra.

All tables extend MDB/CU1/BasicSource, which contains the parameter sourceId (Unique source identifier) of type long (BAS-020; FM-036). The purpose of this parameter is to enable cross-matching with Gaia observations, with the Initial Gaia Source List (RLS-001) and the initial list of SSOs, and between different ground-based observations for the same source.

Note that this ICD does not define the format of the file(s) used for storing the data (ASCII, GBin, FITS, etc.), only the content and type of parameters. The MDB Dictionary tool provides facilities to generate data model (DM) java classes corresponding to the CU8 ICD. The ICD classes for observed spectra will be part of the jar file containing the DPC datamodel, which is released by CU1, and can be used for converting observed spectra files between different formats. Several Gaia wiki pages contain information on the DAL/DM formats[5], and examples for format converters (e.g. GBin to ASCII and reverse)[6].

More information about all spectral libraries (observed and computed), e.g. links to conversion codes between formats, and where and how to submit and obtain data files, will be given on the wiki page

`http://www.rssd.esa.int/wikiSI/index.php?title=CU8:_Spectral_libraries:_general.`

The list of parameters describing targets and observations is based on the ICD for computed spectra (FT-002), as well as on the IVOA Recommendation for the Simple Spectral Access Protocol,

[3] `http://www.rssd.esa.int/wikiSI/index.php?title=CU8:_Configuration_Control_Board`

[4] `http://www.rssd.esa.int/mantisSI/index.php?instance=GAIA`

[5] `http://www.rssd.esa.int/wikiSI/index.php?title=CU8:_ICD`, `http://www.rssd.esa.int/wikiSI/index.php?title=CU1:DalToolsExample`

[6] `http://www.rssd.esa.int/wikiSI/index.php?title=CU8_Converters&instance=Gaia`

Version 1.04 (Tody et al. 2008[7]). Also, the relevant part of the CU5 data model (DWE-009) has been consulted, and the Gaia conventions described in the MDB ICD (JH-001) have been taken into account.

We adopt the following convention for *unknown values*, which is taken from JH-001, p. 35. When the value for a parameter is not provided (because it is not relevant in the given context, is not available, or cannot be computed), the providers should set its value to NaN when the parameter has a floating point representation. When the parameter is an integer number, if there is a value that can be used to flag the absence of a proper value (i.e. -1 for always positive values, 0 for counters, ...) it is used and documented in the detailed description, otherwise an extra boolean parameter is added to the table to indicate if the value of the parameter is known or not (this last case does currently not appear in the tables described in this ICD).

The following conventions are adopted for parameters of type "string". We do not define any string delimiters. Strings may be of arbitrary length but of maximum length 4000 characters (this is the value used by the MDB dictionary tool function "generate MySQL schema"). There is currently no general Gaia convention for unknown or undefined string values, and we do not define any default value here. Unknown string fields can be left empty, bu this could change in a future version of this ICD. If the data are stored in "plain" ASCII format (i.e. not binary, FITS, XML etc.), fields must be separated by a separator character (e.g. | or whitespace). In that case, the string values cannot contain that character (e.g. whitespace). We do not define the specific format for ASCII files here, but recommend to adopt the format defined for Gaia ASCII tables in the GaiaTools package[8]. See the Appendix for references on conventions for string values used in other data models (VOTable, FITS, MySQL).

Four parameters related to the observing programme and data processing are defined for each table (observer, pi, dateObs, dateProc). The purpose of these parameters is to allow users of the data to obtain additional information on observing conditions and details of data processing. These parameters also allow to settle questions on ownership of the data. If possible, contact details should be provided along with the names of observer and PI.

Several arrays are defined – for wavelength points, corresponding fluxes and flux errors, and the polarization spectrum. In general, wavelength increases monotonically from the first to the last point, except when boolean parameter "echelle" is true. In that case, several echelle orders are provided next to each other in the same array. If the orders are overlapping, a negative step in wavelength will occur in between orders. Spectra are provided as monochromatic flux F_λ in $Wm^{-2}nm^{-1}$ if absolute ($1\ Wm^{-2}nm^{-1} = 100$ erg $s^{-1}cm^{-2}Å^{-1}$), as relative flux, in arbitrary units, or normalized (the parameter fluxCalibType specifies which case applies).

[7] http://www.ivoa.net/Documents/REC/DAL/SSA-20080201.html
[8] http://gaia.esac.esa.int/GaiaTools/api/latest/gaia/cu1/tools/dal/file/AsciiGaiaTable.html

3 Parameter table descriptions

3.1 Parameter types

Type	Number of bytes
byte	1
boolean	1
char	2
short	2
int	4
long	8
float	4
double	8
string	(0 – 4000)
DPC/CU8/SPLIB/FluxCalibType	-
MDB/CU8/SourceType	-
MDB/CU8/StarType	-
MDB/CU8/GalaxyType	-
MDB/CU8/QuasarType	-

DPC/CU8/SPLIB/FluxCalibType is an enumeration containing the valid values for the parameter fluxCalibType. The last four parameter types are enumerations defined in the MDB/CU8 area of the data model (see `http://www.rssd.esa.int/wikiSI/index.php?title=CU8:_ICD#CU8_ICD_.26_DM`). The contents of these parameter types are given in the following five subsections (descriptions generated from the MDB dictionary tool).

The remaining subsections contain the descriptions of the parameter tables presented above (generated from the MDB dictionary tool).

3.2 Overview of the DPC/CU8/SPLIB/FluxCalibType

The following table describes the parameters associated with a FluxCalibType, this file is generated by CU8.

Contributor:Ulrike Heiter

Name	Description	Type	Units
absolute	absolute flux calibration		
relative	relative flux calibration		
arbitrary	no flux calibration - arbitrary units		
normalized	normalized flux - normalization described in parameter fluxCalibDescription		

Parameters Detailed description

• absolute flux calibration (**absolute**): Absolute flux calibration has been done. Flux units are $Wm-2nm-1$. Give details or references in the parameter fluxCalibDescription.

• relative flux calibration (**relative**): Relative flux calibration has been done, i.e. the slope of the continuum has been derived.Describe details and units in the parameter fluxCalibDescription.

• no flux calibration - arbitrary units (**arbitrary**): Fluxes are in arbitrary units. Describe details in the parameter fluxCalibDescription.

• normalized flux - normalization described in parameter fluxCalibDescription (**normalized**): Flux has been normalized. Describe the meaning of "normalized" in the parameter fluxCalibDescription.

3.3 Overview of the MDB/CU8/SourceType

The following table describes the parameters associated with a SourceType, this file is generated by CU8.

Contributor:Anne-Marie Janotto

Name	Description	Type	Units
STAR	Object is a single star but no white dwarf		
WD	Object is a white dwarf		
PHYSBINARY	Object is a physical Binary		
NONPHYSBINARY	Object is a non - physical binary		
QUASAR	Object is a quasar		
GALAXY	Object is a galaxy		
SSO	Object is a Solar System Object		
UNKNOWN	Object is an unknown		
UNDEFINED	Object is undefined		

Parameters Detailed description

• Object is a single star but no white dwarf (**STAR**): Object is a single star but no white dwarf

- Object is a white dwarf (**WD**): Object is a white dwarf
- Object is a physical Binary (**PHYSBINARY**): Object is a physical Binary
- Object is a non - physical binary (**NONPHYSBINARY**): Object is a non-physical binary
- Object is a quasar (**QUASAR**): Object is a quasar
- Object is a galaxy (**GALAXY**): Object is a galaxy
- Object is a Solar System Object (**SSO**): Object is a Solar System Object
- Object is an unknown (**UNKNOWN**): Object is an unknown
- Object is undefined (**UNDEFINED**): Object is undefined

3.4 Overview of the MDB/CU8/StarType

The following table describes the parameters associated with a StarType, this file is generated by CU8.

Contributor:Anne-Marie Janotto

Name	Description	Type	Units
star	star does not show any sign of peculiarity		
els	Emission Line Stars		
beStar	Main sequence B type emission line star		
beBracketStar	B type star with forbidden emission lines		
cS	Cool star		
activeStar	Cool active star		
aAS	Anomalous Abundance Stars		
hgMn	Mercury - Manganese Star		
ap	Chemically peculiar star		
am	Metal - enhanced A - type star		
whiteDwarf	White dwarf		
unknown	unknown type		

Parameters Detailed description

- star does not show any sign of peculiarity (**star**): star does not show any sign of peculiarity

- Emission Line Stars (**els**): Emission Line Stars
- Main sequence B type emission line star (**beStar**): Main sequence B type emission line star
- B type star with forbidden emission lines (**beBracketStar**): B type star with forbidden emission lines
- Cool star (**cS**): Cool star
- Cool active star (**activeStar**): Cool active star
- Anomalous Abundance Stars (**aAS**): Anomalous Abundance Stars
- Mercury - Manganese Star (**hgMn**): Mercury-Manganese Star
- Chemically peculiar star (**ap**): Chemically peculiar star
- Metal - enhanced A - type star (**am**): Metal-enhanced A-type star
- White dwarf (**whiteDwarf**): White dwarf
- unknown type (**unknown**): unknown type

3.5 Overview of the MDB/CU8/GalaxyType

The following table describes the parameters associated with a GalaxyType, this file is generated by CU8.

Contributor:Anne-Marie Janotto

Name	Description	Type	Units
galE	Early type galaxy		
galS	Spiral type galaxy		
galI	Irregular type galaxy		
galB	Starburst type galaxy		

Parameters Detailed description

- Early type galaxy (**galE**): Object is an early type galaxy
- Spiral type galaxy (**galS**): Object is a spiral galaxy
- Irregular type galaxy (**galI**): Object is an irregular galaxy
- Starburst type galaxy (**galB**): Object is a starburst galaxy

3.6 Overview of the DPC/CU8/SPLIB/StarObserved

The following table describes the parameters associated with a StarObserved, this file is generated by CU8.

Contributors:Frederic Thevenin, Ulrike Heiter, Jose Hernandez, Paraskevi Tsalmantza

Extends MDB/CU1/BasicSource, which contains the parameter sourceId (Unique source identifier) of type long.

Name	Description	Type	Units
name	target identification	string	
sourceType	the source main classification type (STAR)	MDB/CU8/SourceType	
refEpoch	Reference epoch	float	Julian Years
alpha	Right Ascension	double	deg
alphaError	Standard error of alpha	double	mas
delta	Declination	double	deg
deltaError	Standard error of delta	double	mas
varpi	Parallax	double	mas
varpiError	Standard error of varPi	double	mas
muAlphaStar	Proper motion component in alpha direction	double	mas/year
muDelta	Proper motion component in delta direction	double	mas/year
muDeltaError	Standard error of muDelta	double	mas/year
linkCu68	link to CU6 - CU8 database	string	
linkExtern	link to external catalogue	string	
observer	observer	string	
pi	PI	string	
dateObs	date of the observation	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
dateProc	date of the processing of the spectrum	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
instrument	name of the instrument used	string	
snr	signal to noise ratio	float	see description
resolution	resolving power (N/A value= -1)	int	see description

Name	Description	Type	Units
refLambda	reference wavelength	float	nm
ntot	number of points (N/A value = 0)	long	
vradHelio	heliocentric radial velocity	float	km/s
vradMeth	method for deriving vradHelio	string	
dopCorDone	Doppler correction done?	boolean	
fluxCalibType	type of flux calibration	FluxCalibType	
fluxCalibDescription	description of flux calibration	string	
npar	number of parameter determinations	int	
teff	effective temperature	float [npar]	K
teffError	Standard error of effective temperature	float [npar]	K
teffMeth	method for deriving Teff	string [npar]	
logg	log surface gravity	float [npar]	log cgs
loggError	Standard error of log surface gravity	float [npar]	log cgs
loggMeth	method for deriving logg	string [npar]	
vturb	microturbulence	float	km/s
vmacro	macroturbulence	float	km/s
vrot	rotational velocity	float	km/s
y	helium content (mass fraction)	float	see description
zMetal	metallicity (mass fraction)	float	see description
mass	stellar mass	float	Solar Mass
radius	stellar radius	float	Solar Radius

Name	Description	Type	Units
luminosity	stellar luminosity	float	Solar Luminosity
vMag	observed V magnitude	float	mag
gMag	computed G magnitude	float	mag
grvs	computed GRVS magnitude	float	mag
ebv	reddening	float	mag
starType	type of extreme star	MDB/CU8/StarType	
extraParam	extra parameter	float	see description
extraParamDescription	description of extraParam	string	
abundMeth	method for deriving abundances	string	
alphaFe	ratio alpha elements / Fe	float	dex
nele	number of elements with abundances	int	
zElement	atomic numbers of element with abundances	int [nele]	
abundance	element abundances	float [nele]	dex
abundanceError	standard errors of element abundances	float [nele]	dex
echelle	Does the spectrum contain several echelle orders?	boolean	
lambdaObserved	Observed wavelengths	double [ntot]	nm
fluxObserved	Observed flux	double [ntot]	see description
fluxObservedError	Error of observed flux	double [ntot]	see description
circPolObs	Observed circular polarization	double [ntot]	see description

Parameters Detailed description

- target identification (**name**): The target identification is done by the name of the catalogue and the corresponding number according to SIMBAD nomenclatures if possible. Ex: HD 61421.

- the source main classification type (STAR) (**sourceType**): the source main classification type (STAR or WD)

- Reference epoch (**refEpoch**): The reference epoch to which the astrometric source parameters are referred to.

- Right Ascension (**alpha**): Right Ascension α of object in ICRS at reference epoch `refEpoch`

- Standard error of alpha (**alphaError**): Standard error in $\alpha * \cos(\delta)$ of object in ICRS at reference epoch `refEpoch`

- Declination (**delta**): Declination δ of object in ICRS at reference epoch `refEpoch`

- Standard error of delta (**deltaError**): Standard error in δ of object in ICRS at reference epoch `refEpoch`

- Parallax (**varpi**): Absolute stellar parallax ϖ at reference epoch `refEpoch`

- Standard error of varPi (**varpiError**): Standard error of absolute stellar parallax at reference epoch `refEpoch`

- Proper motion component in alpha direction (**muAlphaStar**): Projection of proper motion vector in direction of increasing Right Ascension times $\cos(\delta)$ at reference epoch `refEpoch`: $\mu_{\alpha*}$

- Proper motion component in delta direction (**muDelta**): Projection of proper motion vector in direction of increasing Declination at reference epoch `refEpoch`: μ_δ

- Standard error of muDelta (**muDeltaError**): Standard error of projection of proper motion vector in direction of increasing Declination at reference epoch `refEpoch`

- link to CU6 - CU8 database (**linkCu68**): Link to entry in CU6 - CU8 database.

- link to external catalogue (**linkExtern**): Link to an external catalogue.

- observer (**observer**): Name of the observer.

- PI (**pi**): Principal Investigator (name) of observing programme within which the object was observed.

- date of the observation (**dateObs**): UTC date of observation. Hours etc. can be omitted.

- date of the processing of the spectrum (**dateProc**): UTC date of processing of the data. Hours etc. can be omitted.

- name of the instrument used (**instrument**): Name of the instrument used for the observation. Telescope and spectrograph.

- signal to noise ratio (**snr**): Signal to noise ratio of the spectrum per resolution element at the refLambda given.

- resolving power (N/A value= - 1) (**resolution**): This is used for the resolving power of the spectrograph used for the observed spectrum: $\lambda/\Delta\lambda$, at the specified reference wavelength refLambda. When unknown, it is set to -1.

- reference wavelength (**refLambda**): This is used as reference wavelength for the resolving power and the SNR of the observed spectrum.

- number of points (N/A value = 0) (**ntot**): Total number of points per spectrum. When no spectrum is provided, this parameter is set to 0.

- heliocentric radial velocity (**vradHelio**): Heliocentric radial velocity of the object.

- method for deriving vradHelio (**vradMeth**): Method used for deriving the heliocentric radial velocity.

- Doppler correction done? (**dopCorDone**): Has a Doppler correction been applied to the spectrum, i.e. is the radial velocity removed?

- type of flux calibration (**fluxCalibType**): Type of the flux calibration. Valid types are absolute, relative, arbitrary or normalized. If absolute, the unit is in $Wm^{-2}nm^{-1}$. If normalized, the meaning is described in parameter fluxCalibDescription. Additional comments or references for the flux calibration should be given in parameter fluxCalibDescription for all types.

- description of flux calibration (**fluxCalibDescription**): Description of the meaning of "normalized", or additional comments or references for the flux calibration.

- number of parameter determinations (**npar**): Number of different determinations of Teff and logg. Set to 0 if no parameter determination is available.

- effective temperature (**teff**): The effective temperature of the star (npar values).

- Standard error of effective temperature (**teffError**): Standard error of effective temperature (npar values).

- method for deriving Teff (**teffMeth**): Method for deriving the effective temperature and/or reference to relevant article (npar values).

- log surface gravity (**logg**): Logarithm of the stellar surface gravity g in cgs (npar values).

- Standard error of log surface gravity (**loggError**): Standard error of logarithm of stellar surface gravity g in cgs (npar values).

- method for deriving logg (**loggMeth**): Method for deriving the surface gravity and/or reference to relevant article (npar values).

- microturbulence (**vturb**): Microturbulence parameter derived (for 1D analysis).

- macroturbulence (**vmacro**): Macroturbulence parameter derived (for 1D analysis).

- rotational velocity (**vrot**): Projected rotational velocity v sin i.

- helium content (mass fraction) (**y**): Helium content Y of the star in the units X+Y+Z=1.

- metallicity (mass fraction) (**zMetal**): Metallicity Z of the star in the units X+Y+Z=1.

- stellar mass (**mass**): Stellar mass in solar units if known.

- stellar radius (**radius**): Stellar radius in solar units if known.

- stellar luminosity (**luminosity**): Stellar luminosity in solar units if known.

- observed V magnitude (**vMag**): Apparent V magnitude.

- computed G magnitude (**gMag**): G magnitude computed from observed spectrum or derived from photometry.

- computed GRVS magnitude (**grvs**): GRVS magnitude computed from observed spectrum or derived from photometry.

- reddening (**ebv**): Measured reddening E(B-V).

- type of extreme star (**starType**): This indicates the type of extreme or peculiar star: WR, Be, Ap, HgMn etc. The Enumeration defined in DPC/CU8/DPC/StarType should be consulted for available types and adapted if necessary.

- extra parameter (**extraParam**): extraParam is a number that has a priori no physical meaning. Could be used e.g. for activity parameter for active stars. Parameter and unit should be specified in extraParamDescription.

- description of extraParam (**extraParamDescription**): Description of extraParam, including units.

- method for deriving abundances (**abundMeth**): Method for deriving the chemical abundances.

- ratio alpha elements / Fe (**alphaFe**): Mean abundance of alpha elements (Ne, Mg, Si, S, Ar, Ca, Ti) compared to Fe abundance, relative to solar values: $< \log(N_\alpha/N_{\rm Fe}) - \log(N_\alpha/N_{\rm Fe})_\odot >$. The elements included for computing this parameter and a reference for the solar values are given in the abundMeth field.

- number of elements with abundances (**nele**): Number of elements with abundances in array "abundance". Set to 0 if no abundances are available.

- atomic numbers of element with abundances (**zElement**): Atomic numbers of elements in array "abundances". Array of nele values.

- element abundances (**abundance**): Abundances of elements whose atomic numbers are given in array "zElement". Array of nele values. Number abundances $N_{\rm X}$ of element X are given on a logarithmic scale relative to hydrogen with an offset of 12: $\log(N_{\rm X}/N_{\rm H}) + 12$.

- standard errors of element abundances (**abundanceError**): Standard errors of element abundances in array "abundances". Array of nele values.

- Does the spectrum contain several echelle orders? (**echelle**): If true, then the wavelength and flux arrays contain several echelle orders. If false, there is only one spectrum with wavelengths monotonically increasing.

• Observed wavelengths (**lambdaObserved**): Observed wavelength points of the spectrum (ntot values). In general, wavelength increases monotonically from the first to the last point, except when parameter ”echelle” is true. In that case, different echelle orders are provided next to each other in the same array. If the orders are overlapping, a negative step in wavelength will occur in between orders.

• Observed flux (**fluxObserved**): Observed flux points of the spectrum (ntot values). For type of calibration see fluxCalib parameter. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Error of observed flux (**fluxObservedError**): Errors of observed flux points of the spectrum (ntot values). Same units as fluxObserved. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Observed circular polarization (**circPolObs**): Observed circular polarization (Stokes V), normalised to continuum flux I_c. Array of ntot values.

3.7 Overview of the DPC/CU8/SPLIB/GalObserved

The following table describes the parameters associated with a GalObserved, this file is generated by CU8.

Contributors:Frederic Thevenin, Ulrike Heiter, Jose Hernandez, Paraskevi Tsalmantza

Extends MDB/CU1/BasicSource. See StarObserved.

Name	Description	Type	Units
name	target identification	string	
sourceType	the source main classification type (GALAXY)	MDB/CU8/SourceType	
galaxyType	the galaxy type	MDB/CU8/GalaxyType	
refEpoch	Reference epoch	float	Julian Years
alpha	Right Ascension	double	deg
alphaError	Standard error of alpha	double	mas
delta	Declination	double	deg
deltaError	Standard error of delta	double	mas
linkCu68	link to CU6 - CU8 database	string	
linkExtern	link to external catalogue	string	
observer	observer	string	
pi	PI	string	
dateObs	date of the observation	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
dateProc	date of the processing of the spectrum	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
instrument	name of the instrument used	string	
snr	signal to noise ratio	float	see description
resolution	resolving power (N/A value= -1)	int	see description
refLambda	reference wavelength	float	nm
ntot	number of points (N/A value = 0)	long	
vradHelio	Heliocentric radial velocity	float	km/s
vradMeth	method for deriving vradHelio	string	

Name	Description	Type	Units
dopCorDone	Doppler correction done?	boolean	
fluxCalibType	type of flux calibration	FluxCalibType	
fluxCalibDescription	description of flux calibration	string	
vMag	observed V magnitude	float	mag
gMag	computed G magnitude	float	mag
grvs	computed GRVS magnitude	float	mag
ebv	reddening	float	mag
extraParam	extra parameter	string	
extraParamDescription	description of extraParam	string	
echelle	Does the spectrum contain several echelle orders?	boolean	
lambdaObserved	Observed wavelengths	double [ntot]	nm
fluxObserved	Observed flux	double [ntot]	see description
fluxErrorObserved	Error of observed flux	double [ntot]	see description
circPolObs	Observed circular polarization	double [ntot]	see description

Parameters Detailed description

- target identification (**name**): The target identification is done by the name of the catalogue and the corresponding number according to SIMBAD nomenclatures if possible. Ex: HD 61421.

- the source main classification type (GALAXY) (**sourceType**): the source main classification type (GALAXY)

- the galaxy type (**galaxyType**): the galaxy type; one of the options defined in enumeration MDB/CU8/GalaxyType, which might be extended in the future; currently (2009-06-05): galE (Early type galaxy) galS (Spiral type galaxy) galI (Irregular type galaxy) galB (Starburst type galaxy)

- Reference epoch (**refEpoch**): The reference epoch to which the astrometric source parameters are referred to.

- Right Ascension (**alpha**): Right Ascension α of object in ICRS at reference epoch `refEpoch`

- Standard error of alpha (**alphaError**): Standard error in $\alpha * \cos(\delta)$ of object in ICRS at reference epoch `refEpoch`

- Declination (**delta**): Declination δ of object in ICRS at reference epoch `refEpoch`

- Standard error of delta (**deltaError**): Standard error in δ of object in ICRS at reference epoch `refEpoch`

- link to CU6 - CU8 database (**linkCu68**): Link to entry in CU6 - CU8 database.

- link to external catalogue (**linkExtern**): Link to an external catalogue.
- observer (**observer**): Name of the observer.
- PI (**pi**): Principal Investigator (name) of observing programme within which the object was observed.
- date of the observation (**dateObs**): UTC date of observation. Hours etc. can be omitted.
- date of the processing of the spectrum (**dateProc**): UTC date of processing of the data. Hours etc. can be omitted.
- name of the instrument used (**instrument**): name of the instrument used for the observation. Telescope and spectrograph.
- signal to noise ratio (**snr**): Signal to noise ratio of the spectrum per resolution element at the refLambda given.
- resolving power (N/A value= - 1) (**resolution**): This is used for the resolving power of the spectrograph used for the observed spectrum: $\lambda/\Delta\lambda$, at the specified reference wavelength refLambda. When unknown, it is set to -1.
- reference wavelength (**refLambda**): This is used as reference wavelength for the resolving power and the SNR of the observed spectrum.
- number of points (N/A value = 0) (**ntot**): Total number of points per spectrum. When no spectrum is provided, this parameter is set to 0.
- Heliocentric radial velocity (**vradHelio**): Heliocentric radial velocity of the object.
- method for deriving vradHelio (**vradMeth**): Method used for deriving the heliocentric radial velocity.
- Doppler correction done? (**dopCorDone**): Has a Doppler correction been applied to the spectrum, i.e. is the radial velocity removed?
- type of flux calibration (**fluxCalibType**): Type of the flux calibration. Valid types are absolute, relative, arbitrary or normalized. If absolute, the unit is in $\mathrm{Wm^{-2}nm^{-1}}$. If normalized, the meaning is described in parameter fluxCalibDescription. Additional comments or references for the flux calibration should be given in parameter fluxCalibDescription for all types.
- description of flux calibration (**fluxCalibDescription**): Description of the meaning of ”normalized”, or additional comments or references for the flux calibration.
- observed V magnitude (**vMag**): Apparent V magnitude.
- computed G magnitude (**gMag**): G magnitude computed from observed spectrum or derived from photometry.

• computed GRVS magnitude (**grvs**): GRVS magnitude computed from observed spectrum or derived from photometry.

• reddening (**ebv**): Measured reddening E(B-V).

• extra parameter (**extraParam**): Extra parameter which could be used e.g. as an additional type indicator.

• description of extraParam (**extraParamDescription**): Description of extraParam, including options for values.

• Does the spectrum contain several echelle orders? (**echelle**): If true, then the wavelength and flux arrays contain several echelle orders. If false, there is only one spectrum with wavelengths monotonically increasing.

• Observed wavelengths (**lambdaObserved**): Observed wavelength points of the spectrum (ntot values). In general, wavelength increases monotonically from the first to the last point, except when parameter "echelle" is true. In that case, different echelle orders are provided next to each other in the same array. If the orders are overlapping, negative step in wavelength will occur in between orders.

• Observed flux (**fluxObserved**): Observed flux points of the spectrum (ntot values). For type of calibration see fluxCalib parameter. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Error of observed flux (**fluxErrorObserved**): Errors of observed flux points of the spectrum (ntot values). Same units as fluxObserved. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Observed circular polarization (**circPolObs**): Observed circular polarization (Stokes V), normalised to continuum flux I_c. Array of ntot values.

3.8 Overview of the DPC/CU8/SPLIB/QSOObserved

The following table describes the parameters associated with a QSOObserved, this file is generated by CU8.

Contributors:Ulrike Heiter, Jose Hernandez, Paraskevi Tsalmantza

Extends MDB/CU1/BasicSource. See StarObserved.

Name	Description	Type	Units
name	target identification	string	
sourceType	the source main classification type (QUASAR)	MDB/CU8/SourceType	
quasarType	quasar type	MDB/CU8/QuasarType	
refEpoch	Reference epoch	float	Julian Years
alpha	Right Ascension	double	deg
alphaError	Standard error of alpha	double	mas
delta	Declination	double	deg
deltaError	Standard error of delta	double	mas
linkCu68	link to CU6 - CU8 database	string	
linkExtern	link to external catalogue	string	
observer	observer	string	
pi	PI	string	
dateObs	date of the observation	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
dateProc	date of the processing of the spectrum	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
instrument	name of the instrument used	string	
snr	signal to noise ratio	float	see description
resolution	resolving power (N/A value= -1)	int	see description
refLambda	reference wavelength	float	nm
ntot	number of points (N/A value = 0)	long	
fluxCalibType	type of flux calibration	FluxCalibType	
fluxCalibDescription	description of flux calibration	string	

Name	Description	Type	Units
vMag	observed V magnitude	float	mag
gMag	computed G magnitude	float	mag
ebv	reddening (foreground extinction)	float	mag
z	redshift	float	
i	i magnitude	float	mag
alphaSdss	SDSS power law parameter	float	
ai	absorption index	float	km/s
extraParam	extra parameter	float	see description
echelle	Does the spectrum contain several echelle orders?	boolean	
lambdaObserved	Observed wavelengths	double [ntot]	nm
fluxObserved	Observed flux	double [ntot]	see description
fluxErrorObserved	Error of observed flux	double [ntot]	see description
circPolObs	Observed circular polarization	double [ntot]	see description

Parameters Detailed description

- target identification (**name**): The target identification is done by the name of the catalogue and the corresponding number according to SIMBAD nomenclatures if possible. Ex: HD 61421.

- the source main classification type (QUASAR) (**sourceType**): the source main classification type (QUASAR)

- quasar type (**quasarType**): BAL type if applicable.

- Reference epoch (**refEpoch**): The reference epoch to which the astrometric source parameters are referred to.

- Right Ascension (**alpha**): Right Ascension α of object in ICRS at reference epoch `refEpoch`

- Standard error of alpha (**alphaError**): Standard error in $\alpha * \cos(\delta)$ of object in ICRS at reference epoch `refEpoch`

- Declination (**delta**): Declination δ of object in ICRS at reference epoch `refEpoch`

- Standard error of delta (**deltaError**): Standard error in δ of object in ICRS at reference epoch `refEpoch`

- link to CU6 - CU8 database (**linkCu68**): Link to entry in CU6 - CU8 database.

- link to external catalogue (**linkExtern**): Link to an external catalogue.

- observer (**observer**): Name of the observer.

• PI (**pi**): Principal Investigator (name) of observing programme within which the object was observed.

• date of the observation (**dateObs**): UTC date of observation. Hours etc. can be omitted.

• date of the processing of the spectrum (**dateProc**): UTC date of processing of the data. Hours etc. can be omitted.

• name of the instrument used (**instrument**): name of the instrument used for the observation. Telescope and spectrograph.

• signal to noise ratio (**snr**): Signal to noise ratio of the spectrum per resolution element at the refLambda given.

• resolving power (N/A value= - 1) (**resolution**): This is used for the resolving power of the spectrograph used for the observed spectrum: $\lambda/\Delta\lambda$, at the specified reference wavelength refLambda. When unknown, it is set to -1.

• reference wavelength (**refLambda**): This is used as reference wavelength for the resolving power and the SNR of the observed spectrum.

• number of points (N/A value = 0) (**ntot**): Total number of points per spectrum. When no spectrum is provided, this parameter is set to 0.

• type of flux calibration (**fluxCalibType**): Type of the flux calibration. Valid types are absolute, relative, arbitrary or normalized. If absolute, the unit is in $\mathrm{Wm^{-2}nm^{-1}}$. If normalized, the meaning is described in parameter fluxCalibDescription. Additional comments or references for the flux calibration should be given in parameter fluxCalibDescription for all types.

• description of flux calibration (**fluxCalibDescription**): Description of the meaning of ”normalized”, or additional comments or references for the flux calibration.

• observed V magnitude (**vMag**): Apparent V magnitude.

• computed G magnitude (**gMag**): G magnitude computed from observed spectrum or derived from photometry.

• reddening (foreground extinction) (**ebv**): Measured reddening E(B-V).

• redshift (**z**): Redshift measured.

• i magnitude (**i**): Magnitude (i).

• SDSS power law parameter (**alphaSdss**): SDSS power law parameter (alpha SDSS).

• absorption index (**ai**): Absorption index (AI), equivalent width of all absorption in km/s.

• extra parameter (**extraParam**): extraParam is a number that has a priori no physical meaning. Could be used e.g. for activity parameter for active stars. Parameter and unit should be specified in extraParamDescription.

• Does the spectrum contain several echelle orders? (**echelle**): If true, then the wavelength and flux arrays contain several echelle orders. If false, there is only one spectrum with wavelengths monotonically increasing.

• Observed wavelengths (**lambdaObserved**): Observed wavelength points of the spectrum (ntot values). In general, wavelength increases monotonically from the first to the last point, except when parameter "echelle" is true. In that case, different echelle orders are provided next to each other in the same array. If the orders are overlapping, negative step in wavelength will occur in between orders.

• Observed flux (**fluxObserved**): Observed flux points of the spectrum (ntot values). For type of calibration see fluxCalib parameter. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Error of observed flux (**fluxErrorObserved**): Errors of observed flux points of the spectrum (ntot values). Same units as fluxObserved. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Observed circular polarization (**circPolObs**): Observed circular polarization (Stokes V), normalised to continuum flux I_c. Array of ntot values.

3.9 Overview of the DPC/CU8/SPLIB/AsteroidObserved

The following table describes the parameters associated with a AsteroidObserved, this file is generated by CU8.

Contributors:Frederic Thevenin, Ulrike Heiter, Alfonso Olias Sanz, Jose Hernandez

Extends MDB/CU1/BasicSource, which contains the parameter sourceId (Unique source identifier) of type long.

Name	Description	Type	Units
name	asteroid identification	string	
sourceType	the source main classification type (SSO)	MDB/CU8/SourceType	
epoch	epoch for orbital elements	float	MJD
a	semimajor axis	double	AU
e	eccentricity	double	see description
i	inclination	float	deg
ascNode	ascending node	float	deg
argPeri	argument of perihelion	float	deg
anomaly	anomaly	float	deg
taxoClass	taxonomic classification	string	
linkCu4	link to CU4 database	string	
linkCu68	link to CU6 - CU8 database	string	
linkExtern	link to external catalogue	string	
observer	observer	string	
pi	PI	string	
dateObs	date of the observation	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
dateProc	date of the processing of the spectrum	string	yyyy-mm-ddThh:mm:ss.sssssssss (ISO time string)
instrument	name of the instrument used	string	
snr	signal to noise ratio	float	see description
resolution	resolving power (N/A value= -1)	int	see description
refLambda	reference wavelength	float	nm

Name	Description	Type	Units
ntot	number of points (N/A value = 0)	long	
absMagH	absolute magnitude H	float	mag
vradHelio	heliocentric radial velocity	float	km/s
vradMeth	method for deriving vradHelio	string	
dopCorDone	Doppler correction done?	boolean	
fluxCalibType	type of flux calibration	FluxCalibType	
fluxCalibDescription	description of flux calibration	string	
slopeG	slope parameter G	float	mag
colorInd	Color Index B - V	float	mag
vMag	observed V magnitude	float	mag
gMag	computed G magnitude	float	mag
grvs	computed GRVS magnitude	float	mag
echelle	Does the spectrum contain several echelle orders?	boolean	
lambdaObserved	Observed wavelengths	double [ntot]	nm
fluxObserved	Observed flux	double [ntot]	see description
fluxErrorObserved	Error of observed flux	double [ntot]	see description
circPolObs	Observed circular polarization	double [ntot]	see description

Parameters Detailed description

- asteroid identification (**name**): Asteroid number or provisional designation.
- the source main classification type (SSO) (**sourceType**): the source main classification type (SSO)
- epoch for orbital elements (**epoch**): epoch for orbital elements
- semimajor axis (**a**): semimajor axis of orbit at specified epoch
- eccentricity (**e**): Orbital eccentricity e. e=0, 0¡e¡1, e=1, e¿1 for circular, elliptic, parabolic and hyperbolic orbits, respectively.
- inclination (**i**): inclination of orbit
- ascending node (**ascNode**): ascending node of orbit
- argument of perihelion (**argPeri**): orbital element: argument of perihelion
- anomaly (**anomaly**): orbital element: anomaly
- taxonomic classification (**taxoClass**): Taxonomic classification.

- link to CU4 database (**linkCu4**): Link to CU4 database.
- link to CU6 - CU8 database (**linkCu68**): Link to entry in CU6-CU8 database.
- link to external catalogue (**linkExtern**): Link to an external catalogue.
- observer (**observer**): Name of the observer.
- PI (**pi**): Principal Investigator (name) of observing programme within which the object was observed.
- date of the observation (**dateObs**): UTC date of observation. Hours etc. can be omitted.
- date of the processing of the spectrum (**dateProc**): UTC date of processing of the data. Hours etc. can be omitted.
- name of the instrument used (**instrument**): name of the instrument used for the observation. Telescope and spectrograph.
- signal to noise ratio (**snr**): Signal to noise ratio of the spectrum per resolution element at the refLambda given.
- resolving power (N/A value= - 1) (**resolution**): This is used for the resolving power of the spectrograph used for the observed spectrum: $\lambda/\Delta\lambda$, at the specified reference wavelength refLambda. When unknown, it is set to -1.
- reference wavelength (**refLambda**): This is used as reference wavelength for the resolving power and the SNR of the observed spectrum.
- number of points (N/A value = 0) (**ntot**): Total number of points per spectrum. When no spectrum is provided, this parameter is set to 0.
- absolute magnitude H (**absMagH**): Absolute magnitude H (reduced magnitude at zero solar phase angle).
- heliocentric radial velocity (**vradHelio**): Heliocentric radial velocity of the object.
- method for deriving vradHelio (**vradMeth**): Method used for deriving the heliocentric radial velocity.
- Doppler correction done? (**dopCorDone**): Has a Doppler correction been applied to the spectrum, i.e. is the radial velocity removed?
- type of flux calibration (**fluxCalibType**): Type of the flux calibration. Valid types are absolute, relative, arbitrary or normalized. If absolute, the unit is in $\mathrm{Wm^{-2}nm^{-1}}$. If normalized, the meaning is described in parameter fluxCalibDescription. Additional comments or references for the flux calibration should be given in parameter fluxCalibDescription for all types.

• description of flux calibration (**fluxCalibDescription**): Description of the meaning of ”normalized”, or additional comments or references for the flux calibration.

• slope parameter G (**slopeG**): Slope parameter G.

• Color Index B - V (**colorInd**): Color index B-V of the asteroid during observations.

• observed V magnitude (**vMag**): Apparent V magnitude during observations.

• computed G magnitude (**gMag**): G magnitude computed from observed spectrum or derived from photometry.

• computed GRVS magnitude (**grvs**): GRVS magnitude computed from observed spectrum or derived from photometry.

• Does the spectrum contain several echelle orders? (**echelle**): If true, then the wavelength and flux arrays contain several echelle orders. If false, there is only one spectrum with wavelengths monotonically increasing.

• Observed wavelengths (**lambdaObserved**): Observed wavelength points of the spectrum (ntot values). In general, wavelength increases monotonically from the first to the last point, except when parameter ”echelle” is true. In that case, several echelle orders are provided next to each other in the same array. If the orders are overlapping, a negative step in wavelength will occur in between orders.

• Observed flux (**fluxObserved**): Observed flux points of the spectrum (ntot values). For type of calibration see fluxCalib parameter. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Error of observed flux (**fluxErrorObserved**): Errors of observed flux points of the spectrum (ntot values). Same units as fluxObserved. When absolute flux the unit is: $\mathrm{Wm^{-2}nm^{-1}}$.

• Observed circular polarization (**circPolObs**): Observed circular polarization (Stokes V), normalised to continuum flux I_c. Array of ntot values.

Appendix

String values can be treated in a variety of ways in data models. Here we give some references to and quotes from other data models concerning string values. Eventually a general convention should be adopted within DPAC.

MySQL:

Reference: MySQL 6.0 Reference Manual, 10.4.1. The CHAR and VARCHAR Types.
Web address: `http://dev.mysql.com/doc/refman/6.0/en/char.html`.

The MDB dictionary tool generates mysql schemas to create tables where string type fields are represented as VARCHAR(4000) type data fields.

IVOA:

Reference: VOTable Format Definition, Version 1.2, IVOA Working Draft, 2008-09-14.
Web address: `http://www.ivoa.net/Documents/WD/VOTable/VOTable-20080914.html`.

Quotes:

> Section 6 indicates the default null values for each of the primitive data types when the TABLEDATA data representation is being used. Some of the primitive data types have one or more default null values defined (for the ”char”, ”float” and ”double” types, an empty cell may be used). Other types (”boolean”, ”unsignedByte”, ”short”, and ”int”) have no default null value defined, and thus, when they are needed, they must be defined explicitly [...].
>
> Note that strings are not a primitive type: strings are represented in VOTable as an array of characters.

FITS:

Reference: FITS Standard 3.0, 2008 July 10, p. 21, 4.2.1 Character String.
Web address: `http://fits.gsfc.nasa.gov/standard30/fits_standard30.pdf`.

FITS metadata is stored in a human readable ASCII header (80 character fixed-length strings that carry keyword/value pairs).

Quotes:

> A character string value shall be composed only of the set of restricted ASCII text characters, decimal 32 through 126 (hexadecimal 20 through 7E) enclosed by single quote characters (””, decimal 39, hexadecimal 27). A single quote is represented within a string as two successive single quotes, e.g., O’HARA = ’O”HARA’. Leading spaces are significant; trailing spaces are not.
>
> Note that there is a subtle distinction between the following 3 keywords:

```
KEYWORD1= ''          / null string keyword
KEYWORD2= ' '         / empty string keyword
KEYWORD3=             / undefined keyword
```

The maximum possible length of a keyword string is 68 characters.

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