

# Swift UVOT Serendipitous Source Catalogue (UVOTSSC) (First release, v1.1)

## 1 Introduction

All the information in this document, plus any updates, can be found at:

[http://www.ucl.ac.uk/mssl/astro/space\\_missions/swift/uvotssc](http://www.ucl.ac.uk/mssl/astro/space_missions/swift/uvotssc).

A paper introducing the catalogue was given at the "Swift: 10 years of discovery" conference in Rome, December 2014. It can be found at:

<http://pos.sissa.it/> or <http://adsabs.harvard.edu/abs/2015arXiv150306597P>

The first release of the Swift UVOT Serendipitous Source Catalogue (UVOTSSC) has been produced by processing the data obtained from the Swift Ultraviolet and Optical Telescope (UVOT) from the beginning of the mission (2005) until 1st of October of 2010. The data processing was performed at the Mullard Space Science Laboratory (MSSL, University College London, U.K.) using Swift FTOOLS from NASA's High Energy Astrophysics Software (HEASoft-6.11), with some customising of the UVOT packages in order to get more complete source detection and properly apply quality flags to those sources that were detected within the UVOT image artefacts. The total number of observations with 17'x17' images used for version 1 of the catalogue is 23,059, giving 6,200,016 sources in total, of which 2,027,265 have multiple entries in the source table because they have been detected in more than one observation. Some sources were only observed in one filter. The total number of entries in the source table is 13,860,568. The S/N ratio for all sources exceeds 5 for at least one UVOT filter, the rest of the filters having a S/N greater than 3.

## 2 Description

The UVOT source catalogue is compiled in the form of a FITS-file containing two tables:

- SOURCES – the main table containing UVOT sources
- SUMMARY – the auxiliary table containing information about each observation

The link between these two tables is made through the column N\_SUMMARY which, for each source in the first table, gives the entry number of the observation in the SUMMARY table in which this source was detected. For each of the sources, there is also the observation identification number given in the column "OBSID" which coincides with the OBSID in the SUMMARY table.

In total, the table SOURCES has 82 columns with the source parameters. The description of each column is given below. If more than one filter was used in the observation, any sources detected in more than one filter are matched, so that there is a single catalogue entry for each source for each observation. However, the same source could be detected in the exposures belonging to different observations, in which case it would have different entries in the catalogue table. Thus, among the 13 860 568 catalogue entries 6 200 016 unique sources are identified, whereas 2 027 265 sources have multiple entries.

The catalogue gives the AB and Vega magnitudes, as well as fluxes for each source and each filter (see Oke, J.B. 1974, ApJS, 27, 21) in units of  $ergs\ sec^{-1}cm^{-2}\text{\AA}^{-1}$  )

The catalogue is also available in six sections, each one covering 4 hours in RA, to make them smaller and more manageable. The SUMMARY table is the same and complete for all 6 sections.

## 3 Catalogue file format

### 3.1 Format of SOURCES table

The UVOTSSC **SOURCES** table contains the following columns which give the astrometric, photometric, source-parameterisation and source-flagging parameters.

#### 3.1.1 IAUNAME

The column IAUNAME provides individual source identification strings in the conventions of the International Astronomical Union. For each source, its name starts from the string UVOTSSC1 characterising the sources as obtained from the NASA SWIFT mission with the UVOT telescope, version 1. This string is followed with the Right Ascension and Declination coordinates for the epoch J2000 in the form JHHMMSS.s±GGmmss. N.B. Because of problems with the rounding of position coordinates a single IAU name can refer to more than one SRCNUM; there are 149 known cases. They have been distinguished by having a letter a,b,c,..etc. appended to their IAU name.

#### 3.1.2 N\_SUMMARY

This column provides the reference number of the observation summary given in the auxiliary table SUMMARY (i.e., this is the entry number of the SUMMARY table).

#### 3.1.3 OBSID

Gives the unique observation identification number corresponding to the observation in which the source was detected.

#### 3.1.4 NFILT

This column gives the number of the UVOT filters included into this source observation.

#### 3.1.5 SRCNUM

This column gives a unique source number throughout the UVOTSSC source catalogue (please, note that the number of entries in the SOURCES table is larger than the total number of individual sources).

#### 3.1.6 RA and DEC

These columns contain the **Right Ascension** and **Declination (J2000)** of each source in degrees. All the entries in the table are in order of increasing RA value.

#### 3.1.7 RA\_ERR and DEC\_ERR

These columns contain the standard errors (in arcseconds) of the source RA and DEC positions – i.e.  $(1/n)\sqrt{\sum_{k=1}^n err_k^2}$ , where  $err_k$  are the errors of the n source positions for different filters. Please, note that input errors from the individual source-list files are first converted from pixels to arcsecs.

#### 3.1.8 filter\_SRCDIST

These are 6 columns corresponding to different UVOT filters (UVW2, UVM2, UVW1, U, B and V) and giving the distance (in arcseconds) to the closest neighbouring detected in that filter (the search for the neighbouring sources was limited to 30 arcseconds radius).

#### 3.1.9 N\_OBSID

The number of individual observations (ObsIDs) in which the source was detected. This should correspond to the number of entries for that particular source in the SOURCES table.

#### 3.1.10 filter\_SIGNIF

For each filter there is a column for the source significances (signal-to-noise).

### 3.1.11 filter\_VEGAMAG

For each filter there is a column for the source Vega-system magnitudes.

### 3.1.12 filter\_ABMAG

For each filter there is a column for the source AB magnitudes. These values are computed from the Vega magnitudes.

### 3.1.13 filter\_MAG\_ERR

For each filter this column gives the error on the magnitude, a single error value being appropriate for both Vega magnitudes and AB magnitudes.

### 3.1.14 filter\_FLUX and filter\_FLUX\_ERR

For each filter there is a column for the source fluxes and their standard errors in units of  $erg/s/cm^2/Angstrom$ . The fluxes were derived using the count rate to flux conversion factors from Poole et al. which have been based on GRB spectra. This differs slightly from the count rate to flux conversion factor based on Pickles star spectra expressed as a flux ratio as follows:

Table 1: Multiplication factors to convert FLUX in catalogue to FLUX calibrated with Pickles stars.

| Filter | Factor (Pickles/GRB) |
|--------|----------------------|
| V      | 0.998                |
| B      | 0.893                |
| U      | 0.940                |
| UVW1   | 0.963                |
| UVM2   | 0.884                |
| UVW2   | 0.965                |

The flux conversion factors are valid for UVOT B-V less than -0.36.

### 3.1.15 filter\_MAJOR

This column gives the computed value for the mean full-width-half-maximum of the source along the major-axis (in arcseconds), for each filter.

### 3.1.16 filter\_MINOR

For each filter there is a column for the computed full-width-half-maximum of the source along the minor-axis (in arcseconds).

### 3.1.17 filter\_POSANG

For each filter, this column gives the computed value for the position-angle of the major-axis source (measured in degrees anti-clock wise from the Right-Ascension axis).

### 3.1.18 filter\_EXTENDED

For each filter there is a column to show if the source is considered extended, which was determined by comparing the source major axis with the size of the UVOT point spread function.

### 3.1.19 filter\_QUALITY\_FLAG

For each filter there is a column for the quality for each source, as determined from all the merged sources for that filter (see next section).

## 3.2 Quality flag

Each source has an associated “Quality flag” which is given in the final columns of the **SOURCES** table. The flag bit values are shown in the following table. Multiple flags are summed to give the final quality flag value.

Table 2: Quality flag values for the UVOTSSC source catalogue

| Bit number | Reason   | Integer value |
|------------|--|---------------|
| 0          | Cosmetic defects (BAD PIXELS) within the source region | 1             |
| 1          | Source on a READOUT STREAK                             | 2             |
| 2          | Source on a “SMOKE RING”                               | 4             |
| 3          | Source on a DIFFRACTION SPIKE                          | 8             |
| 4          | Source affected by MOD-8 noise pattern                 | 16            |
| 5          | Source within a “HALO RING”                            | 32            |
| 6          | Source near to a BRIGHT source                         | 64            |
| 7          | MULTIPLE EXPOSURE values within photometry aperture    | 128           |
| 8          | Source within an EXTENDED FEATURE                      | 256           |

### 3.2.1 Examples of usage

1. Quality flag = 1 - Source contains one or more bad pixels
2. Quality flag = 3 - Source contains one or more bad pixels and lies on a read-out streak
3. Quality flag = 7 - Source contains one or more bad pixels and lies on a read-out streak and lies within a “smoke-ring” region.

### 3.2.2 Notes on individual quality flags

1. **Bad Pixels** (Quality bit number 1) A point-source will have this flag set if any pixel within the photometry aperture, or any within the background annulus, has a corresponding pixel in the quality image with a non-zero value. Similarly, an extended source will have this flag set if any corresponding pixel in the quality image has a non-zero value.
2. **Count Rate** If the count per frame exceeds 0.96 counts/frame, it cannot be corrected for coincidence loss and the magnitude will be suspect. These magnitudes (and other associated columns) have been removed from the catalogue. If no valid measurements are available for any filter the source has been removed entirely from the catalogue.

## 3.3 Format of SUMMARY table

The UVOTSSC **SUMMARY** table contains information on each observation included in the catalogue, with the following columns.

### 3.3.1 N\_SUMMARY

This column provides the link to the **SOURCES** table. Each source can be linked to the observation details in the SUMMARY table via this number.

### 3.3.2 OBSID

This gives the unique observation identification number.

### 3.3.3 TARGET ID

This is the name of the target given by the proposer of the observation.

### **3.3.4 FILTERS**

This lists the filters used in the observation.

### **3.3.5 DATE\_MIN**

This is the date when the first exposures for this observation started to be taken. Most observations are completed within a few days of this date.

### **3.3.6 RA\_PNT**

The Right Ascension for the telescope pointing direction in decimal degrees.

### **3.3.7 DEC\_PNT**

The Declination for the telescope pointing direction in decimal degrees.

### **3.3.8 PA\_PNT**

Position Angle for the telescope pointing in degrees.

### **3.3.9 EXP\_filter**

The total exposure time in seconds for each filter summed together before detecting sources.

### **3.3.10 NSOURCES\_filter**

The total number of sources detected in this filter for this observation.

### **3.3.11 VEGAMAG\_LIM\_filter**

The three sigma detection limiting magnitude in this filter for this observation, in the Vega photometry system.

### **3.3.12 ABMAG\_LIM\_filter**

The three sigma detection limiting magnitude in this filter for this observation, in the AB photometry system.

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