



The XMM-Newton spectral-fit database

Amalia Corral

Institute for Astronomy, Astrophysics, Space Applications, and Remote Sensing

(IAASARS, NOA, Greece)

I. Georgantopoulos (PI), X-ray group (IAASARS), XMM-SSC (University of Leicester, UK)

The project (XMMFITCAT)

- ESA (PRODEX) funded project carried out by the X-ray group at NOA in collaboration with the XMM-Newton Survey Science Centre (XMM SSC) in the University of Leicester.
- **Goal:** Use the spectral data from the XMM-Newton Serendipitous source catalogue (latest version 3XMM-DR4) to construct a database of spectral-fitting results.
 - Construct samples of X-ray sources according to spectral properties.
 - Pinpoint “peculiar” sources.
 - Get X-ray properties of samples selected at other wavelengths.

3XMM-DR4 spectral data

- **3XMM-DR4** is the largest catalogue of X-ray sources built to date. Photometric information for more than 500,000 detections of $\sim 370,000$ sources.
- **3XMM-DR4** also contains pipeline extracted spectra and ancillary matrices for detections with EPIC net (background subtracted) counts > 100 counts in 0.2-12 keV: 120,000 detections, $\sim 85,000$ unique sources.
- **XMMFITSAT**: only 3XMM-DR4 spectra with > 50 cts in 0.5-10 keV per instrument and exposure.

$>114,000$ detections, $\sim 78,000$ unique sources

Spectral models

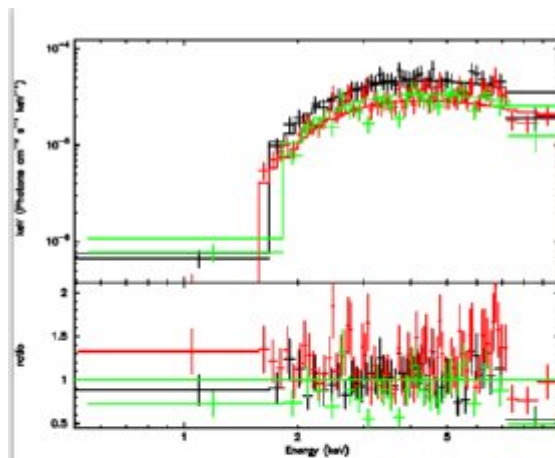
- The aim of the database is not to find the “best-fit model” (limited number of models), but to obtain a representation of the spectral shape as good as possible.
- Six models implemented (most commonly observed spectral shapes), and three energy bands defined.

Energy range (keV)	3XMMDR4 bands		XMMFITCAT bands	
0.2 - 0.5	1			
0.5 - 1.0	2	Total	Soft	Full
1.0 - 2.0	3			
2.0 - 4.5	4		Hard	
4.5 - 10	5			
10 -12				

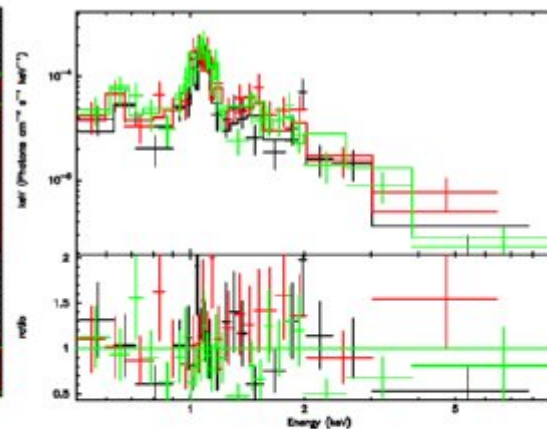
Spectral models

- Simple models are applied to all detections:
 - **Absorbed power-law** in **Full**, **Hard**, and **Soft** bands: Γ , N_H , Norm
 - **Absorbed thermal model** in **Full** and **Soft** bands: N_H , kT , Norm
 - **Absorbed black-body model** in **Soft** band: N_H , kT , Norm.
- Complex models are applied if EPIC counts > 500 counts, and only in the **Full** band.
 - **Thermal plus power-law**: N_{H1} , kT , Norm1, N_{H2} , Γ , Norm2
 - **Black-body plus power-law**: N_H , kT , Norm1, Γ , Norm2
 - **Double power-law**: N_{H1} , $\Gamma1$, Norm1, N_{H2} , $\Gamma2$, Norm2

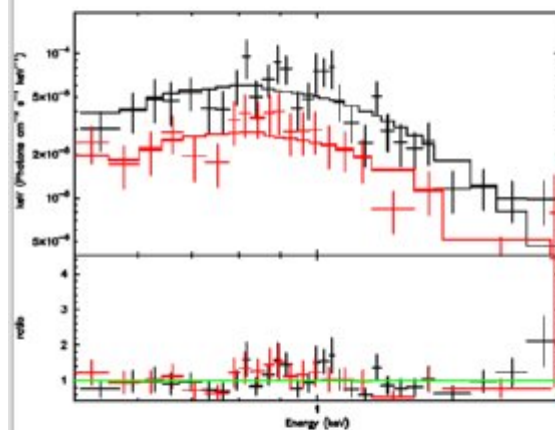
WAPO



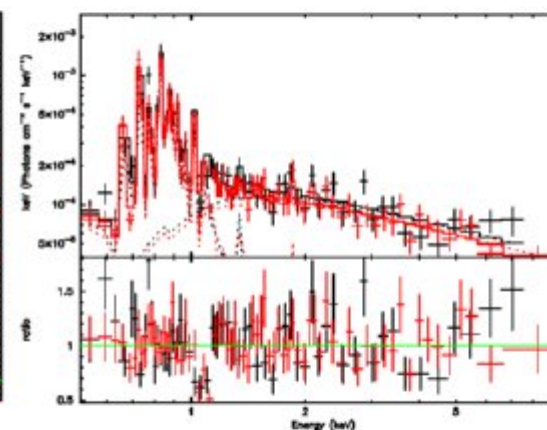
WAMEKAL



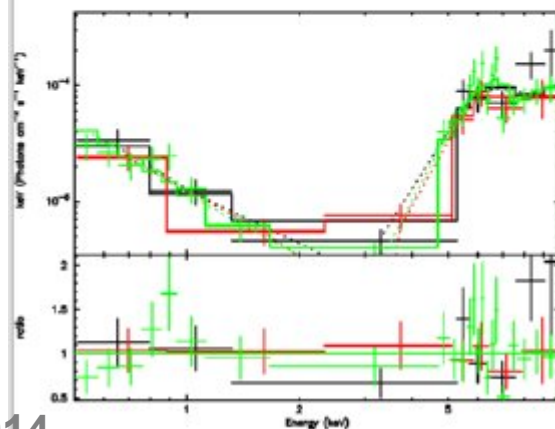
WABB



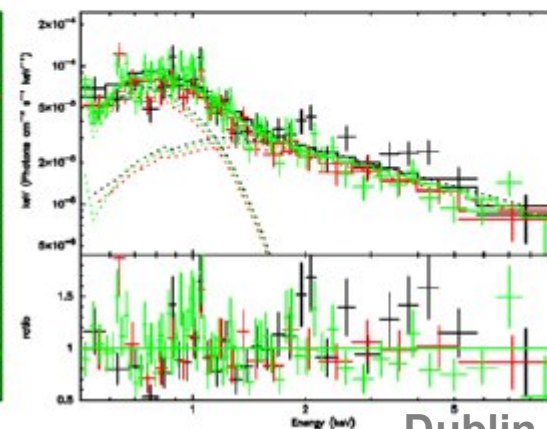
WAMEKALPO



WAPOPO



WABBPO



Automated fitting

- **Each detection fitted separately -> spectral-fitting results for each detection, not for each source.**
- All models are applied to all detections (depending on number of counts).
- For each model, best-fit parameters and errors are computed (90% level); and fluxes and errors (90% level, in each XMMFITCAT energy band); an estimate of goodness of fit.

Automated fitting - Goodness of fit

- Xspec 12.7.1, C-stat → no goodness of fit.
- Goodness: performs a number of simulations and returns the percentage of simulations that gives a lower value of the statistic. **As a guide to the user: acceptable fit if goodness < 50%, preferred model: the simplest one with the lowest goodness value.**
- Also provided χ^2 as a test statistic, when using C-stat as fit statistic (goodness < 50 $\Leftrightarrow \chi^2_c < 1.5$).

XMMFITCAT

- **Output:** one row for each source detection, and 214 columns containing information about the observation, a summary of the spectra-fitting, and spectral-fitting results for each spectral model applied (best-fit parameters and errors, fluxes, and goodness of fit)
- ~ 18% of sources: multiple observations with spectra: spectral variability studies.

IAUNAME	DETID	SRCID	OBS_ID	SRC_NUM	SRC_HEX	SC_RA	SC_DEC	T_COUNTS	H_COUNTS	S_COUNTS	GNH	A_FIT	P_MODEL
3XMMJ000548.6+200150	1833	19268	0600540501	65	0041	1.45289	20.03057	59.16699	-99.	-99.	0.03516	<input checked="" type="checkbox"/>	1
3XMMJ000548.8+200627	1836	7186	0101040101	14	000E	1.45339	20.10758	96.23369	-99.	80.12826	0.03564	<input type="checkbox"/>	0
3XMMJ000548.8+200627	1837	7186	0600540601	9	0009	1.45339	20.10758	580.6626	139.84521	437.29176	0.03564	<input checked="" type="checkbox"/>	0
3XMMJ000548.8+200627	1838	7186	0306870101	7	0007	1.45339	20.10758	255.86811	70.98639	181.71661	0.03563	<input checked="" type="checkbox"/>	0
3XMMJ000548.7+201513	1839	13087	0600540601	104	0068	1.4532	20.25367	79.26334	50.03315	-99.	0.03649	<input checked="" type="checkbox"/>	0
3XMMJ000548.8+200627	1840	7186	0600540501	9	0009	1.45339	20.10758	422.29079	100.01115	320.50835	0.03564	<input checked="" type="checkbox"/>	0
3XMMJ000549.5+201308	1845	7101	0600540601	10	000A	1.45629	20.21902	668.22002	179.17344	484.68514	0.03628	<input checked="" type="checkbox"/>	0
3XMMJ000549.5+201308	1846	7101	0306870101	4	0004	1.45629	20.21902	390.1877	103.21101	284.48779	0.03628	<input checked="" type="checkbox"/>	0
3XMMJ000549.5+201308	1848	7101	0101040101	11	000B	1.45629	20.21902	164.87083	-99.	124.67539	0.03628	<input checked="" type="checkbox"/>	0
3XMMJ000549.5+201308	1849	7101	0600540501	8	0008	1.45629	20.21902	519.88876	108.72877	406.54006	0.03628	<input checked="" type="checkbox"/>	0
3XMMJ000550.0-344757	1855	18222	0404910101	15	000F	1.4585	-34.79917	95.76618	-99.	64.51116	0.01318	<input checked="" type="checkbox"/>	0
3XMMJ000550.4-343742	1861	33310	0404910101	18	0012	1.46033	-34.6285	87.80419	-99.	62.66844	0.01329	<input type="checkbox"/>	0
3XMMJ000550.7+201716	1864	7812	0306870101	14	000E	1.46166	20.28797	236.87845	112.47384	121.87379	0.03665	<input checked="" type="checkbox"/>	0
3XMMJ000550.7+201716	1865	7812	0101040101	17	0011	1.46166	20.28797	110.29757	-99.	68.56283	0.03665	<input checked="" type="checkbox"/>	1
3XMMJ000550.7+201716	1866	7812	0600540601	33	0021	1.46166	20.28797	282.75284	142.658	138.45195	0.03665	<input checked="" type="checkbox"/>	0
3XMMJ000550.7+201716	1867	7812	0600540501	31	001F	1.46166	20.28797	123.73808	51.90408	70.41663	0.03665	<input checked="" type="checkbox"/>	0

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3XMM-DR4

IAUNAME	DETID	SRCID	OBS_ID	SRC_NUM	SRC_HEX	SC_RA	SC_DEC	I_COUNTS	H_COUNTS	S_COUNTS	GNH	A_FIT	P_MODEL
3XMMJ000548.7+200150	1833	19268	0600540501	65	0041	1.4522	20.01957	59.16699	-99.	-99.	0.03516	<input checked="" type="checkbox"/>	1
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3XMMJ000548.8+200627	1837	7186	0600540601	9	0009	1.45339	20.10758	580.6626	139.84521	437.29176	0.03564	<input checked="" type="checkbox"/>	0
3XMMJ000548.8+200627	1838	7186	0306870101	7	0007	1.45339	20.10758	255.86811	70.98639	181.71661	0.03563	<input checked="" type="checkbox"/>	0
3XMMJ000548.7+201513	1839	13087	0600540601	104	0068	1.4532	20.2536	79.26334	50.03315	-99.	0.03649	<input checked="" type="checkbox"/>	0
3XMMJ000548.8+200627	1840	7186	0600540501	9	0009	1.45339	20.10758	422.29079	100.01115	320.50835	0.03564	<input checked="" type="checkbox"/>	0
3XMMJ000549.5+201308	1845	7101	0600540601	10	000A	1.45629	20.21902	668.22002	179.17344	484.68514	0.03628	<input checked="" type="checkbox"/>	0
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3XMMJ000550.0-344757	1855	18222	0404910101	15	000F	1.4585	-34.79117	95.76618	-99.	64.51116	0.01318	<input checked="" type="checkbox"/>	0
3XMMJ000550.4-343742	1861	33310	0404910101	18	0012	1.46033	-34.6285	87.80419	-99.	62.66844	0.01329	<input type="checkbox"/>	0
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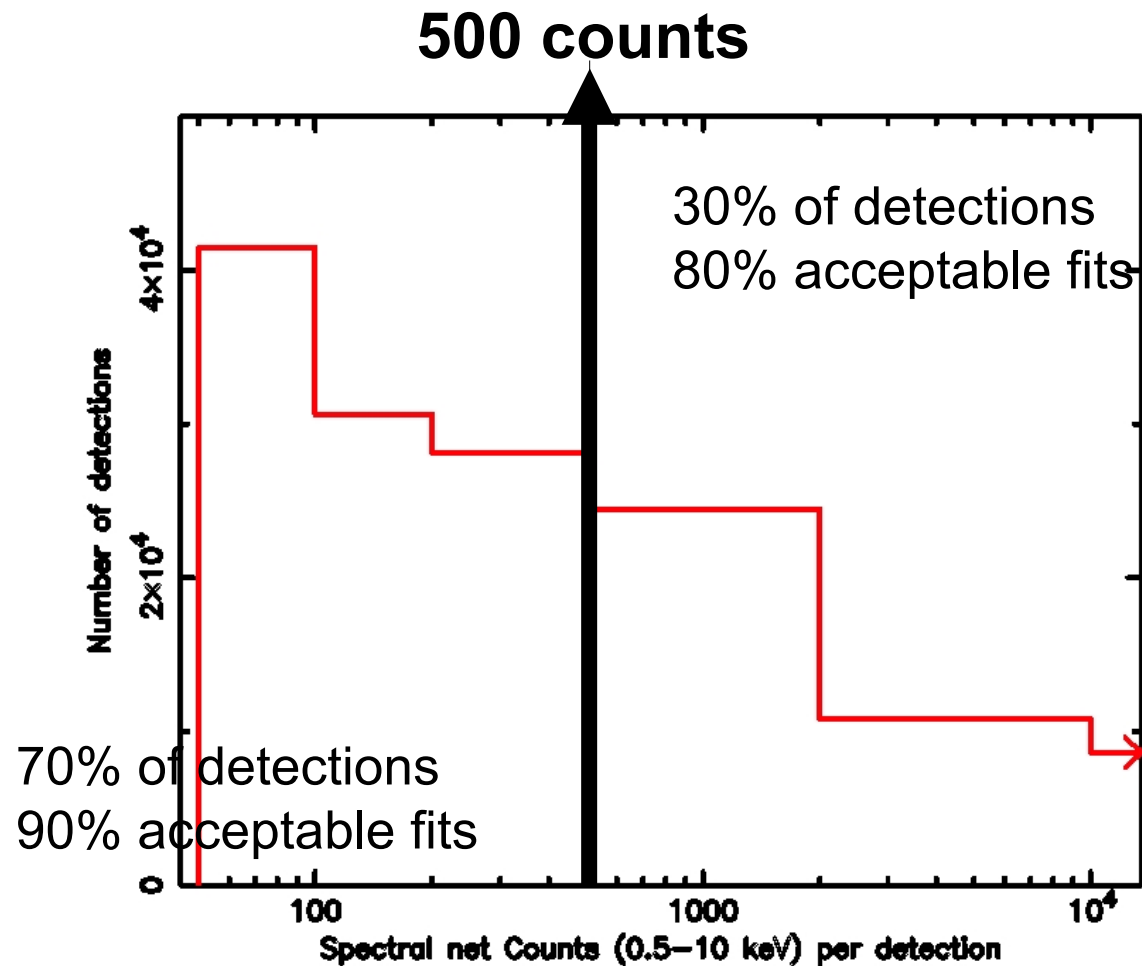
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Fit summary

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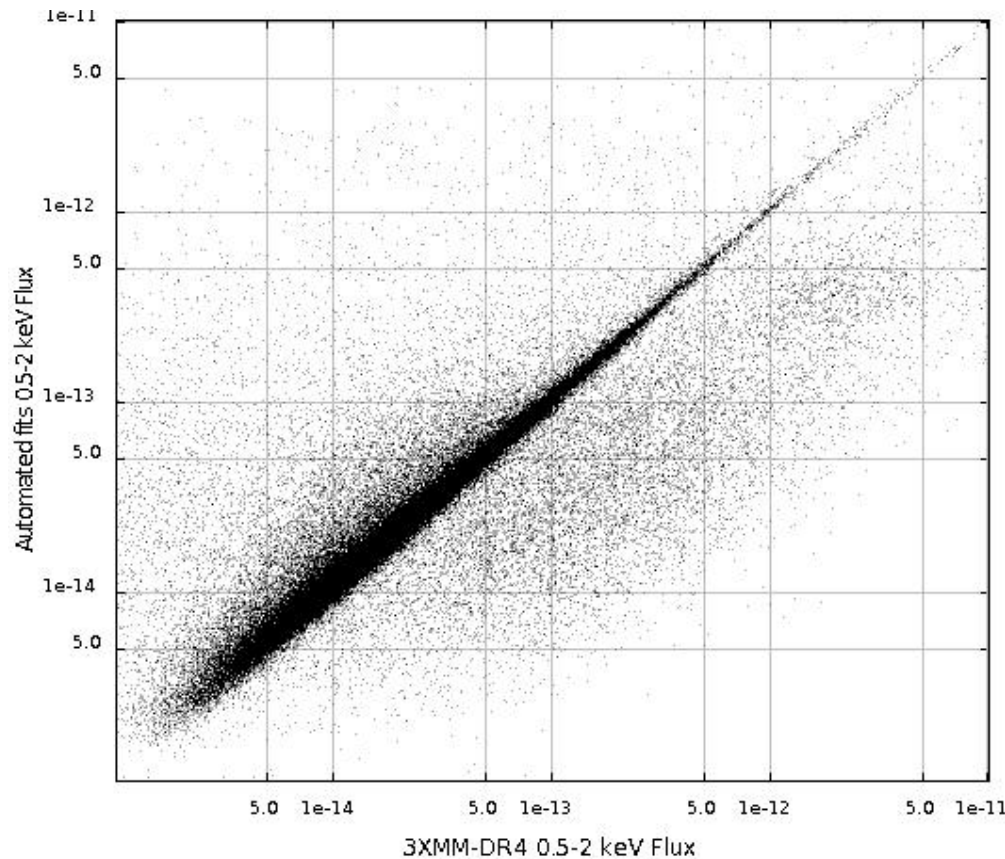
Results



Less than 1% of detections missing one fit due to errors.

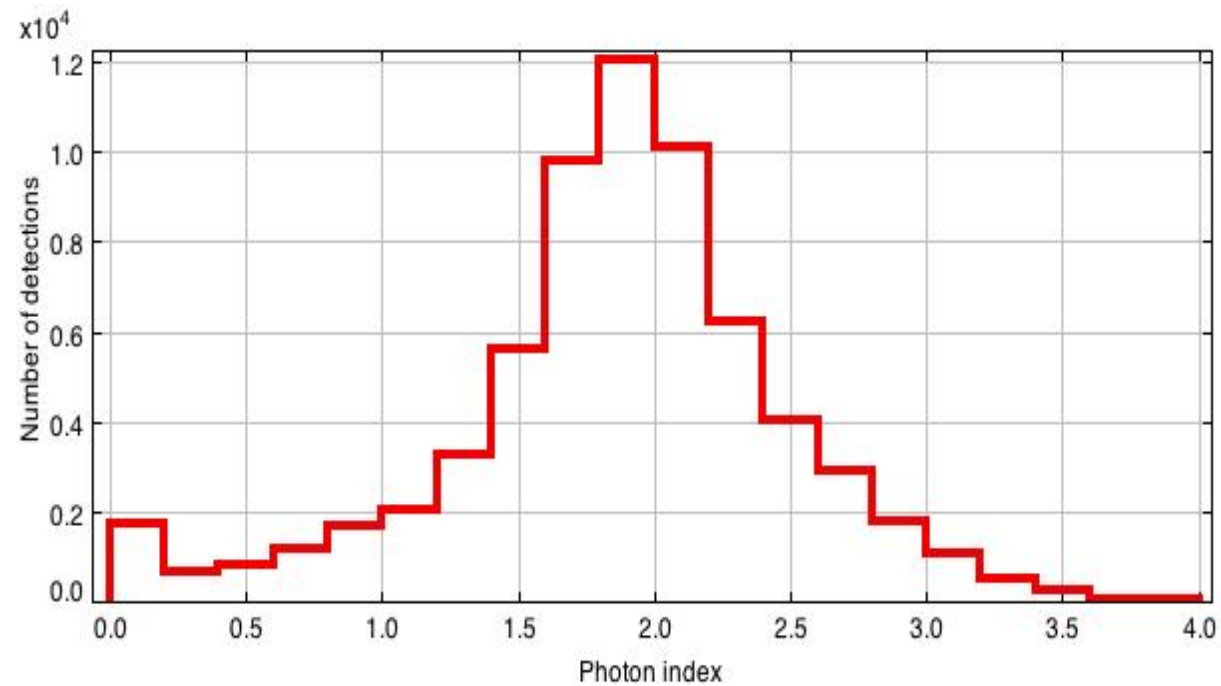
Acceptable fits even for large number of counts.

Results

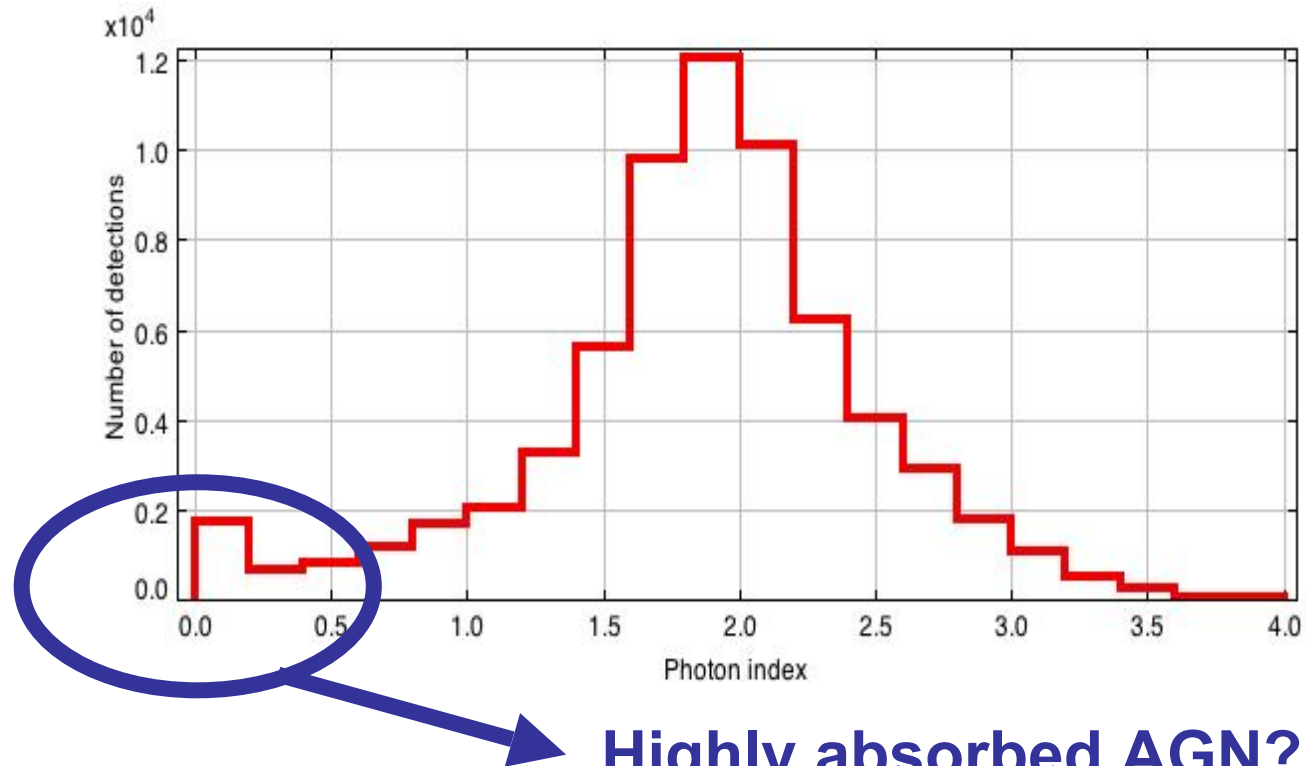


Consistent within errors for $\sim 70\%$ of the detections. Significant differences: power-law with a steep photon index, or thermal model.

Results



Results



Highly absorbed AGN?

(I. Georgantopoulos talk yesterday)

Access

- Full database (FITS table) from 3XMM-DR4 released on March 2014 (and documentation).

<http://xraygroup.astro.noa.gr/Webpage-prodec/index.html>

- LEDAS (Leicester Database and Archive Service): query capabilities. 3XMMspectral.
- XCAT-DB: query and spectral-fitting visualisation tool.

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XMM-Newton Spectral fit database

XMM-Newton spectral-fit database

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Summary

This project aims to the construction of a spectral-fit database for all the pipeline-extracted spectra within the [XMM-Newton serendipitous source catalogue](#). The main goal is to provide the astronomical community with a tool to query the catalogue according to spectral properties and thus, to construct large and representative samples of X-ray sources fulfilling the spectral criteria.

This project is funded by the [ESA-PRODEX program](#) and consists of the collaboration between the [X-ray Astronomy and Cosmology group](#) at the [Istitute for Astronomy, Astrophysics, Space Applications, and Remote Sensing \(IAASARS\)](#) at the [National Observatory of Athens \(NOA\)](#), and the [X-ray and Observational Astronomy Group \(XROA\)](#) at the Department of Physics and Astronomy at the [University of Leicester](#).

March 2014 The first full version of the XMM-Newton spectral-fit database can be retrieved from [this page](#).

March 2014 The spectral-fitting results corresponding to a XMM/SDSS cross-correlation can be retrieved from [this page](#).

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Retrieve XMMFITCAT as a FITS table

Documentation

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- XCAT-DB: query and spectral-fitting visualisation tool.

<http://www.ledas.ac.uk/arnie5/arnie5.php?action=advanced&catname=3xmmspectral>

LEDAS:
ARNIE services

Leicester Database and Archive Service

ARNIE Index
ARNIE Quick Help
ARNIE Tutorial

Search...
All Databases
All Helpfiles

For comments or help, e-mail:
ledas-help@star.le.ac.uk

Database: 3XMMSPECTRAL
3XMM-DR4 Spectral Fitting Catalogue: 3XMMSPECTRAL

Database HELP

Database Index | Basic Search | Advanced Search

Name Resolver **Search Co-ordinates**

Name: Co-ords:

RESOLVE NAME
SUBMIT QUERY

Co-ordinate system:
☐ Equatorial ☐ Ecliptic ☐ Galactic
Equinox: ☐ 1950 ☐ 2000

Search Type **Output Options**

☐ Cone search, radius: arcmin.
☐ Square search, width: arcmin.
☐ Rectangle search, size: x arcmin

Output coordinates in:
☐ Decimal ☐ Sexagesimal
Output system:
☐ Equatorial ☐ Ecliptic ☐ Galactic
Output epoch:
☐ J2000 ☐ B1950
Output format:
HTML Table

Filter Search

Show	Sort	Parameter	Filter	A	Filter	B	Definition
<input checked="" type="checkbox"/>		LAUNAME	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	3AUG source name
<input checked="" type="checkbox"/>		DETID	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Unique detection ID
<input checked="" type="checkbox"/>		SRCID	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Unique source identification ID
<input checked="" type="checkbox"/>		OBS_ID	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	XMM-Newton observation identification
<input checked="" type="checkbox"/>		SRC_NUM	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Source number in individual source

Output number of lines: 100

SUBMIT QUERY

If you have any problems, please consult the [help page](#) or mail ledas-help@star.le.ac.uk

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ARCHIVES ASCA CHANDRA GINGA ROSAT ARNIE

LEDAS:

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Leicester Database and Archive Service

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All Helpfiles

Database: 3XMMSPSCTRAL

3XMM-DR4 Spect

Filter Search

Name Resolver

Name:

☒ [WAPO_NH](#)

☐ [WAPO_NH_HI](#)

☐ [WAPO_NH_LO](#)

☒ [WAPO_NH_ERR](#)

☒ [WAPO_GAMMA](#)

☒ [WAPO_GAMMA_HI](#)

☒ [WAPO_GAMMA_LO](#)

☒ [WAPO_GAMMA_ERR](#)

☒ [WAPO_NORM](#)

Search Type

☒ Cone search
 ☐ Square search
 ☐ Rectangle search

Filter Search

Show Sort

Select All

☒ LAUNAME
 ☒ DETID
 ☒ SRCID
 ☒ OBS_ID
 ☒ SRC_NUM

Output number of lines:

100

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HELP

Co-ordinate system:

☒ Equatorial
 ☐ Ecliptic
 ☐ Galactic

Equinox:

☐ 1950
 ☒ 2000

Output coordinates in:

☒ Decimal
 ☐ Sexagesimal

Output system:

☒ Equatorial
 ☐ Ecliptic
 ☐ Galactic

Output epoch:

☒ J2000
 ☐ B1950

Output format:

HTML Table

Query XMMFITS according best-fit spectral parameters, and different models.

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- LEDAS (Leicester Database and Archive Service): query capabilities. 3XMMspectral.
- XCAT-DB: query and spectral-fitting visualisation tool (**soon**).

<http://xcatdb.unistra.fr/3xmm/> (soon)

Unique Sources

Individual Detection

Welcome to the 3XMM

The 3XMM catalogue results from the XMM-Newton mission. This work has been achieved by the European Space Agency (ESA) and the European Southern Observatory (ESO). Catalogue data are also available from the XMM-Newton Science Data Centre (XMM-Newton SDC).

Database Content

- Individual detections with positions
- 3XMM Slim Catalogue of unblended sources
- EPIC spectra, EPIC time series

Data Access

Click on the *Unique Sources* button to view the list of unique sources.
Click on the *Individual Detection* button to view the list of individual detections.

Planned Enhancement

- Publication of VO services
- Help Video
- RGS and OM Data
- Enhanced quick look facility

3XMM Interface by the Observatory of Strasbourg

- DB content - Watchouts - Contact - [2xmmidr3](#) - b

Query Setup on Unique Detections

Position

Detection Parameters

Source Parameters

Require Related Products

Filter by Correlations with Arch. Src.

Cone Search Setup

Coord/Name

Radius(arcmin) 1

System ICRS

Upload Position List

List of Active Constraints

Click on a button to append, the constraint to the list

QL stmt

Query Panel

SUBMIT

Result Limit 1000

Display/Hide Query Text

Reset Query Form

Select ENTRY From CatalogueEntry In CATALOGUE
Limit 1000

<http://xcatdb.unistra.fr/3xmm/> (soon)

Unique Sources

Individual Detection

3XMM Interface by the Observatory of Strasbourg

- DB content - Watchouts - Contact - 2xmmidr3 - b

Query Setup on Unique D

Position

Detection Pa

Filter by Correlations with

Cone Search Setup

Coord/Name

Radius(arcmin) 1

System ICRS

Upload Position List

Query Panel

SUBMIT

Result Limit

Select ENTRY From Catalog

Limit 1000

Welcome to the 3XMM

The 3XMM catalogue results from
This work has been achieved by
Catalogue data are also available

Database Content

- Individual detections with pos
- 3XMM Slim Catalogue of uni
- EPIC spectra, EPIC time serie

Data Access

Click on the *Unique Sources* but

Click on the *Individual Detection*

Planned Enhancement

- Publication of VO services
- Help Video
- RGS and OM Data
- Enhanced quick look facility

model=phabs(pow) nh=0.01e*22 bin=10cts/bin PhoIndex=2.2 norm=1
data and folded model

normalized counts s⁻¹ keV⁻¹

Energy (keV)

ratio

Get Query Form

Query XMMFITCAT plus spectral-fit and data visualization tool

XMM/SDSS

<http://xraygroup.astro.noa.gr/Webpage-prodec/index.html>

- Spectral-fitting results from XMM-Newton SDSS-DR7 cross-correlation (Georgakakis & Nandra 2011)
- Detected in the hard band (2-8 keV): ~14,000.
 - Sources with redshifts available ~ 8000 (spectral fits modified to include redshift effects)
 - Sub-sample with spectroscopic redshifts used in selection of highly absorbed AGN (Corral et al., submitted; Fe $K\alpha$ emission line fitting included; **I. Georgantopoulos talk yesterday**)

Summary

- Construction of XMMFITCAT from 3XMM-DR4 completed, catalogue released to the public.
- Plus additional results from a XMM/SDSS cross-correlation also released.
- Working on catalogue paper.
- **Future:** spectral-fitting results will be included in future versions of the XMM-Newton Serendipitous Source catalogue. Athena, eROSITA ?