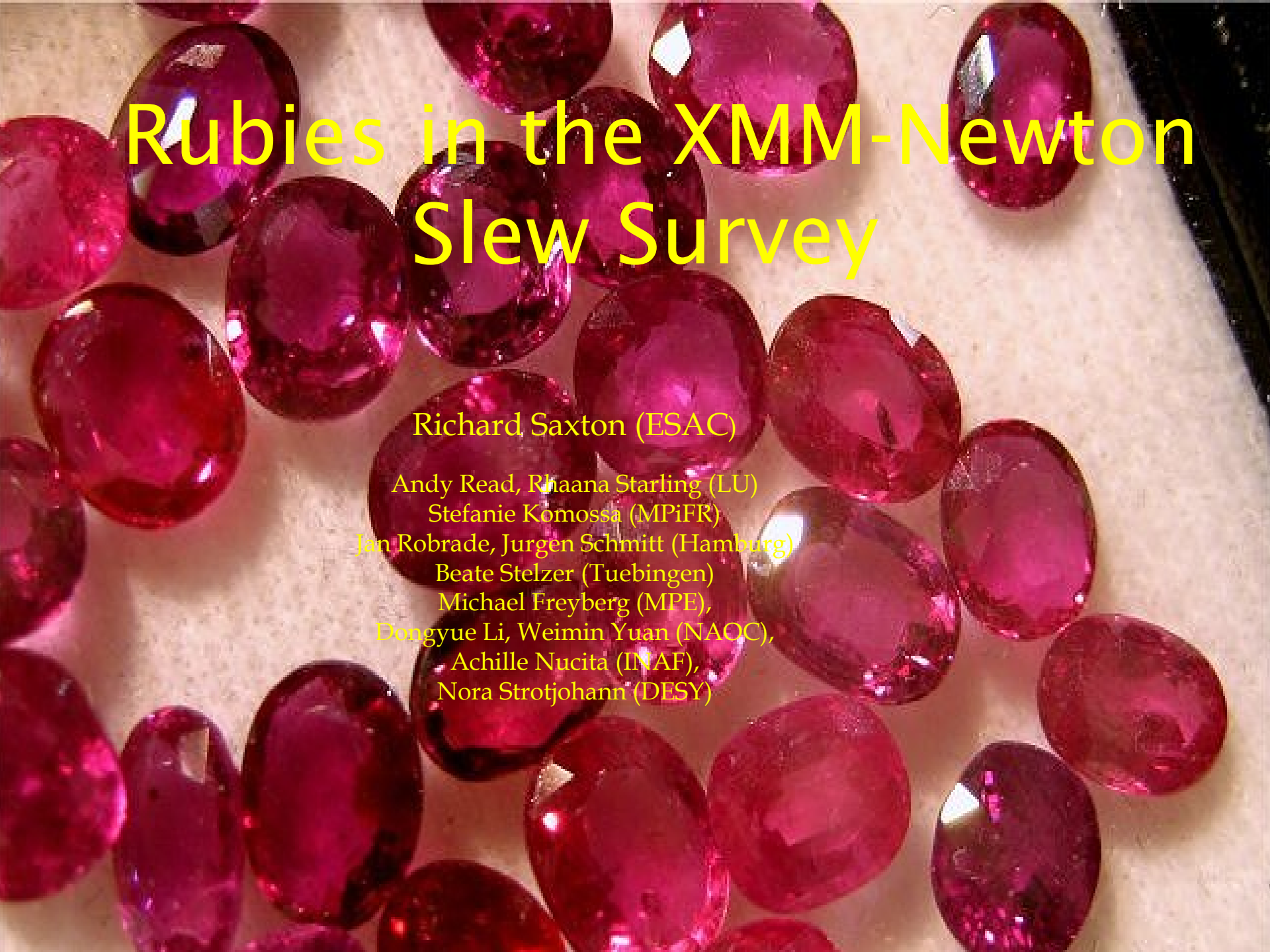
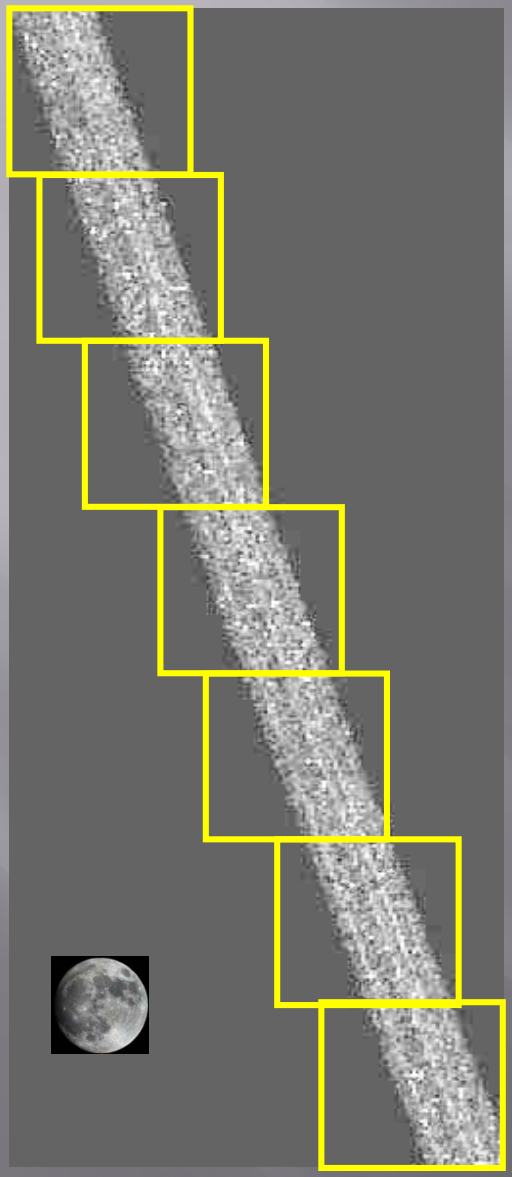


Rubies in the XMM-Newton Slew Survey

Richard Saxton (ESAC)

Andy Read, Rhaana Starling (LU)
Stefanie Komossa (MPiFR)
Jan Robrade, Jurgen Schmitt (Hamburg)
Beate Stelzer (Tuebingen)
Michael Freyberg (MPE),
Dongyue Li, Weimin Yuan (NAOC),
Achille Nucita (INAF),
Nora Strotjohann (DESY)

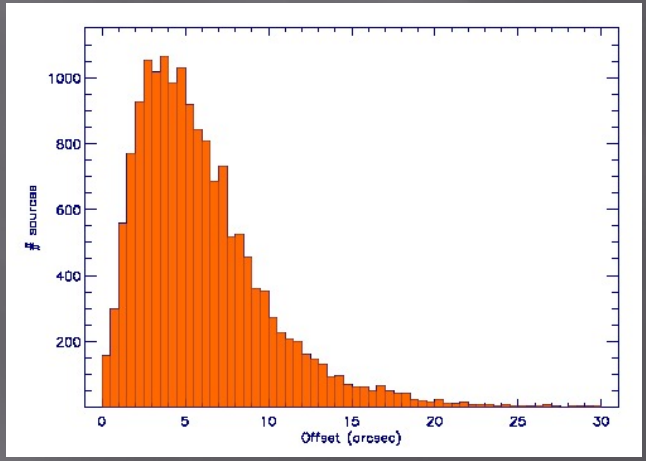
Slew – basic details



Slews are on average, 70 degs long and 0.5 degs wide.

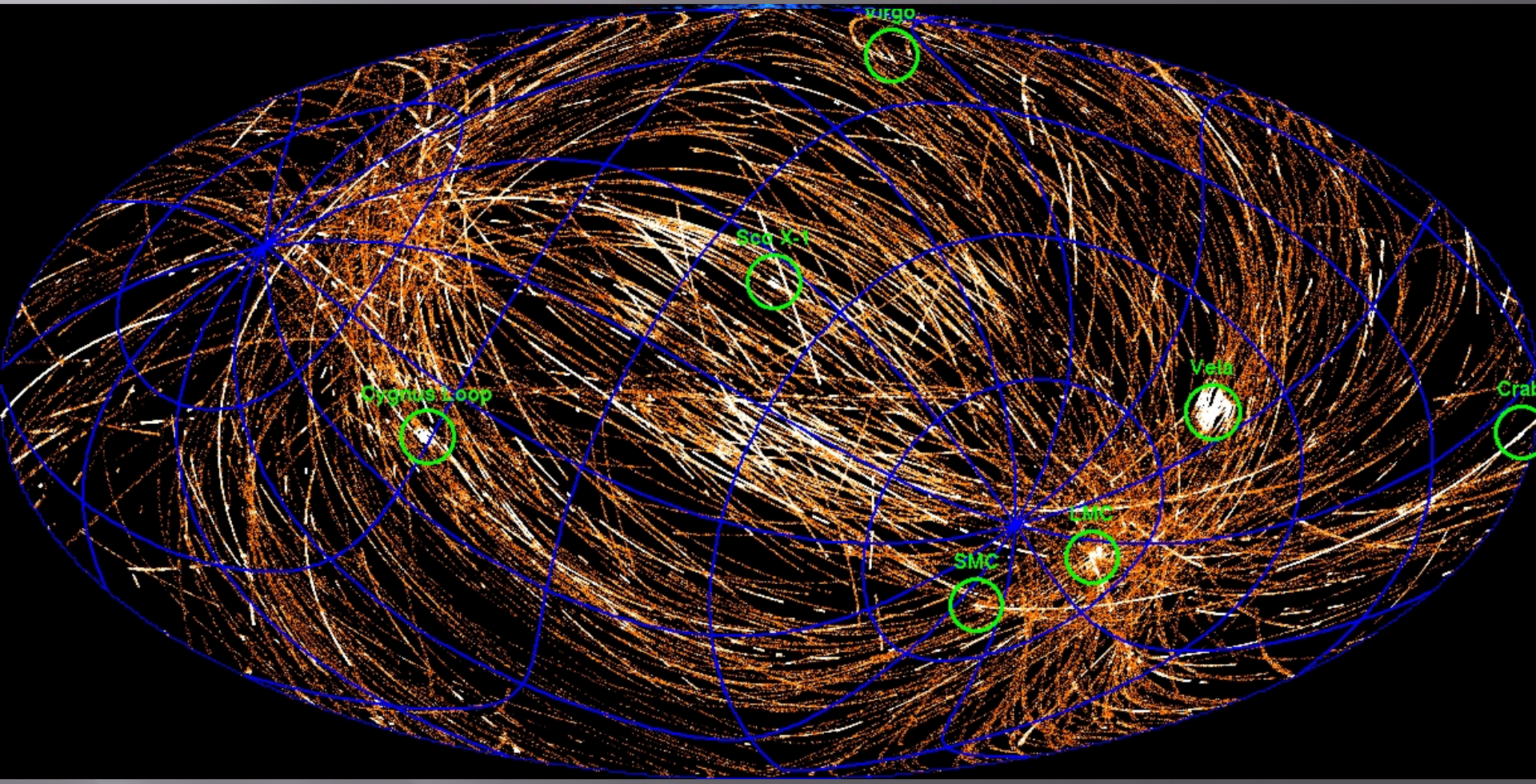
Data is taken with the EPIC-pn camera, *Medium* filter and the observing mode of the previous observation

Produce sub-images of ~1 deg^2 in 0.2-2, 2-12 and 0.2-12 keV bands (soft, hard and full bands)



Positional error:
7.3" (1-sig) ,
11.3" (90%)

XMMSL2 sky coverage



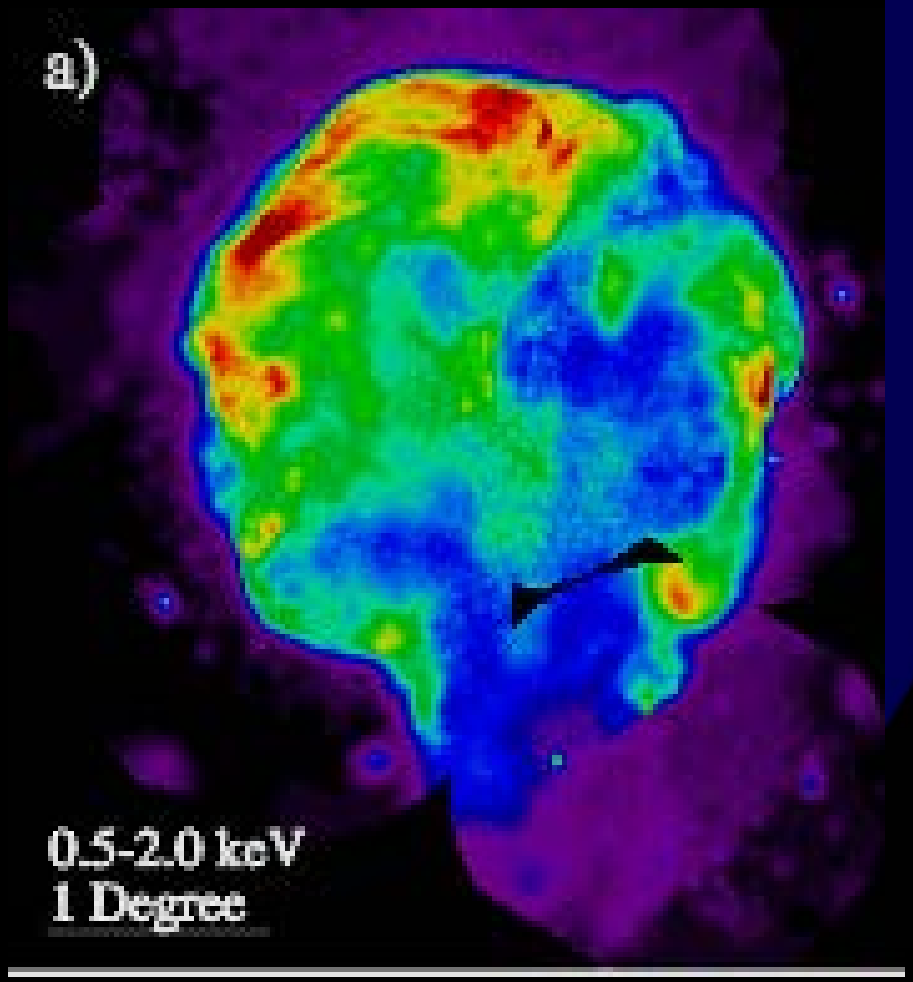
XMMSL2 – released March 2017 (2114 slews up until end of 2014)
65000 deg^2, 29393 detections and 23000 individual sources

85% of sky covered at least once

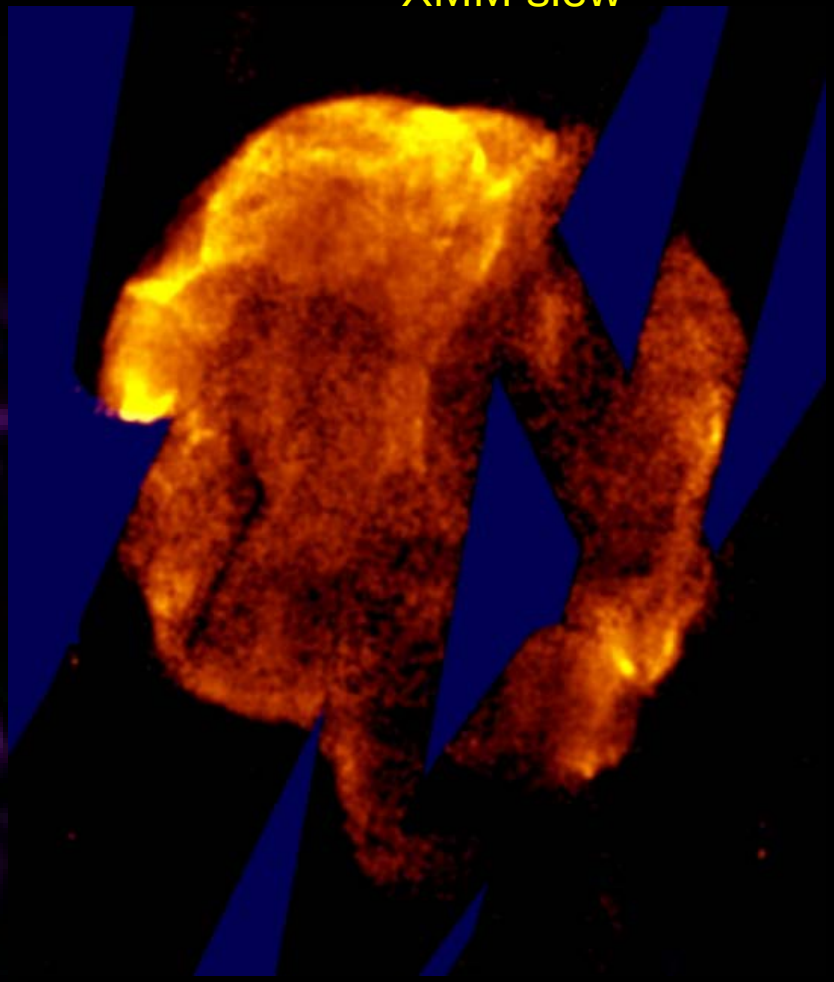
0.2 – 2 keV band : $F_{0.2\text{-}2} > 6 \times 10^{-13}$ cgs
2 – 12 keV band : $F_{2\text{-}12} > 4 \times 10^{-12}$ cgs

Cygnus Loop

ROSAT



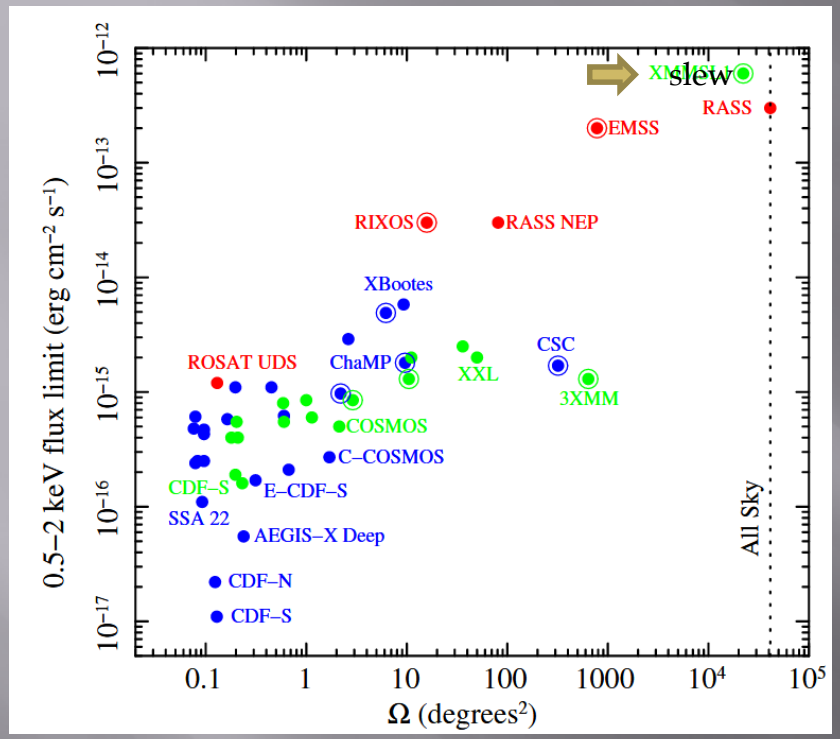
XMM slew



ROSAT

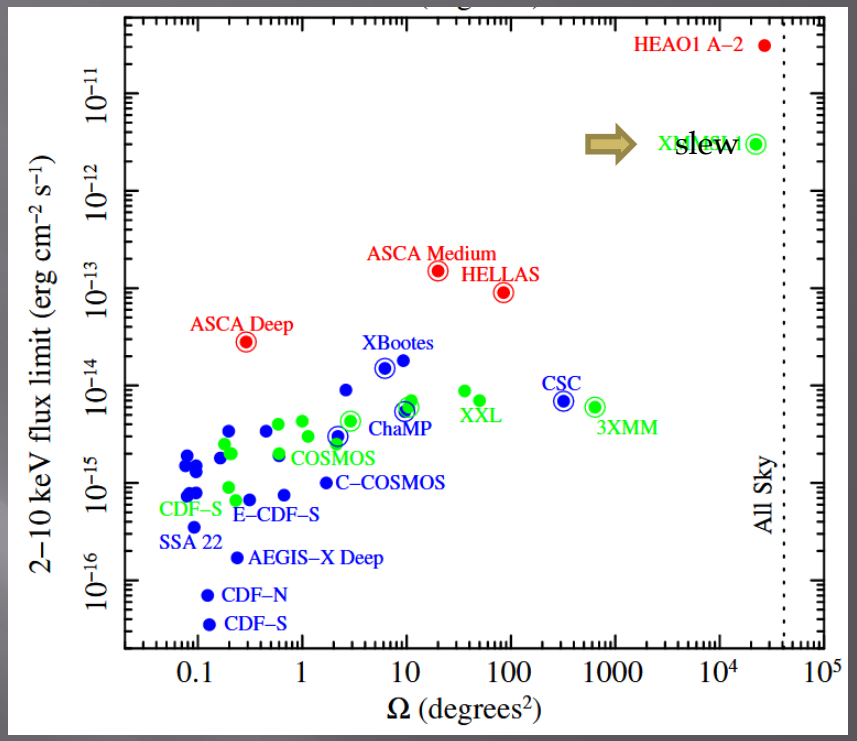
XMM-Newton Slew
~½ hour observing time !

Coverage / Depth



Soft X surveys

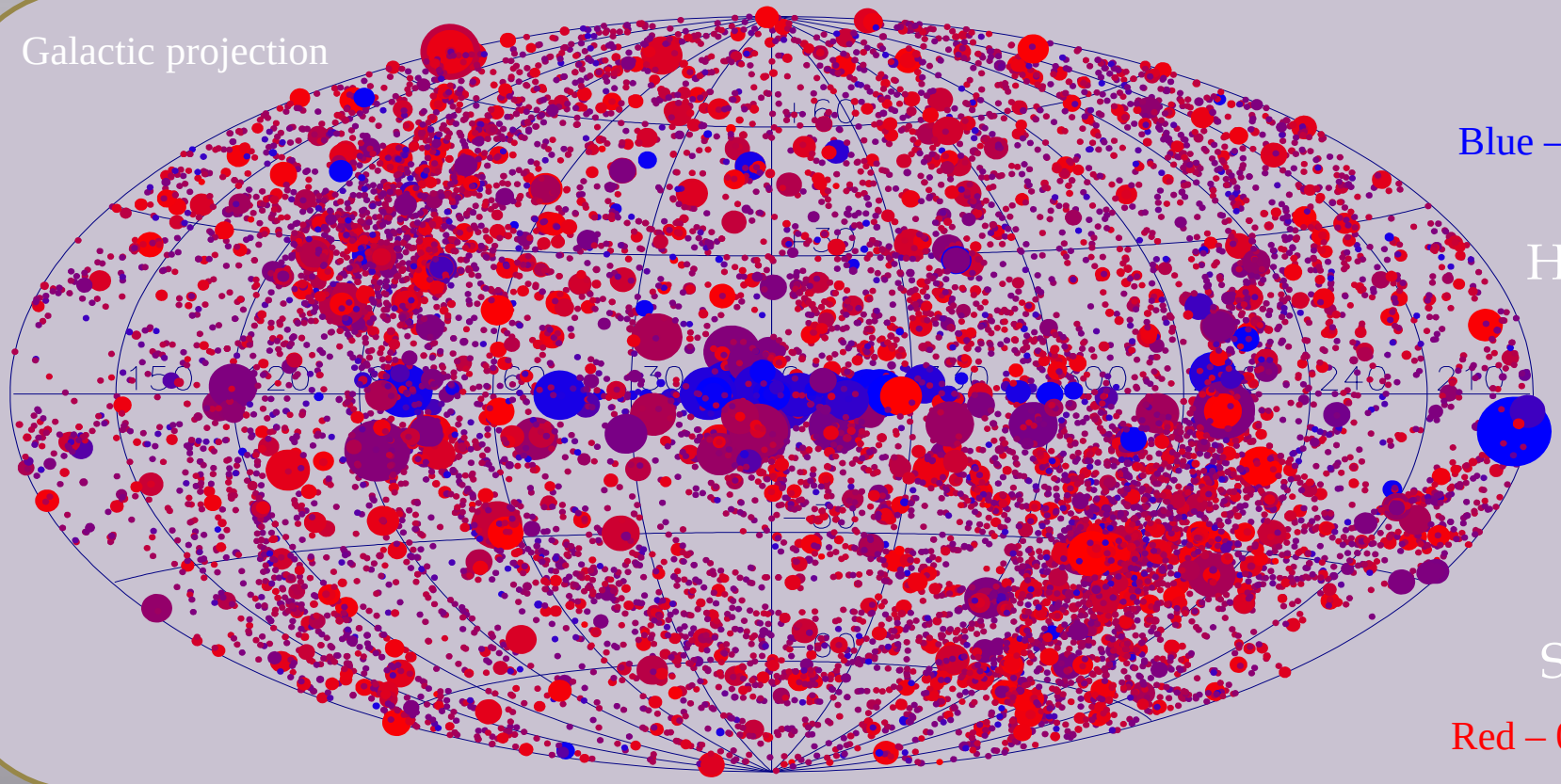
Brandt et al. 2015



Hard X surveys

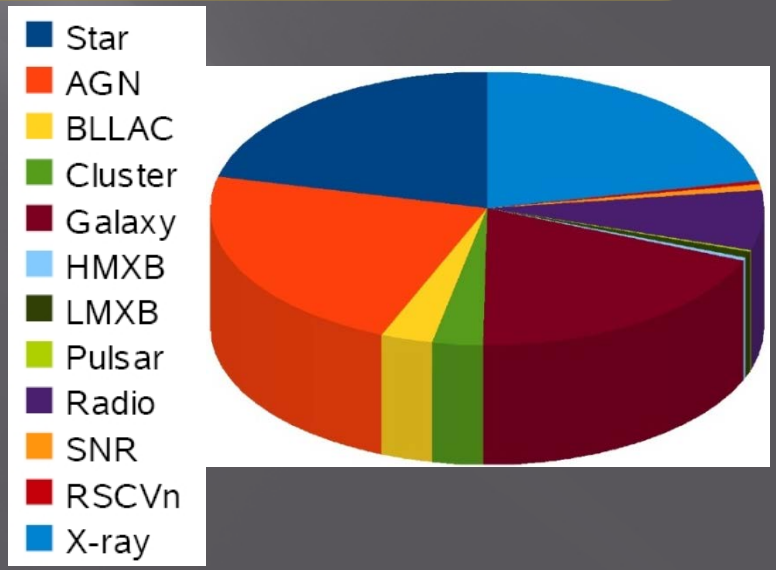
F_0.2-2 ≥ 6×10^{-13} ergs/s/cm2

F_2-10 ≥ 4×10^{-12} ergs/s/cm2

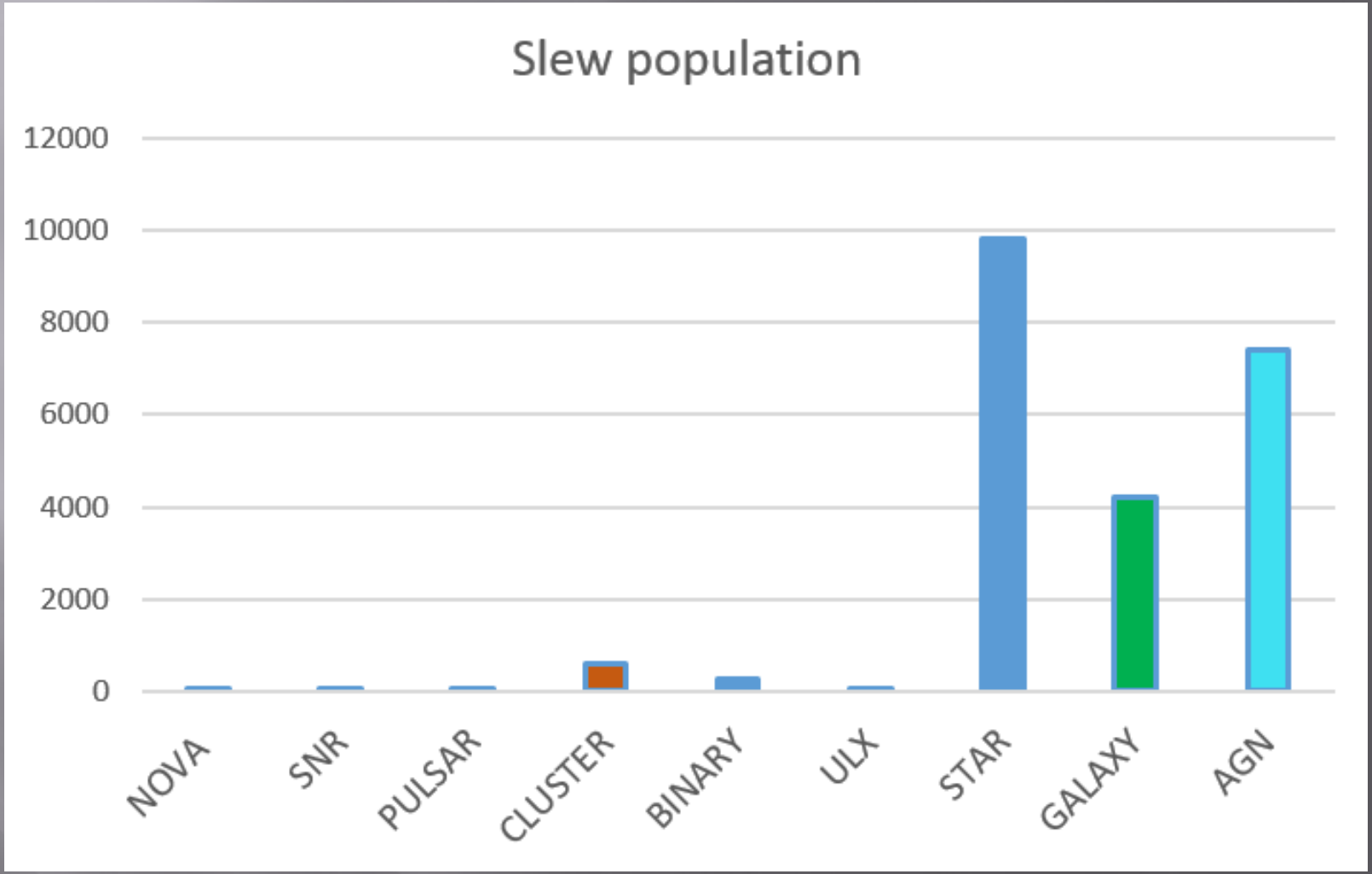


Circle size ≡ source flux

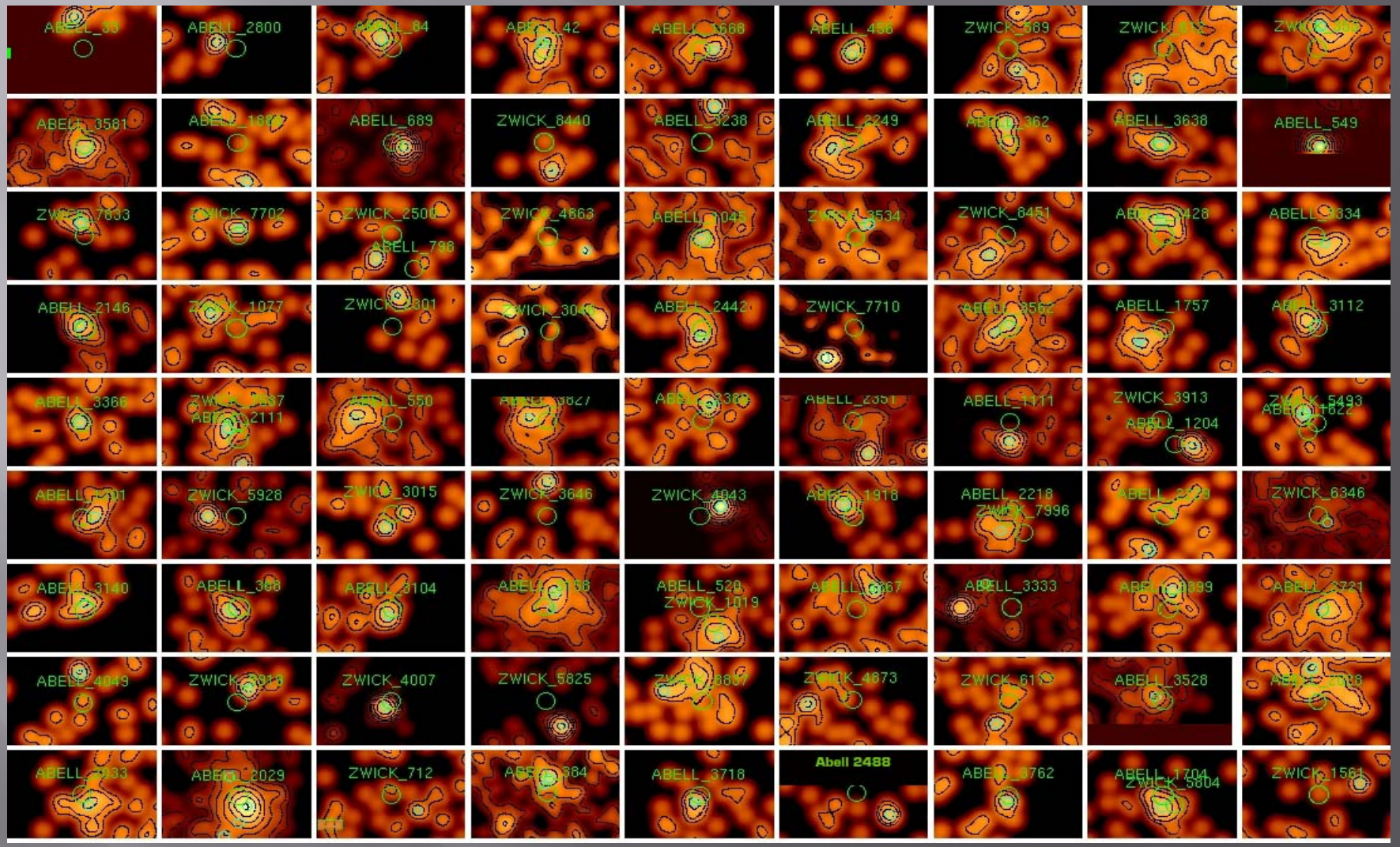
75% of sources are identified



Population full

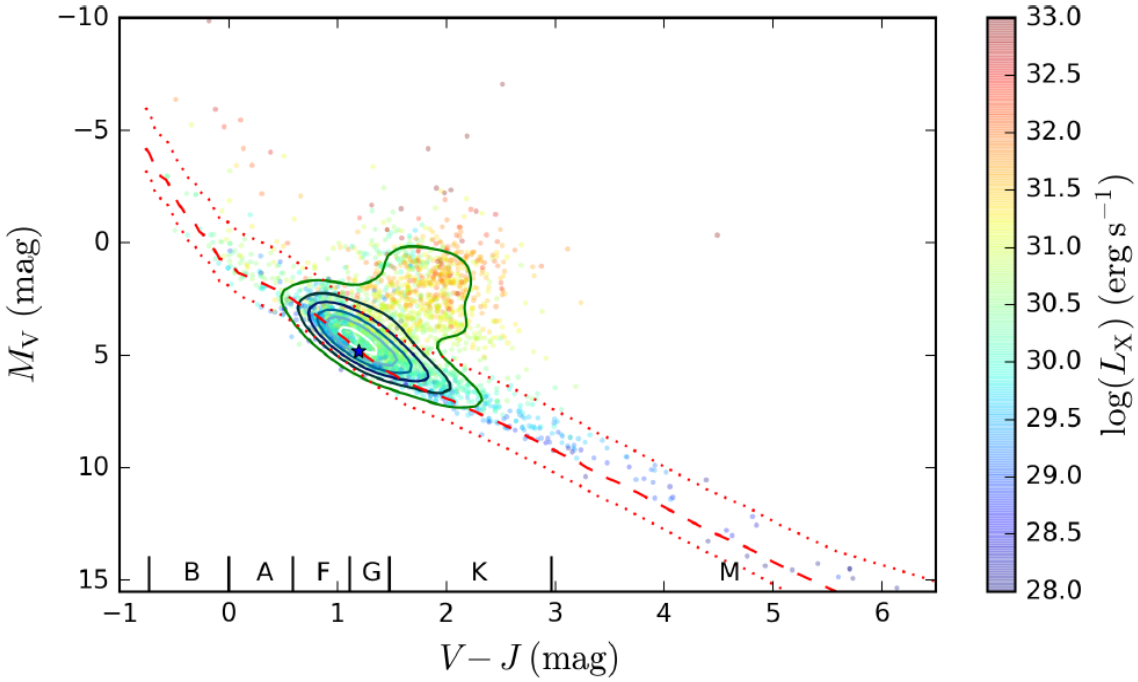


Clusters of galaxies



>500 clusters of galaxies detected

Stellar population



Freund et al. 2018

X-corr of XMMSL2 with Gaia DR1

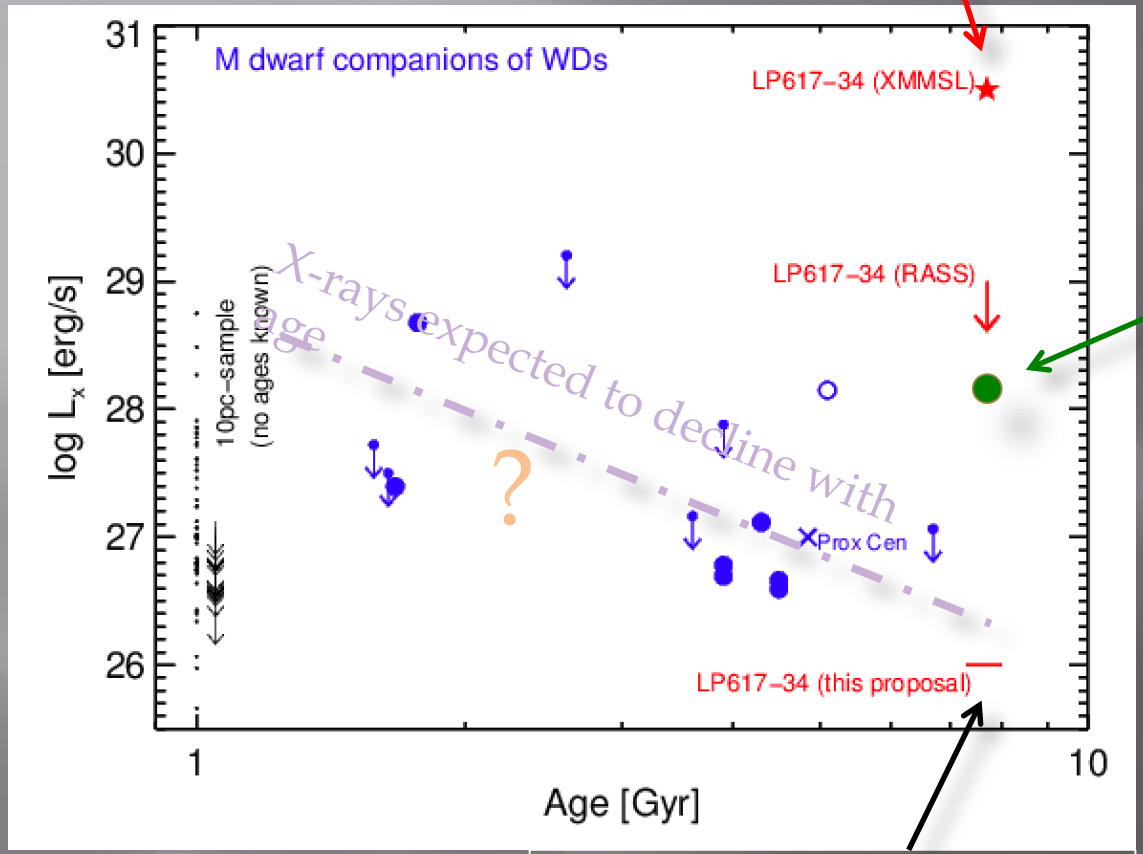
Black points – src with >17 XMMSL2 counts

Stars with known parallax distance. Lines denote main sequence

The XMMSL2 catalog contains ~25% stars.
Most of the stellar XMMSL2 sources are late-type dwarfs with an outer convection zone.
Only about 75%of the XMMSL2 sources have a RASS identification.
Hence, a substantial portion of the stellar XMMSL2 sources are previously unknown X-ray sources caught in an active or flaring state.

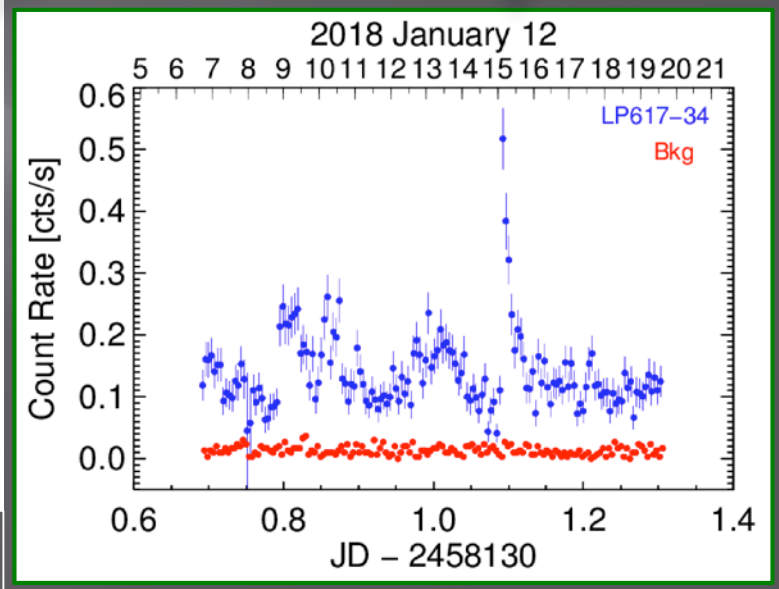
A puzzling M dwarf among the XMMSL transients *(Stelzer et al., in prep.)*

An M dwarf seen as transient XMM-slew source → probably a flare
But: M dwarf has age > 7 Gyr → very low activity expected



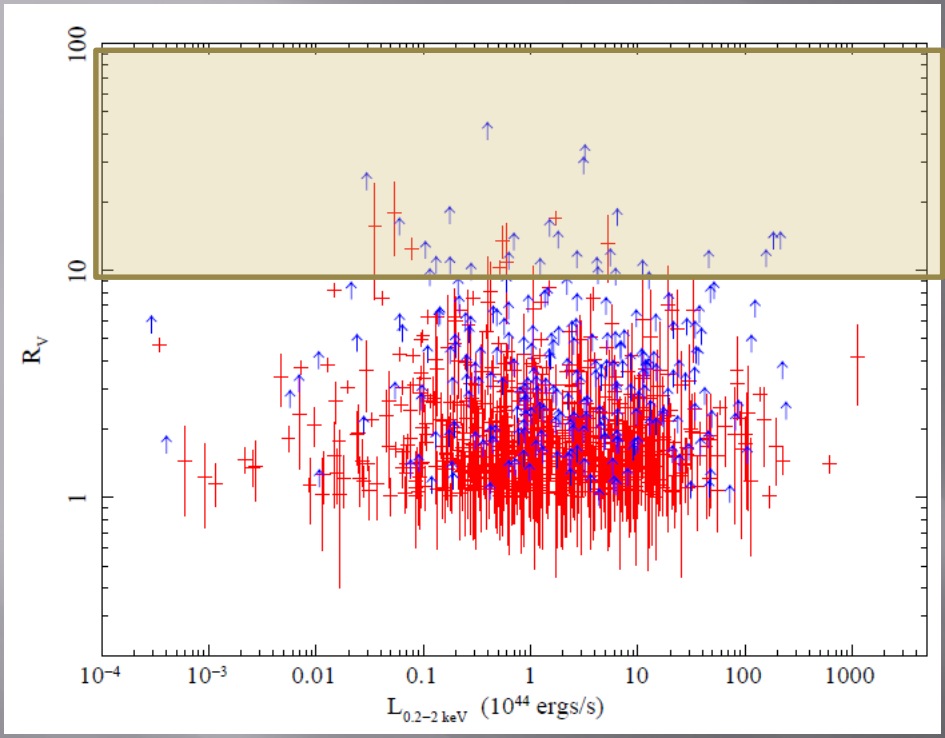
Sensitivity limit of pointed follow-up XMM observation

detected L_x in XMM follow-up + corresponding EPIC/pn lightcurve



→ **EXCEPTIONALLY STRONG ACTIVITY DISCOVERED IN A VERY OLD M DWARF**

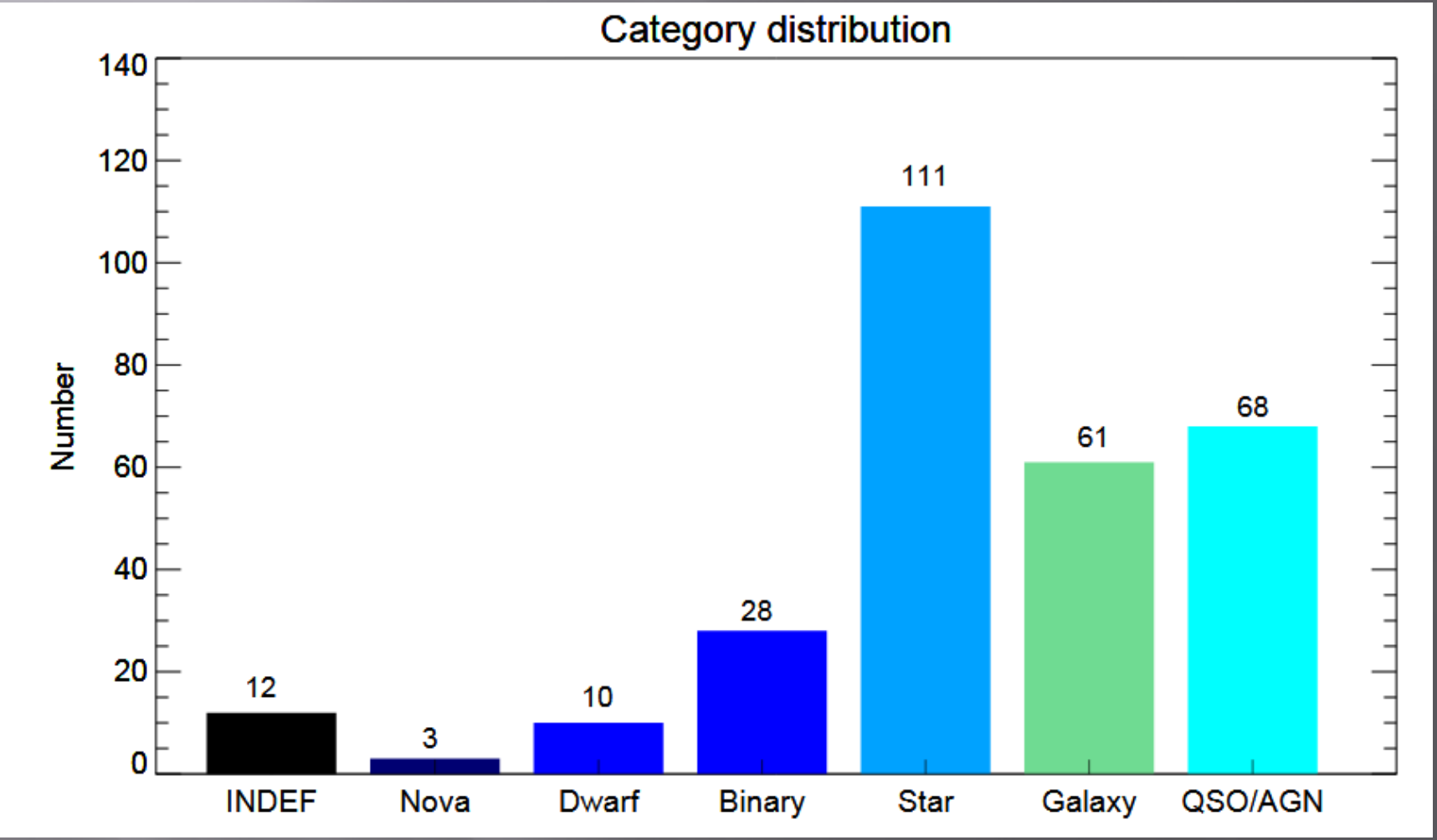
Point sources: variability



~5% of sources have >10 variability

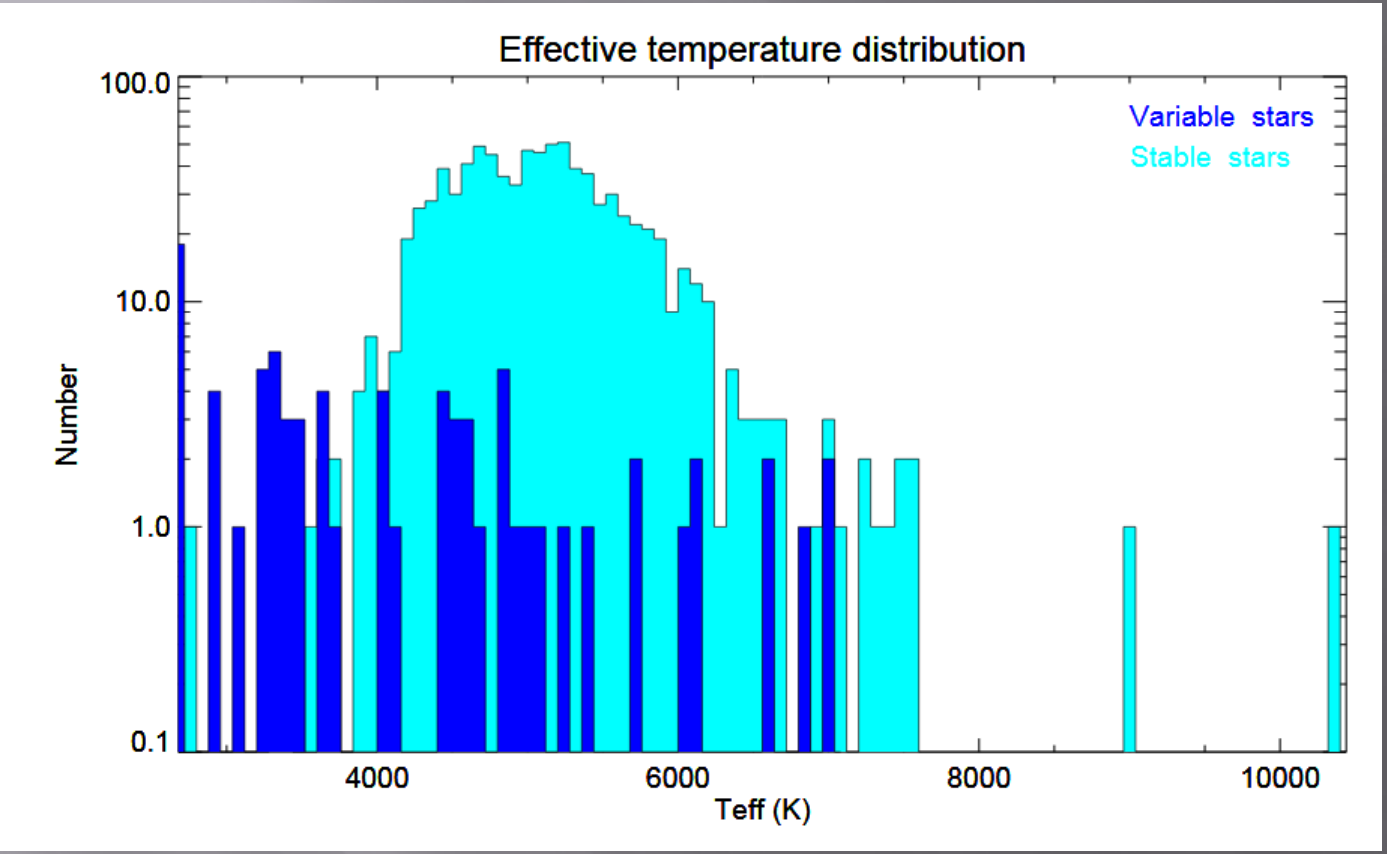
Form sample of 318 objects with XMM_slew / RASS flux ratio>10 And >5 counts in XMM slew.

Population of transients



Li et al. in prep

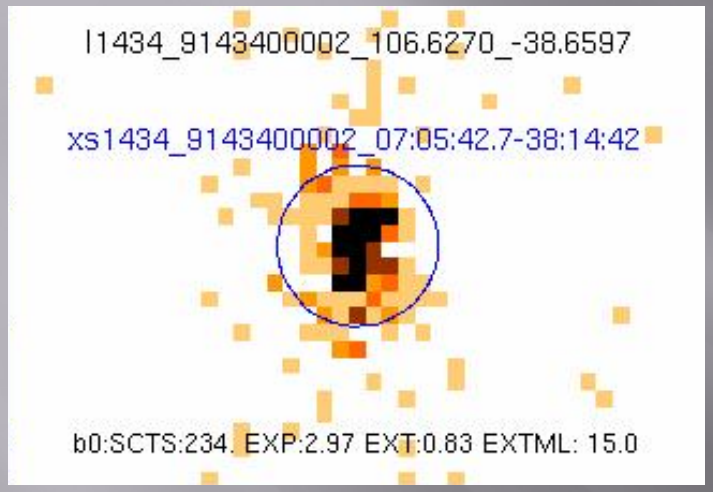
Transient population stars



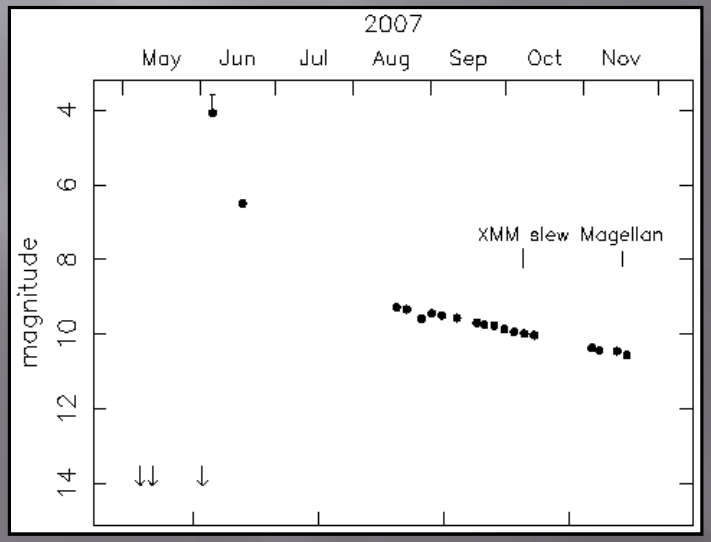
Li et al. in prep

On average variable stellar population consists of lower mass, cooler stars, usually K or M dwarves

Novae



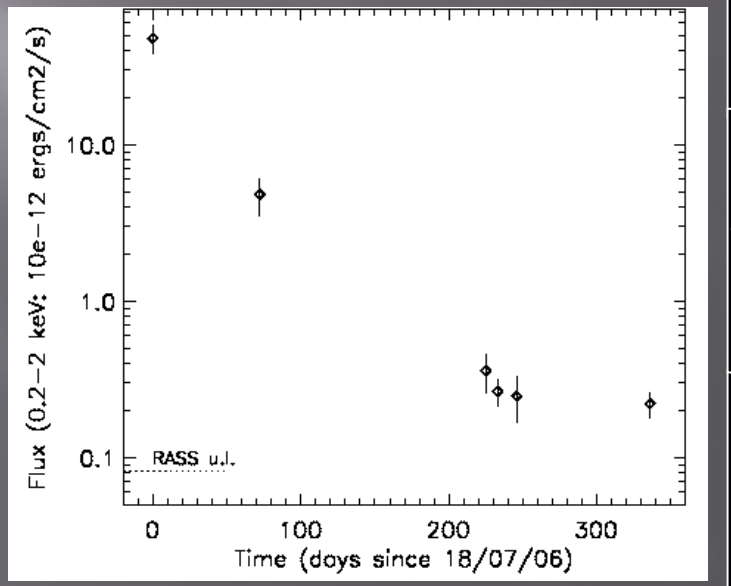
V598 Pup – 50 c/s, Oct 2007



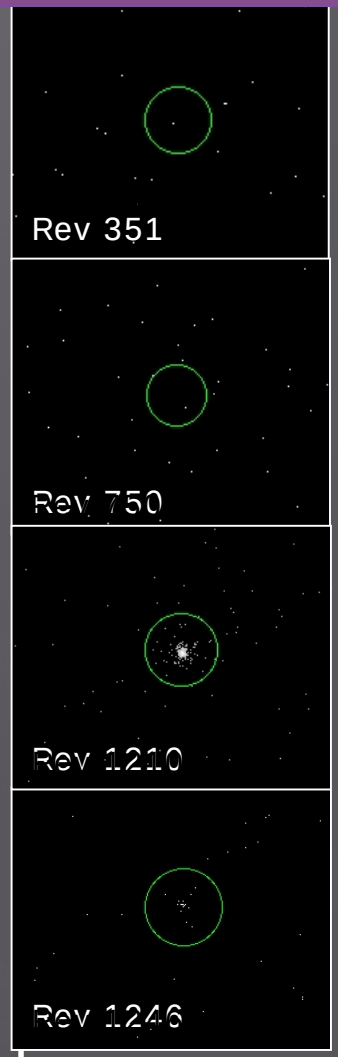
Read et al. 2008

XMMSL1 J060636.2-694932
25 c/s, July 2006

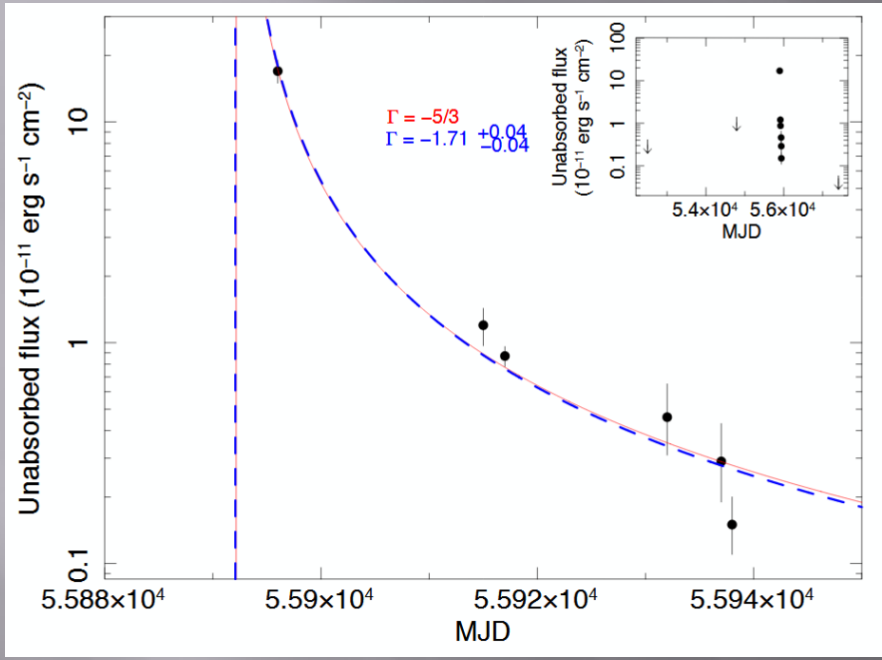
Nova detected in LMC

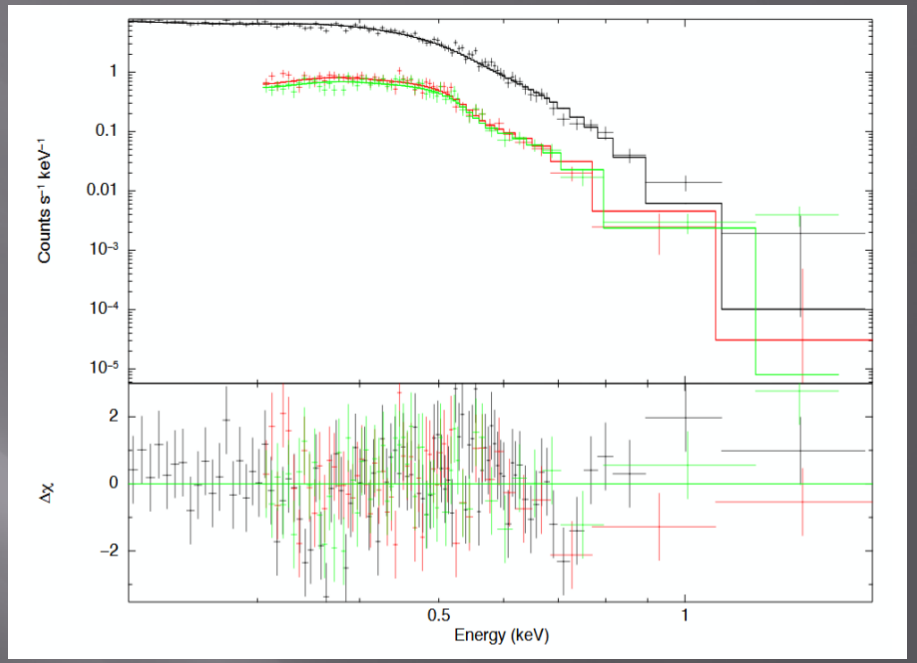


Read et al. 2009



Nova – XMMSL1 0630-60



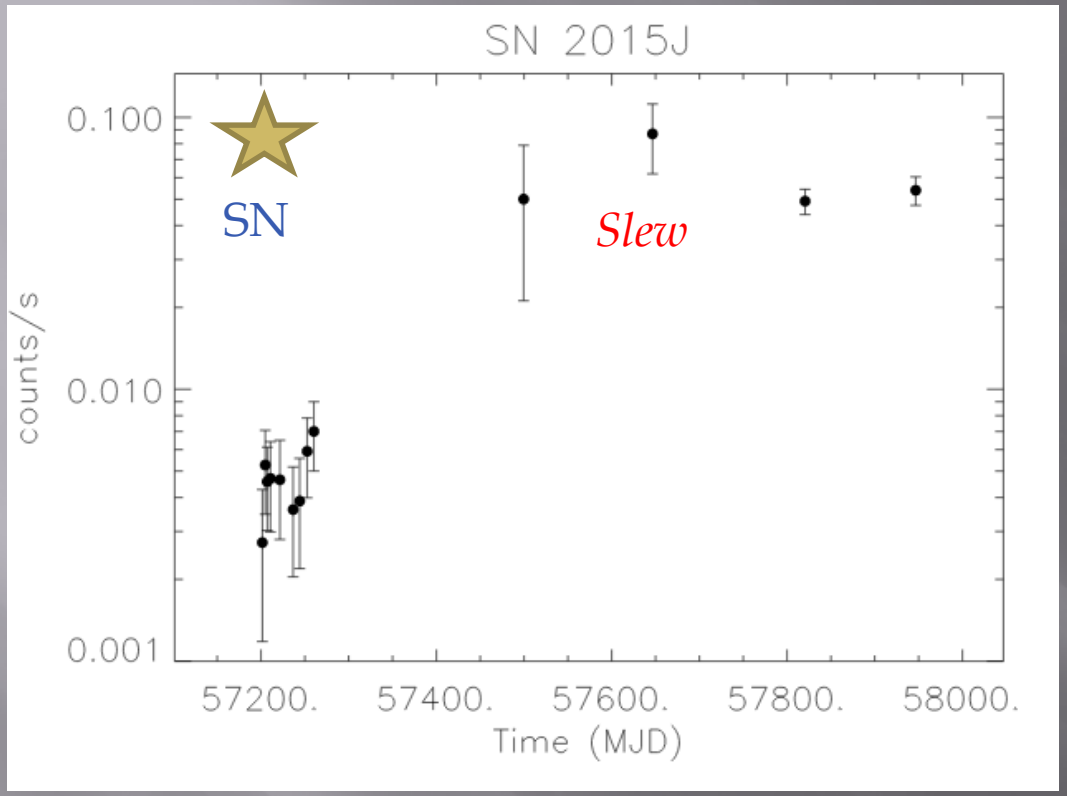


XMMSL1 J063045.9-603110 – 32 c/s (Dec 2011) with very faint optical counterpart

Mainetti et al. 2016 suggested it as a TDE based on subsequent X-ray LC and soft spectrum

Oliviera et al. 2017 – optical spectrum showing Nova in nebula phase.

Supernovae



Nucita et al. 2017

SN 2015J - Type IIn

L_X~5x10^{41} ergs/s

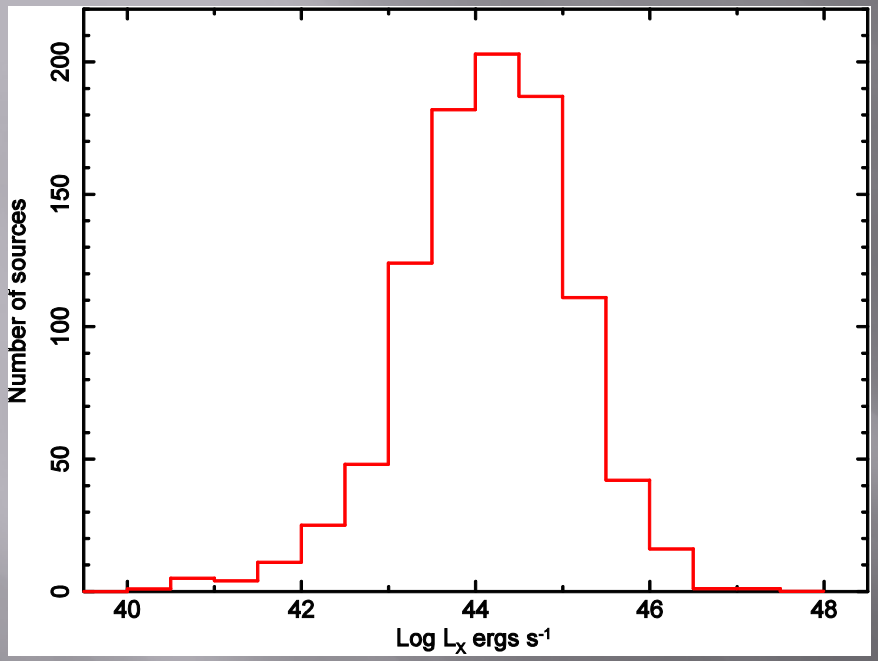
L_X~2x10^{40} ergs/s

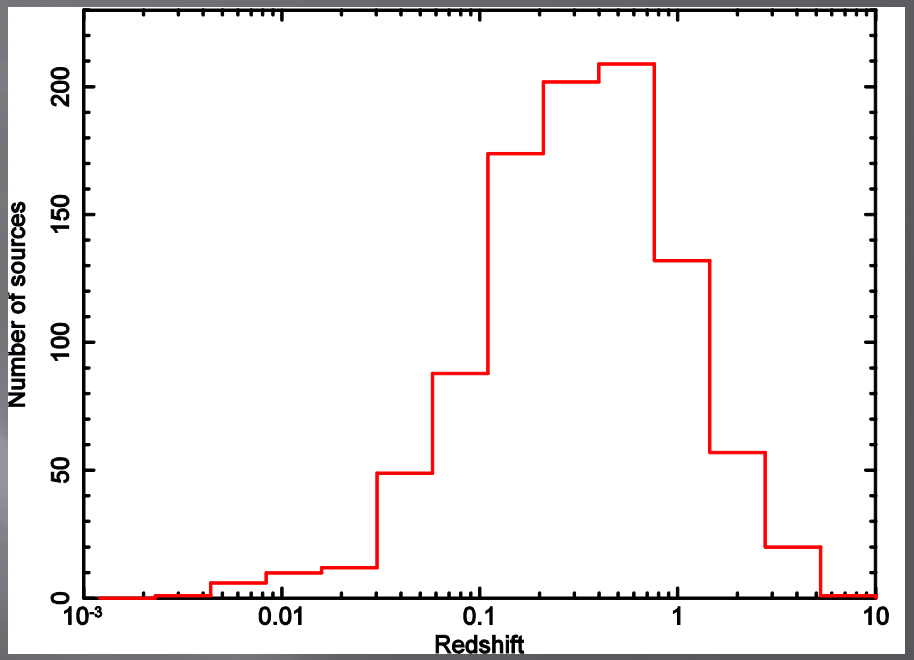
Some SN exploding into dense environments show delayed high-L, X-ray emission relative to Optical.

L_X~5x10^{41} ergs/s, kT~200 eV

Also SN2010jl, SN2006jd similar luminosity but much harder X-ray spectrum, lasted for several years

AGN



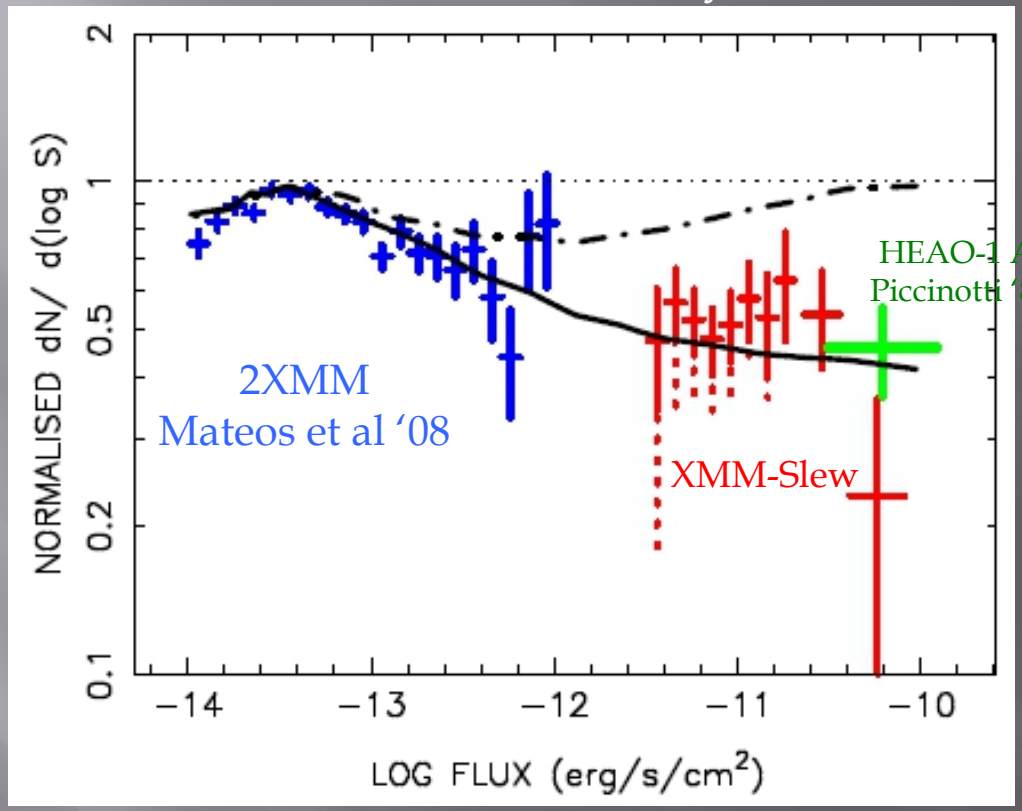


Probing principally $10^{42}<Lx<10^{46}$

$0.03<z<2.0$

AGN – hard-band (extragalactic) luminosity function

2-10 keV AGN luminosity function



Warwick et al. 2012

Model of *Gilli et al. 2007*

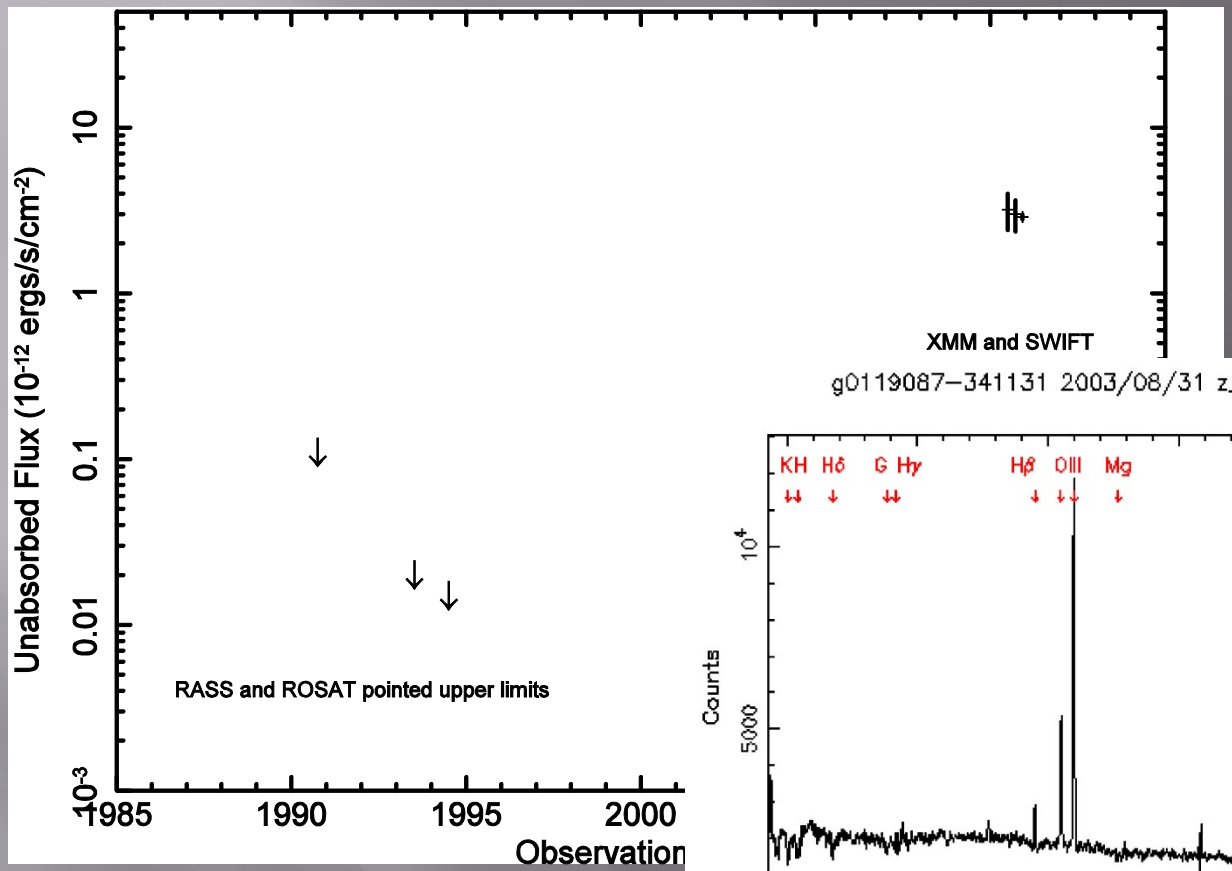
Solid line = AGN-only
Dashed=AGN+clusters

Blue from 2XMM
Red from XMM slew
Green from HEAO-1/A2

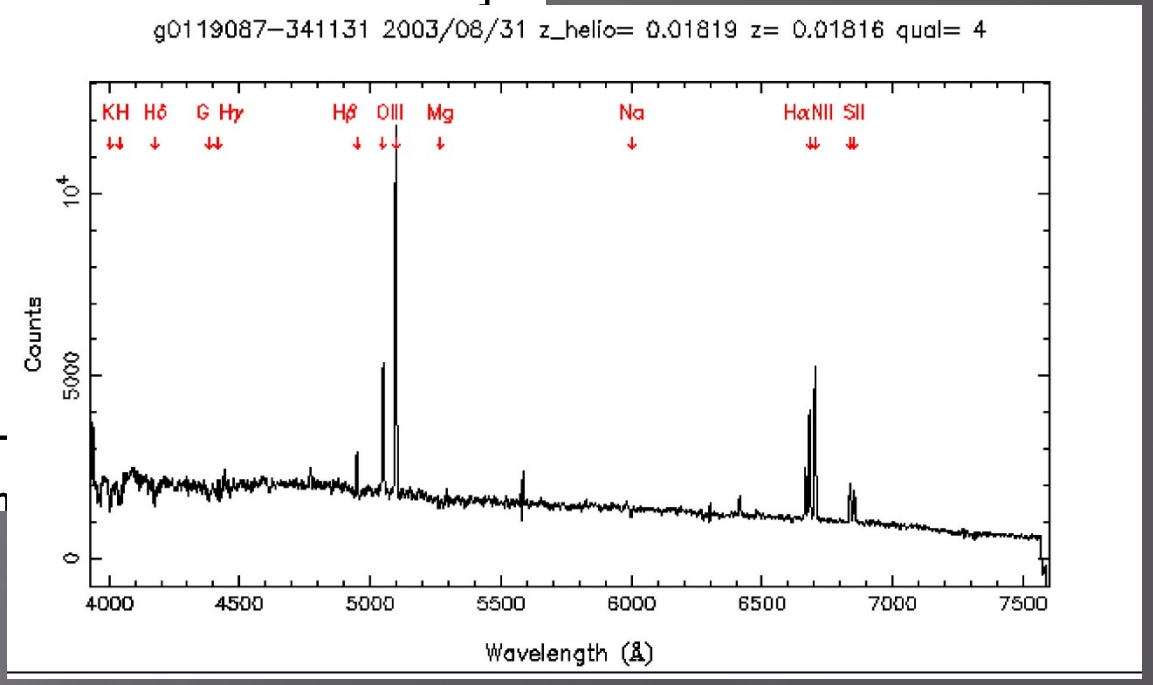
Slew number counts fit well with extension from 2XMM

Clusters under-represented – due to insensitivity of current detection algorithm ?

Flares from AGN

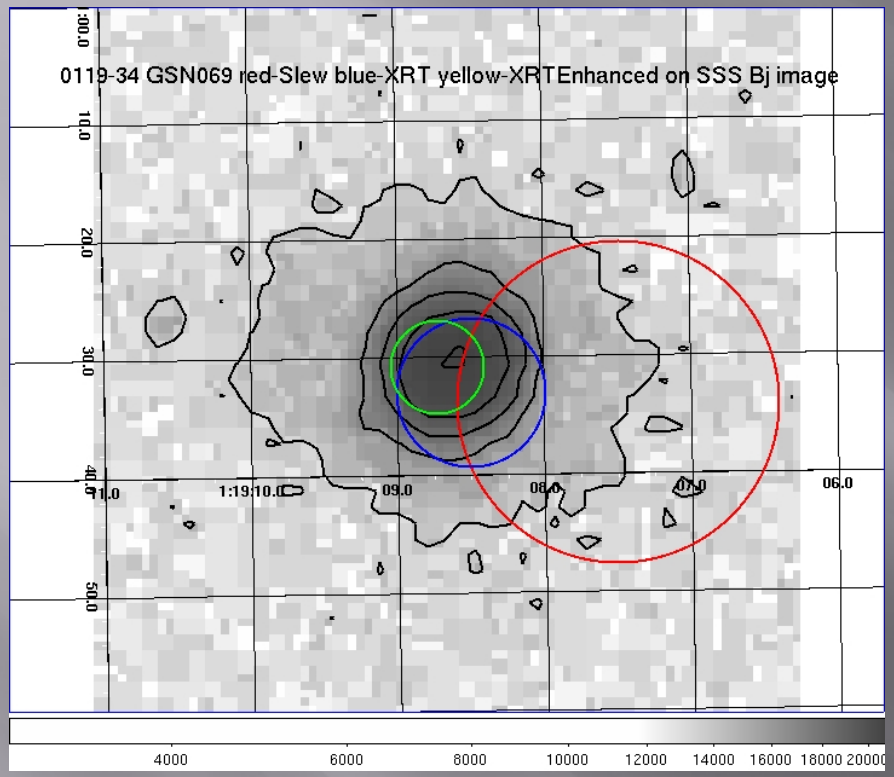


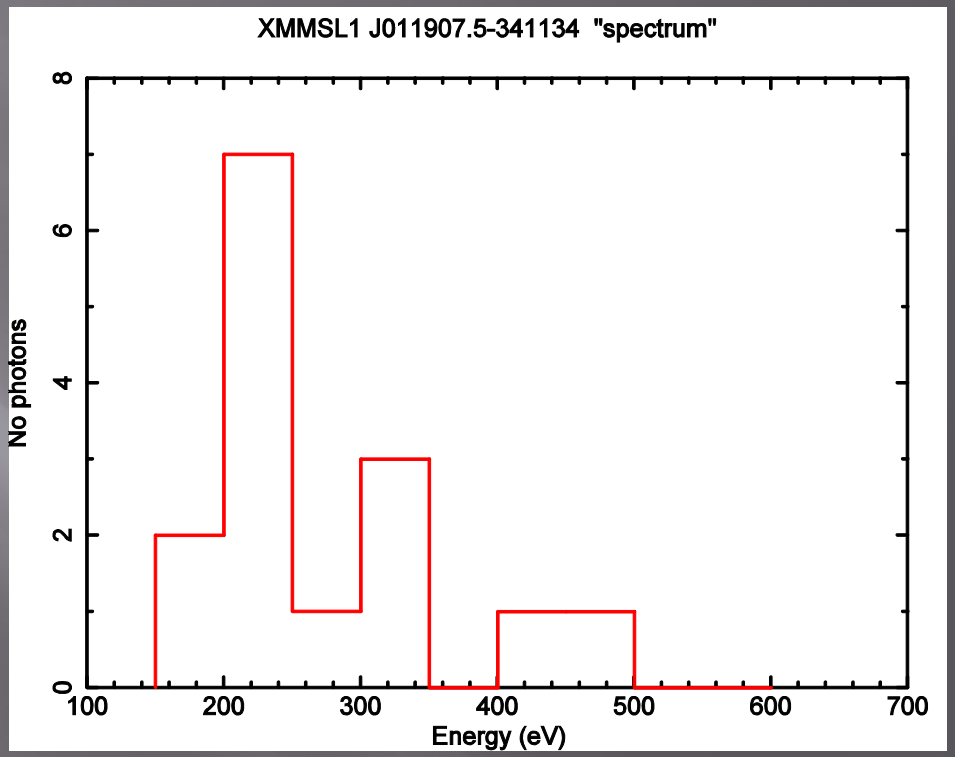
GSN 069



Seyfert 2 - line widths are <200 km/s – z=0.01816

Flares from AGN - GSN 069



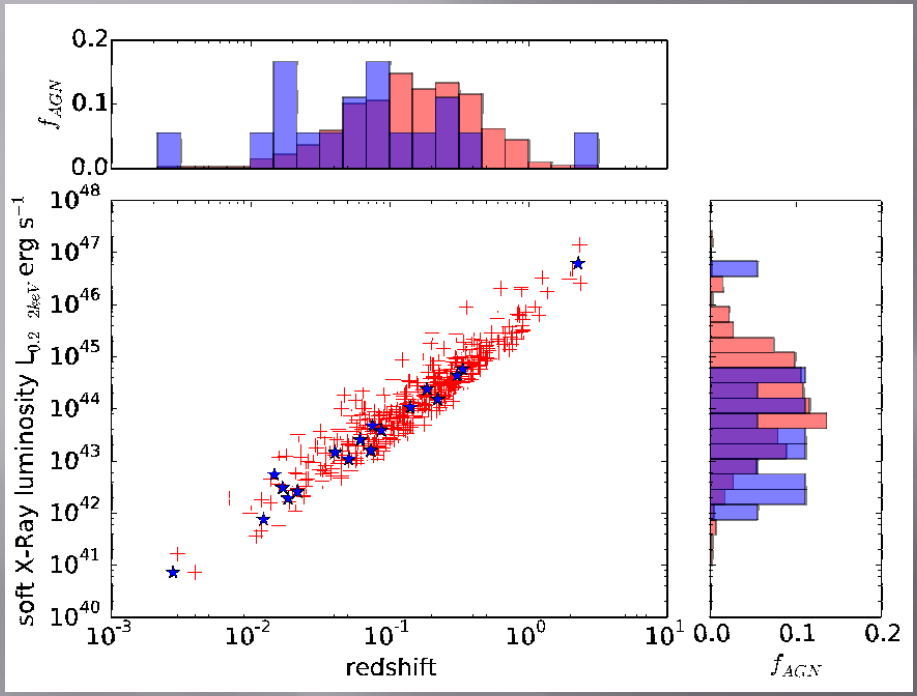


July 2010 - XMM slew source found with

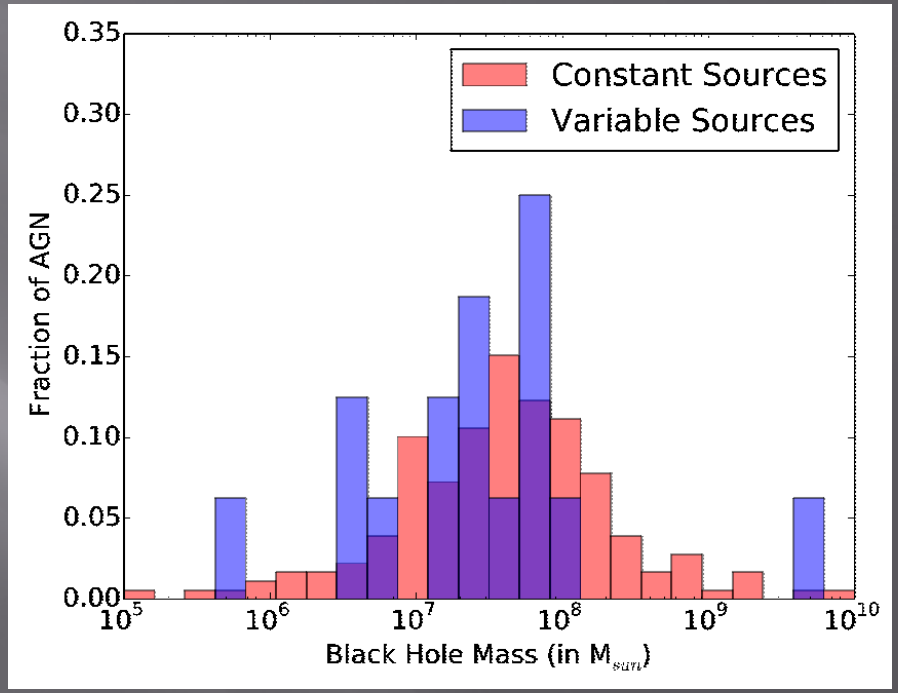
$F_{0.2\text{-}2keV}$ =3E-12 ergs/s/cm^{-2}

Very soft spectrum (15 photons)
kT~70 eV

AGN – high variability



Strotjohann et al. 2016

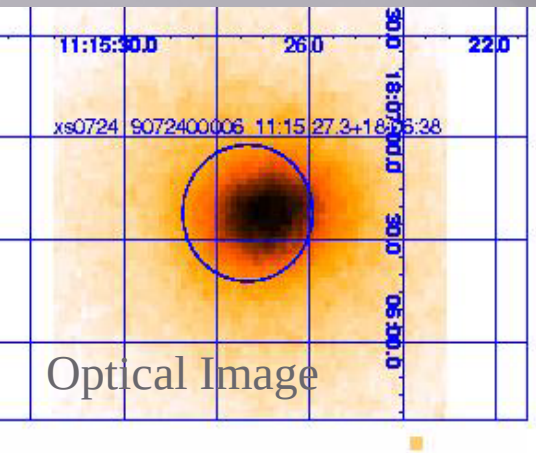


M_BH from K luminosity

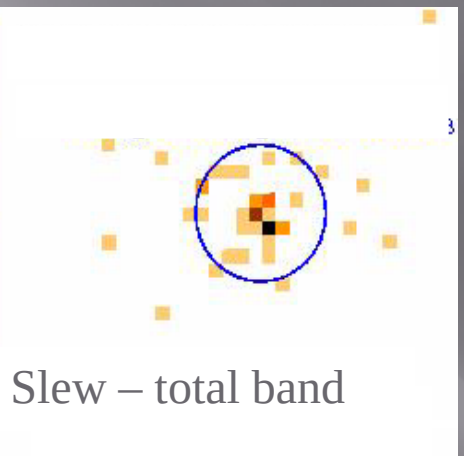
Sample of 24 galaxies with >10 variability from RASS

Tidal Disruption Events

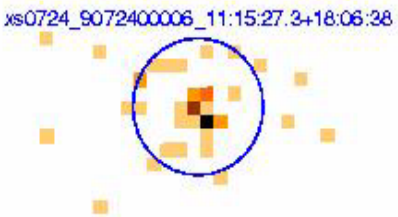
NGC 3599



Optical Image



Slew – total band

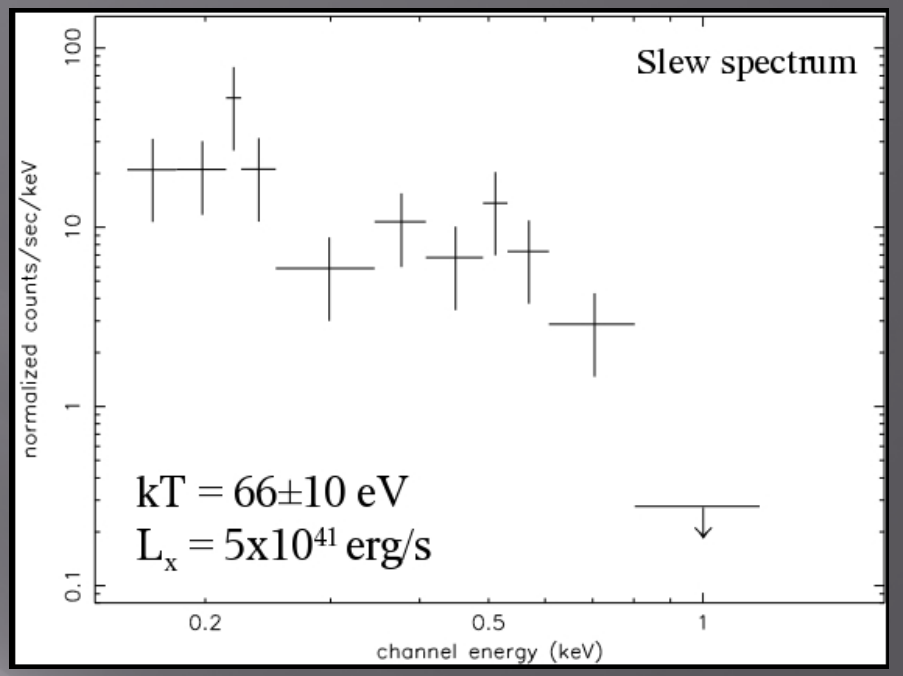


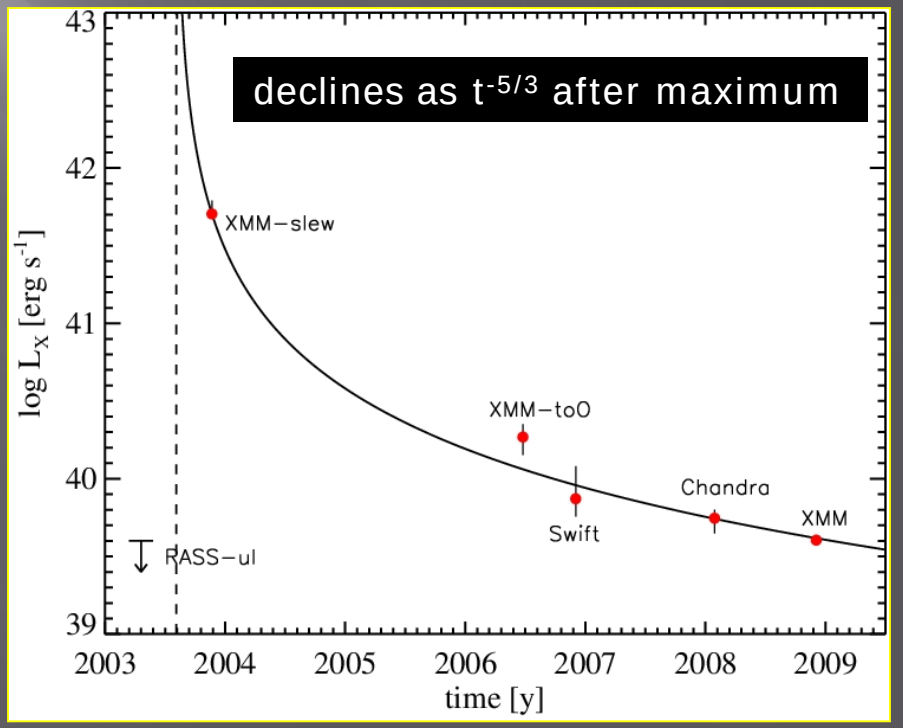
Slew – soft band

Slew – hard band

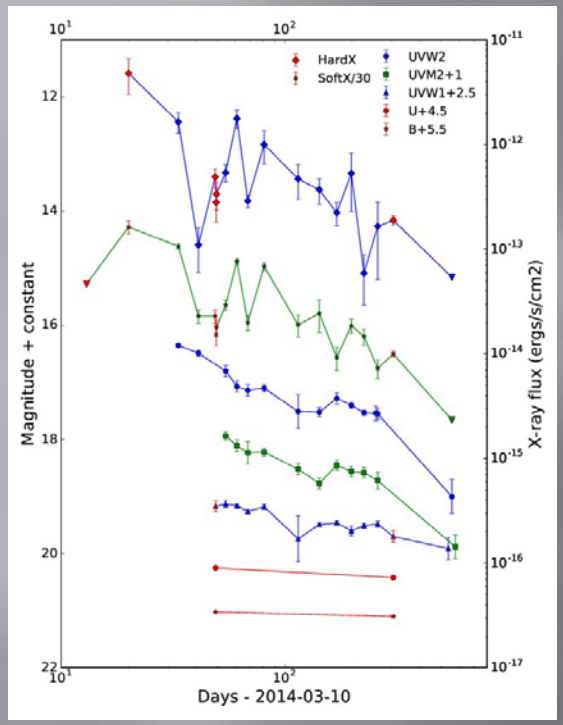
- Distance = 65 million light years
- Closest tidal disruption candidate to date

(Esquej et al, 2007, 2008)



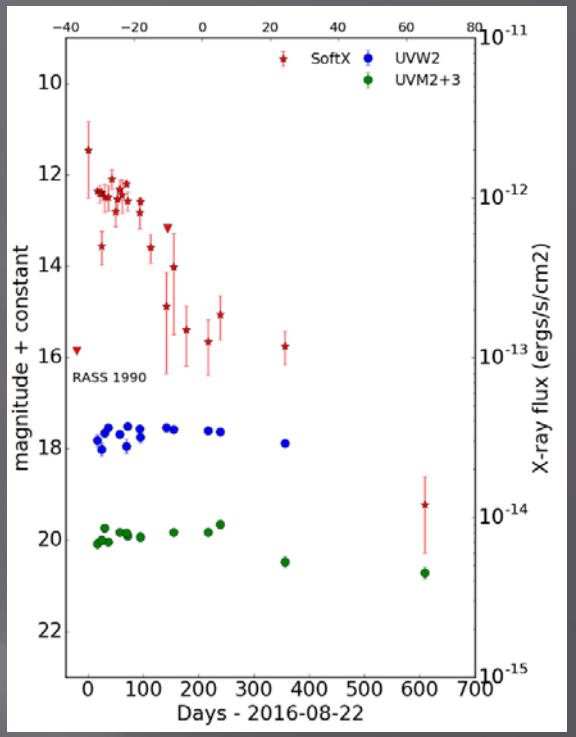


TDE – fast follow-up



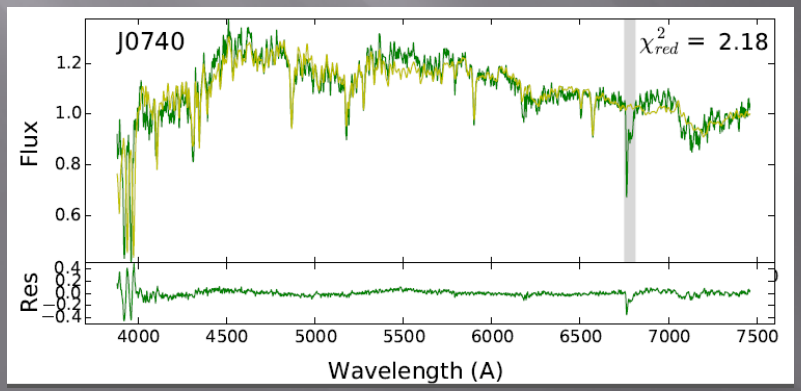
2MASS 0740-85

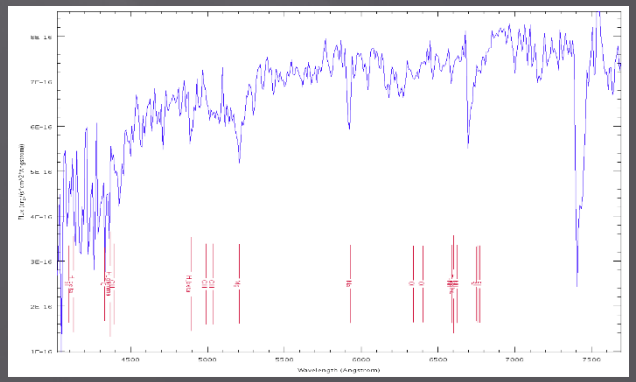
Saxton et al. 2017



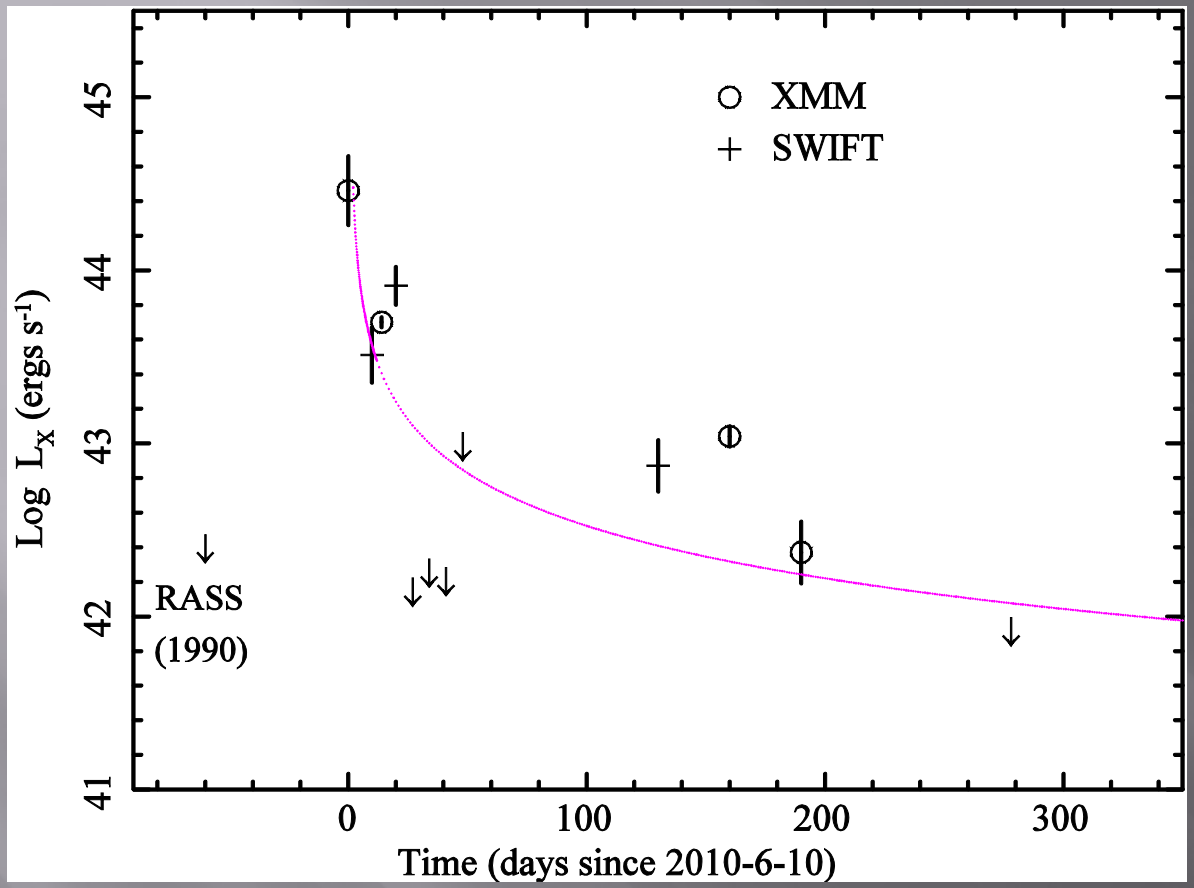
XMMSL1 1446+68

Saxton et al. in prep.





Unusual TDE light-curve: SDSS J1201+30

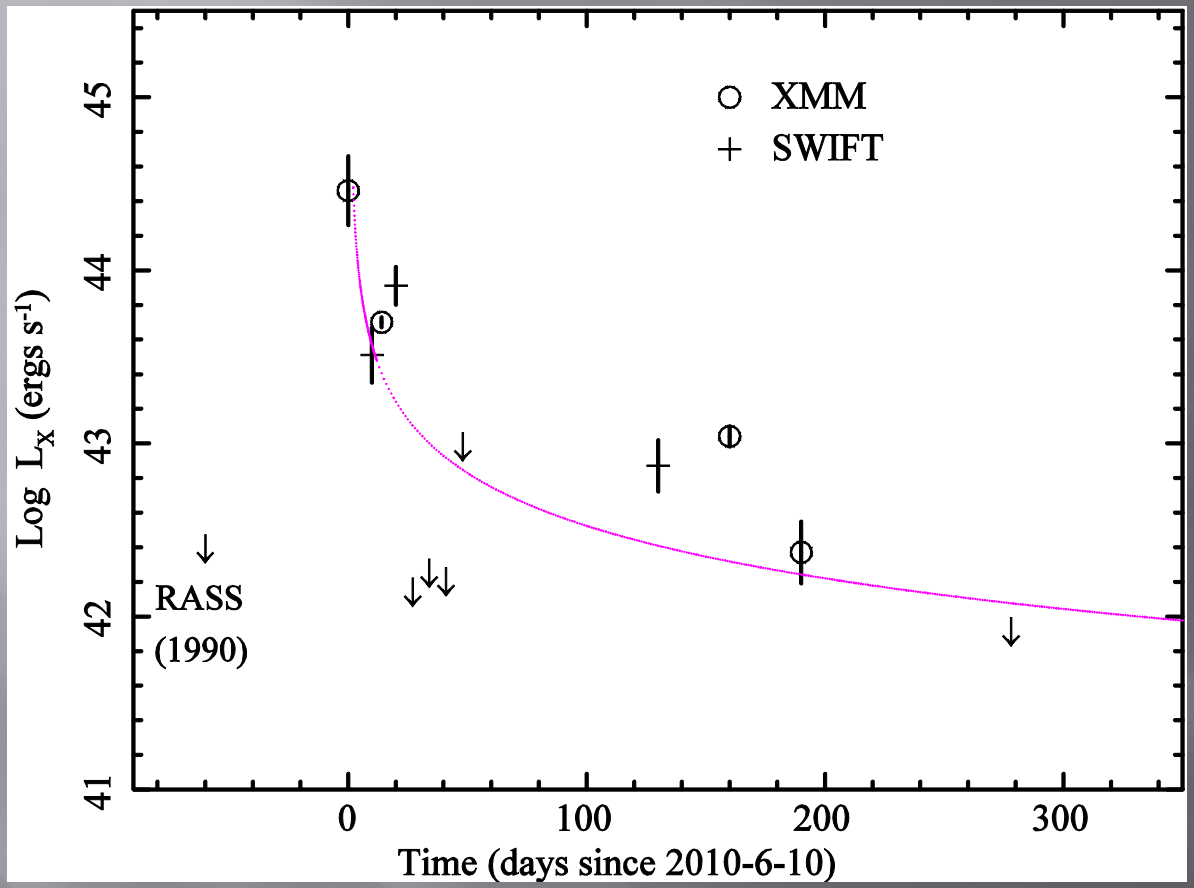


Fast variability in early phase. SDSS 1201+30, factor 50 drop in flux within 1 week

Saxton et al. 2012

What causes the flux drop?

SDSS J1201+30 : binary black-hole TDE ?



Liu, Li & Komossa 2014

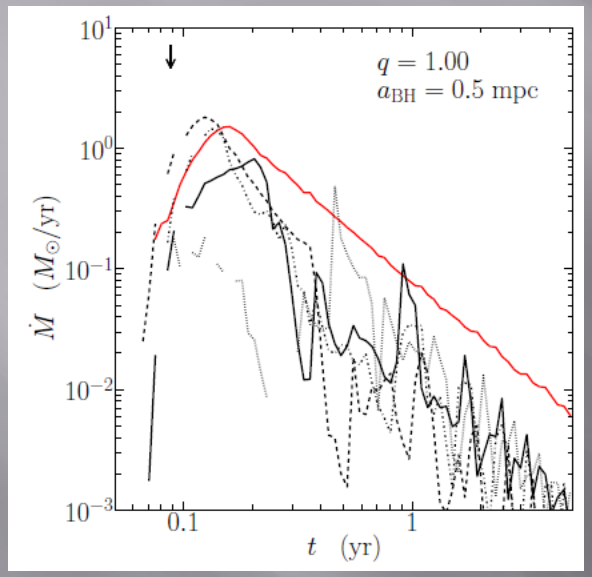
Dip can be reproduced by a binary with M_BH=10^7,a secondary with M_BH=8x10^5 and separation of 6 mpc, orbital period $T_b \leq$ few 100 days

Pericentre of secondary black hole

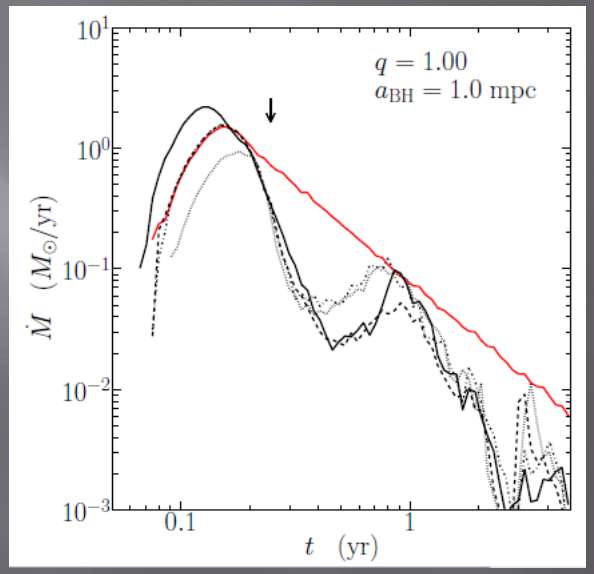
Liu, Li and Chen 2009

Binary black-hole TDE model

Vigneron et al. 2018



Light curve of TDE occuring in plane of binary orbit



perpendicular to BBH orbit

Near real-time analysis

XMM-Newton Slew Survey
Comparison with ROSAT source catalogues
0.2 - 2.0 keV

9215900005 9216100004 9216300002 9216300003 9216400003 9216500002 9216700002 9216700003 9216700004 9216800003
9216800004 9216900002 9216900004 9217000002 9217100005 9217200003 9217200004 9217200005 9217700002 9217700003

Slew: 9215900005
Exposure start time:02:48:06 2011-09-24
Exposure stop time:04:24:06 2011-09-24
Analysis time: Tue Oct 4 01:43:39 2011

Go to the Main page

Click for a printable version of the table

Results for all listed slews - ASCII format

Histogram of the expected range of ratios :XMM Newton/Rosat

Green: XMM Newton data. Brown: ROSAT and comparison data.

XMMNewton_NAME	RA	DEC	SCTS	EXT	DET_ML	RATE	RATE_err	BG (e-4)	R_Cat	RA	DEC	OFFSET arcmin	FLUX RATIO	FLUX RATIO_err	NAME	XMM_IMAGE
XMMSL1 J162145.8+640533	245.4408	64.0927	7.0	0	24.3	0.93	0.27	3.99	b	16 21 46.70	+64 05 31.5	0.11	1.61	0.51	1RXS J162146.7+640531	Image
XMMSL1 J171411.6+524937	258.5484	52.8270	6.1	0	11.6	0.63	0.22	10.63	f	17 14 12.10	+52 49 35.0	0.08	3.52	1.49	1RXS J171412.1+524935	Image
XMMSL1 J174558.3+391922	266.4928	39.3230	6.3	0	19.1	0.76	0.25	6.63	f	17 45 58.30	+39 19 11.0	0.20	2.87	1.10	CCDM J17460+3919A	Image
XMMSL1 J174858.8+370338	267.2449	37.0608	6.3	0	23.3	0.75	0.23	5.40	b	17 48 58.20	+37 03 47.0	0.18	1.17	0.37	CCDM J17490+3704AB	Image
XMMSL1 J175719.6+313327	269.3318	31.5576	6.2	0	18.8	0.75	0.24	4.20	b	17 57 18.50	+31 33 14.5	0.32	0.83	0.30	2MASS J17571890+3133160	Image

http://xmm.esac.esa.int/external/xmm_products/slew_results/web_slew.shtml

Raw slew data made available after 8-12 days. Since 2009, processed automatically, compared with RASS and results made available on web page.

Future prospects

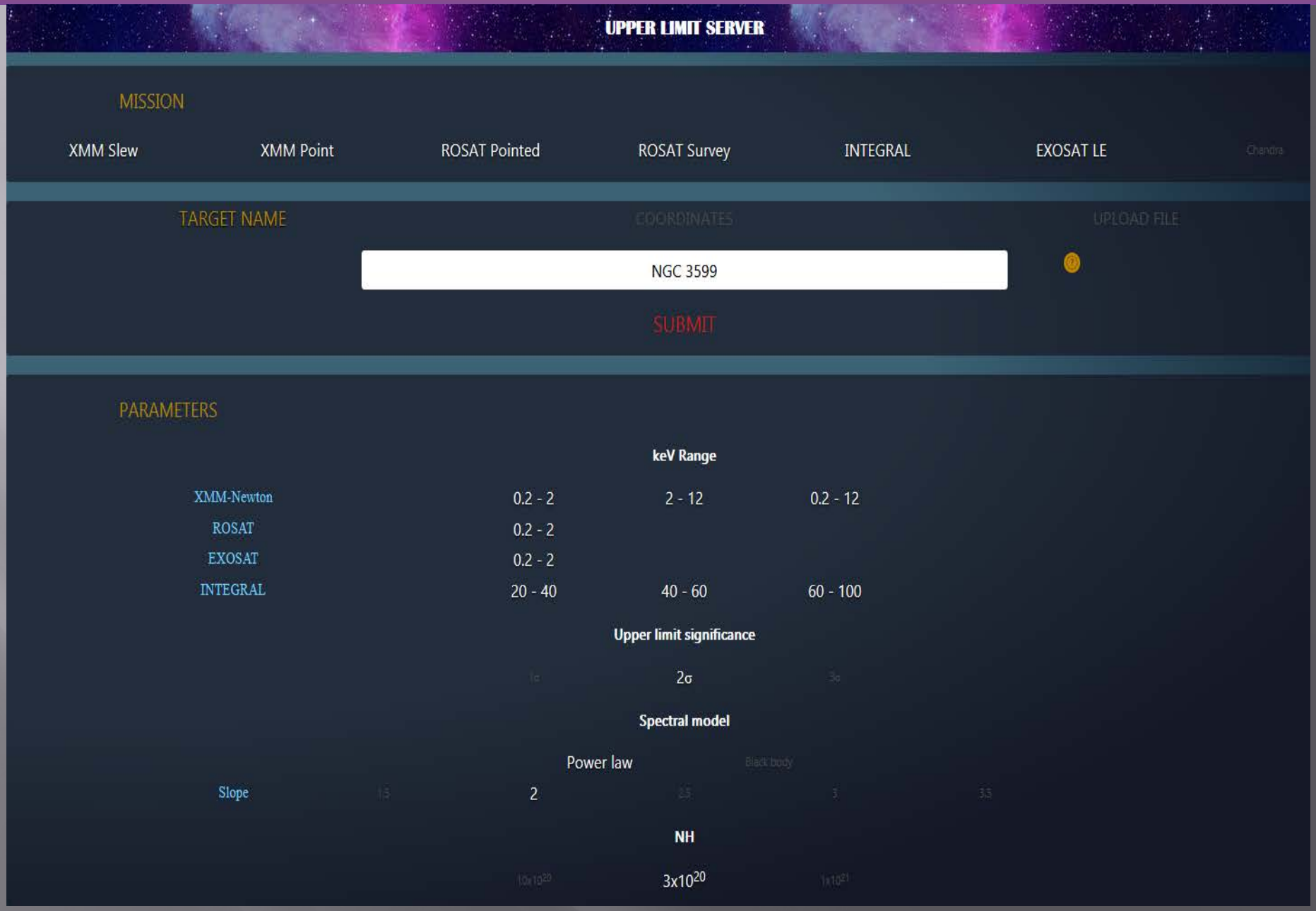
- Release of XMMSL2 – delta 1 with data from 2015-2018 by end of this year.

- Is the slew survey worth continuing in the eRosita / Einstein Probe era ?

- Maybe not, but we will always have [illegible]s Toulouse

- HILIGT (see poster)

HILIGT – multi-mission flux/upper limit server



Output

XMM-NEWTON SLEW

NGC3599 168.8623 . 18.1103

Observation Date	Count rate 0.2 - 2	Count rate 2 - 12	Count rate 0.2 - 12	Exp. time(s)	Flux 0.2 - 2	Flux 2 - 12
2002/05/27 04:32:50	5.8109 ± 1.1722	<1.1450	6.7236 ± 1.3813	4.3216	(8.3444 ± 1.6833) e-12	<1.0470e-11
2003/11/22 17:38:28	4.7725 ± 0.7293	<0.4806	5.1788 ± 0.7957	9.0814	(6.8533 ± 1.0473) e-12	<4.3954e-12
2004/05/20 03:21:04	<2.1956	<3.3426	<2.8699	1.6601	<3.1529e-12	<3.0564e-11
2006/06/23 14:23:12	<0.3618	<0.4984	<0.4324	10.0753	<5.1950e-13	<4.5574e-12
2008/12/02 23:38:16	<0.3211	<0.4417	<0.3841	11.3529	<4.6104e-13	<4.0392e-12
2015/06/14 06:14:33	<0.4872	<0.5795	<0.5332	7.4818	<6.9958e-13	<5.2991e-12
2017/06/13 12:33:16	<0.6699	<0.4847	<0.7203	8.5947	<9.6194e-13	<4.4326e-12

XMM-NEWTON POINTED

Observation Date	Count rate 0.2 - 2	Count rate 2 - 12	Count rate 0.2 - 12	Exp. time(s)	Flux 0.2 - 2	Flux 2 - 12
2006/06/23 12:24:00	0.1224 ± 0.0066	0.0079 ± 0.0018	0.1303 ± 0.0068	5017	(1.7579 ± 0.0949) e-13	(7.2828 ± 1.6686) e-14
2008/12/02 11:27:05	0.0343 ± 0.0011	0.0030 ± 0.0003	0.0373 ± 0.0011	41734	(4.9253 ± 0.1581) e-14	(2.7566 ± 0.3561) e-14

INTEGRAL

Observation Date	Count rate 20 - 40	Count rate 40 - 60	Count rate 60 - 100	Exp. time(s)	Flux 20 - 40	Flux 40 - 60
No data found	No data found	No data found	No data found	No data found	No data found	No data found



Multi-mission – fluxes and upper limits