The NuSTAR view of radio-quiet AGN

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Vninice Hnanice
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Outline

- Brief introduction
- Results
- Conclusions

Outline

- Brief introduction

Introduction

For the first time in X-ray astronomy, NuSTAR is providing us with high SNR spectra at energies above 10 keV, a crucial energy band for a sound characterization of the underlying physical continuum, and, therefore, for a **tight estimate of the spin of the central BH and high-energy cutoff energy**. Many of the objects studied so far have a **simultaneous coverage** with XMM-Newton/Suzaku and NuSTAR, providing the best data sets so far for this kind of

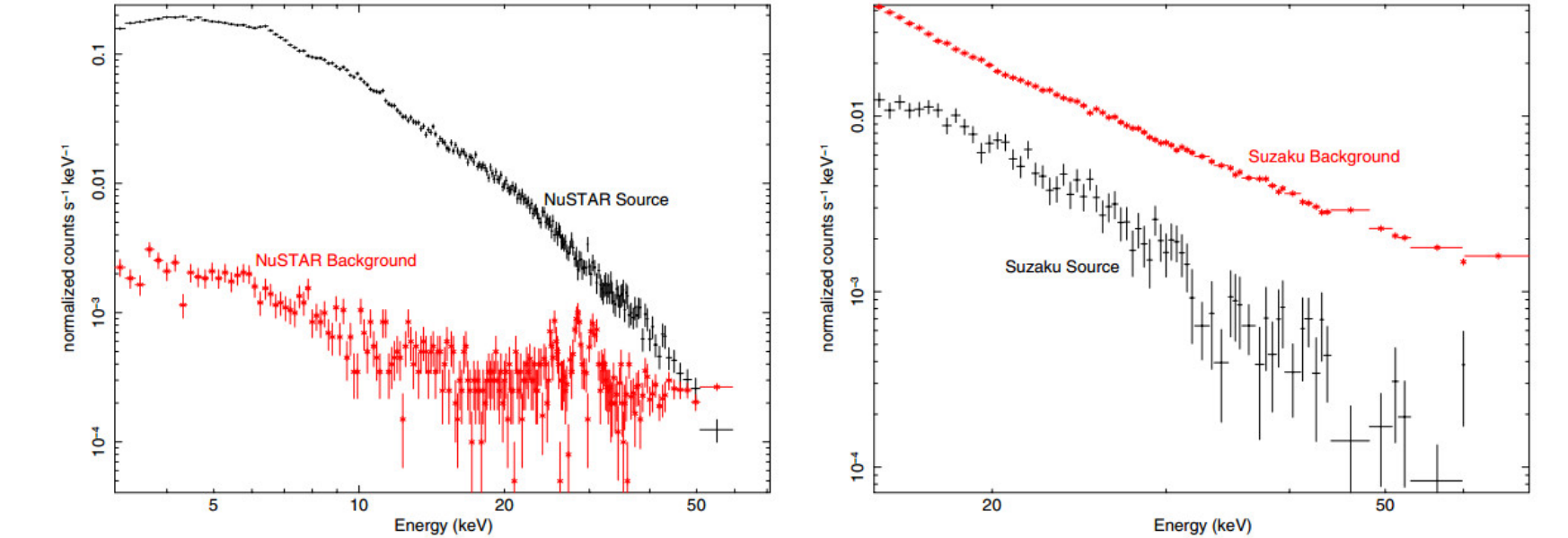
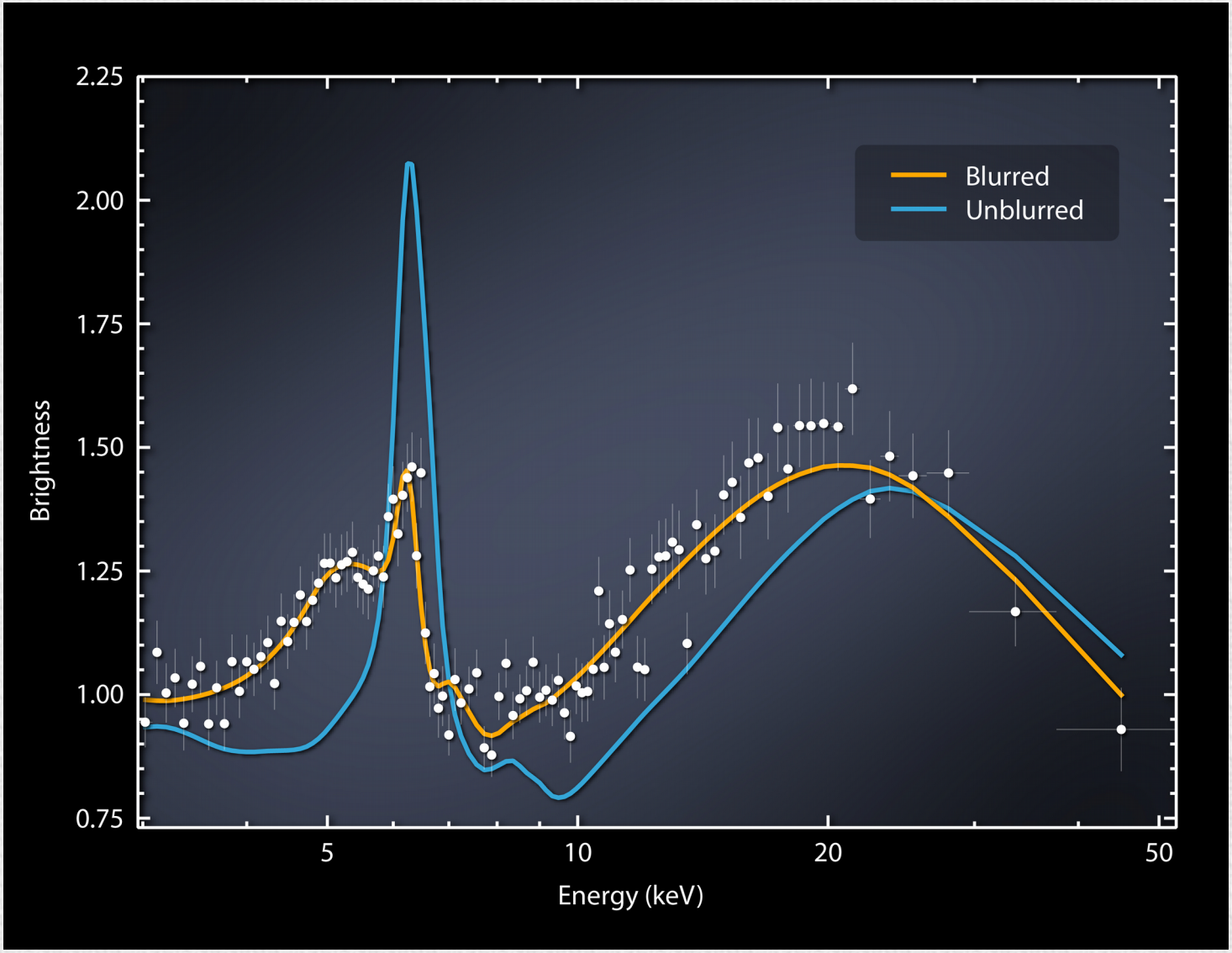


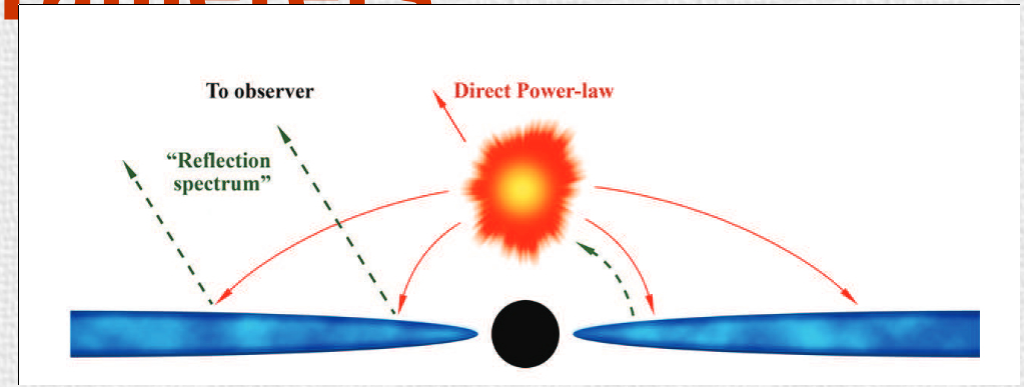
Figure 1. Left: source (in black) + background (in red) spectra from the *NuSTAR* FPMA in the 3–80 keV band. Right: archival *Suzaku* HXD-PIN source (in black) + background (in red) spectra in the 15–70 keV band. The source is at the same 15–70 keV flux level in both observations, within a few percent.

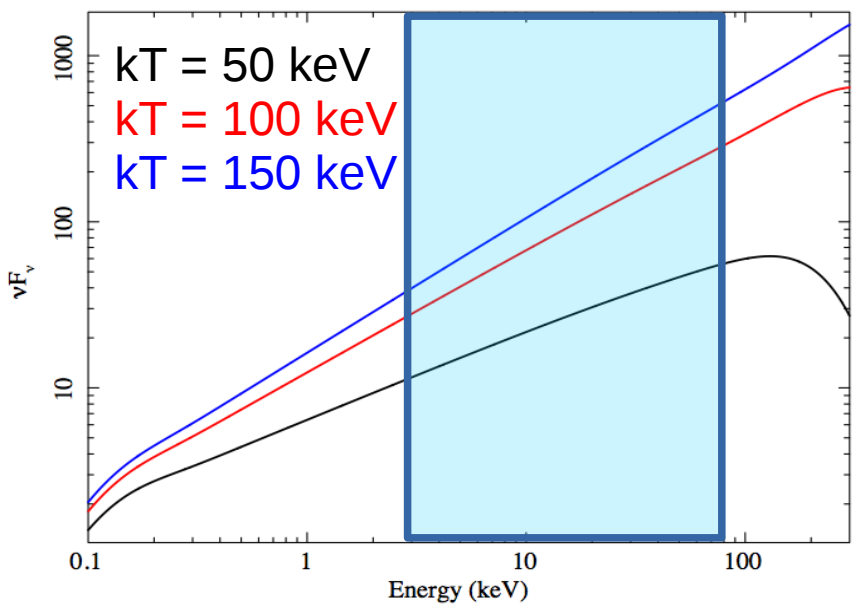
Introduction – Black hole spin measurements



Mrk 335 – NASA/JPL 2014 Press release

Introduction - Coronal parameters





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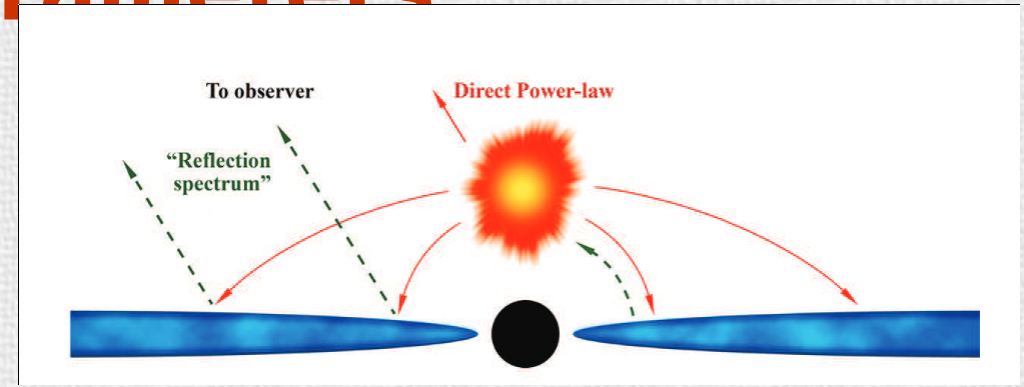
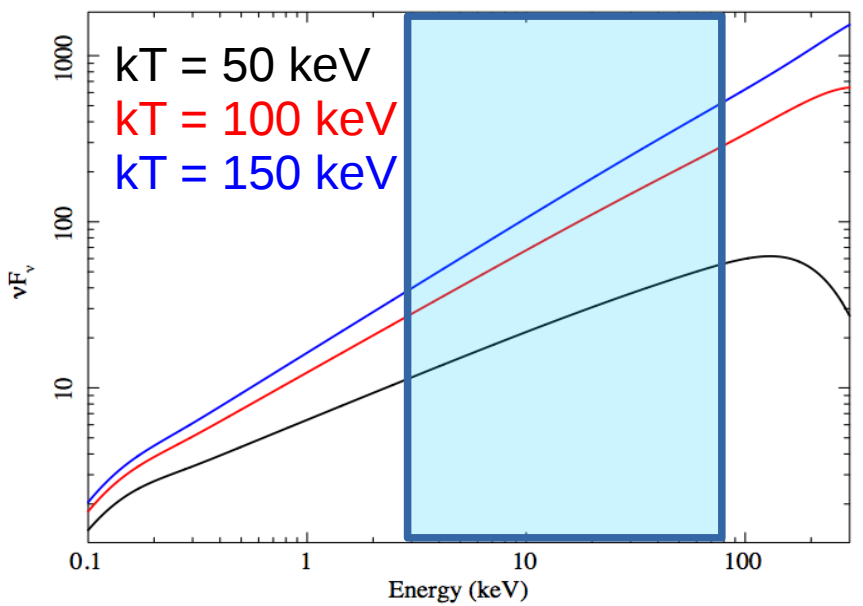
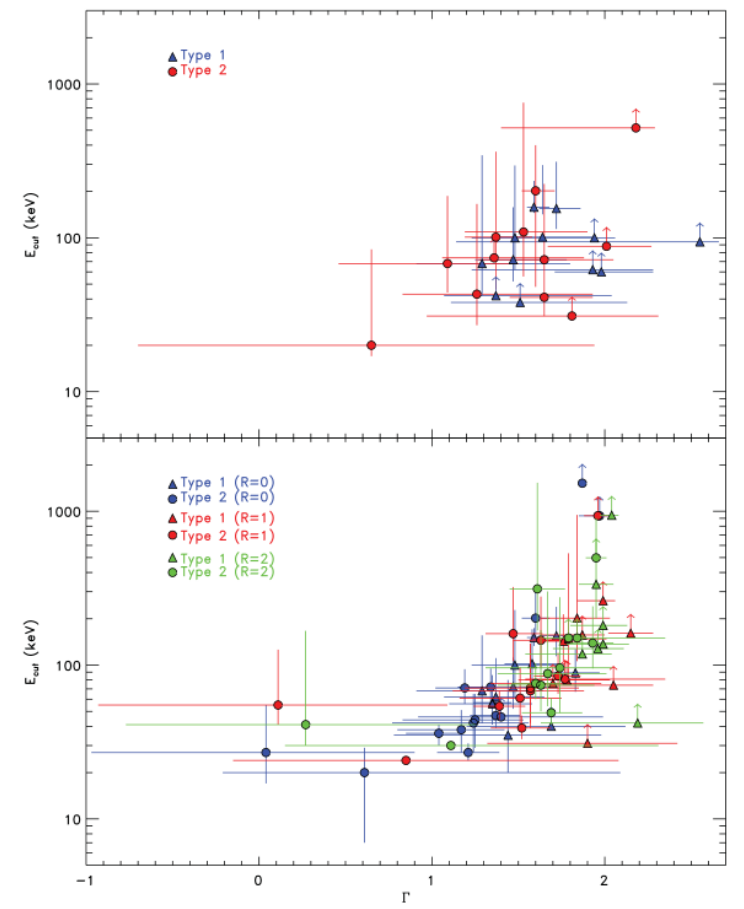






Molina+2013

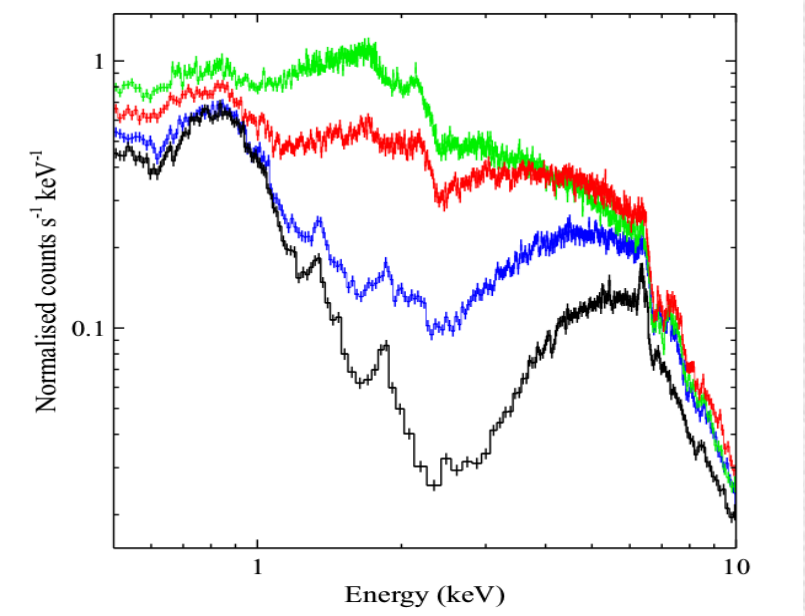
Outline

- Results

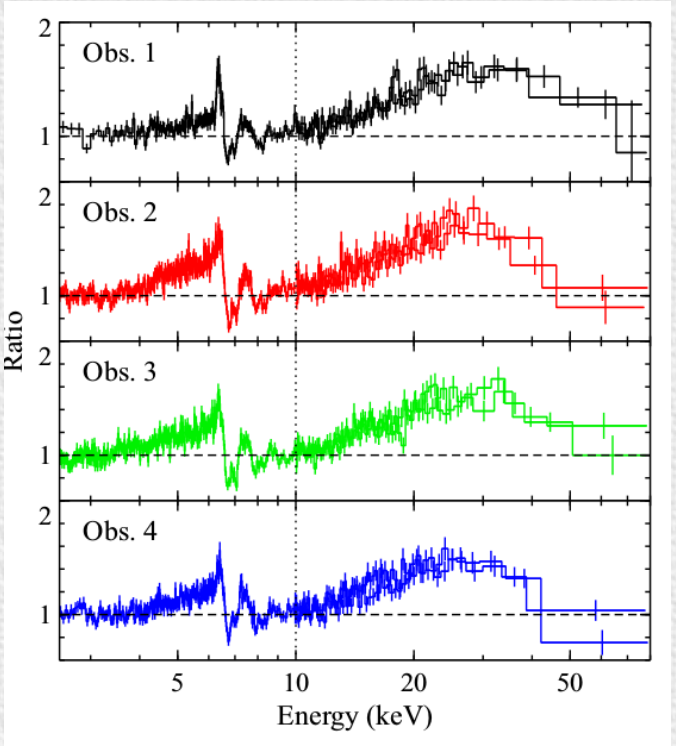
Results – Black hole spin measurements

Target	Spin	Data	Reference
1H0707-495	> 0.988	XMM-Newton/NuSTAR	Kara et al. (2015)
Ark 120	~ 0.5	XMM-Newton/NuSTAR	Matt et al., 2014
Fairall 9	0.973 ± 0.003	XMM-Newton/NuSTAR	Lohfink et al. (2016)
MCG-6-30-15	$0.91^{+0.06}_{-0.07}$	XMM-Newton/NuSTAR	Marinucci et al., 2014a
Mrk 335	> 0.9	Swift/NuSTAR	Parker et al., 2014
NGC 1365	> 0.97	XMM-Newton/NuSTAR	Risaliti et al., 2013 Walton et al., 2014
NGC4151	> 0.9	Suzaku/NuSTAR	Keck et al. (2015)
SWIFT J2127.4	$0.58^{+0.11}_{-0.17}$	XMM-Newton/NuSTAR	Marinucci et al., 2014b

NGC 1365

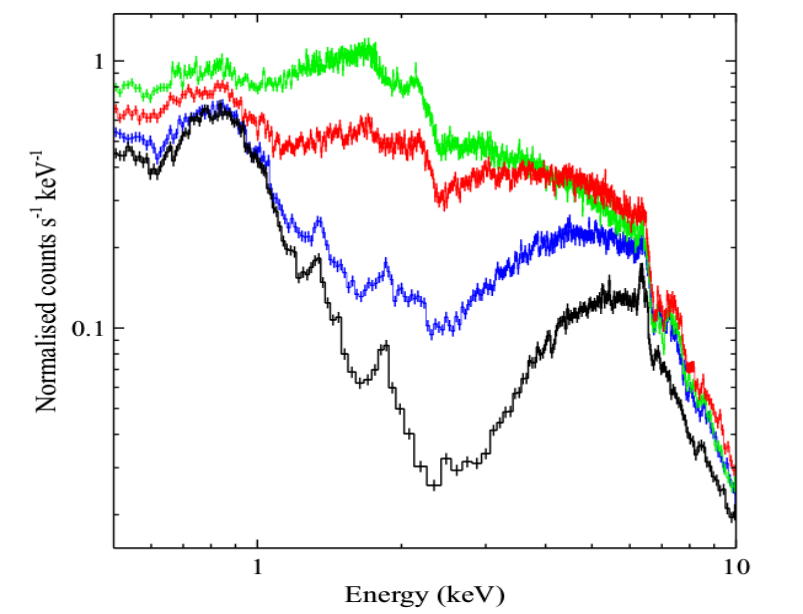


Walton+2014



Residuals to a Γ=1.75 power law continuum

NGC 1365



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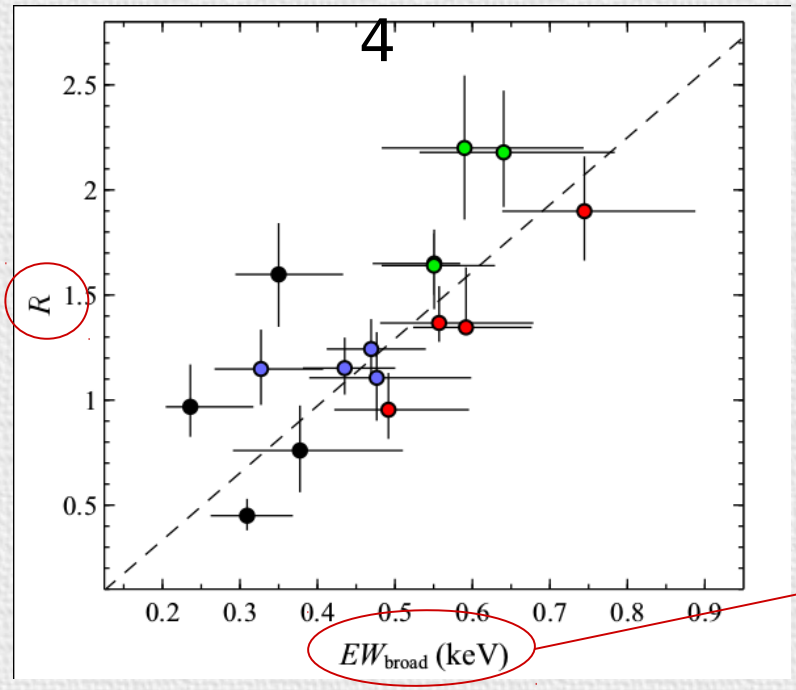
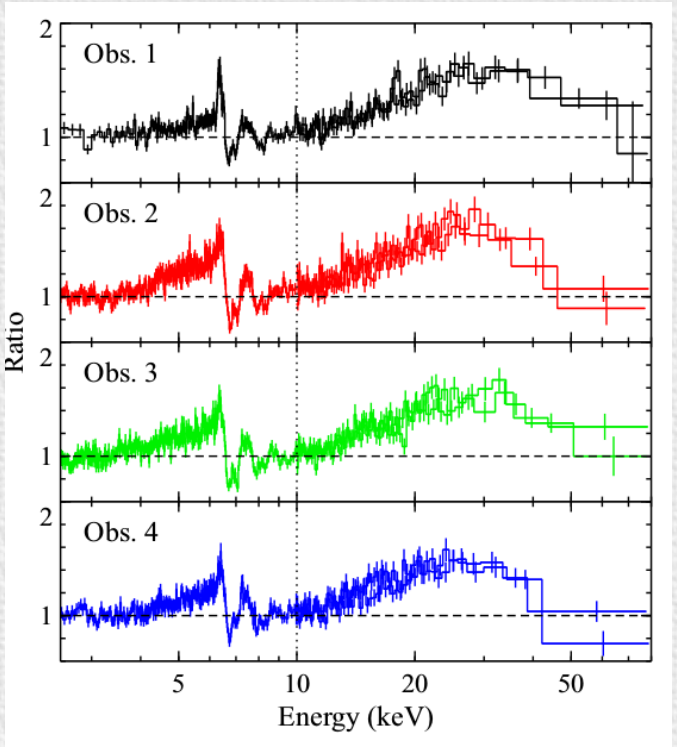
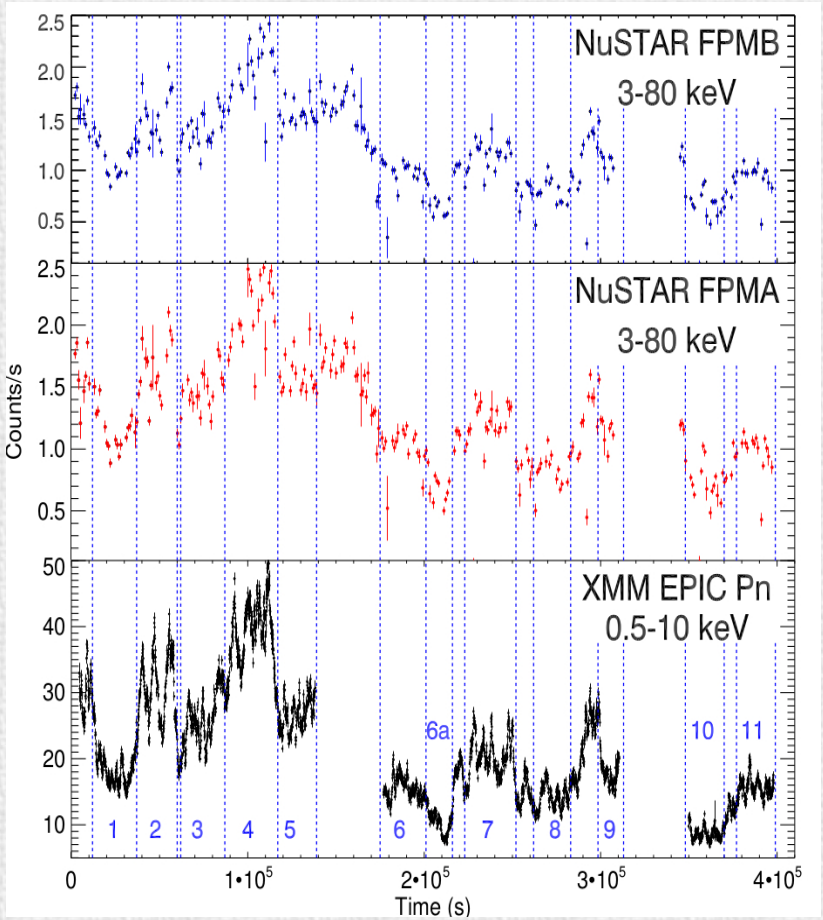




Residuals to a Γ=1.75 power law continuum

Both parameters indicate a quantity which is relative to the primary continuum

MCG-6-30-16



Marinucci+2014

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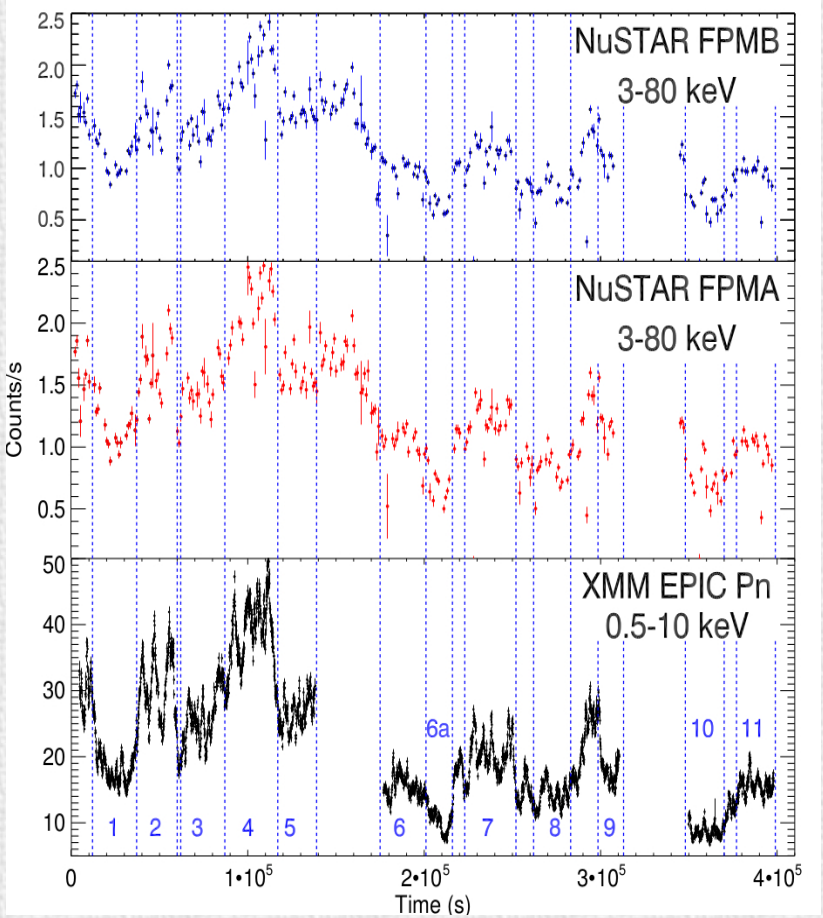

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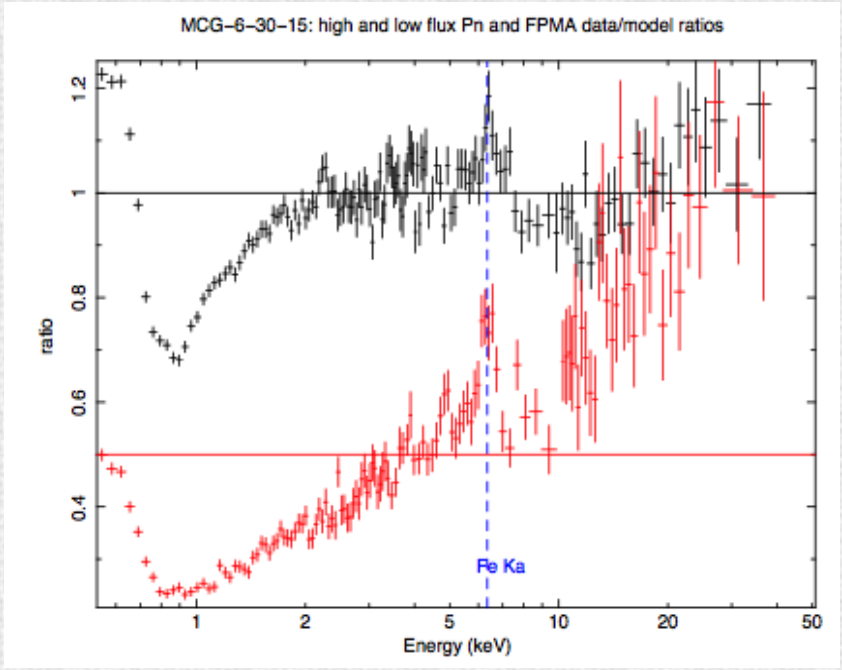

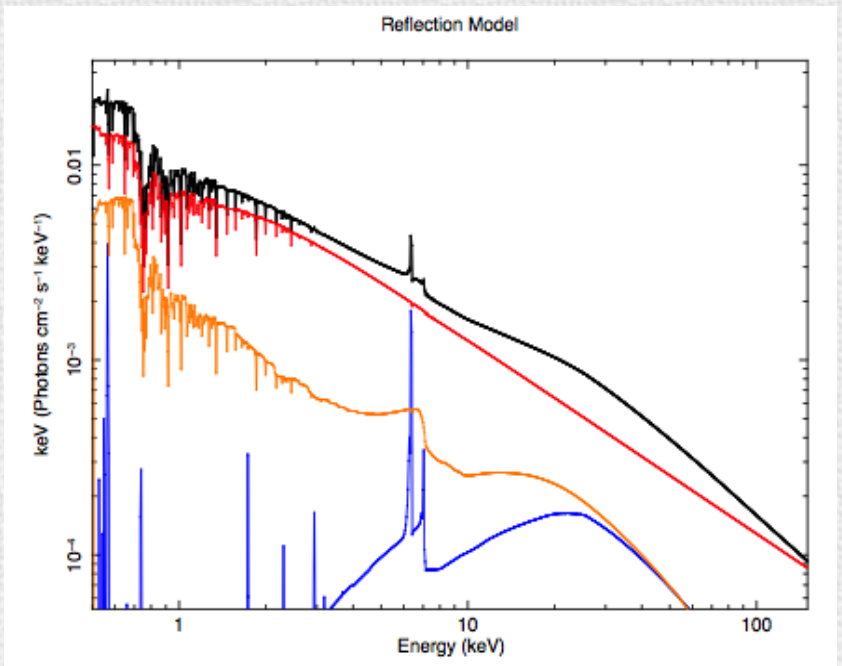

Results – Coronal parameters

Source	z	$\log(M)$ $[M_\odot]$	r_{co} $[r_G]$	F_x	E_{cut} [keV]	Γ	Θ	ℓ	Data	References
NGC 5506	0.006	8 ± 1	10	2.9	720^{+130}_{-190}	$1.91^{+0.03}_{-0.03}$	$0.71^{+0.13}_{-0.36}$	4^{+33}_{-3}	SWIFT/NU	1 – 2
NGC7213	0.006	$7.98^{+0.22}_{-0.24}$	10	0.71	> 240	$1.84^{+0.03}_{-0.03}$	> 0.05	$1.0^{+0.7}_{-0.4}$	NU	3 – 4
MCG-6-30-15	0.008	6.7 ± 1	2.9	8.2	> 110	$2.061^{+0.005}_{-0.005}$	> 0.04	258^{+2323}_{-232}	XMM/NU	5 – 6
NGC 2110	0.008	8.3 ± 1	10	8.9	> 210	$1.64^{+0.03}_{-0.03}$	> 0.07	10^{+89}_{-9}	SWIFT/NU	7 – 8
MCG 5-23-16	0.009	7.85 ± 1	10	4.2	116^{+6}_{-5}	$1.85^{+0.01}_{-0.01}$	$0.11^{+0.01}_{-0.04}$	15^{+136}_{-14}	NU	9 – 11
SWIFT J2127.4+5654	0.014	7.18 ± 1	13	1.1	108^{+11}_{-10}	$2.08^{+0.01}_{-0.01}$	$0.11^{+0.01}_{-0.04}$	34^{+308}_{-31}	XMM/NU	12 – 13
IC4329A	0.016	8.1 ± 1	10	4.9	186^{+14}_{-14}	$1.73^{+0.01}_{-0.01}$	$0.18^{+0.01}_{-0.07}$	41^{+365}_{-37}	SU/NU	14 – 15
NGC 5548	0.018	$7.59^{+0.24}_{-0.21}$	4.5	1.3	70^{+40}_{-10}	$1.49^{+0.05}_{-0.05}$	$0.07^{+0.04}_{-0.03}$	88^{+55}_{-37}	XMM/NU	5, 16 – 17
Mrk 335	0.026	$7.42^{+0.12}_{-0.16}$	3	0.10	> 174	$2.14^{+0.02}_{-0.04}$	> 0.06	36^{+16}_{-9}	SWIFT/NU	18 – 19
Ark 120	0.033	$7.66^{+0.05}_{-0.06}$	4.4	0.55	> 68	$1.73^{+0.02}_{-0.02}$	> 0.06	4^{+1}_{-1}	XMM/NU	20 – 21
1H0707-495	0.041	6.31 ± 1	2	0.14	> 63	$3.2^{+0.2}_{-0.2}$	> 0.02	358^{+3219}_{-322}	SWIFT/NU	22 – 23
Fairall 9	0.047	$8.41^{+0.11}_{-0.09}$	21	0.87	> 242	$1.96^{+0.01}_{-0.02}$	> 0.08	12^{+3}_{-3}	XMM/NU	20, 24
3C390.3	0.056	$9.40^{+0.05}_{-0.06}$	10	1.6	116^{+24}_{-8}	$1.70^{+0.01}_{-0.01}$	$0.11^{+0.02}_{-0.04}$	18^{+3}_{-2}	SU/NU	25 – 26
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3C382	0.058	9.2 ± 0.5	10	1.4	214^{+147}_{-63}	$1.68^{+0.03}_{-0.02}$	$0.21^{+0.14}_{-0.11}$	12^{+25}_{-8}	SWIFT/NU	29 – 30

F_x is the 0.1-200 keV X-ray flux in 10^{-10} erg cm^{-2} s^{-1}.

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Fabian+2015

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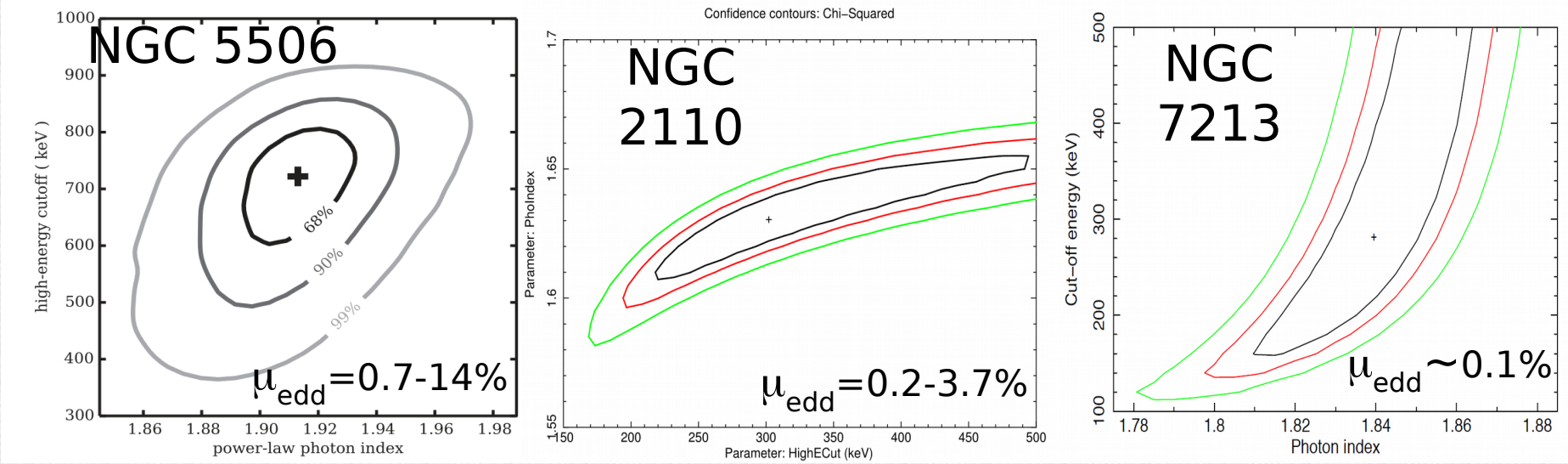
Fabian+2015

Results – Coronal parameters

In some bright sources, high values or lower limits to the cutoff energy have been found, suggesting the presence of a very hot corona surrounding the accretion disc.



Matt+15 Marinucci+15 Ursini+15

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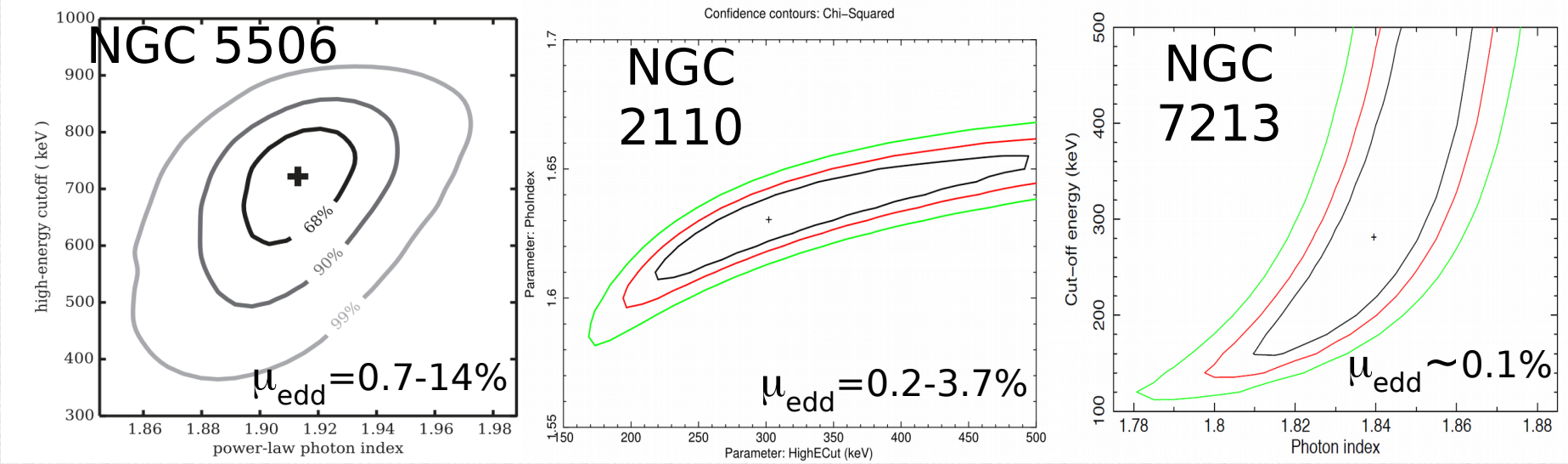
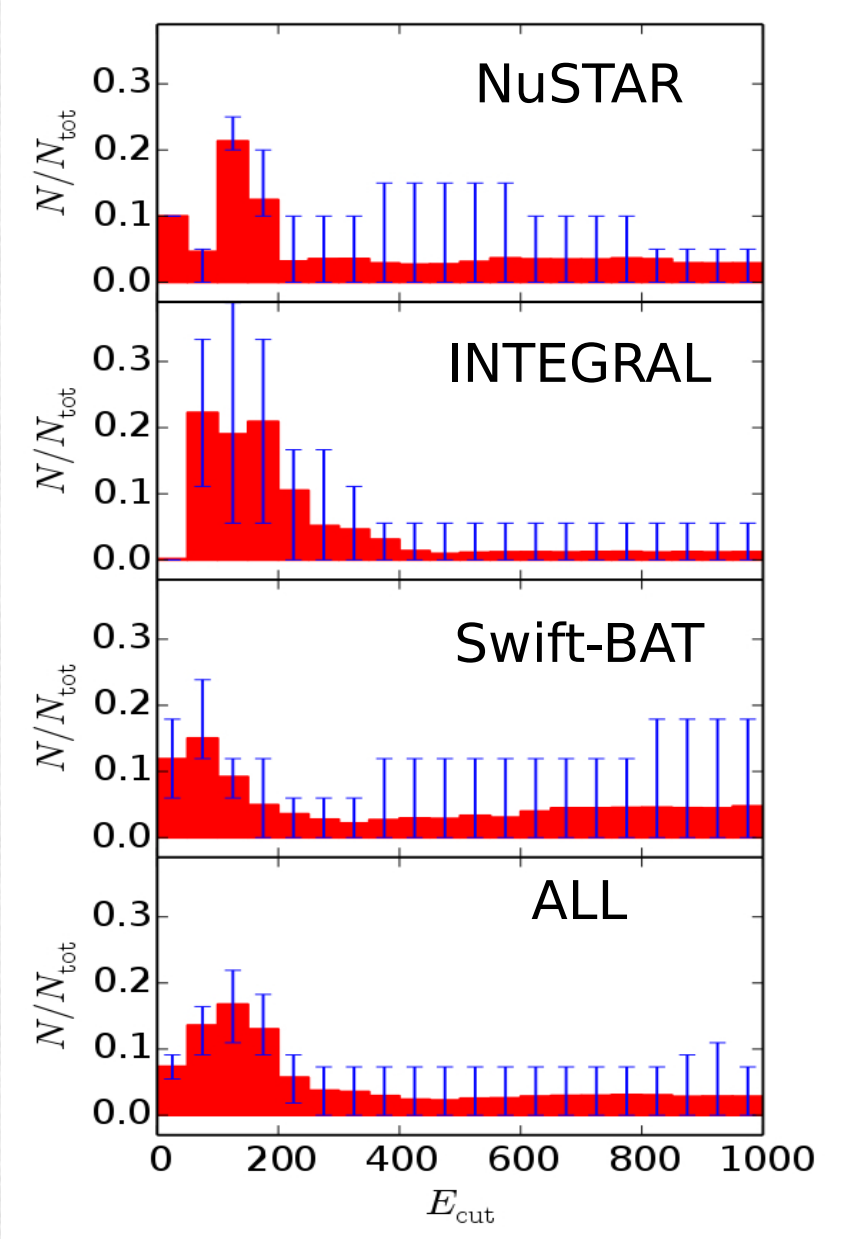


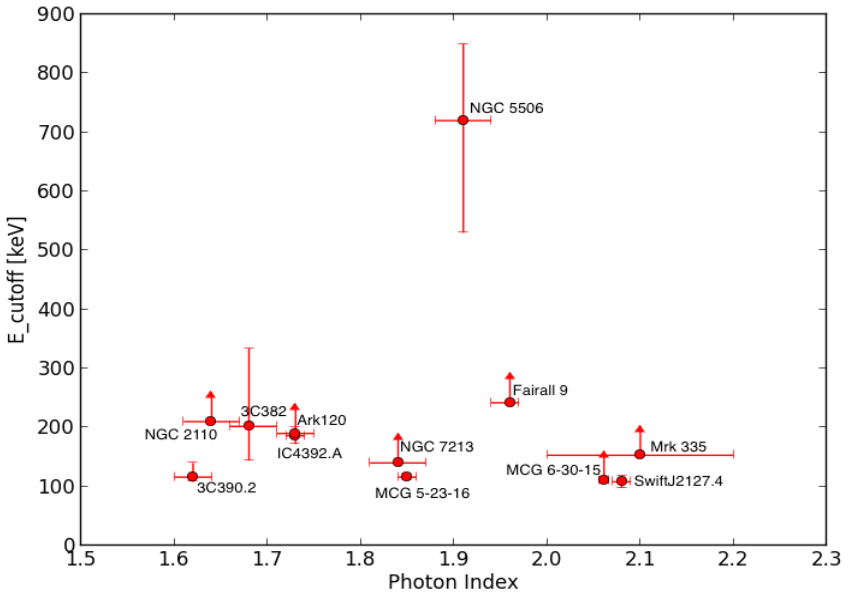
Matt+15 Marinucci+15 Ursini+15

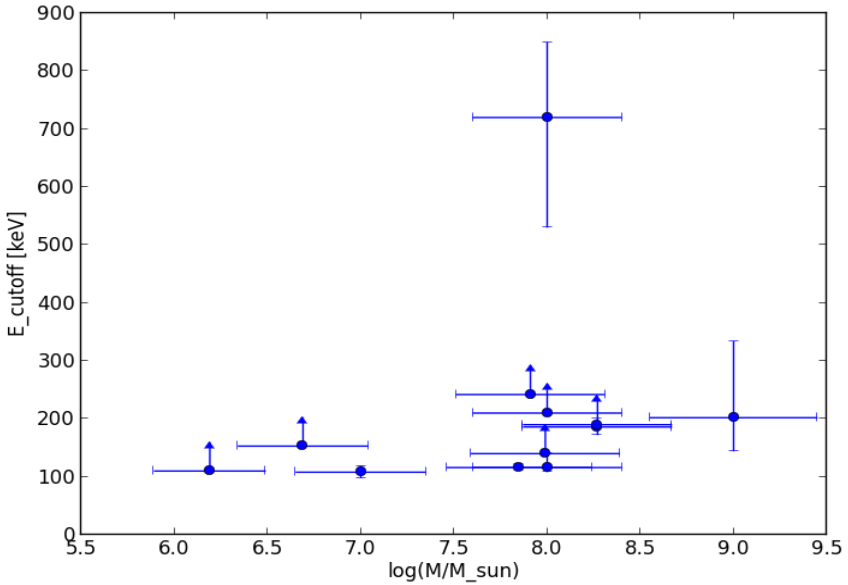
The next step is to build a small catalog and to start looking for correlations between the coronal temperature and other physical properties (e.g. black hole mass, accretion rate).

Results – Coronal parameters



Fabian+15





Tortosa et al., in prep.

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⋮										
GRS 1734-292	0.021	8.9 ± 0.7	10	2.1	58^{+24}_{-7}	$1.55^{+0.15}_{-0.08}$	$0.06^{+0.02}_{-0.02}$	5^{+20}_{-4}	XMM/INT/BAT/NU	
MCG+8-11-11						?	?			
Swift/NU										
NGC 6814						?	?		Swit/NU	

More observations are under scrutiny ..

Outline

- Conclusions

Conclusions

- A number of robust black hole spin measurements have been presented since the launch of NuSTAR

- Following the continuum helps in keeping track of the broad Iron Kα component

- High energy cut-off have been measured in several AGN with NuSTAR (more are yet to come!)

- They are not ubiquitous

- Further observations will help us in understanding the nature of the primary continuum, such as the relation between the accretion rate and the cutoff energy and the link between the disc reflection and the extension of the hot corona.