The 3XMM catalogue

Natalie Webb

Institut de Recherche en Astrophysique et Planétologie
Toulouse, France

and for the XMM-Newton Survey Science Centre (SSC)
The XMM-Newton Survey Science Centre (SSC) was selected by ESA to ensure that the scientific community can exploit XMM-Newton data.

Responsibilities:
- Development of science analysis software (SAS)
- Pipeline processing of all XMM-Newton observations.
- Follow-up/identification of the XMM-Newton serendipitous sky - the XID Programme
- Compilation of the Serendipitous Source Catalogue.
3XMM-DR7

3 February 2000 – 15 December 2016 – made public 1st June 2017!

727790 detections, some sources up to 59 times
499266 unique sources
162045 sources with spectra and lightcurves
11220 extended sources

Covers 1032 sq. deg of sky

Cross correlation with many catalogues

Rosen, Webb et al. (2016)

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The X-ray Universe 2017, Rome, Italy
In 3XMM-DR7, the median flux:

$\sim 1.9 \times 10^{-14}$ erg cm$^{-2}$ s$^{-1}$ (0.2 - 12.0 keV)

$\sim 23\%$ sources fluxes $< 1 \times 10^{-14}$ erg cm$^{-2}$ s$^{-1}$ (0.2 - 12.0 keV)

$\sim 6 \times 10^{-15}$ erg cm$^{-2}$ s$^{-1}$ (0.2 - 2.0 keV)

$\sim 8 \times 10^{-15}$ erg cm$^{-2}$ s$^{-1}$ (2.0 - 12.0 keV)

5631 sources variable ($\chi^2 < 1 \times 10^{-5}$)
3XMM-DR7 – data proposed

332 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

\[ HR_i = \frac{\text{Band}_{i+1} - \text{Band}_i}{\text{Band}_{i+1} + \text{Band}_i} \]
3XMM-DR7 – data quality

Astrometry

- Cross-match with latest version of SDSS quasars catalogue

- Comparison between 2XMM-DR3 and 3XMM-DR7
3XMM-DR7 – relative size

X-ray missions/catalogues

<table>
<thead>
<tr>
<th>Mission/Catalogue</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHURU (1971)</td>
<td></td>
</tr>
<tr>
<td>HEAO-1 (1979)</td>
<td></td>
</tr>
<tr>
<td>ROSAT 2RXS (2016)</td>
<td></td>
</tr>
<tr>
<td>Swift 1SXPS (2014)</td>
<td></td>
</tr>
<tr>
<td>Chandra CSC 2.0 (2017)</td>
<td></td>
</tr>
<tr>
<td>XMM 3XMM-DR7 (2017)</td>
<td></td>
</tr>
</tbody>
</table>

X-ray detections

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The X-ray Universe 2017, Rome, Italy
The catalogue is excellent for:

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

2 magnetic cataclysmic variables (CVs)

(Webb et al., submitted)

1.6 hr period

2.15 hr period

credit: M. A. Garlick

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The X-ray Universe 2017, Rome, Italy
Accreting compact objects

2 more magnetic CVs

(Lin, Webb & Barret, 2014)
Extreme tidal disruption event

Lin et al. (2017)

See also poster by Sébastien Soler J20 for other examples

Natalie Webb
The X-ray Universe 2017, Rome, Italy
<table>
<thead>
<tr>
<th>ID</th>
<th>Observatory</th>
<th>Date</th>
<th>Spectral model</th>
<th>$\chi^2$/dof</th>
<th>Luminosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Rosat</td>
<td>1990 Jul 11-1991 Aug 13*</td>
<td>-</td>
<td>-</td>
<td>&lt;11</td>
</tr>
<tr>
<td>R2</td>
<td>Rosat</td>
<td>1992 Jun 20-1993 Jul 10</td>
<td>-</td>
<td>-</td>
<td>&lt;0.9</td>
</tr>
<tr>
<td>X1</td>
<td>XMM-Newton</td>
<td>2004 Sep 23</td>
<td>$\Gamma=3.4\pm0.3$</td>
<td>113.4/108</td>
<td>$11\pm^{0.1}_{4.0}$</td>
</tr>
</tbody>
</table>
# HLX-1

<table>
<thead>
<tr>
<th>ID</th>
<th>Observatory</th>
<th>Date</th>
<th>Spectral model</th>
<th>$\chi^2$/dof</th>
<th>Luminosity</th>
</tr>
</thead>
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<td>1990 Jul 11-1991 Aug 13*</td>
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</table>

![Graph showing Swift XRT count rate (0.3-10 keV) vs Modified Julian Day](image.png)
2XMM J011028.1-460421 (HLX-1, Farrell, Webb et al., Nature, 2009) ~8" from nucleus of ESO 243-49 (z=0.0224, ~95 Mpc) Associated with ESO 243-49 => $L_x = 1.1 \times 10^{42}$ erg s$^{-1}$ (0.2-10.0 keV, Wiersema et al. 2010) Spectral analysis + modelling => black hole with mass ~ $10^4$ M$\odot$

For more information on HLX-1 see poster F04
Stacked catalogue

New stacked source detection tasks in SAS to
● provide a standardised source-detection method for overlapping observations
● more convenient handling of multiple pointings for the users
● optimize stacked source parameters
● basis of a “stacked catalogue” of repeatedly observed sources

Images stacked with emldetect
Source detection using edetect_stack

<table>
<thead>
<tr>
<th>#OBS</th>
<th>#grps</th>
<th>Proto-catalogue:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>204</td>
<td>736 observations,</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>278 stacks,</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>≥ 25,500 detections</td>
</tr>
<tr>
<td>5-8</td>
<td>4-6</td>
<td></td>
</tr>
<tr>
<td>9,10,12</td>
<td>1 each</td>
<td></td>
</tr>
</tbody>
</table>
Field of view coincides with 3XMM FOV

6,880,116 detections

4,751,899 unique sources

867,022 have multiple entries

Visible (U, B and V) and UV (UVW1, UVM2 and UVW2)

Detections down to AB magnitude:  

<table>
<thead>
<tr>
<th></th>
<th>FWHM (&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVW2~ 23.0</td>
<td>1.98</td>
</tr>
<tr>
<td>UVM2~ 24.1</td>
<td>1.8</td>
</tr>
<tr>
<td>UVW1~ 24.8</td>
<td>2.0</td>
</tr>
<tr>
<td>U ~ 25.2</td>
<td>1.55</td>
</tr>
<tr>
<td>B ~ 24.0</td>
<td>1.39</td>
</tr>
<tr>
<td>V ~ 23.4</td>
<td>1.38</td>
</tr>
</tbody>
</table>

(Page et al. 2012)
3XMM-DR8 planned for first half of 2018

4XMM anticipated for 2019
- full re-reduction of all data (~10500 obs.) with improved software and improved calibration

to include:
- variability between observations in catalogue
- added variability analysis
- improved source flagging
- sky exposure for population studies
......
Summary

Wide range of rare objects found in 3XMM catalogue

New incremental version planned for 2018 (DR8)
New major version, 4XMM-DR9 planned for 2019

Access the catalogue:
XMM-Newton SSC webpages: http://xmmssc.irap.omp.eu
But also at:
XSA at ESA’s XMM-Newton SOC: http://xmm.esac.esa.int/xsa/
XCAT-DB at: http://xcatdb.unistra.fr/3xmmdr7
The IRAP catalogue server XSA: http://xmm-catalog.irap.omp.eu/
Browse at HEASARC NASA GSFC:
http://heasarc.gsfc.nasa.gov/db-perl/W3Browse/w3browse.pl
LEDAS at: http://www.ledas.ac.uk/
ESA sky: http://sky.esa.int/
Backup slides
This source is in external databases: XCatDB, Chandras CSc 20° VO Table, Swift TSXPS 20°, RCSED, Simbad 2°, Vizier 2°, NED 2°

### Detections (observations of this source at different epochs)

<table>
<thead>
<tr>
<th>detid</th>
<th>revol</th>
<th>obs_id</th>
<th>src_num</th>
<th>poserr</th>
<th>ep_6_flux</th>
<th>utc_start</th>
<th>exptime</th>
<th>ep_offax</th>
<th>spectrum</th>
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<tbody>
<tr>
<td>101125704010012</td>
<td>C100</td>
<td>012570401</td>
<td>12</td>
<td>0.325335</td>
<td>8.367034e-13</td>
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<td>4.25273</td>
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</table>