
An introduction to XMM-Newton catalogues

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Catalogues

Most observatories now provide some form of catalogue of detections/sources

Catalogues are useful for :

- Quick access to data products (fluxes, spectra, images, etc)
- Finding new objects
- Population studies
- Cross correlation for multi-wavelength studies

They cover all wavelengths and contain a variety of information

Existing catalogues at : <http://vizier.u-strasbg.fr/viz-bin/VizieR>

- 25839 catalogues

Any one catalogue is usually provided in >1 format

Catalogue formats

Catalogues are often provided in tabular form (fits, csv, text)

These tabular forms can be manipulated with :

- sql scripts
- ftools
- excel (or similar)
- dedicated software such as Topcat/Stilts
- scripts (python, c, idl,)
- many other things !



Often online tools to use to access and visualise data

Allows you to have complete freedom to access all aspects of the catalogue

Inside the catalogues

In general : unique identification of each detection

position of detection

error on position

source extension

time/date of observation

measure of the quality of the detection

measure of flux/magnitude in one or several bands

error on the flux/magnitude

Can also include :

- unique source identification
- spectral/timing products
- measure of the spectra/variability
- images
- tentative source identification
- observing conditions

...and many other products !



XMM-Newton catalogues

- EPIC X-ray detection catalogue – latest version, 4XMM-DR14 (July 2024)
- EPIC X-ray stacked source catalogue - latest version, 4XMM-DR14s (Jul. '24)
- OM UV & optical catalogue – latest version, SUSS6.2 (October 2023)
- EPIC pn slew survey – latest version, XMMSL3 (February 2025)

But also :

- Upper limit servers (FLIX & HiLiGT & RapidXMM) <http://flix.irap.omp.eu/> <https://xmmuls.esac.esa.int/upperlimitserver/> &
- Value added products (classifications (X-ray + optical), spectral fits, redshift, optical variability, ...) <http://xmm-ssc.irap.omp.eu/xmm2athena/>
- Transient alerts <http://flix.irap.omp.eu/stonks>

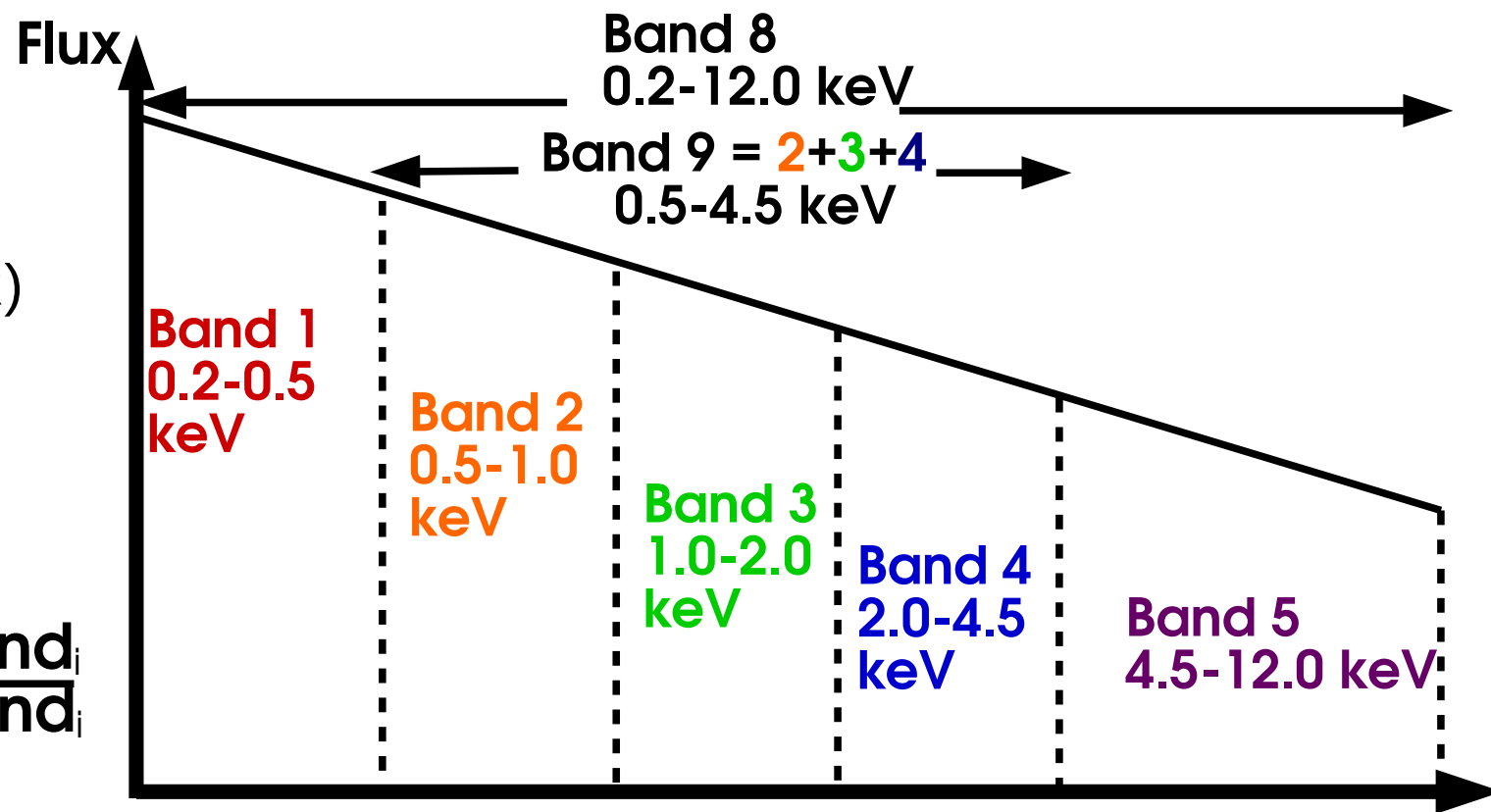
And many servers to access the data :

<http://xmmssc.irap.omp.eu/> <https://xcatdb.unistra.fr/>
<https://nxsa.esac.esa.int/nxsa-web/#search>
<https://xmmssc.aip.de/query/>
<https://heasarc.gsfc.nasa.gov/W3Browse/xmm-newton/xmmssc.html>
<http://xmm-catalog.irap.omp.eu/>

336 columns of information including :

- Identifiers/coordinates
- Observation date/time and observing mode
- Exposure
- /background info
- Extent
- Counts/fluxes/rates
- Hardness ratios (HR)
- Maximum likelihood
- Quality flags
- Variability

$$HR_i = \frac{\text{Band}_{i+1} - \text{Band}_i}{\text{Band}_{i+1} + \text{Band}_i}$$

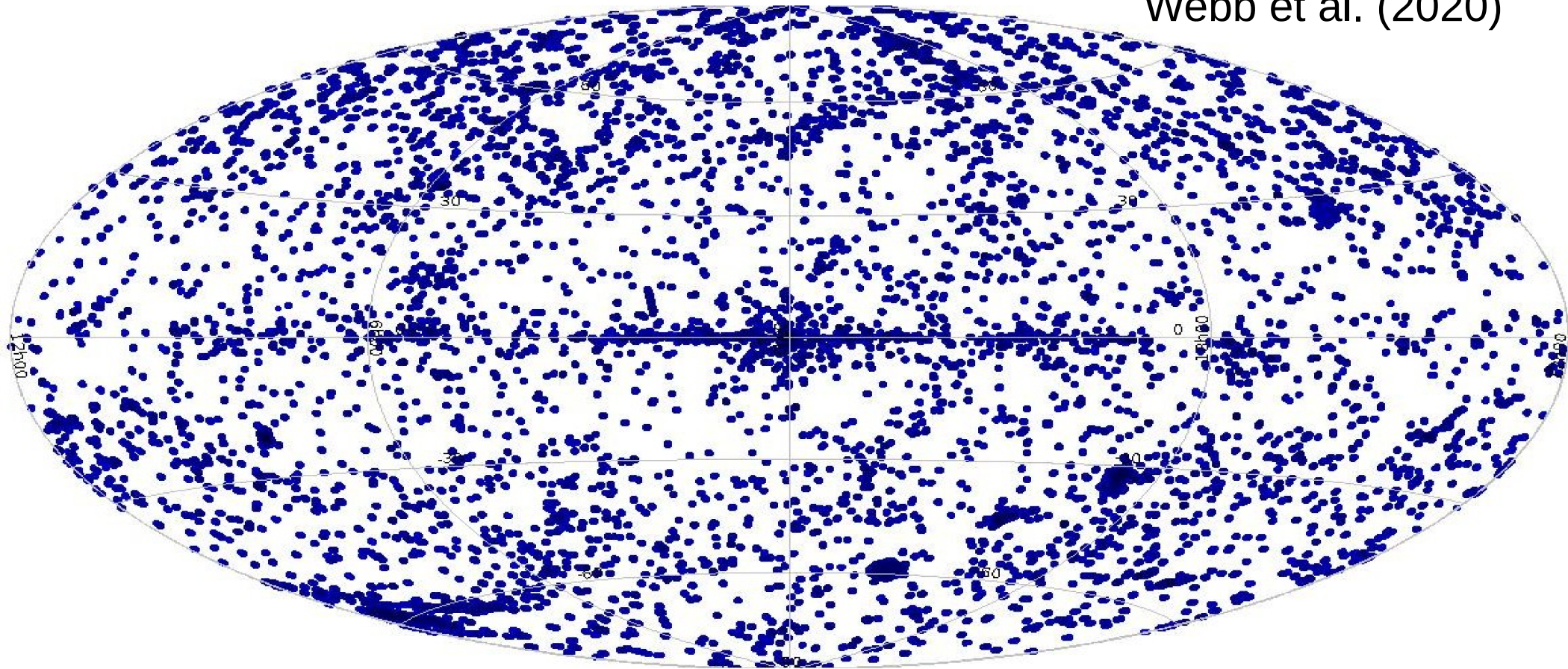


4XMM-DR14 data



1035832 detections, 692109 sources
372313 (36%) with spectra & lightcurves
 ≤ 90 detections/source
Release: 9th July 2024

Webb et al. (2020)



<http://xmmssc.irap.omp.eu>

Catalogue of sources from stacking data

349 columns of information with similar information to the detection catalogue :

- Identifiers/coordinates
- Observation date/time and observing mode
- Exposure /background info
- Extent
- Counts/fluxes/rates
- Hardness ratios (HR)
- Maximum likelihood
- Quality flags
- Variability (**per band**)

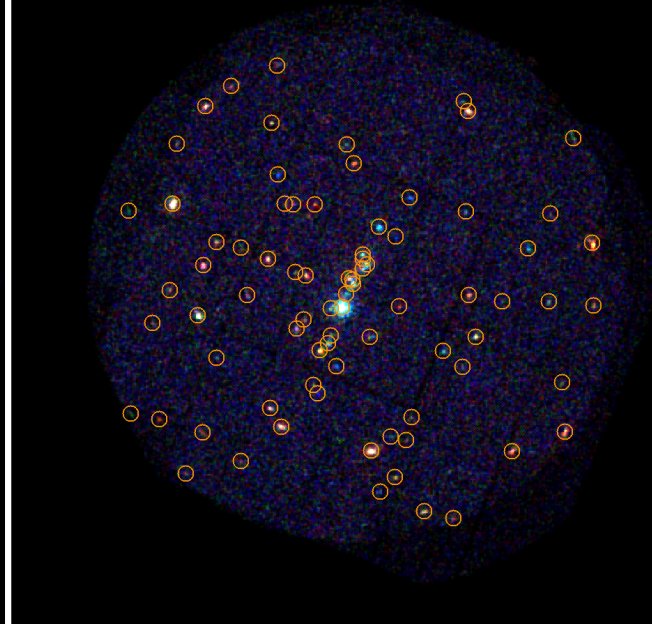
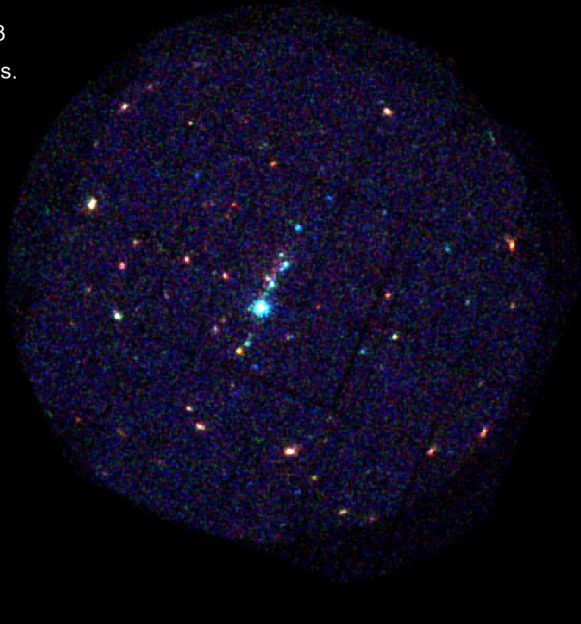
Additional stack specific information :

- Number of exposures per source and for the source detection
- image coordinates & offsets needed for stacking

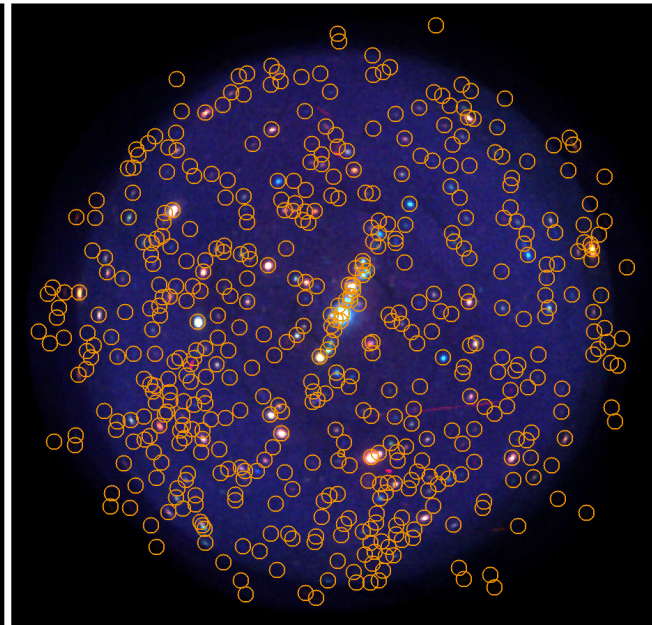
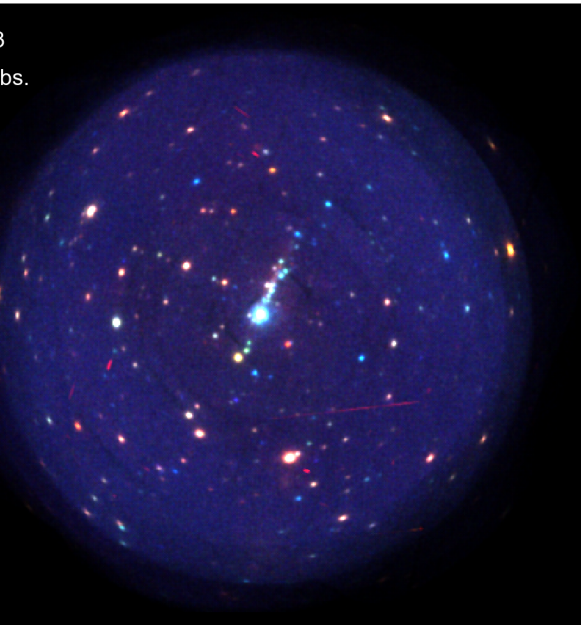
4XMM-DR14s data



2003
1 obs.



2023
31 obs.



4XMM-DR14s

10336 observations

1751 stacks

<2.8 Ms per stack

427522 sources

~16% new sources wrt
4XMM-DR14

(Traulsen et al. 2020)

<http://xmmssc.irap.omp.eu>

Other 4XMM-DR14 products



- Catalogue (FITS & CSV) + slim (source) version of detection catalogue
- Spectra, lightcurves, images, multi-wavelength counterparts
- SQL scripts to read catalogue
- List of all observations as fits/text
- Multi-Order-Coverage maps (MOCs), per observation & per catalogue
- Flux maps per observation (counts and rates)
- Spectral Energy Distributions (SEDs)
- FLIX sensitivity estimator <http://flix.irap.omp.eu>
- Extensive User Guide with plots showing detections, flux limits, etc
- + all the products present in the XMM-Newton Science Archive (and elsewhere!)

<http://xmmssc.irap.omp.eu>



FLIX sensitivity estimator

- Provides sensitivity limit in case of a non-detection

Enter coordinates to estimate sensitivity

Supported coordinates format: 12h34m56.2s -08d24m20.6s
12:34:56.2 -08:24:20.6
12.345 -13.678

Or upload a file with a list of coordinates

Choose file No file chosen

FLIX SENSITIVITY ESTIMATOR

23h57m14.928s 56d43m38.3016s

HOME WEB SERVICES DOCS LINKS ABOUT

Query coordinates: 23h57m14.928s +56d43m38.3016s

Detection maximum likelihood threshold: 10

Radius of circle for flux estimation: 30"

Nearest sources in XMM catalogue:

- 205535103010018 (88.12")
- 205535103010017 (125.83")
- 205535103010019 (135.14")
- 205535103010032 (224.88")
- 205535103010005 (234.0")
- 205535103010012 (245.67")

Average detection threshold - band 8: 1.9e-14 erg/cm2/s

Average encircled flux - band 8: 5.4e-14 erg/cm2/s

Observations of this field at different epochs

Obsid	Date Obs	Axis Offset (arcmin)	Instrument	Filter	Exposure (sec)	Detection Threshold - band 8 (erg/cm2/s)	Encircled Flux - band 8 (erg/cm2/s)
0553510301	2008-06-21	0.0	M1	Medium	11968	2.12e-14	8.13e-14 ± 1.36e-14
			M2	Medium	18112	1.98e-14	5.59e-14 ± 1.14e-14
			PN	Medium	4752	1.57e-14	2.46e-14 ± 8.33e-15

Download full results as: FITS

NEWS

03 Apr 2023

New version of FLIX available! Changes include:

- performance improvements (processing time divided by 2)

WEBSITE C

This website provides exp sensitivity estimator for XN by the XMM-Newton Surve is based on 4XMM Data D

http://flix.irap.omp.eu/

XMMSL3 data

Catalogue of pn detections made during slews between observations

99 columns of information with only 2 bands (0.2-2.0 & 2.0-12.0 keV) + full band:

- Identifiers/coordinates
- Observation date/time and observing mode
- Exposure /background info
- Extent
- Counts/fluxes/rates
- Hardness ratios (HR)
- Maximum likelihood
- Quality flags
- Variability

Additional slew specific information :

- Source identification (where possible)

XMMSL3 data

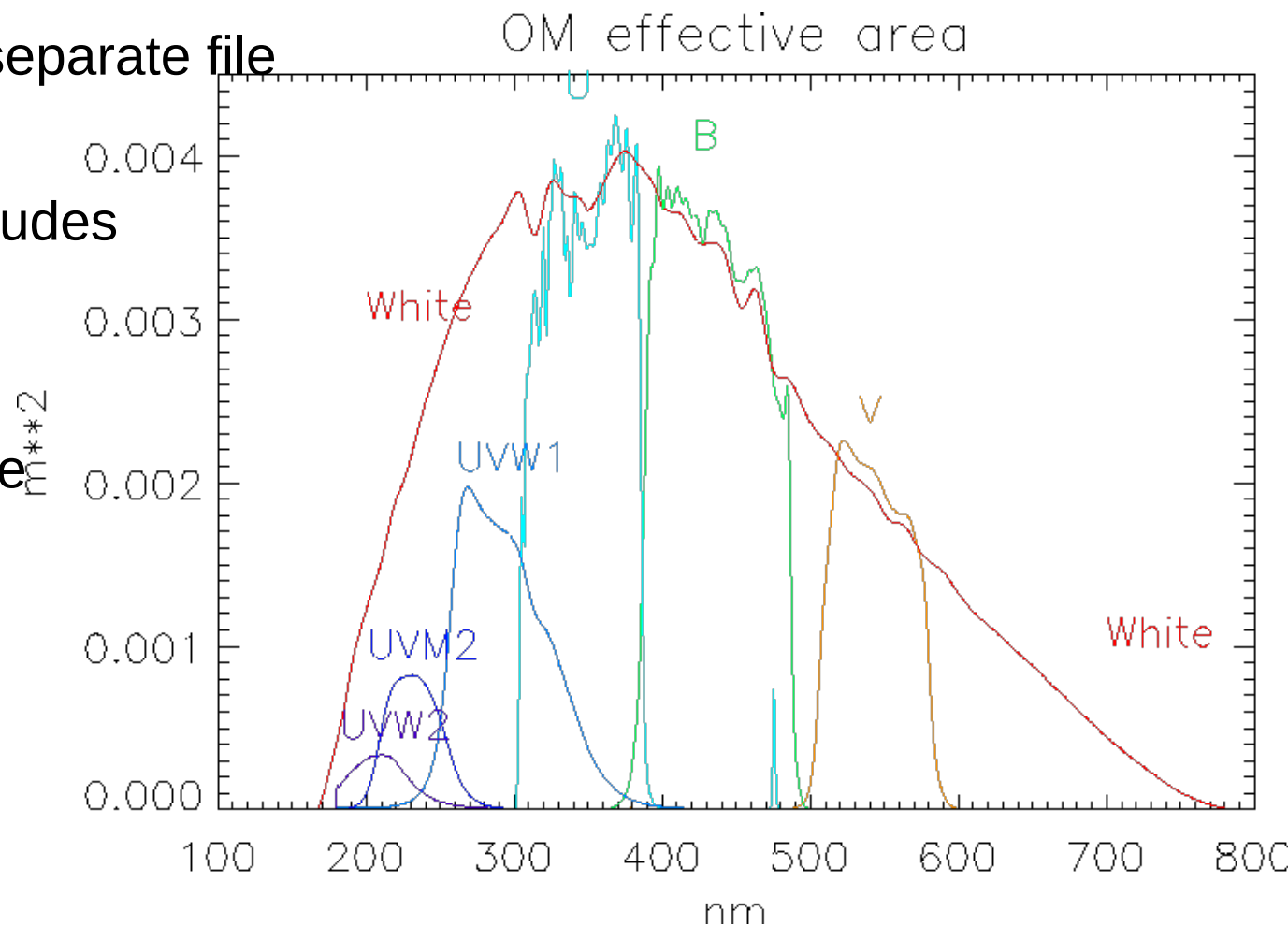
- Period : August 2001-August 2023 (Saxton et al. 2008)
- 140735 detections (68383 new detections)
- 25695 flagged (18%), mostly high background
- Released 19th February 2025



SUSS 6.2

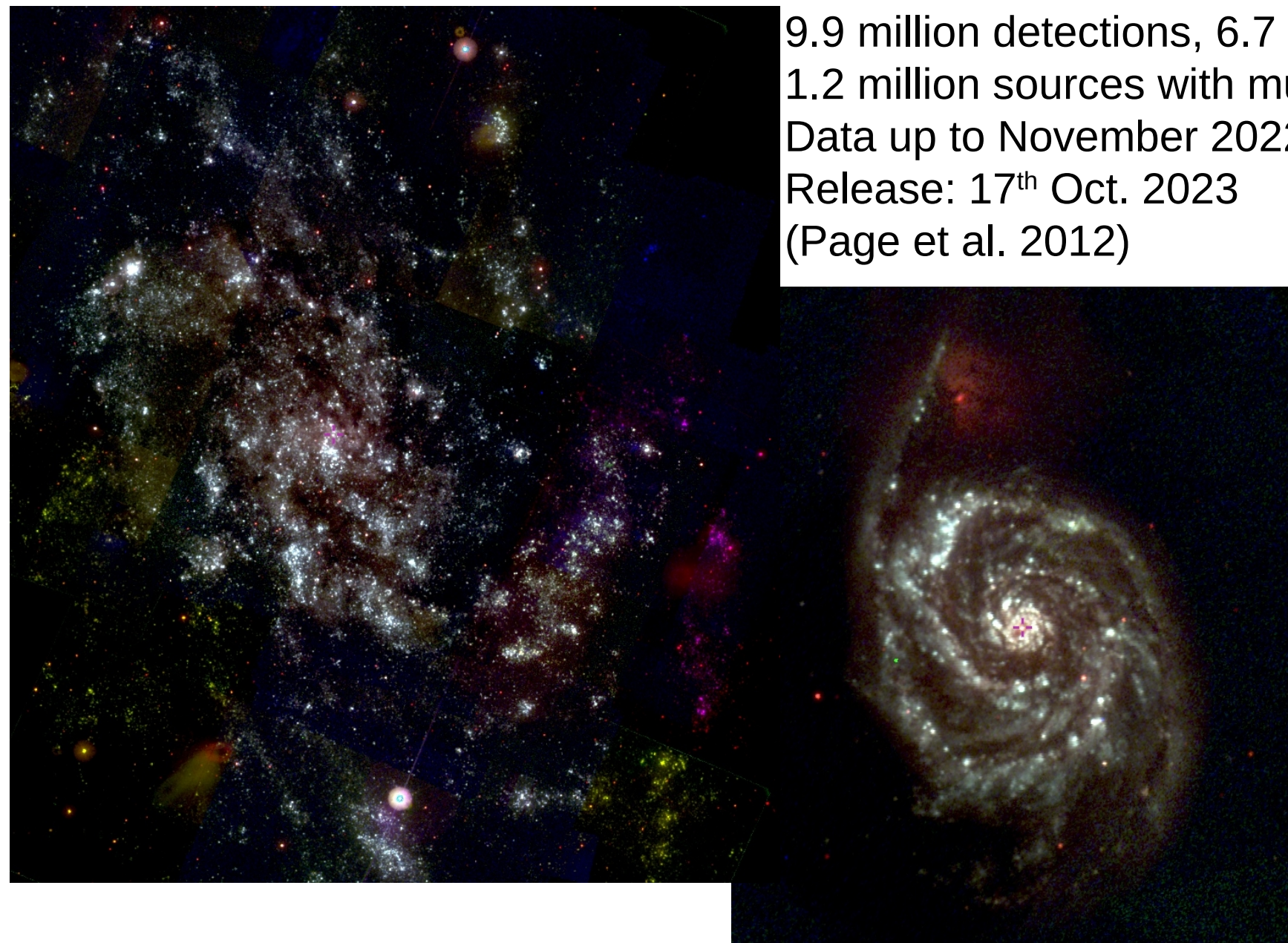
OM catalogue (ultra-violet: UVW2, UVM2, UVW1 + optical: U, B, V) of detections
116 columns of information:

- Identifiers/coordinates
- Observation date/time in separate file
- Extent
- Fluxes, rates & AB magnitudes
- Source significance
- Quality flags
- Detection in stacked image
- Whether fast data exists



SUSS 6.2

9.9 million detections, 6.7 million sources
1.2 million sources with multiple obs.
Data up to November 2022
Release: 17th Oct. 2023
(Page et al. 2012)



What is this source ?

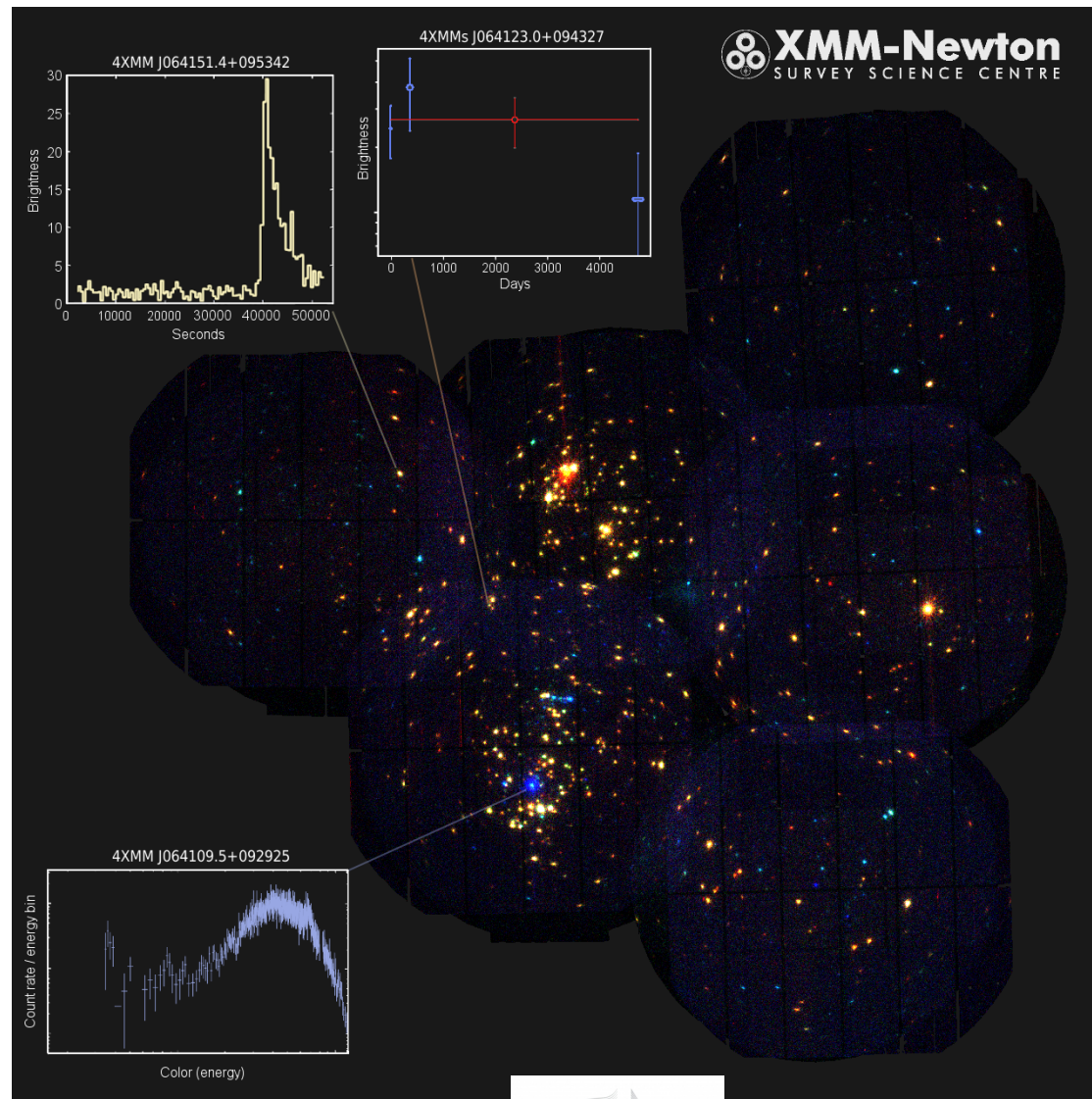
What does it look like at other wavelengths ?

Has it always looked this way or does it change ?

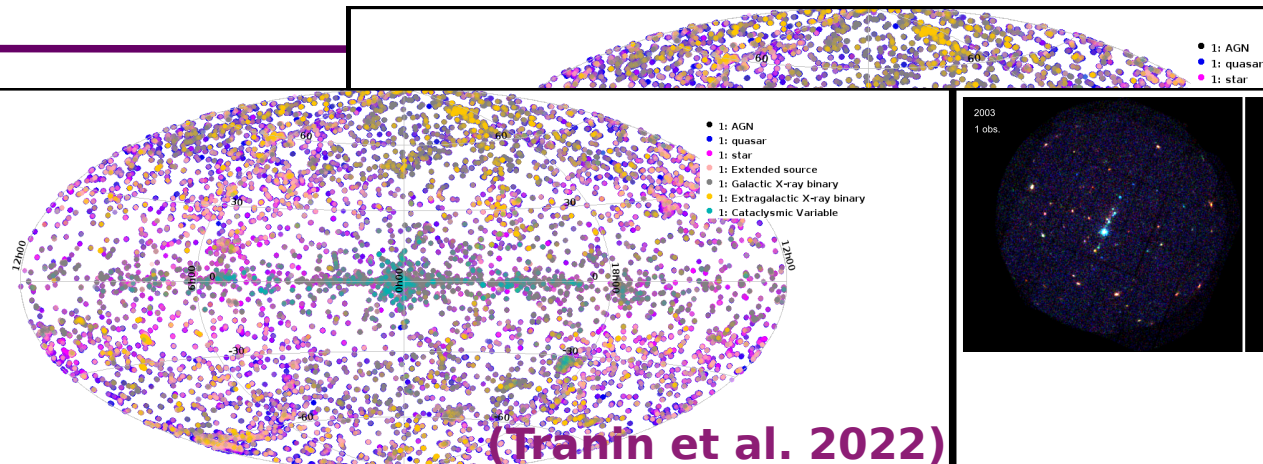
What does the X-ray spectrum look like ?

How far away is it ?

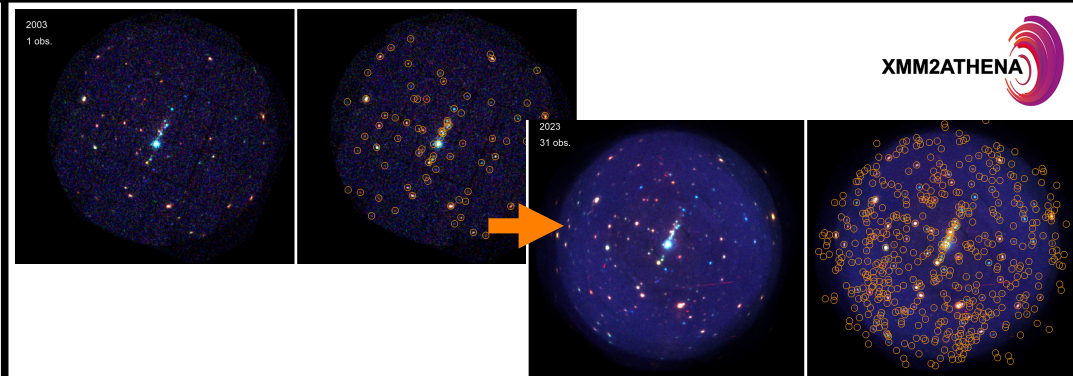
Can we detect new fainter sources ?



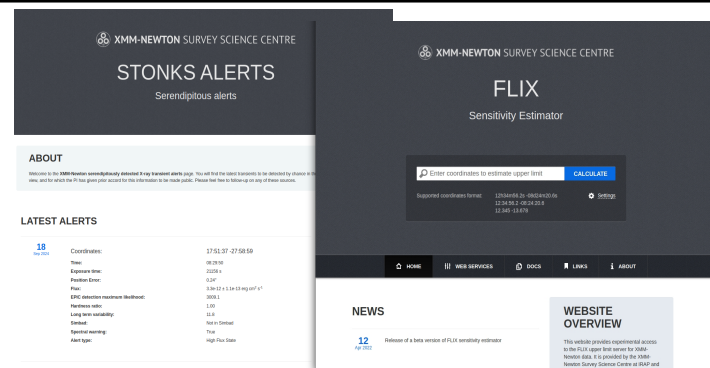
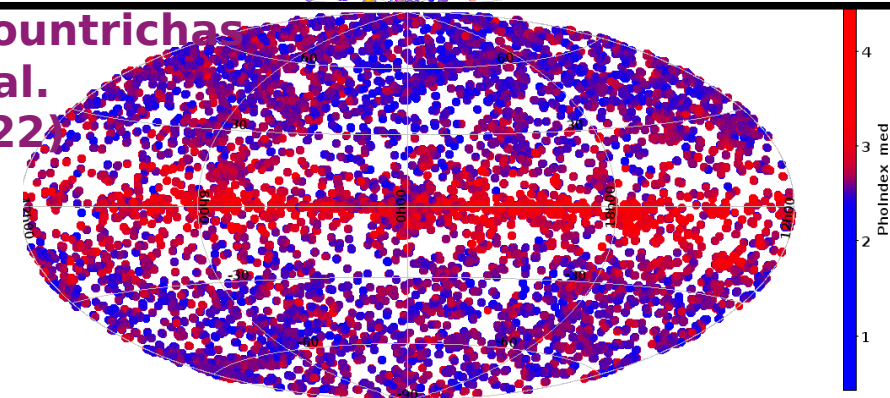
This project has received funding from the European Union's Horizon 2020 programme under grant agreement No 101004168



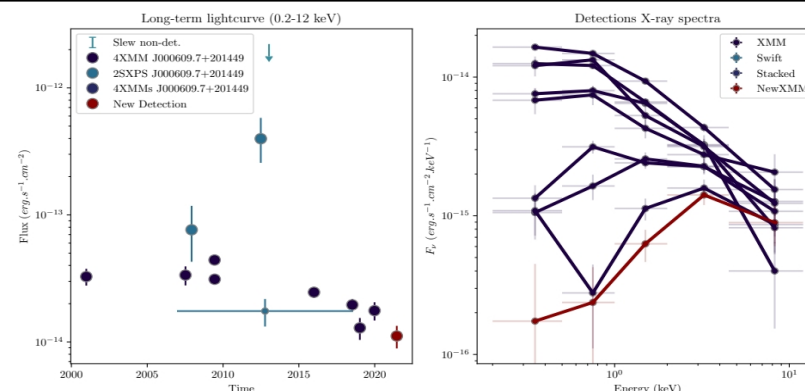
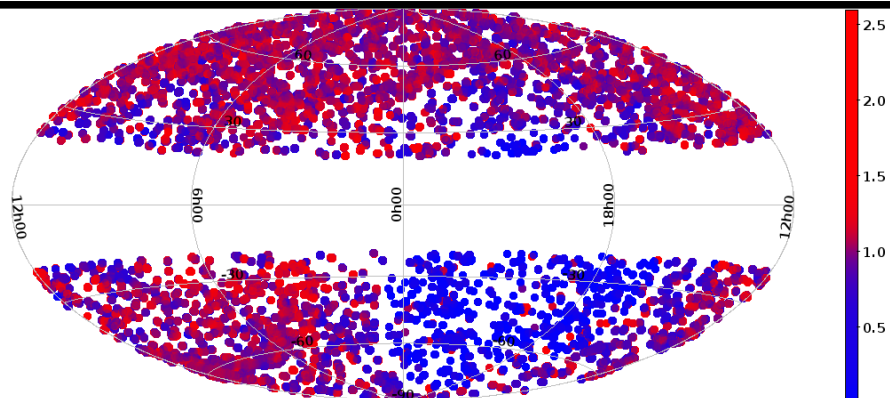
(Tranin et al. 2022)



(Mountrichas et al. 2022)



(Quintin et al. 2024 & Webb et al. 2023)


<http://xmm-ssc.irap.omp.eu/xmm2athena/>

XMM-Newton
SURVEY SCIENCE CENTRE

Natalie Webb

ACME Workshop on Swift & XMM-Newton data analysis, Oct. 2025

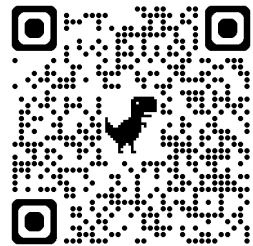
- Re-processed all 17199 observations ready for production of 5XMM
- Catalogue simplified, one single stacked catalogue, with ~441 columns
- To include :
 - OM + multi-wavelength counterparts
 - upper limits
 - long-term variability information + OM variability
 - spectral fits
 - classifications
 - photometric redshifts
- Expected for June 2026



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Topcat – Tool for Operations on Catalogues And Tables

- Allows to view table and meta-data
- Perform statistics on data
- Create plots of data
- Match/concatenate tables
- Perform functions (conversions, arithmetic, format change, ...)
- Use virtual observatory data/software
- Link several virtual observatory services together



Please also download for this session :

- SUSS 6.2 <https://www.cosmos.esa.int/web/xmm-newton/xsa#download>
- 4XMM-DR14s : <https://xmmssc.aip.de/cms/catalogues/4xmm-dr14s/>

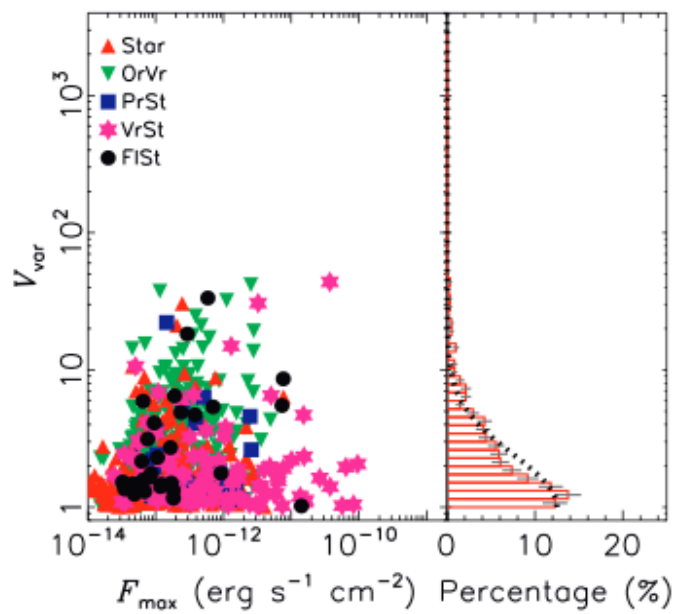
Using Topcat to manipulate the XMM catalogues

- Use the XMM-Newton catalogues to find clean objects with X-ray lightcurves that may be compact objects

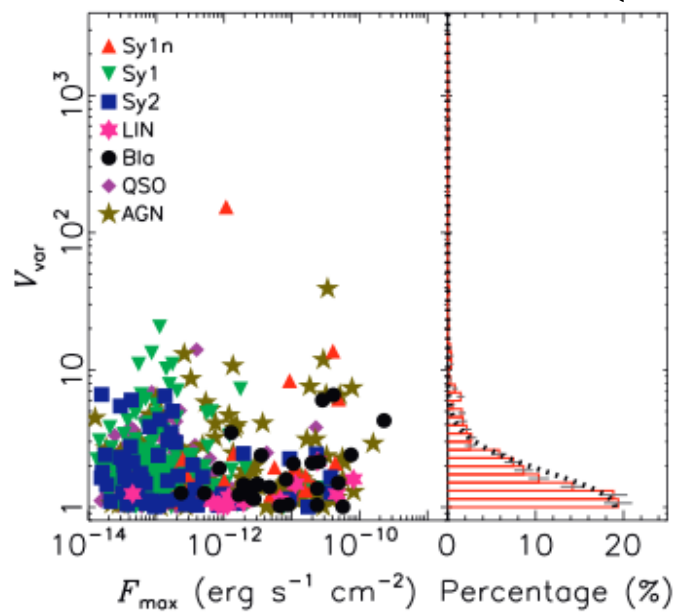
Hints

- Accreting compact objects often have high F_x/F_{opt} ratios
- They can be strongly variable

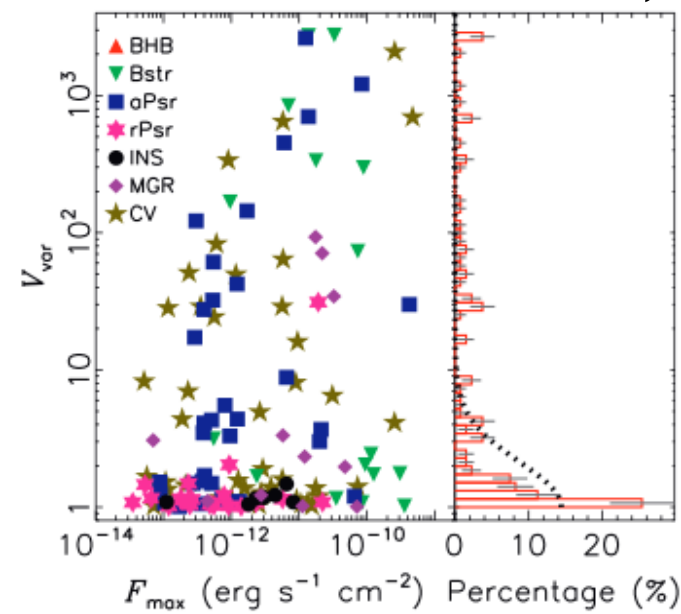
(Lin, Webb & Barret 2012)



(a) Stars



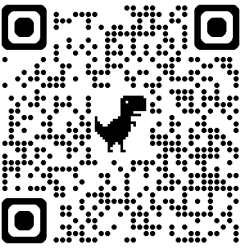
(b) AGN



(c) Compact objects



Find compact objects with X-ray lightcurves



- Retrieve 4XMM-DR14 :
http://xmmssc.irap.omp.eu/Catalogue/4XMM-DR14/4XMM_DR14.html and
SUSS 6.2 <https://www.cosmos.esa.int/web/xmm-newton/xsa#download>

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Find compact objects with X-ray lightcurves



- Retrieve 4XMM-DR14 :
http://xmmssc.irap.omp.eu/Catalogue/4XMM-DR14/4XMM_DR14.html and
SUSS 6.2 <https://www.cosmos.esa.int/web/xmm-newton/xsa#download>
- Cross-match 4XMM-DR14 and SUSS 6.2 using POSERR, common to both
- Use a 2σ radius = $2 \times 1.0714 \times \text{POSERR}$
- There are 205377 matches
- Create a new column in this new table – click right
- Use EP_8_FLUX/V_AB_FLUX
- Use clean optical sources :
V_QUALITY_FLAG_ST== »FFFFFFFFFFFFFFFF »
- Use clean X-ray sources : SUM_FLAG==0
- Create a new subset with these criteria :

Define Row Subset

Window Help

f(x) ? X

Subset Name: Comp. obj. candidates

Expression: `Ex Fopt>10 && Tseries && V_QUALITY_FLAG_ST=="FFFFFFFFFFFFFFFF" && SUM_FLAG==0`

OK Cancel

Match Tables

Window Tuning Help

Match Criteria

Algorithm: Sky with Errors

Scale: 2.1428 arcsec

Table: 4: XMM-OM-SUSS6.2.fits

RA column: RA degrees

Dec column: DEC degrees

Error column: POSERR arcsec

Table 2:

Table: 2: 4xmmdr14_240411.fits

RA column: RA degrees

Dec column: DEC degrees

Error column: POSERR arcsec

Output Rows

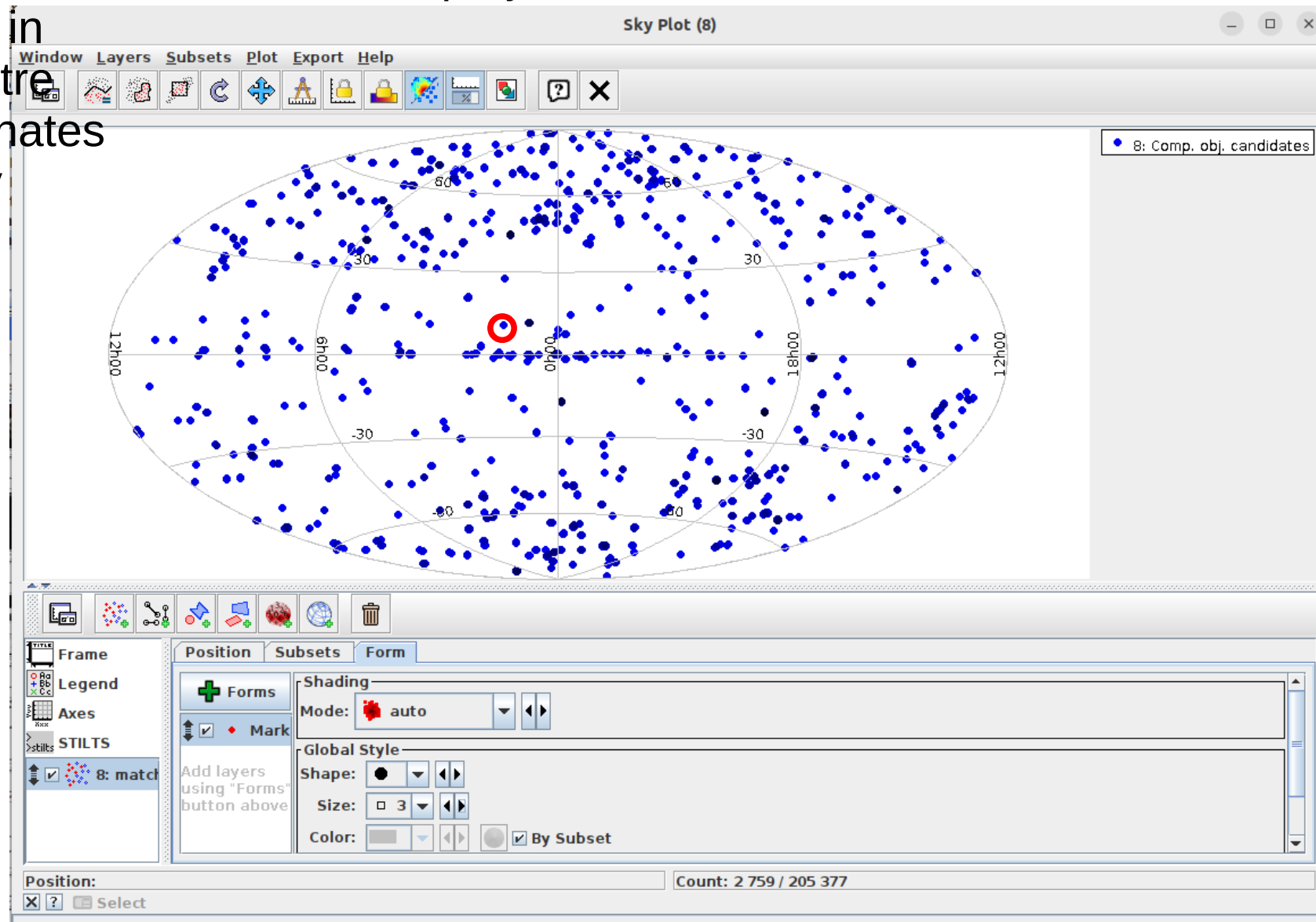
Match Selection: Best match for each Table 1 row

Identify shared refs...
Map links to groups...
Populate index maps...
Match succeeded

Go Stop

Finding compact objects with X-ray spectra/lightcurves

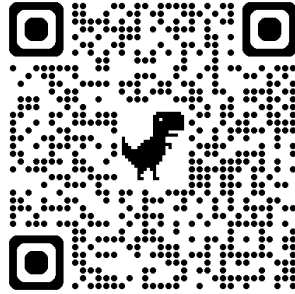
- Plot new subset in Hammer-Aitoff projection:
- Choose one in Galactic centre
- Copy coordinates into ESASky
- View source & products



Finding clean point like sources in extended emission

- Cross-match 4XMM-DR14 with the slew catalogue that you can retrieve here :

<http://xmmssc.irap.omp.eu/Catalogue/XMMSL3/XMMSL3.html>



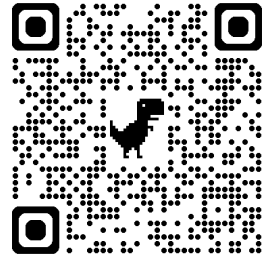
Finding clean point like sources in extended emission

- Cross-match 4XMM-DR14 with the slew catalogue that you can retrieve here :
<http://xmmssc.irap.omp.eu/Catalogue/XMMSL3/XMMSL3.html>
- Use a 2σ radius, but here use RADEC_ERR which is common to both catalogues & is 1σ
- Select a subsample using the slew (with poorer resolution) $EXT_B8 > 6$ (extended emission) with $VAL_FLAG == \text{»CLEAN_SAMPLE«}$ and 4XMM-DR14 $EP_EXTENT < 6$ (point-like source) with the $SUM_FLAG == 0$
- Identify the nature of the source in the centre of the aitoff projection (galactic view sky system and equatorial data sky system) using the slew catalogue
- Check the source nature through ESASky – what is the object ?



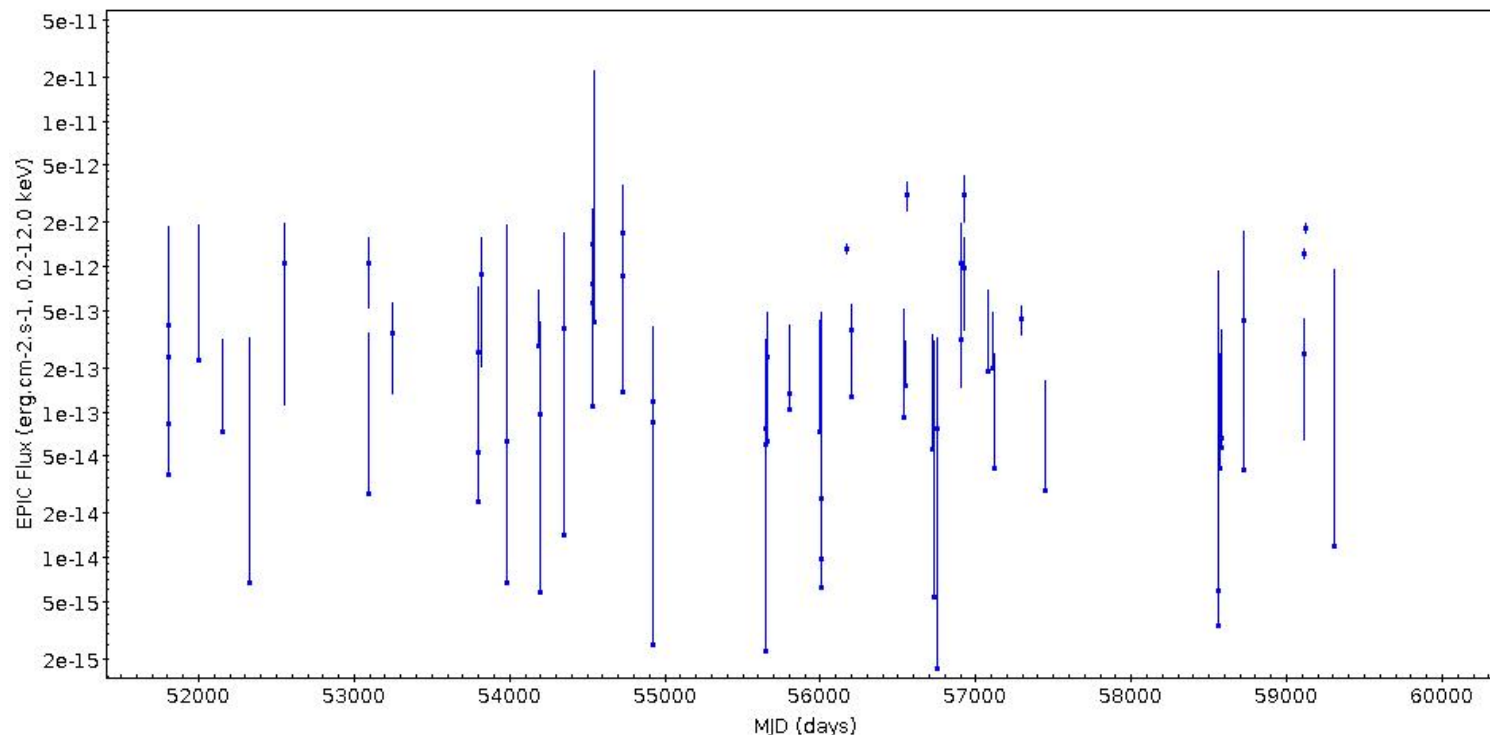
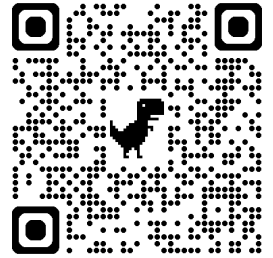
Find a clean source with >70 pointings & plot lightcurve

- Retrieve the 4XMM-DR14s catalogue here :
<https://xmmssc.aip.de/cms/catalogues/4xmm-dr14s/>



Find a clean source with >70 pointings & plot lightcurve

- Retrieve the 4XMM-DR14s catalogue here :
<https://xmmssc.aip.de/cms/catalogues/4xmm-dr14s/>
- Sort the column N_CONTRIB to find sources with >70 pointings
- Choose one source and create a subset of all clean detections (STACK_FLAG==0) using the SRCID
- Plot the EP_FLUX (band 8) and EP_FLUX_ERR (use the form +) as a function of time with the Topcat plotting tool



Using the online data archives

<http://xmm-catalog.irap.omp.eu/>

Provide a 4XMM-DR14 source name or do a cone search

e.g. J133129.6+110755

or : cone('13 31 29.6 +11 07 55', '1deg')

or search categories of sources (CVs, ULXs, ...)

Visualise : Image (XMM and other catalogues)

Source parameters (flux in different bands, date obs., ...)

Fit spectrum

Visualise/extract lightcurve

Cross correlate with other catalogues



Topcat – plot the 4XMM-DR14 catalogue

How many detections in 4XMM-DR14 ?
How many unique sources in 4XMM-DR14 ?
What is the mean number of detections of a source ?
What is the maximum number of detections of a source ?
Plot the whole catalogue in a Hammer-Aitoff projection :

Locate a source
in your image
and

visualise the
catalogue parameters

