

Variable Source Data Catalogues at ESDC

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Issue/Revision: 1.0

Reference: Presentation Reference

Status: Issued

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- ⦿ **Gaia Light Curves**
- ⦿ **Hubble Catalog of Variables (HCV)**
- ⦿ **XMM-Newton Light Curves**

Data contents

- ⦿ Light curves are part of each of the data releases
- ⦿ DR1 about 3 000 light curves
- ⦿ DR2 about 550 000 light curves
- ⦿ DR3 - not yet settled, but they might include up to a hundred million light curves from the variability analysis

Light curves access

- ⦿ Datalink: ancillary data attached to catalogues
- ⦿ Web service providing for each object (identified with its source_id) the list of additional resources available outside the main catalogues.

Gaia Light Curves DataLink access



← → ↻ Not Secure | gea.esac.esa.int/archive/

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gaia archive

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Basic Advanced (ADQL) Query Results

gaia

Job name:

```
1 SELECT Top 100 source_id, designation from gaiadr2.gaia_source where epoch_photometry_url is not null
```

Ctrl+Space for query autocompletion

Query examples

Reset Form Submit Query

Other

- Gaia Data Release 1
- Gaia Data Release 2
- Auxiliary
- Cross match
- Solar System
- Variability
- gaiadr2.gaia_source
- gaiadr2.ruwe

Status

Num. rows	Size
09:22	100 3 KB

Job ID: 1570637362362O
Data product type: Epoch photometry
IDs Column: source_id
Download format: VOTable

Cancel Save Send to SAMP

Download format: VOTable Apply jobs filter Filter this session Select all jobs Delete selected jobs

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Gaia Light Curves DataLink access



- ⦿ <http://geodata.esac.esa.int/data-server/datalink/links?ID=6680733225618222592>
 - ⦿ provides the following VOTable xml response for input source_id 6680733225618222592

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <VOTABLE version="1.3" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
3   xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.3
4   http://www.ivoa.net/xml/VOTable/v1.3" xmlns="http://www.ivoa.net/xml/VOTable/v1.3">
5   <RESOURCE type="results">
6     <INFO name="QUERY_STATUS" value="OK" />
7     <INFO name="PROVIDER" value=""></INFO>
8     <INFO name="QUERY" value=""></INFO>
9     <INFO name="PAGE" value=""></INFO>
10    <INFO name="PAGE_SIZE" value=""></INFO>
11    <INFO name="JOBID" value="1523891646012IDL"><![CDATA[1523891646012IDL]]></INFO>
12    <INFO name="JOBNAME" value=""><![CDATA[DataLink job for user anonymous]]></INFO>
13    <TABLE>
14      <FIELD name="ID" ucd="meta.id;meta.main" datatype="char" arraysize="*" />
15      <FIELD name="access_url" ucd="meta.ref.url" datatype="char" arraysize="*" />
16      <FIELD name="service_def" ucd="meta.ref" datatype="char" arraysize="*" />
17      <FIELD name="error_message" ucd="meta.code.error" datatype="char" arraysize="*" />
18      <FIELD name="semantics" ucd="meta.code" datatype="char" arraysize="*" />
19      <FIELD name="description" ucd="meta.note" datatype="char" arraysize="*" />
20      <FIELD name="content_type" ucd="meta.code.mime" datatype="char" arraysize="*" />
21      <FIELD name="content_length" ucd="phys.size;meta.file" datatype="long" unit="byte" />
22      <DATA>
23        <TABLEDATA>
24          <TR>
25            <TD>6680733225618222592</TD>
26            <TD><![CDATA[http://geodata.esac.esa.int/data-server/data?RETRIEVAL_TYPE=epoch_photometry&ID=6680733225618222592&TABLE=dr2.epoch_photometry&KEY_COLUMN_NAME=source_id]]></TD>
27            <TD></TD>
28            <TD></TD>
29            <TD>#this</TD>
30            <TD><![CDATA[Light curve data]]></TD>
31            <TD></TD>
32            <TD></TD>
33            <TD></TD>
34          </TR>
35        </TABLEDATA>
36      </DATA>
37    </RESOURCE>
38  </VOTABLE>
```

Table Browser for 11: datalink.vot.xml

ID	access_url	semantics	description
1	http://geodata.esac.esa.i...	#this	Light curve data

Gaia Light Curves Serialization

- Epoch photometry
- SELECT Top 100 source_id, designation from gaiadr2.gaia_source where epoch_photometry_url is not null (synthetic columns in gaia_source)
- <http://geadata.esac.esa.int/data-server/datalink/links?ID=6680733225618222592>

Table Browser for 12: lightcurve.vot.xml

	source_id	...	band	time	mag	...	...	flux_over_error
39	6680733225618222592	..	G	2266.43675	13.1382	....		1208.01
40	6680733225618222592	..	G	2266.51076	13.1422	....		1151.9
41	6680733225618222592	..	G	2286.68858	13.1415	....		485.39
42	6680733225618222592	..	G	2286.76261	13.143	....		1515.36
43	6680733225618222592	..	G	2318.24892	13.1448	....		708.027
44	6680733225618222592	..	G	2318.42509	13.1468	....		700.578
82	6680733225618222592	..	BP	2266.43706	13.4896	....		222.581
83	6680733225618222592	..	BP	2266.51108	13.4841	....		245.158
84	6680733225618222592	..	BP	2286.68893	13.4787	....		241.374
85	6680733225618222592	..	BP	2286.76294	13.4922	....		241.643
86	6680733225618222592	..	BP	2318.24923	13.4744	....		239.758
87	6680733225618222592	..	BP	2318.42541	13.5098	....		240.606
124	6680733225618222592	..	RP	2266.43715	12.6434	....		266.473
125	6680733225618222592	..	RP	2266.51116	12.6426	....		272.458
126	6680733225618222592	..	RP	2286.68901	12.6417	....		267.665
127	6680733225618222592	..	RP	2318.24932	12.6481	....		278.323
128	6680733225618222592	..	RP	2318.4255	12.6444	....		277.509

Light curve VOTable



International
Virtual
Observatory
Alliance

Time Series Cube Data Model Version 1.0

IVOA Note 2017-02-05

Working group

Time domain interest group

This version

<http://www.ivoa.net/documents/cubeDM/20170205>

Latest version

<http://www.ivoa.net/documents/cubeDM>

Previous versions

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Editor(s)

Jiří Nádvořník

BANDPASS

```
<FIELD arraysize="*" datatype="char" name="band" ucd="instr.bandpass"  
  utype="ssa:DataID.Bandpass">
```

```
<DESCRIPTION>Photometric band. Values: G (per-transit combined SM-AF flux), BP (blue  
  photometer integrated flux) and RP (red photometer integrated flux).
```

```
</DESCRIPTION>
```

```
</FIELD>
```

TIME

```
<FIELD datatype="double" name="time" ucd="time.epoch;VOX:Image_MJDateObs" unit="d"  
  utype="spec:Spectrum.Data.TimeAxis.Value">
```

```
<DESCRIPTION>Observing time [...]</DESCRIPTION>
```

```
</FIELD>
```

FLUX/MAGNITUDES

```
<FIELD datatype="float" name="flux" ucd="em.opt;phot.flux;stat.mean" unit="e-/s"  
  utype="spec:Spectrum.Data.SpectralAxis.Value">
```

```
<DESCRIPTION>Band flux value for the transit. For G band, it is a combination of individual  
  SM-AF CCD fluxes. For BP and RP bands, it is an integrated CCD flux.
```

```
</DESCRIPTION>
```

```
</FIELD>
```

```
<FIELD datatype="float" name="mag" ucd="phot.mag;em.opt" unit="mag">
```

```
<DESCRIPTION>Vega magnitude. It is computed from the flux applying the DR2 zero-point  
  defined in https://www.cosmos.esa.int/web/gaia/iow\_20180316 </DESCRIPTION>
```

```
</FIELD>
```

ERRORS FLUX/MAGNITUDES

```
<FIELD datatype="float" name="flux_error" ucd="em.opt;phot.flux;stat.error" unit="e-/s">
```

```
<DESCRIPTION>Flux error. The uncertainty flux_error on flux depends on the  
  passband band as follows: band G: [...] </DESCRIPTION>
```

```
</FIELD>
```

```
<FIELD datatype="float" name="flux_over_error" ucd="em.opt;phot.flux;stat.error">
```

```
<DESCRIPTION>Band flux divided by its error.</DESCRIPTION>
```

```
</FIELD>
```

→ Sparse Cube Data Model

Extra for the user / allowed by sparse cube data

```
<FIELD datatype="boolean" name="rejected_by_photometry" ucd="meta.code.status"><DESCRIPTION>Rejected by DPAC photometry processing. Unavailable or rejected by DPAC photometric processing, or negative (unphysical) flux. When true, these rows are not provided in the default output because they are considered only useful for debugging purposes.</DESCRIPTION></FIELD>
```

```
<FIELD datatype="boolean" name="rejected_by_variability" ucd="meta.code.status"><DESCRIPTION>Rejected by DPAC variability processing (or variability analysis). Rejected by DPAC variability processing (or variability analysis), or negative (unphysical) flux.</DESCRIPTION></FIELD>
```

```
<FIELD datatype="long" name="other_flags" ucd="meta.code.status"><DESCRIPTION>Additional processing flags. This field contains extra information on the data used to compute the fluxes and their quality. It provides debugging information that may be safely ignored for many general purpose applications. The field is a collection of binary flags, whose values can be recovered applying bit shifting and masking operations. Each band has different binary flags in different positions, as shown below. Bit numbering is as follows: least significant bit = 1 and most significant bit = 64
```

G band:

Bit 1: SM transit rejected by photometry processing.

[...]

```
</DESCRIPTION></FIELD>
```


Hubble Catalog of Variables (HCV)



Catalog contents

- ⦿ Released on 24th September 2019
- ⦿ 84428 candidate variable sources (out of 3.7 million HSC sources that were searched for variability)
- ⦿ Deepest catalog of variables available
- ⦿ data points in the light curves of the variables in the HCV catalog range from 5 to 120 points (typically having less than ten points)
- ⦿ the time baseline ranges from under a day to over 15 years

HCV access

- ⦿ TAP access via eHST TAP service
 - ⦿ <http://hst.esac.esa.int/tap-service/tap>
 - ⦿ Tables: hcv.hcv, hcv.aux
- ⦿ Dedicated Web UI for accessing and exploring the Hubble Catalog of Variables
 - <http://archives.esac.esa.int/hcv-explorer>
 - version 1.0 released on 24th September 2019
 - offers interactive and connected plotting of the HCV in different views:
 - ▶ plotting of sources in the sky
 - ▶ light curve plotting per source and filter
 - ▶ variable index plotting and results table
 - ▶ download of plots, light curves, selected rows and the full catalog available
 - ▶ programmatic access and jupyter notebook examples also provided.

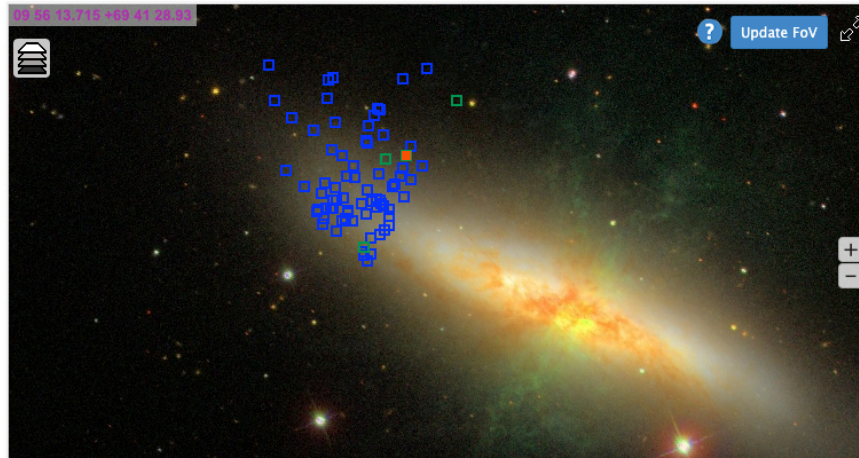
Hubble Catalog of Variables (HCV)



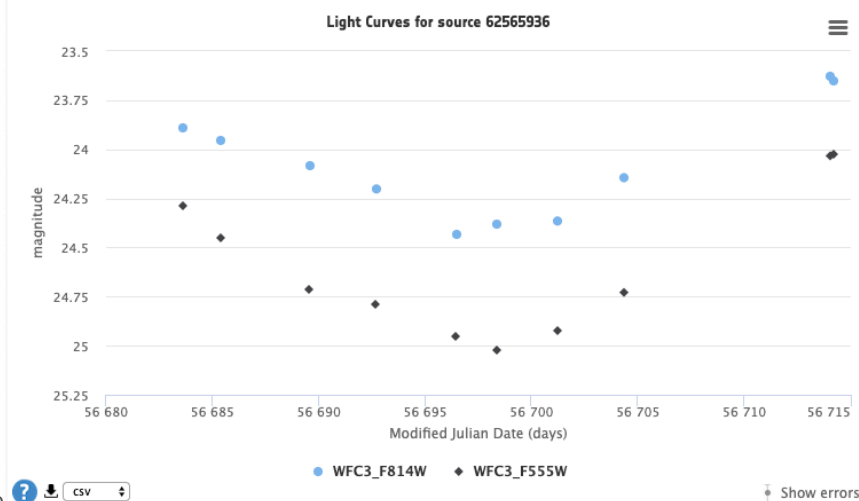
hubble catalog of variables explorer

M82

M82 resolved by Simbad
RA: 148.968458 Dec: 69.6797



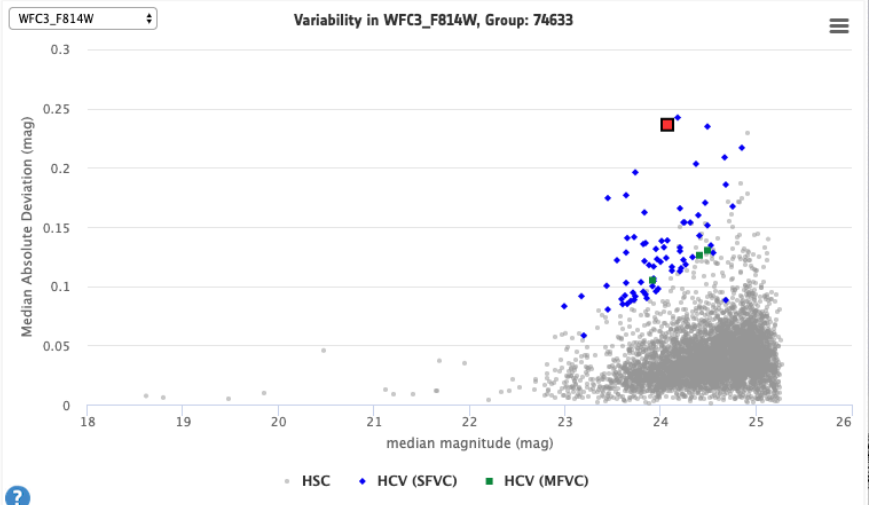
FoV: 11.98'



10 ? csv Show errors

Source	GroupID	Subgr.	R.A. (deg)	Dec. (deg)	P.d.	E.c.	#Filters	Filter	nLC	VarQual	VarF
71564701	74633	-5	149.091659545	69.7021179195	1	0	2	WFC3_F814W WFC3_F555W	8	CACAB	0
70745051	74633	-5	149.126373291	69.7059020996	1	0	1	WFC3_F814W	10	AACAA	1
69360285	74633	-5	149.097885131	69.7268142700	1	0	2	WFC3_F555W WFC3_F814W	10	AABAA AAAAA	1 0
67848689	74633	-5	149.106231685	69.7081604004	1	0	1	WFC3_F814W	10	AACAA	1
67471631	74633	-5	149.115966796	69.7009506226	1	0	1	WFC3_F814W	10	BBCAA	1
66156212	74633	-5	149.081832885	69.7064743042	1	0	1	WFC3_F814W	10	AACAB	1
64141014	74633	-5	149.105239866	69.7230072021	1	0	1	WFC3_F814W	10	AACAA	1
62565936	74633	-5	149.079879760	69.7161102295	2	1	2	WFC3_F555W WFC3_F814W	10 10	AABAA AACAA	1 1
61837866	74633	-5	149.106918335	69.7196121216	1	0	1	WFC3_F814W	10	AACAA	1
61368873	74633	-5	149.082656860	69.7338409424	1	0	1	WFC3_F814W	10	AABAA	1
57827246	74633	-5	149.135116577	69.7015228271	1	0	1	WFC3_F814W	7	AABBA	1
56354155	74633	-5	149.101394653	69.7253875732	1	0	1	WFC3_F814W	10	AABAC	1
55539064	74633	-5	149.132583616	69.7292861936	1	0	1	WFC3_F814W	10	AACAA	1
54114577	74633	-5	149.156585693	69.7248840332	1	0	1	WFC3_F814W	6	AACAA	1
43679040	74633	-5	149.069580076	69.7138671875	1	0	1	WFC3_F814W	10	AACAA	1
41234476	74633	-5	149.160202076	69.7127838135	1	0	1	WFC3_F814W	10	AACAA	1

csv Sources in FoV: 75 1-50 of 75



? HSC HCV (SFVC) HCV (MFVC)

XMM-Newton Light Curves

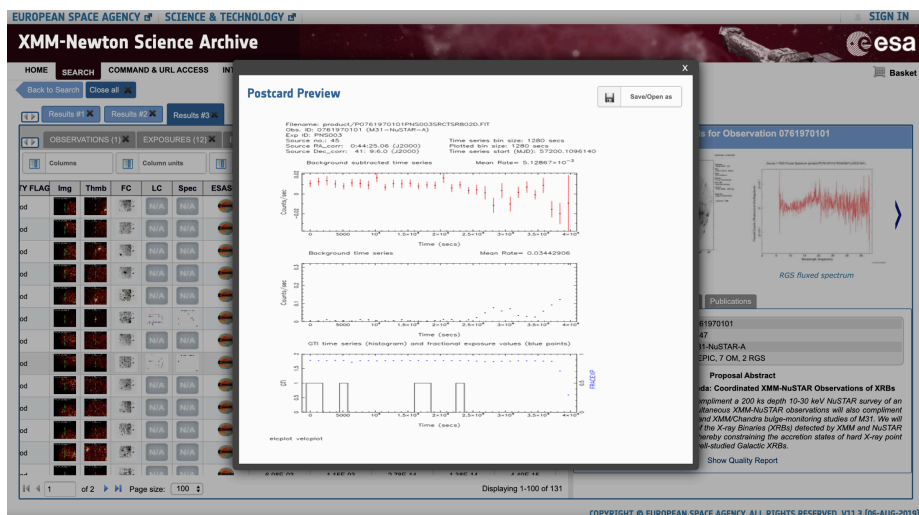
Data contents

- ~ 500 000 light curves available out of the Source Catalogues

Data Access

- Web User interface access to postcard and products
- Programmatic access / TAP

http://nxsa.esac.esa.int/nxsa-sl/servlet/data-action?OBSERVATION_ID=0761970101
&SOURCE_NUMBER=45
&LEVEL=EPIC_SOURCE_LIGHT_CURVE
&PROTOCOL=HTTP



Serialization

- No serialization yet, only light curve fits products

FACTS

- ⦿ Sparse Cube DM allows to specify light curve properties.
- ⦿ Sparse Cube DM allows flexibility given the fact that there is no standard for defining Light Curves.

NEEDS

- ⦿ We have collections of light curves and will have much more in the near future.
- ⦿ All GAIA, HST and (soon) XMM data are python astroquery available. In UI we can adapt the format, but we need a standard for the programmatic access.
- ⦿ We need a DM to ensure proper characterization of light curves, Sparse Cube DM is not enough.
- ⦿ We can benefit from current DataLink implementation for the rest of collections together with the DM definition.

DISCUSSION

- ⦿ ... How do we move forward?

Thank you!