

# The XMM-Newton source catalogue

3XMM-DR8 and 4XMM

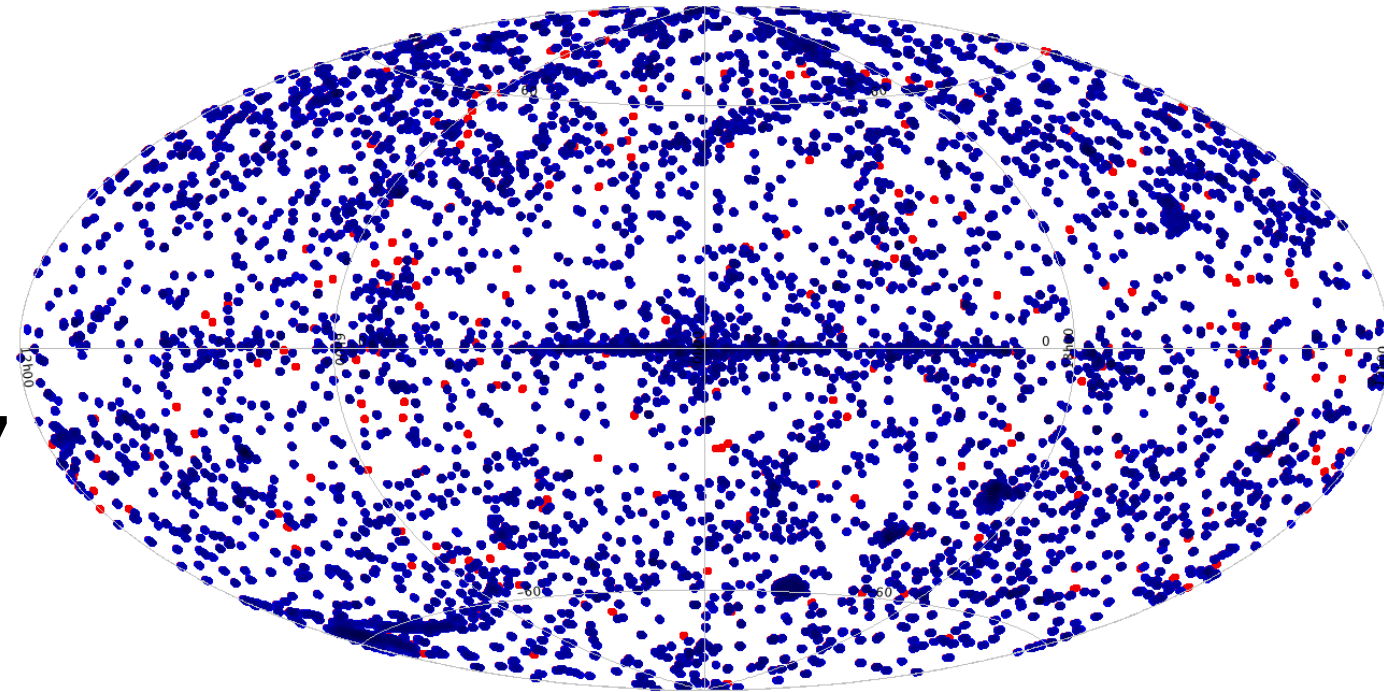
**Mickael Coriat**

On behalf of:

Natalie Webb, Filippos Koliopanos, Maïte Ceballos,  
the XMM-SSC and SOC

## 3XMM-DR8

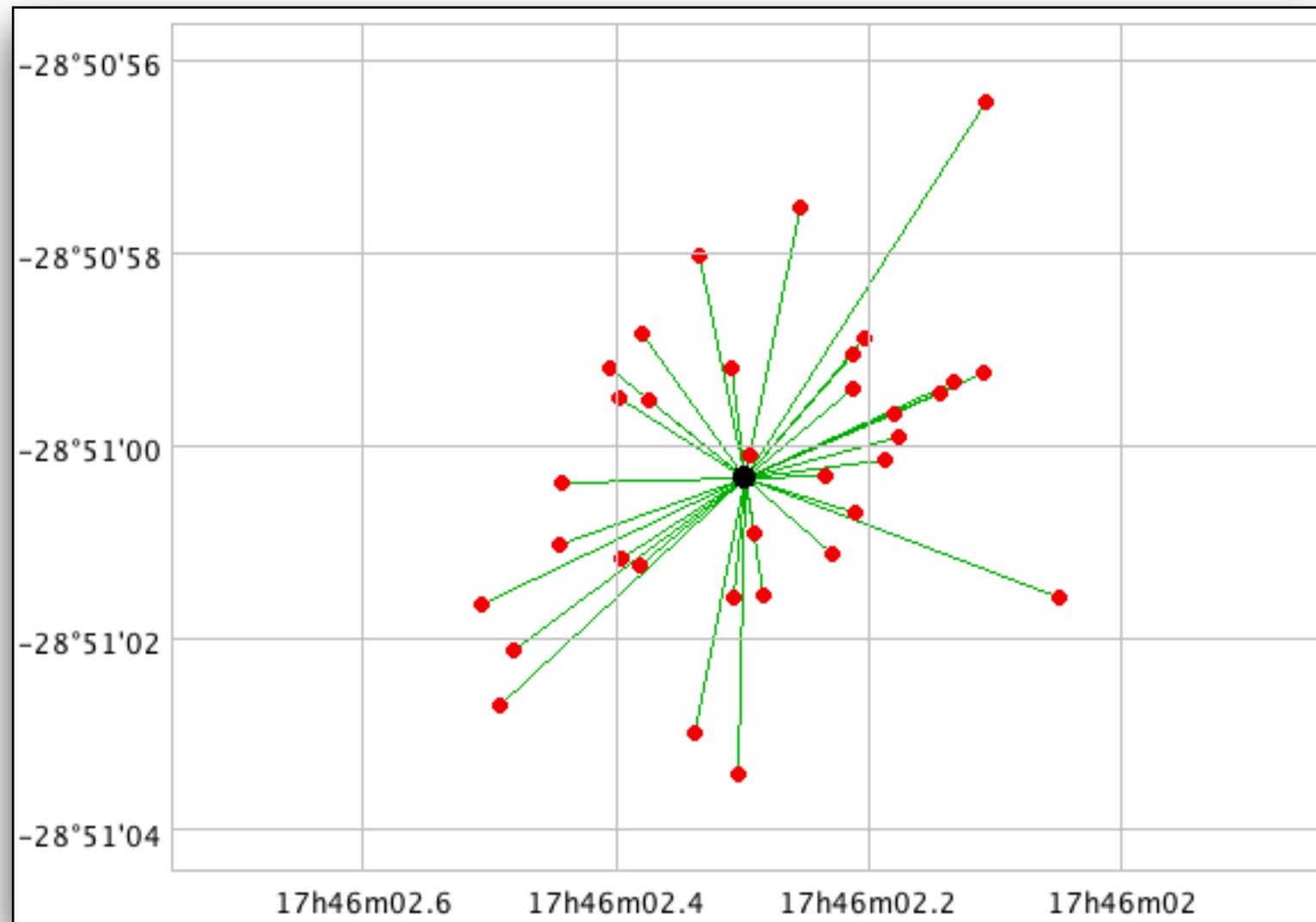
- **Made public 16 May 2018**
- Regular incremental version of 3XMM
- Observing period: Feb. 2000- Dec. 2017
- 775 000 detections
- 530 000 unique sources (some observed 59 times)
- 173 000 sources with light curves and spectra
- 12 000 extended sources
- Cross-correlations with 228 external catalogues



Covers 1089 deg<sup>2</sup> of sky

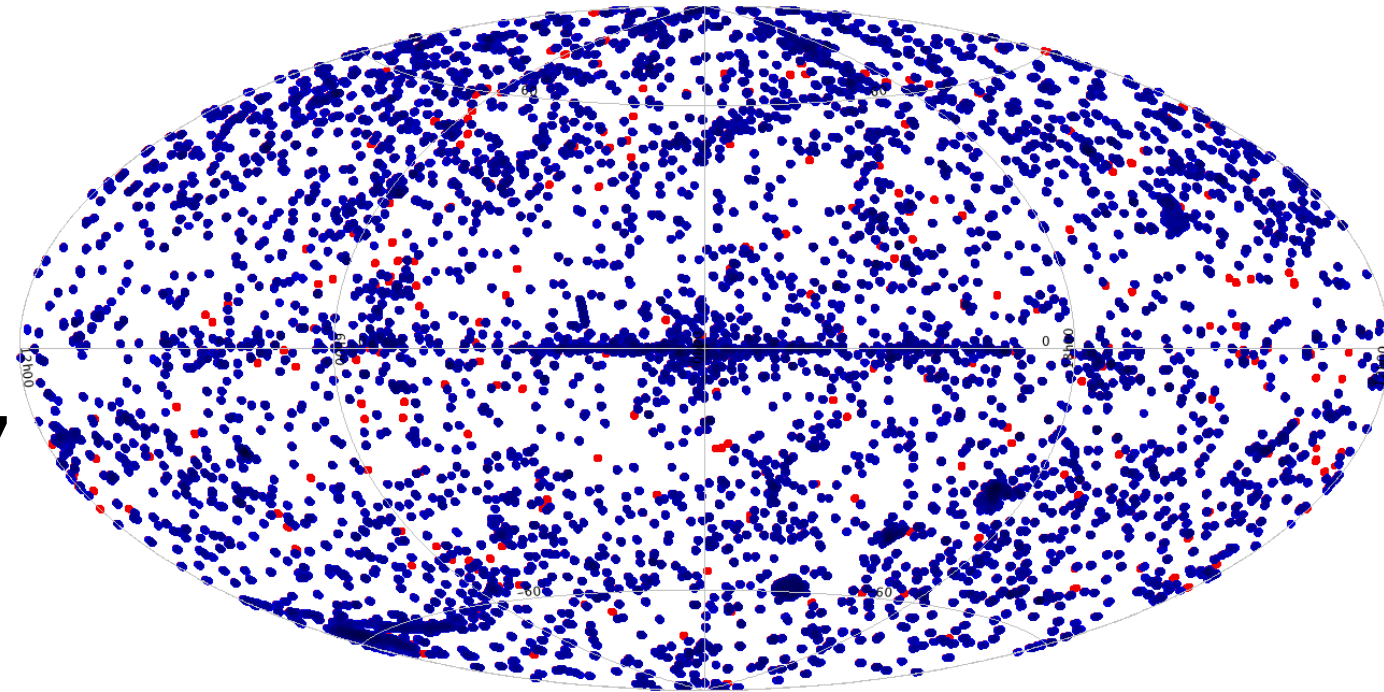
3XMM paper:  
Rosen, Webb et al. 2016

## Detections association



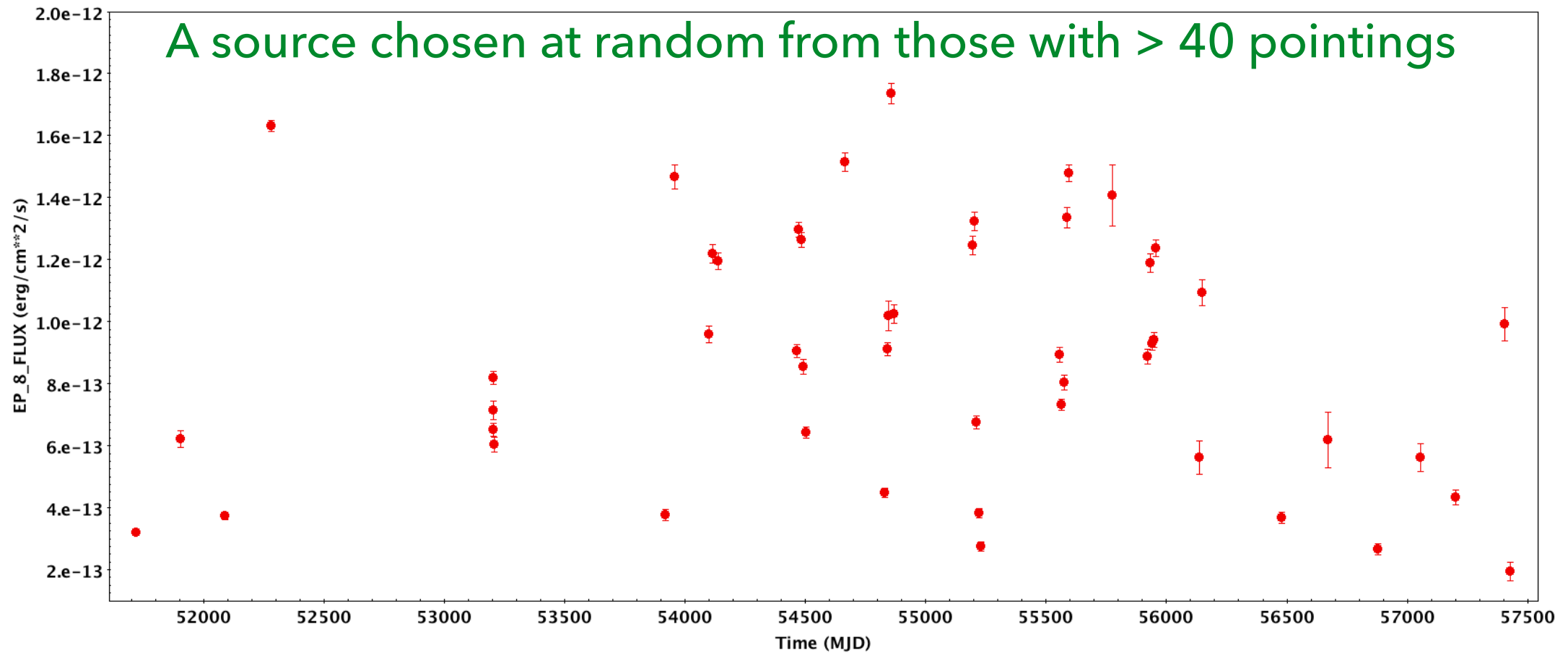
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In 3XMM-DR8, the **median flux** :

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

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

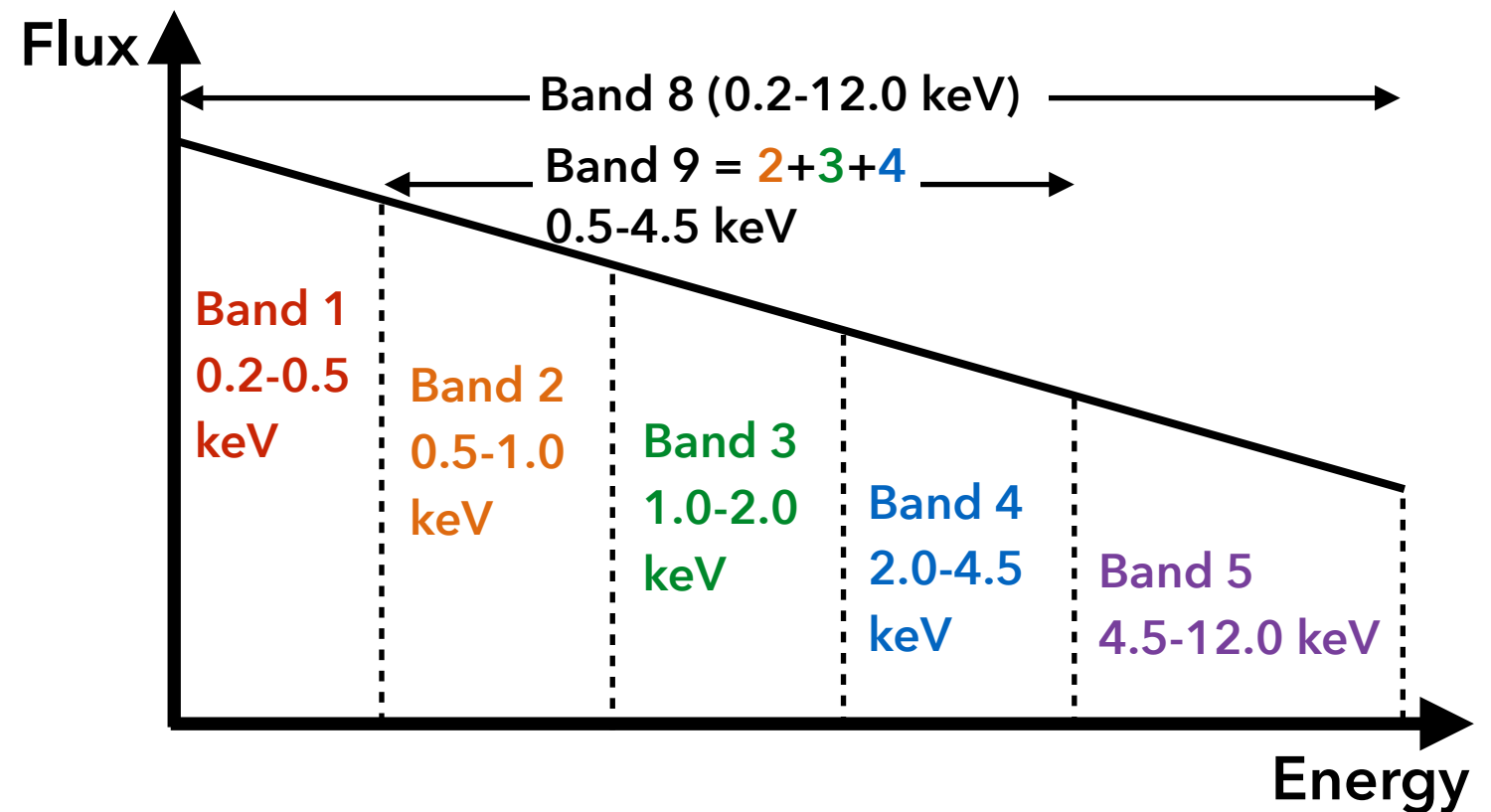
**5934 sources variable** ( $\chi^2 < 1 \times 10^{-5}$ )

## Data proposed

332 columns of information including :

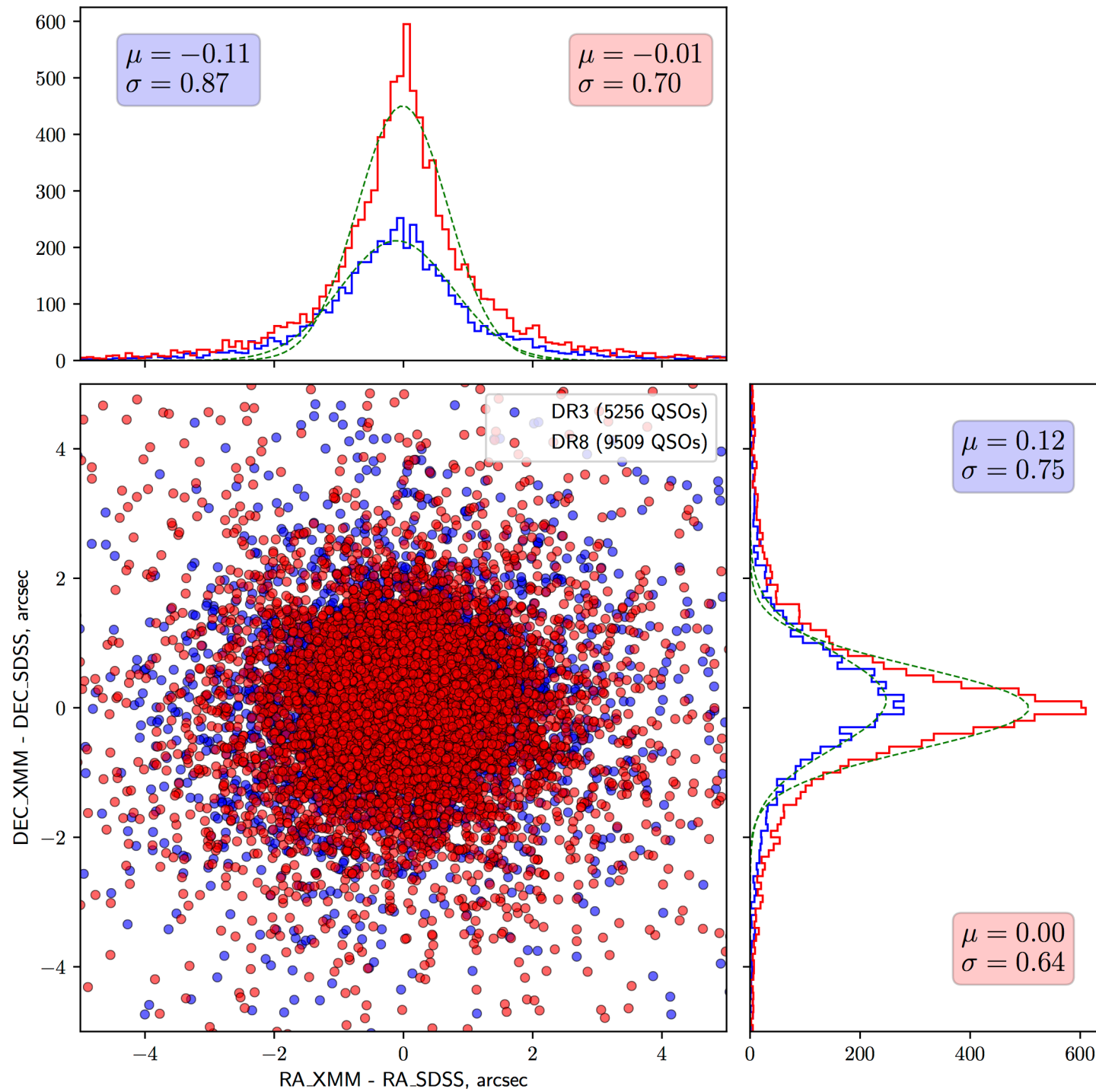
- Identifiers/coordinates
- Observation date/time and observing mode
- Exposure/background info
- Extent
- Counts/fluxes/rates
- Hardness ratios (HR)
- Maximum likelihood
- Quality flags
- Variability

$$HR_i = \frac{Band_{i+1} - Band_i}{Band_{i+1} + Band_i}$$






# Astrometry



- Cross-match with latest version of SDSS quasars catalogue
- Comparison between **2XMM-DR3** and **3XMM-DR8**

# Web-based user interfaces

**XMM-Newton Science Archive** 

HOME SEARCH COMMAND & URL ACCESS INTERACTIVE ANALYSIS TAP QUERIES Sign in

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Results #1 Results #2

OBSERVATIONS (1) EXPOSURES (10) EPIC PPS SOURCES (143) OM PPS SOURCES (499) 3XMM-DR8 Cat (143) OM SOURCE CAT (0) PUBLICATIONS (4) PROPOSALS (1)

Columns Column units Display selected Save table as Send table to

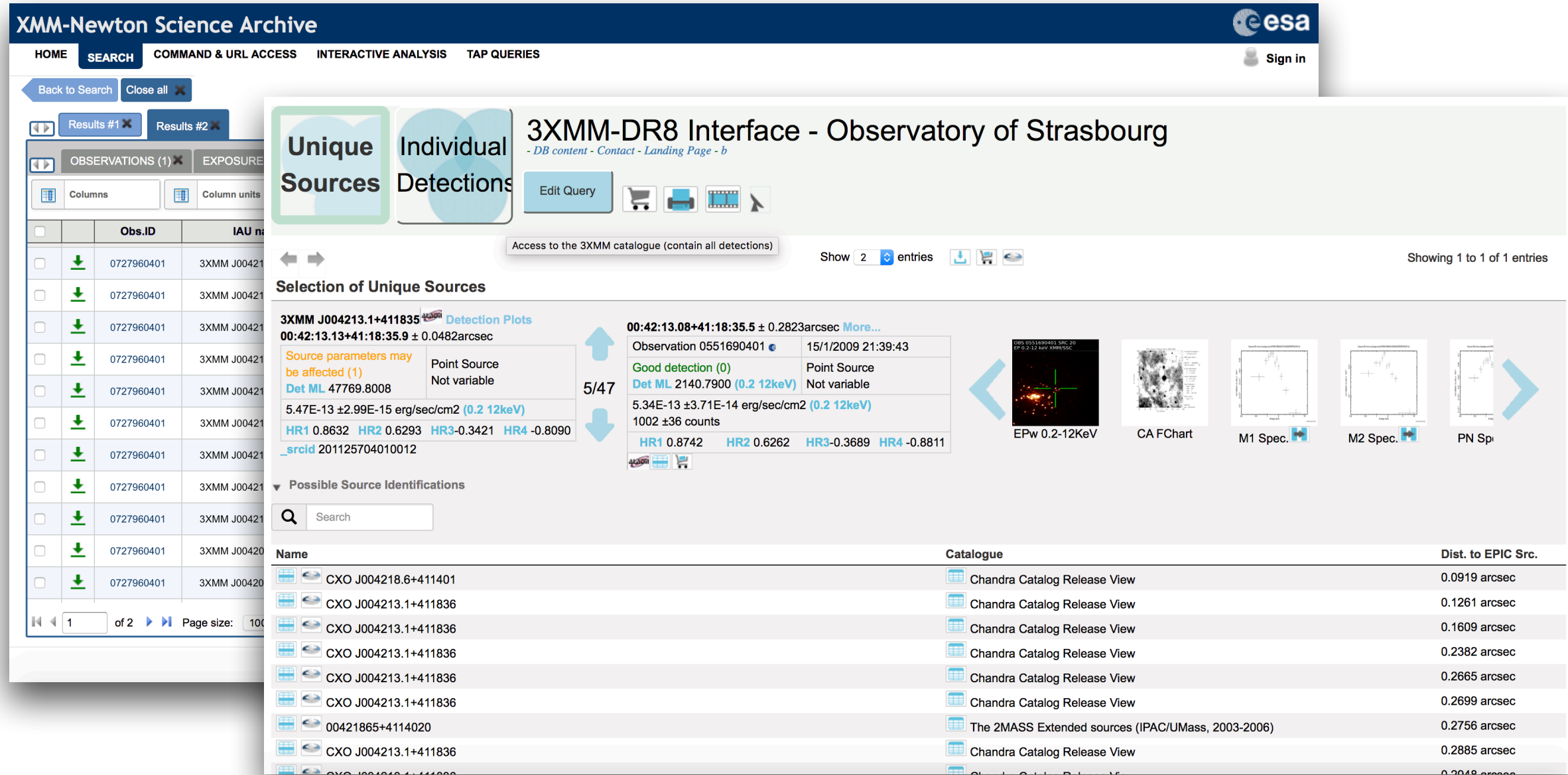
	Obs.ID	IAU name	RA	DEC	PosErr	EP_8 Det ML	QUALITY FLA	Img	Thmb	FC	LC	Spec	ESASky	EP_8 Rate	EP_8 Rate Err	E
<input type="checkbox"/>	0727960401	3XMM J004215.2+411800	00h 42m 15.26s	+41d 18' 00.7"	1.6	9	Good				N/A	N/A		1.00E-02	2.29E-03	
<input type="checkbox"/>	0727960401	3XMM J004215.1+411234	00h 42m 15.11s	+41d 12' 33.8"	0.9	96	Possibly spurious							3.55E-02	3.80E-03	
<input type="checkbox"/>	0727960401	3XMM J004213.1+411835	00h 42m 13.05s	+41d 18' 35.7"	0.3	4344	Good							4.18E-01	1.18E-02	
<input type="checkbox"/>	0727960401	3XMM J004212.1+411758	00h 42m 12.19s	+41d 17' 57.4"	0.8	232	Good							6.12E-02	4.94E-03	
<input type="checkbox"/>	0727960401	3XMM J004211.9+411648	00h 42m 11.82s	+41d 16' 49.2"	1.1	43	Good				N/A	N/A		1.41E-02	2.37E-03	
<input type="checkbox"/>	0727960401	3XMM J004211.7+411049	00h 42m 11.73s	+41d 10' 48.9"	0.7	244	Good				N/A	N/A		5.46E-02	4.99E-03	
<input type="checkbox"/>	0727960401	3XMM J004211.2+410428	00h 42m 11.36s	+41d 04' 28.4"	0.8	452	Good							1.22E-01	9.37E-03	
<input type="checkbox"/>	0727960401	3XMM J004210.9+411248	00h 42m 11.27s	+41d 12' 51.1"	2.0	8	Suspect parameters				N/A	N/A		1.08E-02	5.41E-03	
<input type="checkbox"/>	0727960401	3XMM J004210.2+411510	00h 42m 10.21s	+41d 15' 11.5"	1.3	34	Good				N/A	N/A		1.47E-02	2.51E-03	
<input type="checkbox"/>	0727960401	3XMM J004209.5+411745	00h 42m 09.48s	+41d 17' 46.0"	0.7	196	Good							4.87E-02	4.05E-03	
<input type="checkbox"/>	0727960401	3XMM J004209.0+412048	00h 42m 09.05s	+41d 20' 46.8"	0.7	464	Good							8.06E-02	5.63E-03	

1 of 2 Page size: 100 Displaying 1-100 of 143

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### Web-based user interfaces



**XMM-Newton Science Archive** esa

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Results #1 Results #2

OBSERVATIONS (1) EXPOSURE

Obs.ID	IAU n
0727960401	3XMM J004213.1+411836
0727960401	3XMM J004213.1+411836
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0727960401	3XMM J004213.1+411836

5/47

#### 3XMM-DR8 Interface - Observatory of Strasbourg

Unique Sources Individual Detections

Access to the 3XMM catalogue (contain all detections) Show 2 entries Showing 1 to 1 of 1 entries

**3XMM J004213.1+411836** *Detection Plots*  
 00:42:13.13+41:18:35.9 ± 0.0482arcsec  
 Source parameters may be affected (1) Point Source  
 Det ML 47769.8008 Not variable  
 5.47E-13 ± 2.99E-15 erg/sec/cm2 (0.2 12keV)  
 HR1 0.8632 HR2 0.6293 HR3-0.3421 HR4 -0.8090  
 \_srcid 201125704010012

00:42:13.08+41:18:35.5 ± 0.2823arcsec *More...*  
 Observation 0551690401 15/11/2009 21:39:43  
 Good detection (0) Point Source  
 Det ML 2140.7900 (0.2 12keV) Not variable  
 5.34E-13 ± 3.71E-14 erg/sec/cm2 (0.2 12keV)  
 1002 ± 36 counts  
 HR1 0.8742 HR2 0.6262 HR3-0.3689 HR4 -0.8811

*Possible Source Identifications*

Name	Catalogue	Dist. to EPIC Src.
CXO J004218.6+411401	Chandra Catalog Release View	0.0919 arcsec
CXO J004213.1+411836	Chandra Catalog Release View	0.1261 arcsec
CXO J004213.1+411836	Chandra Catalog Release View	0.1609 arcsec
CXO J004213.1+411836	Chandra Catalog Release View	0.2382 arcsec
CXO J004213.1+411836	Chandra Catalog Release View	0.2665 arcsec
CXO J004213.1+411836	Chandra Catalog Release View	0.2699 arcsec
00421865+4114020	The 2MASS Extended sources (IPAC/UMass, 2003-2006)	0.2756 arcsec
CXO J004213.1+411836	Chandra Catalog Release View	0.2885 arcsec

EPw 0.2-12KeV CA Fchart M1 Spec. M2 Spec. PN Sp.

# Web-based user interfaces

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Obs.ID	IAU n
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0727960401	3XMM J004213.1+411836

1 of 2 Page size: 100

**3XMM-DR8 Interface - Observatory of Strasbourg**

Unique Sources Individual Detections

3XMM J004213.1+411835 **Detection Plots**

00:42:13.13+41:18:35.9 ± 0.0482arcsec

Source parameters may be affected (1)

Det ML 47769.8008 Point Source Not variable

5.47E-13 ± 2.99E-15 erg/sec/cm2 (0.2 12keV)

HR1 0.8632 HR2 0.6293 HR3 -0.3421 HR4 -0.8

\_srcid 201125704010012

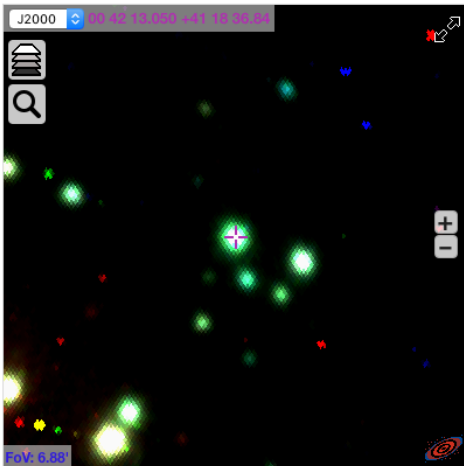
Possible Source Identifications

Search

Name

- CXO J004218.6+411401
- CXO J004213.1+411836
- CXO J004213.1+411836
- CXO J004213.1+411836
- CXO J004213.1+411836
- CXO J004213.1+411836
- 00421865+4114020
- CXO J004213.1+411836

**3XMM J004213.1+411835**



Parameter	Value	Parameter	Value
sc_ep_1_flux	2.80042e-15 ± 8.81486e-17	sc_ep_2_flux	4.11696e-14 ± 3.1302e-16
mjd_first	51720.4884491	sc_ep_3_flux	1.92742e-13 ± 6.938e-16
mjd_last	57427.6167593	sc_ep_4_flux	2.48663e-13 ± 1.36388e-15
sc_chi2prob	0.00323261	sc_ep_5_flux	8.24749e-14 ± 2.41422e-15
sc_ra	10.554711238	sc_ep_8_flux	5.46576e-13 ± 2.9947e-15
sc_dec	41.3099829905	sc_ep_8_fmax	1.74306e-12 ± 7.50653e-14
sc_poserr	0.0481573	sc_ep_8_fmin	1.77926e-13 ± 1.00496e-14
sc_det_ml	47769.8	sc_ep_9_flux	3.97903e-13 ± 1.16751e-15
sc_ext_ml	0.0	sc_extent	0.0
sc_fvar	0.252154 ± 0.0542623	sc_hr1	0.863156 ± 0.00384524
sc_hr2	0.629344 ± 0.00242865	sc_hr3	-0.34211 ± 0.00263369
sc_hr4	-0.809044 ± 0.00393344	sc_sum_flag	1
sc_var_flag	False	confused	False

This source in external databases: XCatDB, Chandra CSC 20" VOTable, Swift 1SXPS 20", RCSED, Simbad 2", Vizier 20", NED 2", Gaia 20" VOTable

Detections (observations of this source at different epochs)

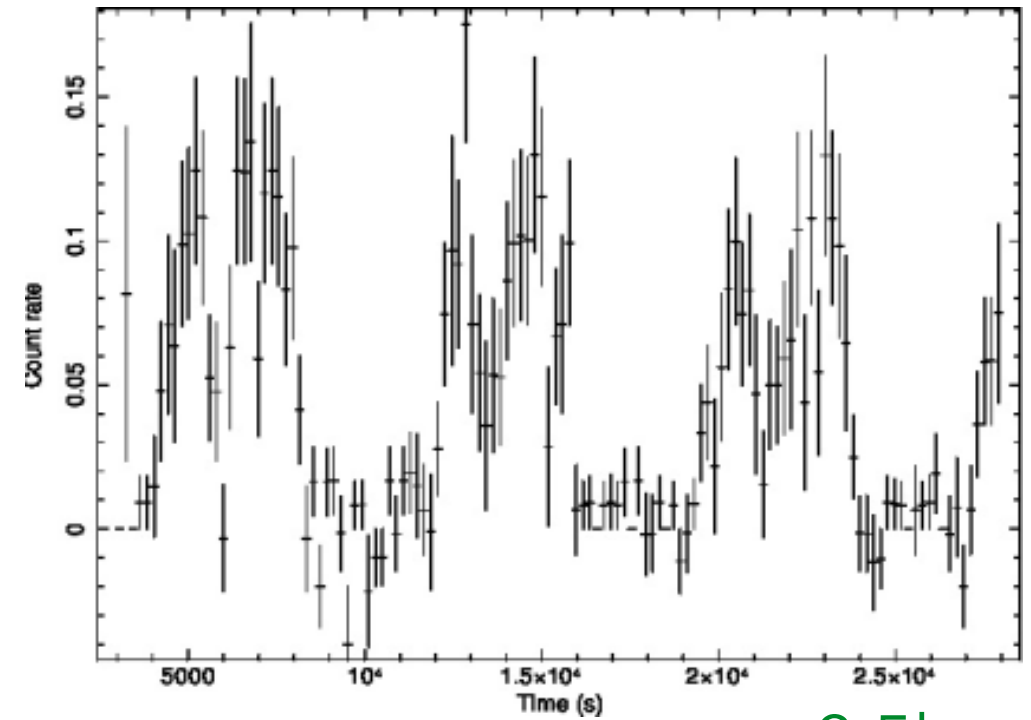
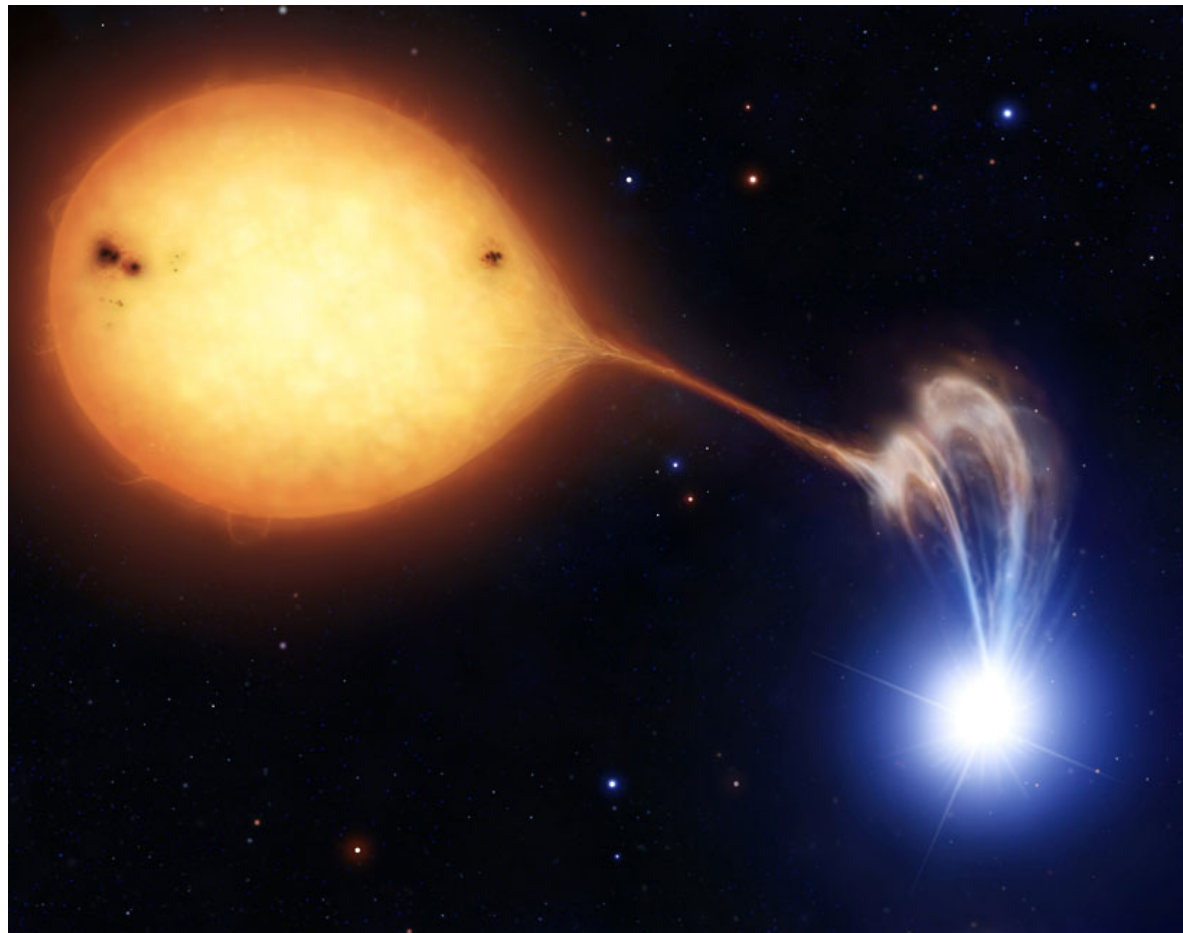
detid	revolut	obs_id	src_num	poserr	ep_8_flux	utc_start	exptime	ep_offax	spectrum
101125704010012	0100	0112570401	12	0.329335	8.36703e-13	2000-06-25 11:43:22.000	31232	5.27103	True (Fit spectrum)
101125706010013	0193	0112570601	13	0.327963	8.83526e-13	2000-12-28 00:51:02.000	9849	5.96841	True (Fit spectrum)
101092701010011	0285	0109270101	11	0.223599	9.89186e-13	2001-06-29 06:59:13.000	52508	5.30718	True (Fit spectrum)
101125701010013	0381	0112570101	13	0.33079	8.2724e-13	2002-01-06 18:44:42.000	61198	6.07995	True (Fit spectrum)
102022302010031	0843	0202230201	31	0.266496	4.0448e-13	2004-07-16 16:40:09.000	18335	4.27041	True (Fit spectrum)

+ LEDAS, HEASARC...

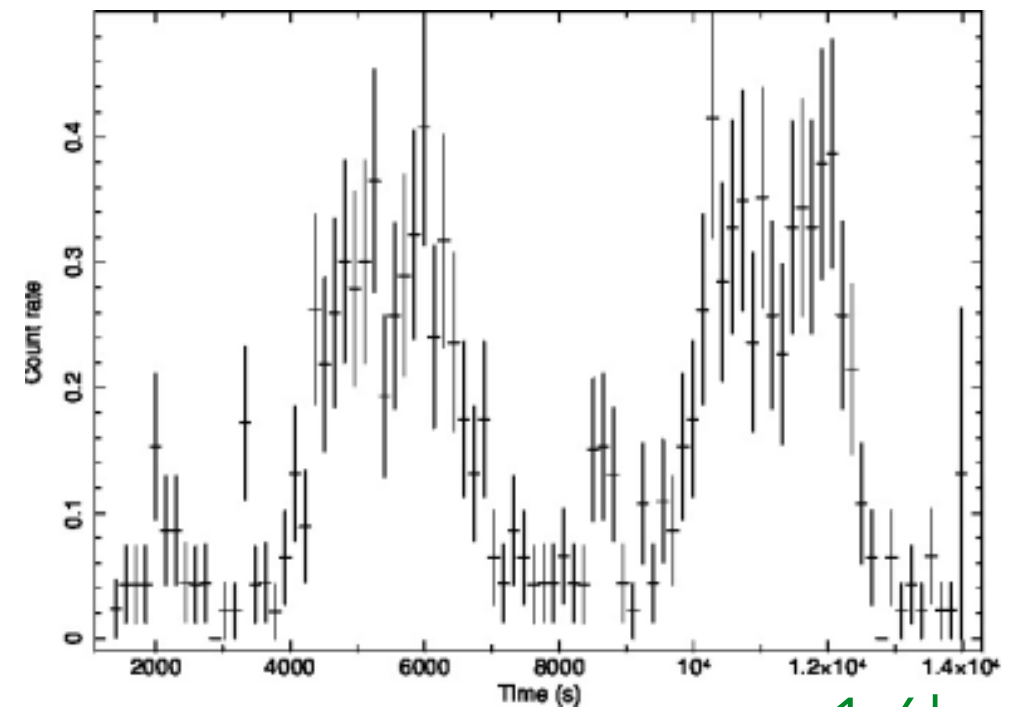
## 3XMM-DR8 uses

The catalogue and associated web services are excellent for :

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



2.5hr period

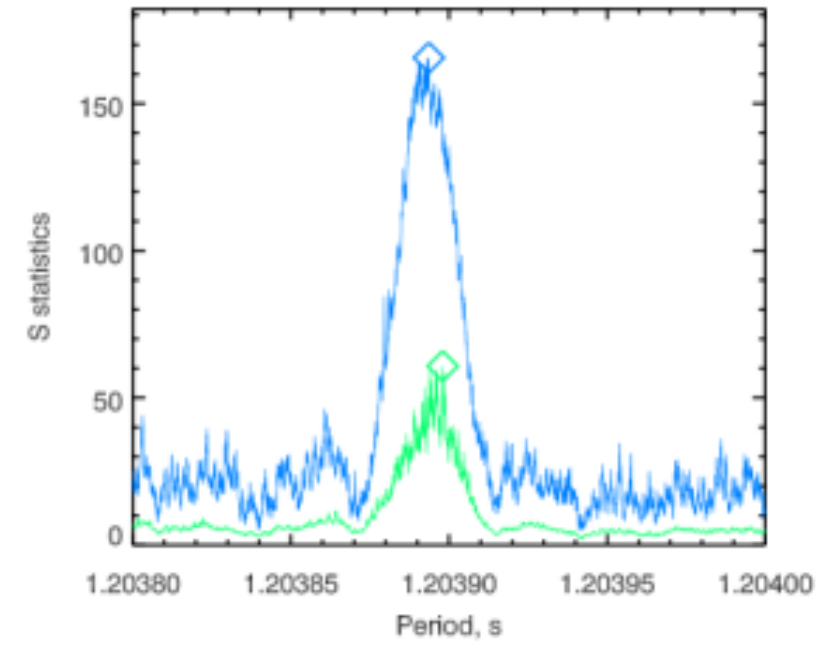
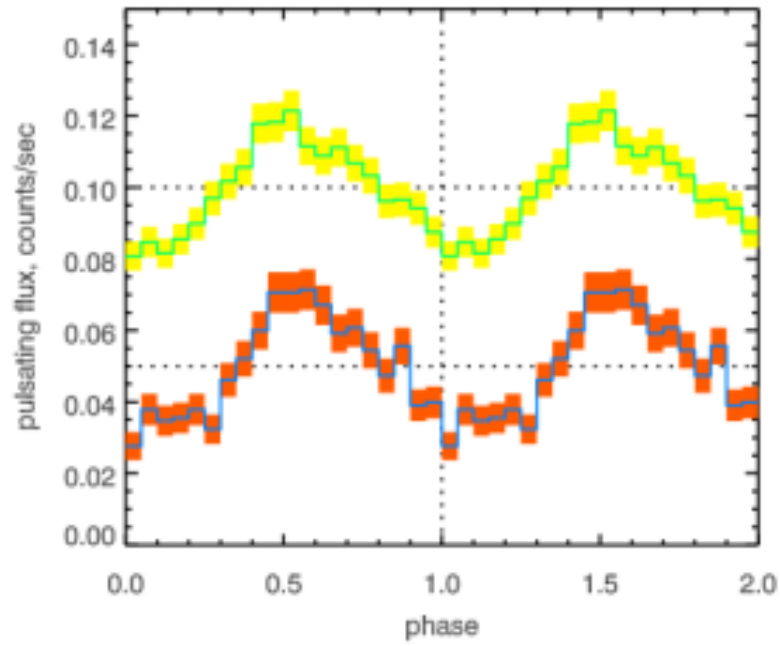


1.6hr period

## 2 magnetic cataclysmic variables

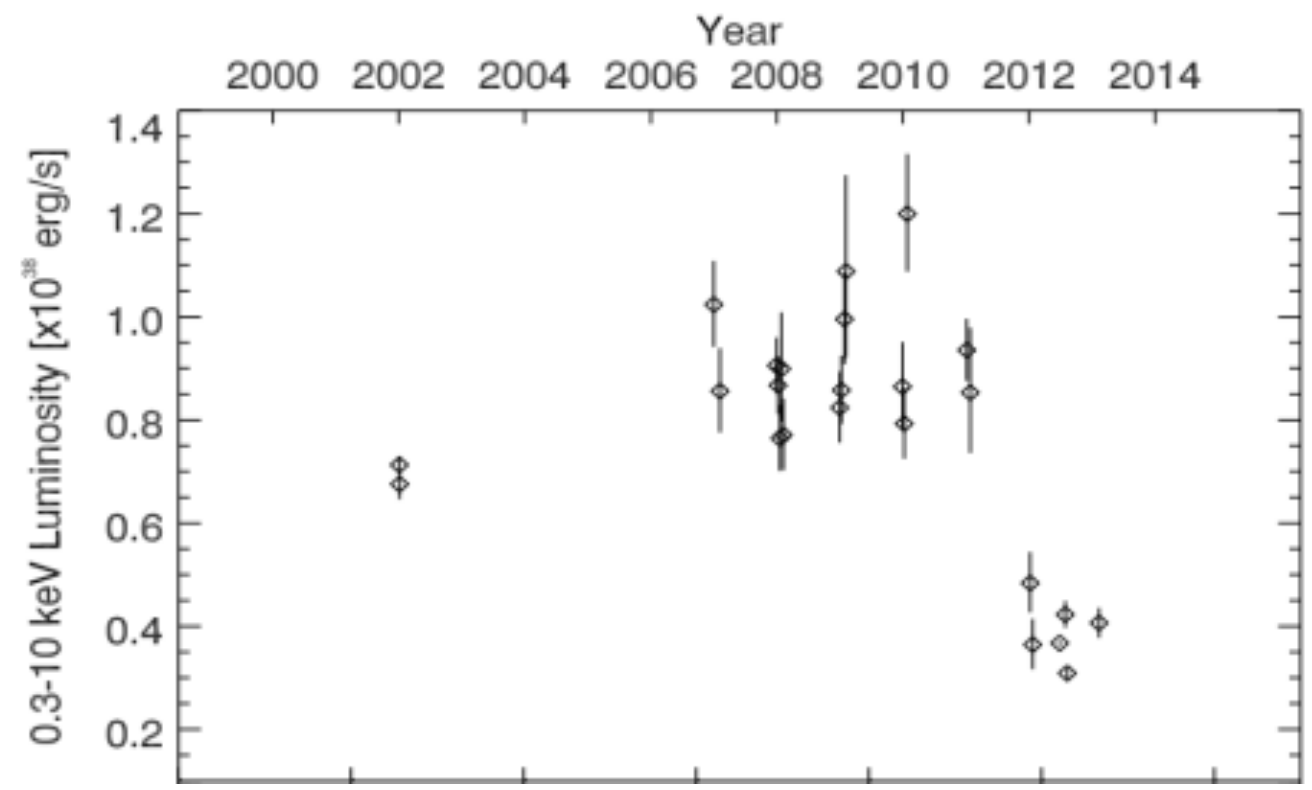
(Webb et al. in press.)





## X-ray pulsar

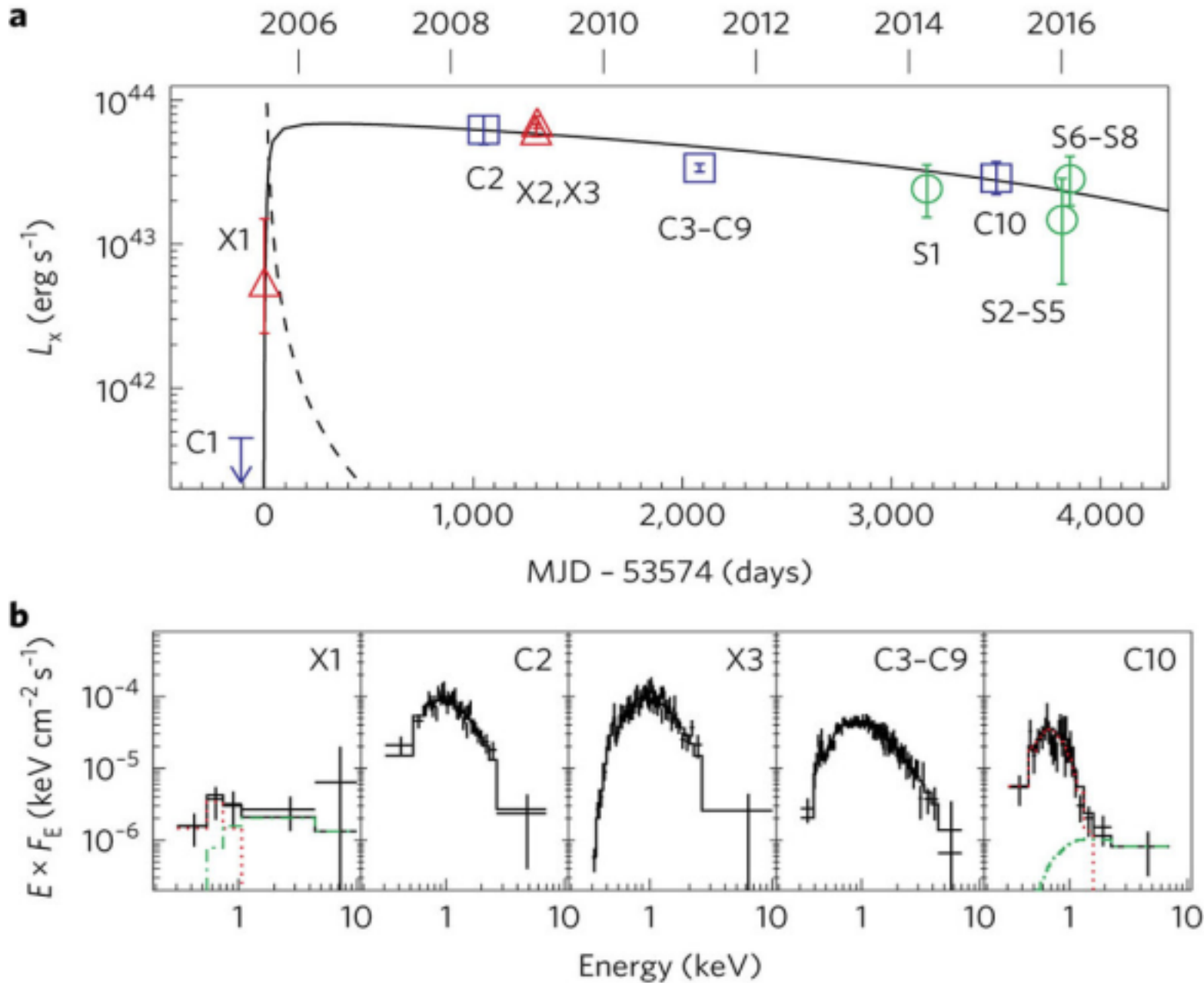
3XMM J004301.4+413017



- $P_{\text{spin}} = 1.20$  s,  $P_{\text{orb}} = 30.5$  h
- In glob. cluster B091D (M 31)
- Slowest glob. cluster pulsar
- Accretes up to 30 %  $L_{\text{edd}}$
- Dynamically formed system

Esposito et al. 2016,  
Zolotukhin et al. 2016



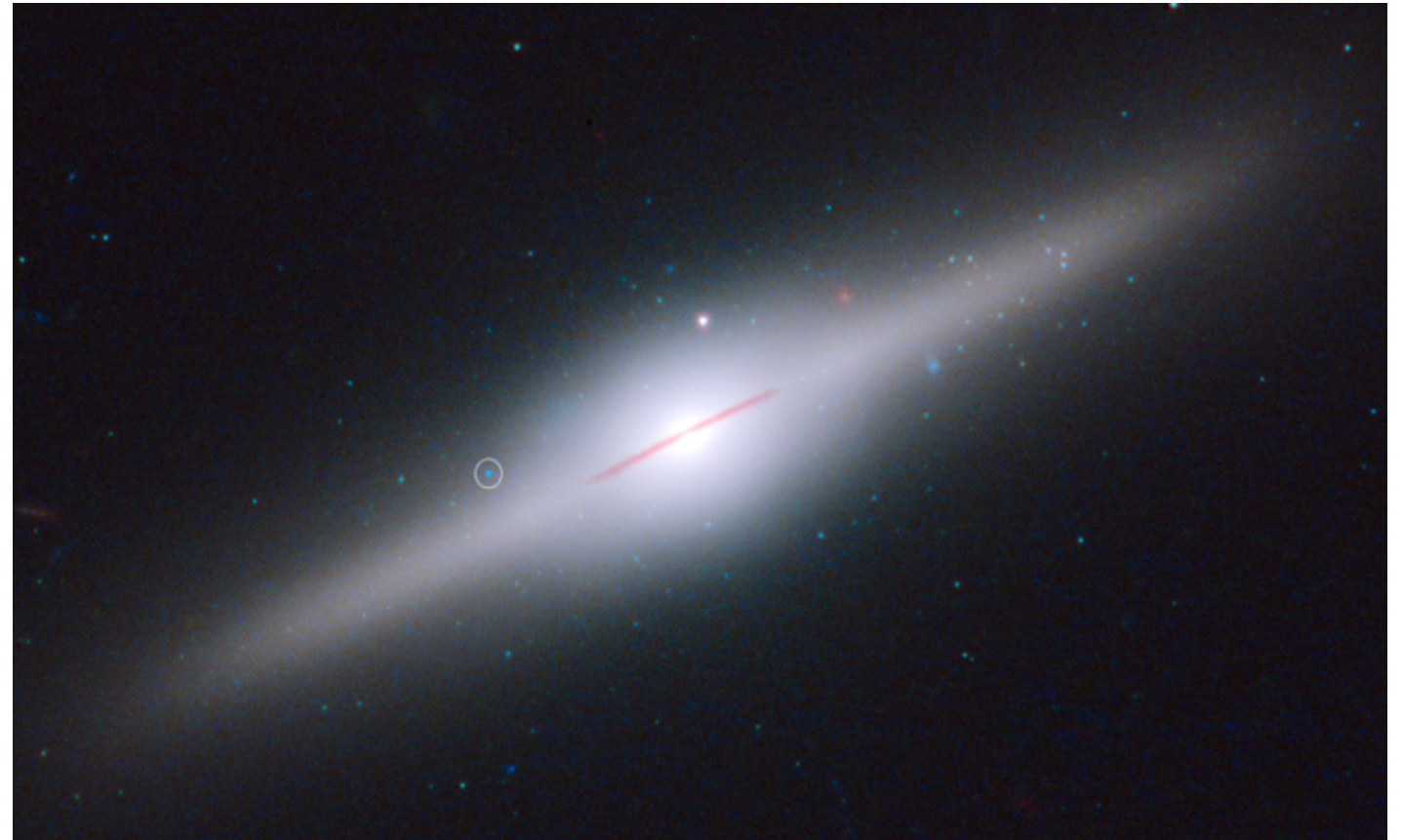


## Extreme tidal disruption event

Lin et al., Nature 2017

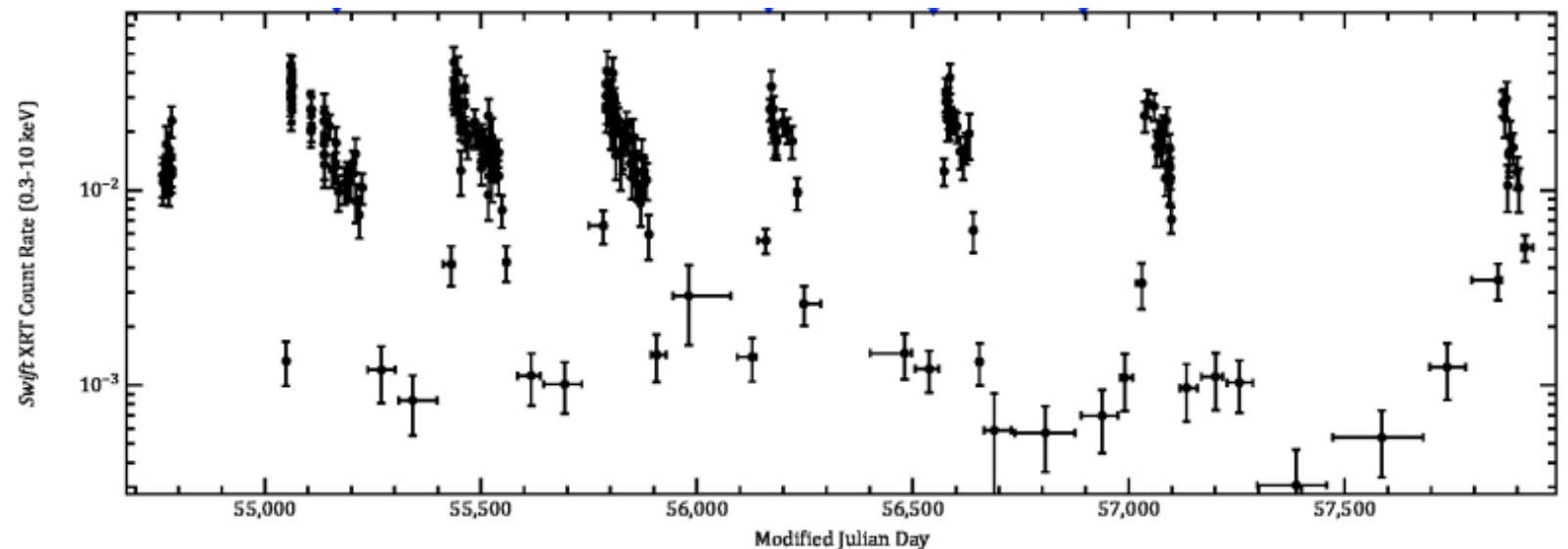
## HLX-1

- $\sim 8''$  from nucleus of ESO 243-49
  - $L_x = 1.1 \times 10^{42} \text{ erg s}^{-1}$  (0.2-10.0 keV)
  - Spectral analysis + modelling
- $\Rightarrow$  black hole with mass  $\sim 10^4 M_\odot$



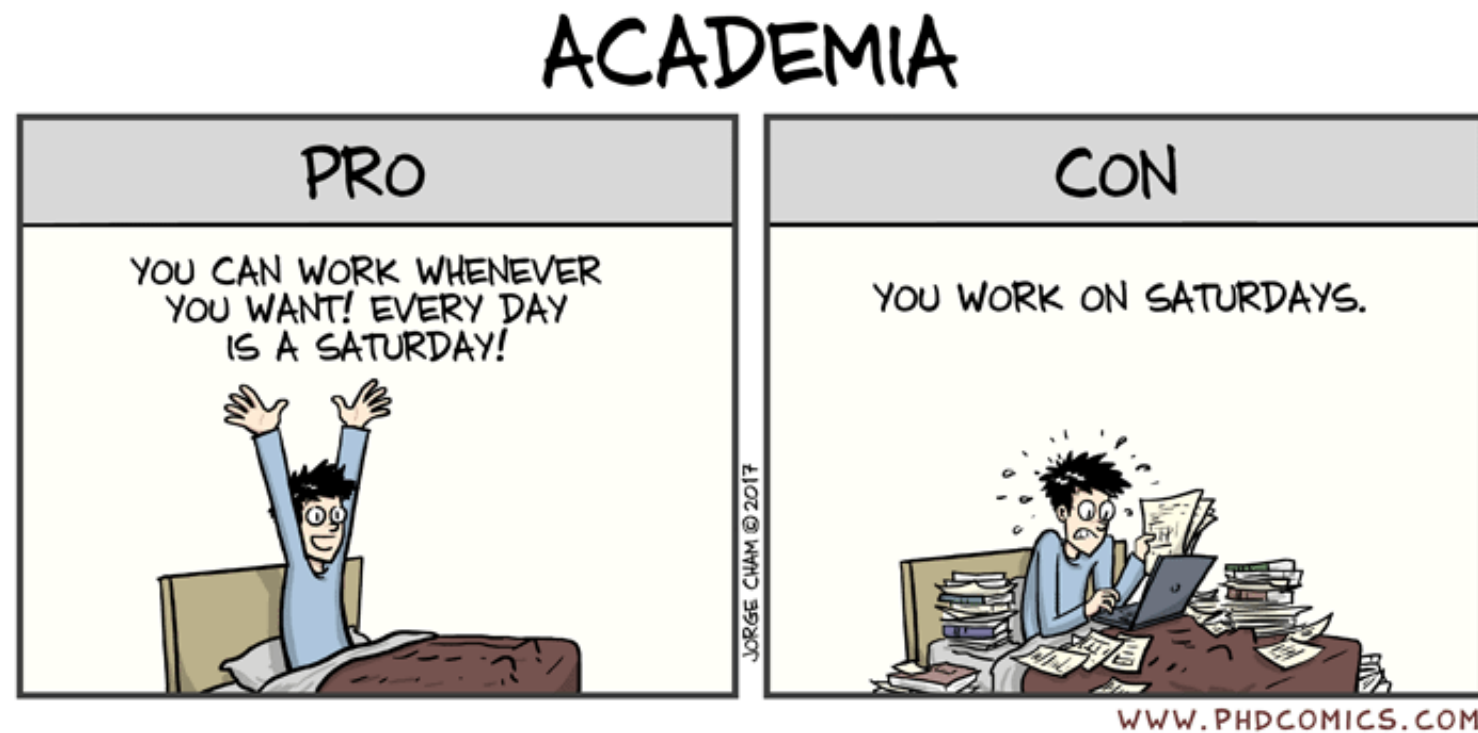
Best IMBH candidate

Farrell et al., Nat. 2009



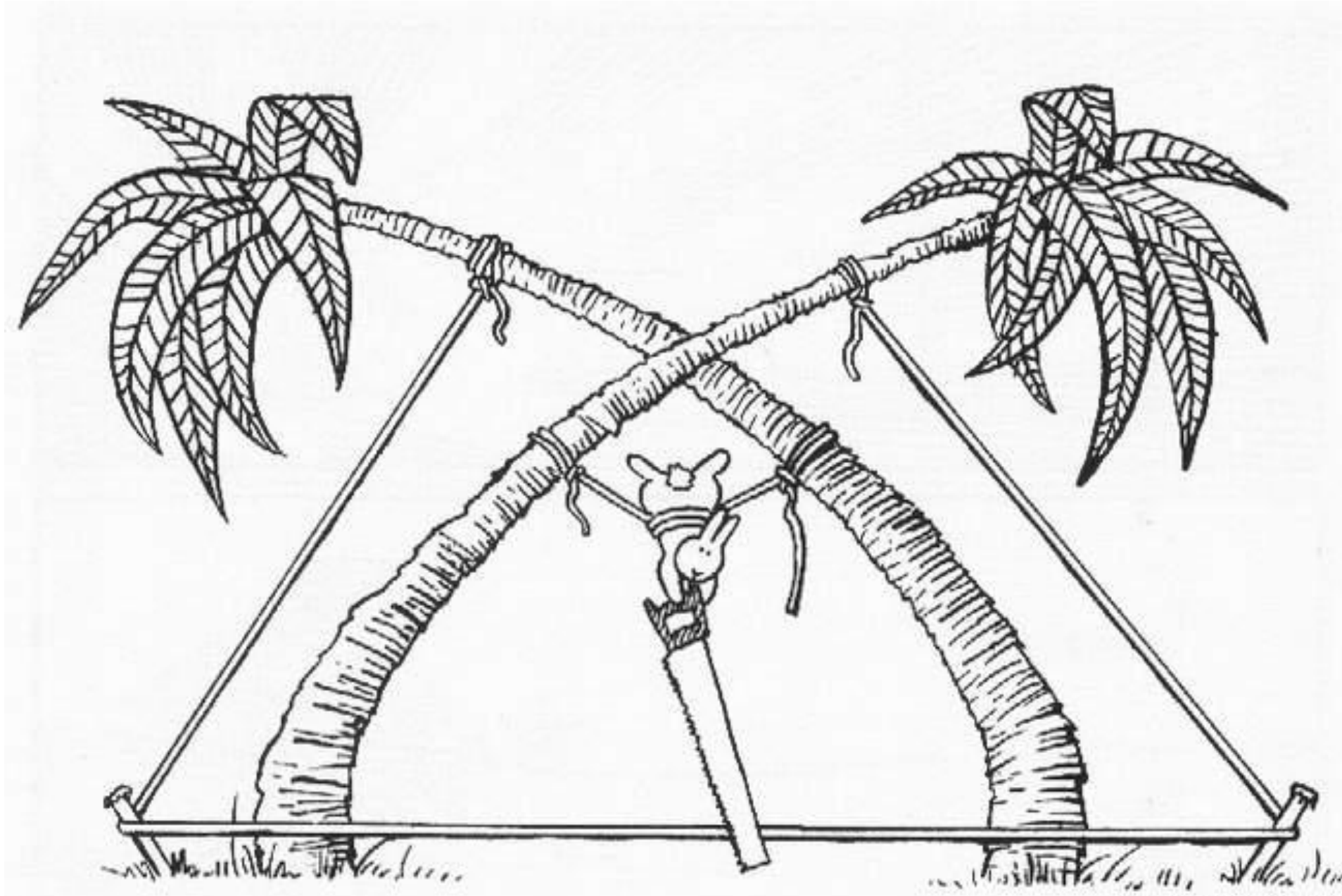
## Next major release: 4XMM

- Anticipated for 2019
- Full re-reduction of all data (~10700 obs.)
- Manual source-level screening will be a huge task...
- ... But feasible in ~3 weeks if 10 persons screen ~50-100 obs/day





## Why 4XMM ?



## Why 4XMM?

- Last re-reduction of all data was in 2012 (and associated release in 2013)
- Previously : 1XMM - 2003, 2XMM - 2007
- **Improvement in software and calibration**
- Some changes since 3XMM:
  - Source spectra and light curves created for pn Timing mode data
  - pn Small Window mode now used for source detection, spectra & light curve
  - Binning of MOS spectra changed from 15eV to 5eV
  - Observations of solar system objects processed such that X-rays images and spectra correctly refer to the moving target



## Why 4XMM?

- Some changes since 3XMM (continued):
  - ▶ Improvements in pile-up diagnostic for EPIC sources
  - ▶ Additional CTI, PHA and energy resolution corrections for EPIC-pn
  - ▶ Improved astrometry calibration etc..

## New diagnostics and informations

- Variability between observations in catalogue
- Added variability analysis (see e.g. Inés Pastor's poster)
- Improved source flagging
- Sky exposure for population studies
- What else ?

**Please, bear with us!**



**They told me I could be anything**

**So I became a unicorn**

