XMM OM Serendipitous Source Survey Catalogue (XMM-SUSS3)

1 Introduction

The third release of the XMM OM Serendipitous Source Survey Catalogue (XMM-SUSS3) was produced by processing the XMM-Newton Optical Monitor (OM) data obtained from the beginning of the mission (2000) until the end of July 2015. The data processing was performed at the European Space Astronomy Centre (ESAC, Spain) using the XMM Science Analysis Software system (SAS) version 15.0. In addition to covering a larger observation period, this release differs from the second release (XMM-SUSS2.1) in the implementation of a new time dependent sensitivity degradation correction. Also the photometry of sources detected on stacked images has been improved and furthermore, these sources are now properly flagged using new SKY_IMAGE columns. The number of observations (OBSIDs) included in the catalogue is 7,886. The total number of entries included in the catalogue is 6,880,116. They correspond to 4,751,899 sources, of which 867,022 have multiple entries in the source table, corresponding to different observations.

The catalogue consists of two tables. The first one contains the sources, with positional and photometric data (count rate, magnitude and flux) and quality flags for each measurement. In the second table we give a summary of the observations from which the sources have been detected and measured.

2 Description

The SUSS3 catalogue is compiled in the form of a FITS-file containing two tables:

- SRCLIST – the main table containing OM 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 included in the first table gives the entry number of the SUMMARY table which characterises the observation corresponding to this source. 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 SRCLIST has 114 columns with the source parameters for 6,880,116 source entries. The description of each column is given below. Within a given observation the detections in different exposures and filters are matched so that the source has a single catalogue entry with data in different columns for each filter used. If the same source is detected again in another observation the source will have a new entry, but will be given the same SRCNUM. Thus, among the 6,880,116 catalogue entries there are 4,751,899 unique sources identified.

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

3 Catalogue file format

3.1 Format of SRCLIST table

The XMM-SUSS3 file contains the following columns in the **SRCLIST** table 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 XMMOM characterising the source as obtained from the XMM-Newton mission with its OM-telescope. This string is followed by the Right Ascension and Declination coordinates for the epoch J2000 in the form JHHMMSS.s±GGmmss.

3.1.2 N_SUMMARY

This column provides the reference number for 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 SRCNUM

This column give a unique source number throughout the XMM-SUSS3 catalogue (please, note that the number of entries in the SRCLIST table is larger that the total number of individual sources in the catalogue because some sources are observed more than once).

3.1.5 filter_SRCDIST

where 'filter' can be V, B, U, UVW1, UVM2 or UVW2. These are 6 columns corresponding to different OM filters giving the distance to the closest neighbour source in arcseconds.

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_HMS and DEC_DMS

These columns contain the Right Ascension and Declination (J2000) of each source in astronomical angular units (hours, minutes and seconds of time for RA and degrees, angular minutes and arcseconds for Dec).

3.1.8 POSERR

This column contains the standard error of the merged source position – i.e. $(1/n)\sqrt{\sum_{k=1}^{n} err_k^2}$, where err_k are the position errors of the n individual sources. Please, note that input errors from the individual source-list files are first converted from pixels to arcsecs.

3.1.9 LII and BII

These two columns contain the Galactic longitude and Galactic latitude computed from the RA and DEC columns.

3.1.10 N_OBSID

The number of individual observations (ObsIDs) in which the source was detected.

3.1.11 filter_SIGNIF

For each filter there is a column for the source significances (signal-to-noise). If more than one exposure contributed to the source entry, these values are the averaged values from the individual sources that were merged.

3.1.12 filter_RATE and filter_RATE_ERR

For each filter there is a column for the source count-rates (corrected for coincidence losses and detector time degradation) and for its standard error. These values are the averaged values, without weighting, from the individual sources that were merged into a source. The standard errors are computed from $(1/n)\sqrt{\sum_{k=1}^{n} err_k^2}$, where err_k for n individual sources.

3.1.13 filter_AB_FLUX and filter_AB_FLUX_ERR

For each filter there is a column for the source fluxes, transformed using the AB magnitude system, and their standard errors. The units are in $erg/s/cm^2/\mathring{A}$. These values are computed from the computed averaged count-rates in the filter_RATE columns.

3.1.14 filter_AB_MAG and filter_AB_MAG_ERR

For each filter there is a column for the source AB magnitudes and its standard errors. These values are computed from the averaged count-rates in the filter_RATE columns.

3.1.15 filter_VEGA_MAG and filter_VEGA_MAG_ERR

For each filter there is a column for the source Vega-system magnitudes and its standard error. These values are computed from the averaged count-rates in the filter_RATE columns.

3.1.16 filter_MAJOR_AXIS

This column gives the computed value for the mean full-width-half-maximum of the source along the major-axis, using the values for each filter.

3.1.17 filter_MINOR_AXIS

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

3.1.18 filter_POSANG

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

3.1.19 filter_QUALITY_FLAG

For each filter there is a column for the quality flag for each source, as determined from all the merged sources for that filter

3.1.20 filter_QUALITY_FLAG_ST

This column gives the quality flag in the form of logical values (string F for false and T for true).

3.1.21 filter_EXTENDED_FLAG

For each filter there is a column for the extension flag for each source: 0 for a point source and 1 for an extended source.

3.1.22 filter_SKY_IMAGE

For each filter there is a column to show whether the entry was derived from a summed exposure made by stacking sky images taken within the same observation.

Table 1: Quality flag values for the XMM-SUSS3 catalogue

Bit number	Reason	Integer value
0	source on a bad pixel	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 mod8 pattern	16
5	source within central enhancement	32
6	source lies near to a bright source	64
7	source is near an edge	128
8	point source within extended source	256
9	very bright pixel within photometry aperture	512
10	multiple exposure values within photometry aperture	1024
11	source is too bright (rate above 0.97 c/frame)	2048

3.2 QUALITY FLAGS

Each source has an associated "quality flag". The flag settings are shown in Table 1.

In addition, the columns filter_SKY_IMAGE flag if a source has been detected in stacked (sky) images obtained with that filter.

3.2.1 Examples

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

- **Source on a Bad Pixel** An object is flagged bad if the photometric aperture used to sum source counts or background includes a bad pixel, as recorded in the Calibration Access Layer of the XMM-Newton Project. All of these pixels are already stored in the quality map and the information is simply propagated to the source table.
- **Source on a Readout streak** Readout streaks occur because there is no shutter to block incident photons during the finite time the CCD takes to readout. The exact deadtime is dependent on detector windowing. Streaks occur over a small number of pixel columns, but stretch across all rows of the image, which is the CCD clocking direction during readout. Readout streaks present two problems:

  Very bright field sources will bias potentially both the flux and positions of neighbouring sources encroaching upon the readout streak.

  A readout streak may potentially generate spurious source detections.
- **Source on a Smoke Ring** A smoke ring is an out of focus ghost image of a bright star caused by internal reflection of light within the detector window. The smoke ring is displaced in the radial direction away from the primary image due to the curvature of the detector window. The detector window reflectivity reduces with increasing photon energy so smoke rings are less frequently seen in the UV filter images. Sources lying in or near a smoke ring might have the photometry compromised by the smoke ring.

- **Source on a Diffraction Spike** The secondary mirror support vanes give rise to diffraction spikes in the brightest sources which provide undesirable image structure around neighbouring sources and generate spurious sources.
- **Source affected by Mod-8 pattern** Sources with count rates approaching 1 count per image frame are subject to coincidence loss, which distorts the PSF and gives rise to a modulo-8 pattern in the region surrounding the source. The morphologies of such sources cannot be recovered and hence they are flagged during construction of the catalogue. At very high count rates, coincidence loss leads to saturation and the photometry of sources cannot be recovered. Occasionally, sources approaching saturation can lose counts due to integer wraparound in individual pixels of the raw data. Photometry of sources approaching the saturation limits should always be treated with caution.
- **Source within Central enhancement** Diffuse light from the sky background reflecting off a chamfer in the detector window housing causes an ring of emission, enhanced by a factor of 2, in the centre of the detector image. Sources within this region are flagged whether or not the background level is large enough to have a significant effect on the photometry. The reflectivity of the ring reduces with increasing photon energy so this is less prominent in the UV filter images.
- **Source near a bright source** The structure around bright sources can lead to spurious sources being detected.
- **Source near edge** Photometry and astrometry will be compromised if a source is partly outside the imaged area. Sources for which any part of the photometric aperture lies outside the field of view are flagged. Since images covering different areas and lying at different angles can be stacked together, there can be more sources affected by this flag than might be expected.
- **Source within an extended source** Photometry of point sources is complicated if they overlap an extended source because both source and background aperture will include some contribution from the extended source. If any pixel of the photometric aperture of a point source is shared by an extended source, then the point source is flagged.
- **Very bright pixel lies within photometry aperture** Indicates that the source has an isolated extremely bright pixel within the photometry aperture.
- **Multiple exposure values within photometry aperture** In the case of stacked images, parts of the image can be built up of more exposure time than other parts. Photometry and astrometry will be compromised if any part of the photometric aperture has a different exposure time. This can also occur if data has been lost or corrupted.
- **Source is too bright** At very high count rates, coincidence loss leads to saturation and the photometry of sources cannot be recovered. Occasionally, sources approaching saturation can lose counts due to integer wraparound in individual pixels of the raw data. Photometry of sources approaching the saturation limits should always be treated with caution. The saturation limit has been set at 0.97 counts per frame. For these sources the rates, fluxes and magnitudes have been removed.

3.3 Format of SUMMARY table

The catalogue **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 **SRCLIST** table. Each source can be linked to the observation details in the SUMMARY table via this number.

3.3.2 REVOLUTION

This gives the XMM-Newton revolution number in which the observation was made.

3.3.3 OBSID

This gives the unique observation identification number.

3.3.4 TARGET

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

3.3.5 FILTERS

This lists the filters used in the observation.

3.3.6 MJD_START and MJD_END

This are the dates (in Modified Julian Date) within which the exposures for this observation were taken.

3.3.7 RA_PNT and DEC_PNT

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

3.3.8 RA_PNT_HMS and DEC_PNT_DMS

The Right Ascension and Declination (J2000) of the telescope pointing direction for the observation in astronomical angular units (hours, minutes and seconds of time for RA and degrees, angular minutes and arcseconds for Dec).

3.3.9 EXPOSURE_filter

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

3.3.10 NSOURCES and NSOURCES_filter

The total number of sources detected in this observation and also per filter.

3.3.11 DETLIM_filter

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

3.3.12 RAOFFSET and DECOFFSET

The offset in arseconds between the requested (nominal) pointing and the actual pointing as determined by aspect correction using the USNO catalogue.

3.3.13 RAOFFSET_ERR and DECOFFSET_ERR

Error on RAOFFSET and DECOFFSET (in arcsec).

3.3.14 OFFSET_RMS

The goodness of fit of the Aspect Correction

V. N. Yershov, A. A. Breeveld and A. Talavera
2017-04-10