ESAC seminar 14-11-18

The complex X-ray spectrum and variability of the AGN 1E0754.6+392

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Galaxy

$L \sim 2 \cdot 10^{10} L_{\odot}$

~30 Kpc

Galaxy → Active Galactic Nucleus

$10^{10} L_\odot \lesssim L \lesssim 10^{14} L_\odot$

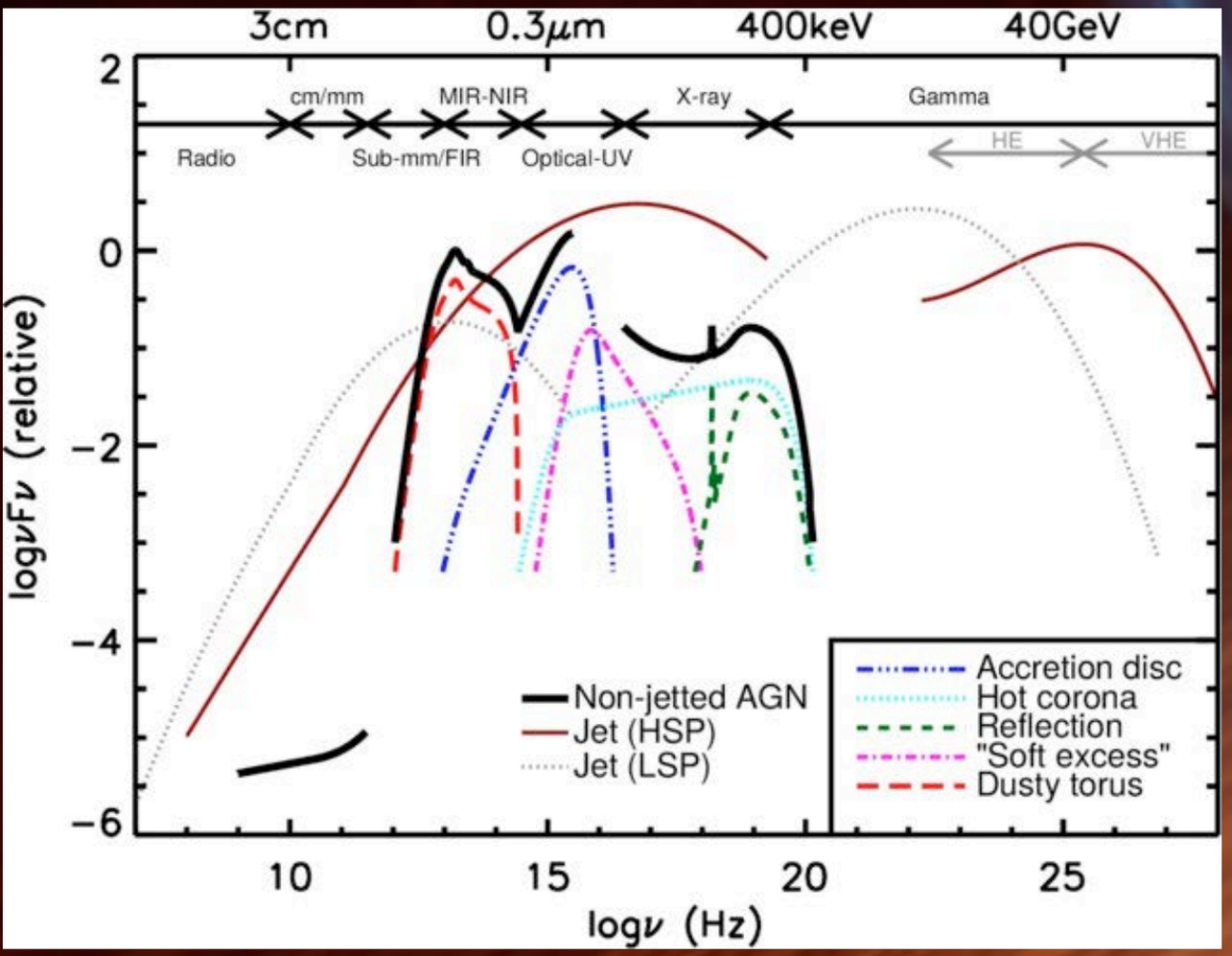
~ 1 pc

$L \sim 2 \cdot 10^{10} L_\odot$

~30 Kpc

IR

Broadband emission



X-ray

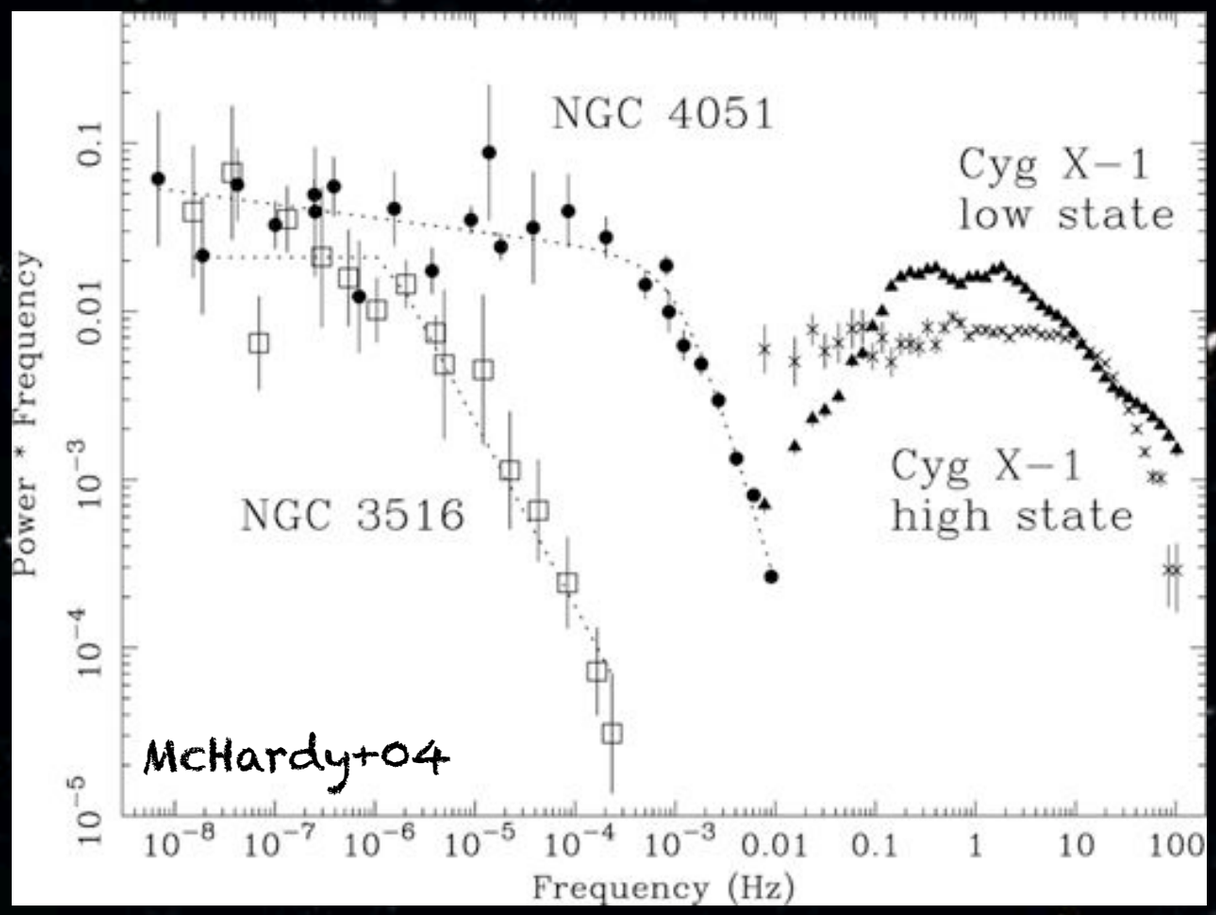
UV

Optical

broadband variability

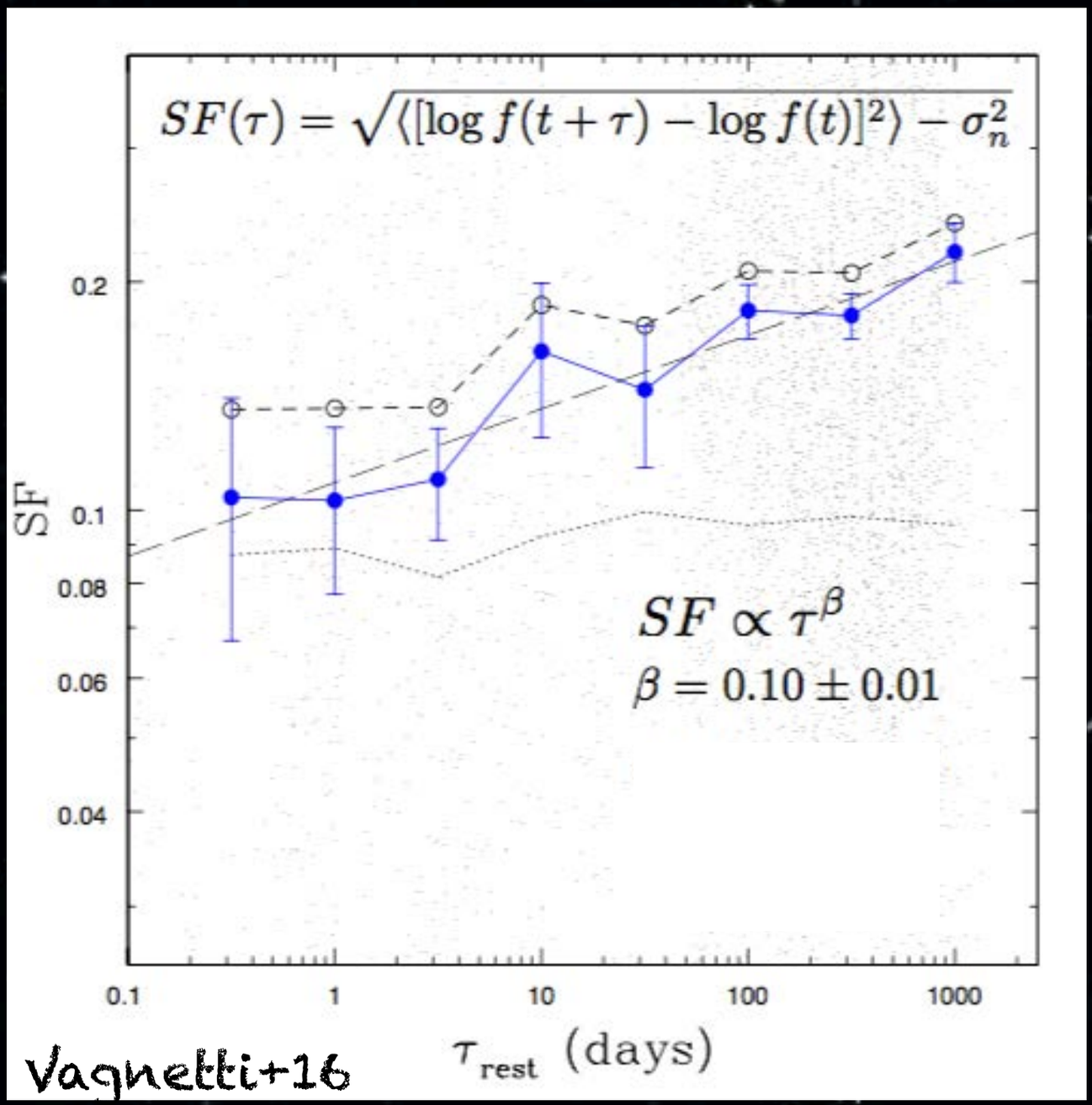
in X-rays

hours



see also Papadakis+04, Ponti+12

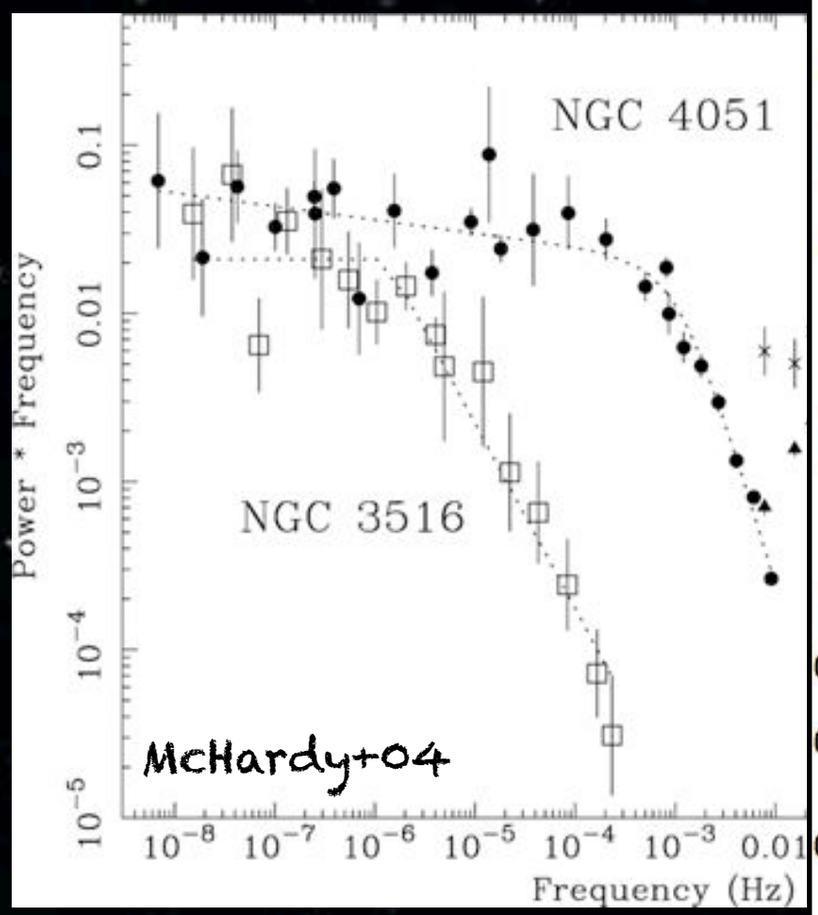
years

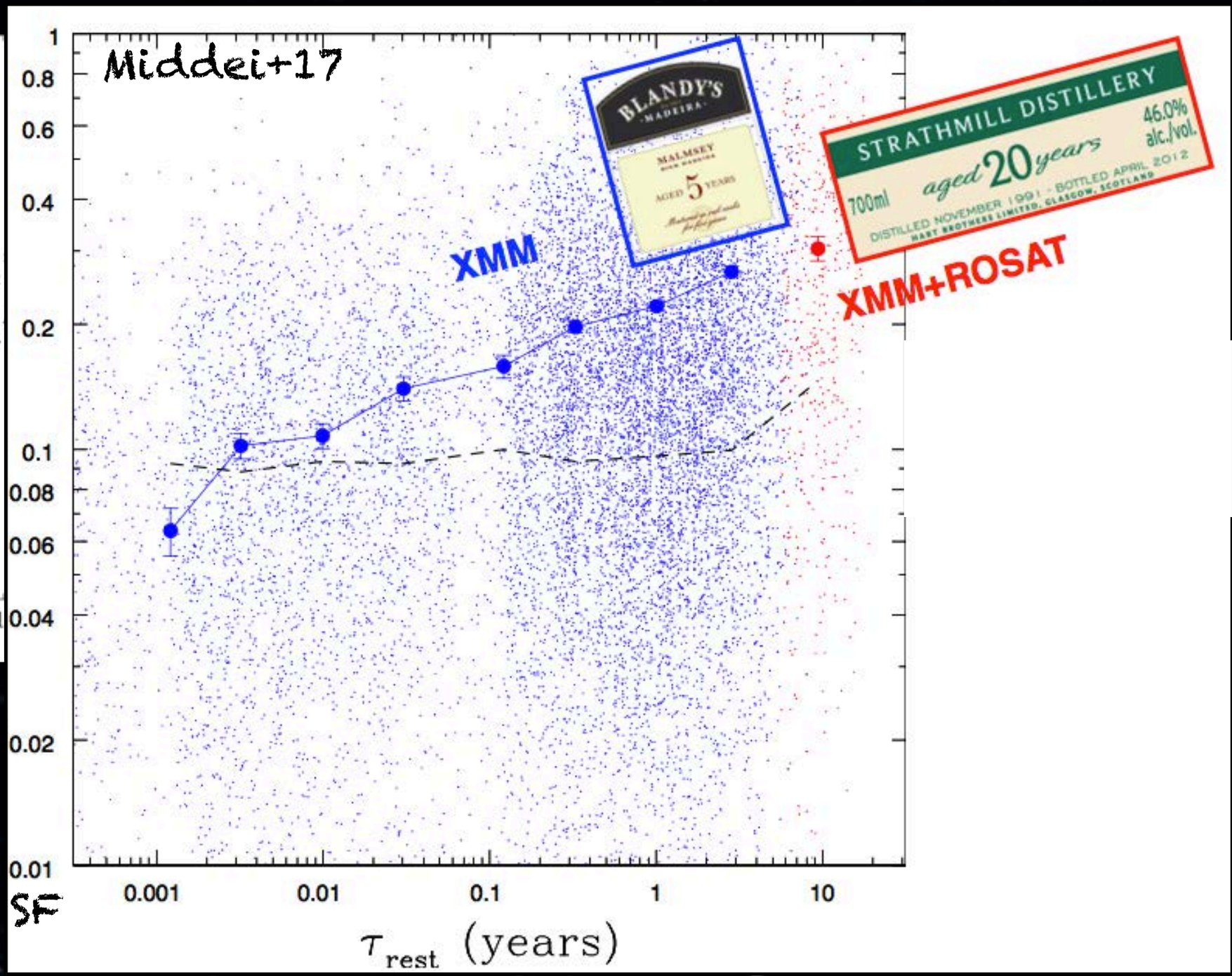


see also Paolillo+17, Gallo+18

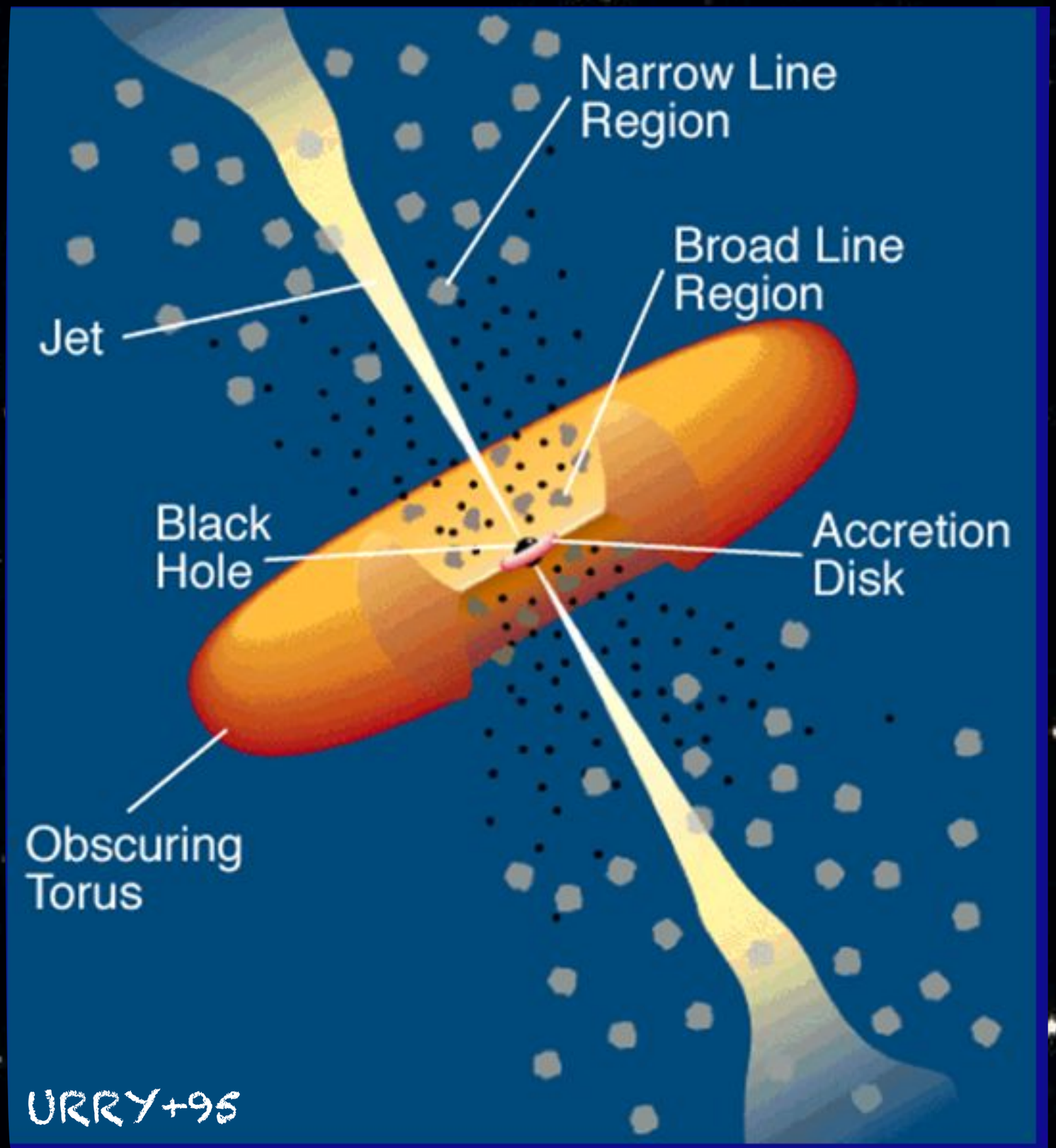
broadband Variability in X-rays

hours | years | decades





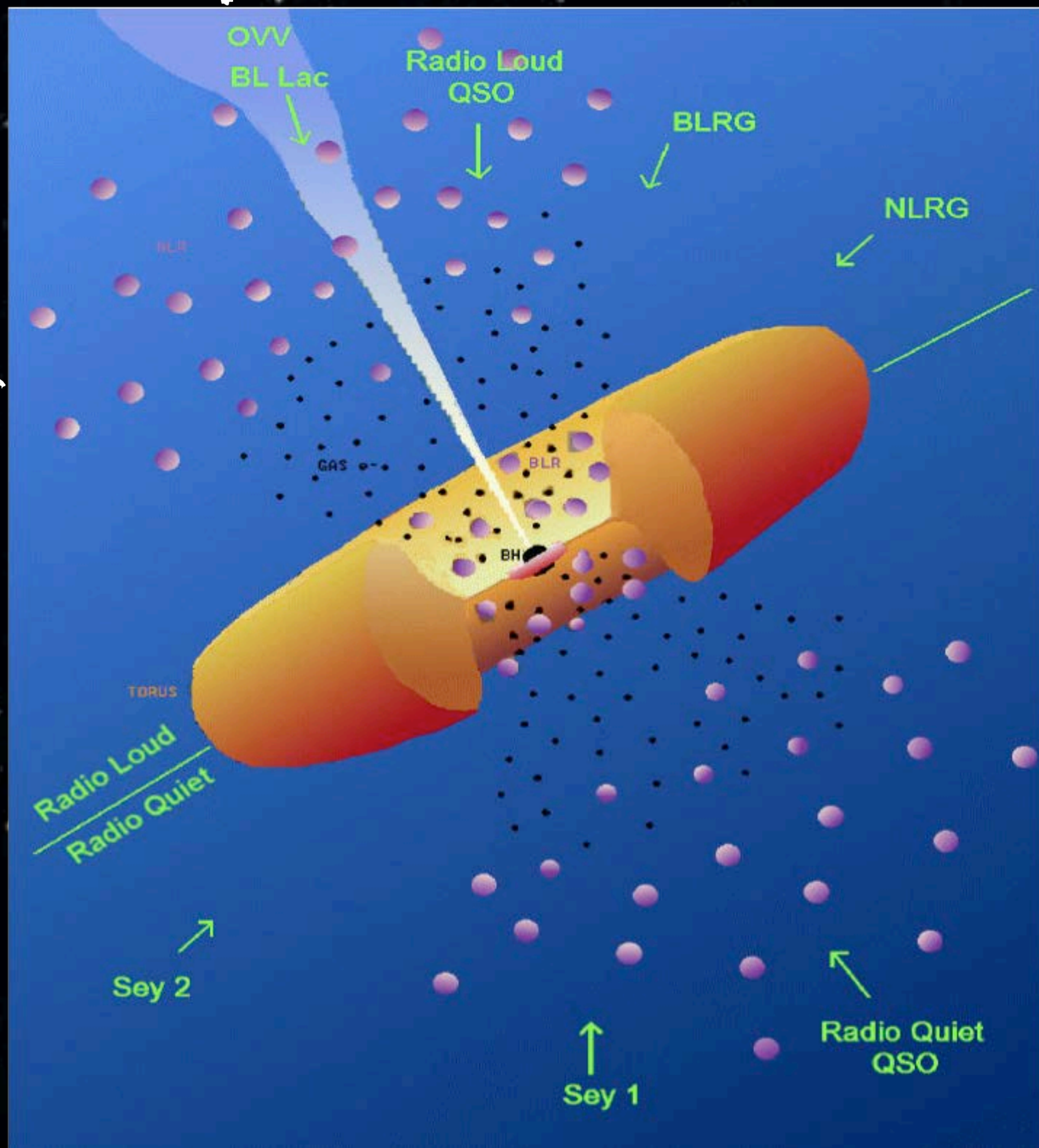
hints of a composite nature



various actors in building the AGN SED

hints of a composite nature

differences in the SED due to observational issues



X-raying the central engine!

absorbed

Primary continuum

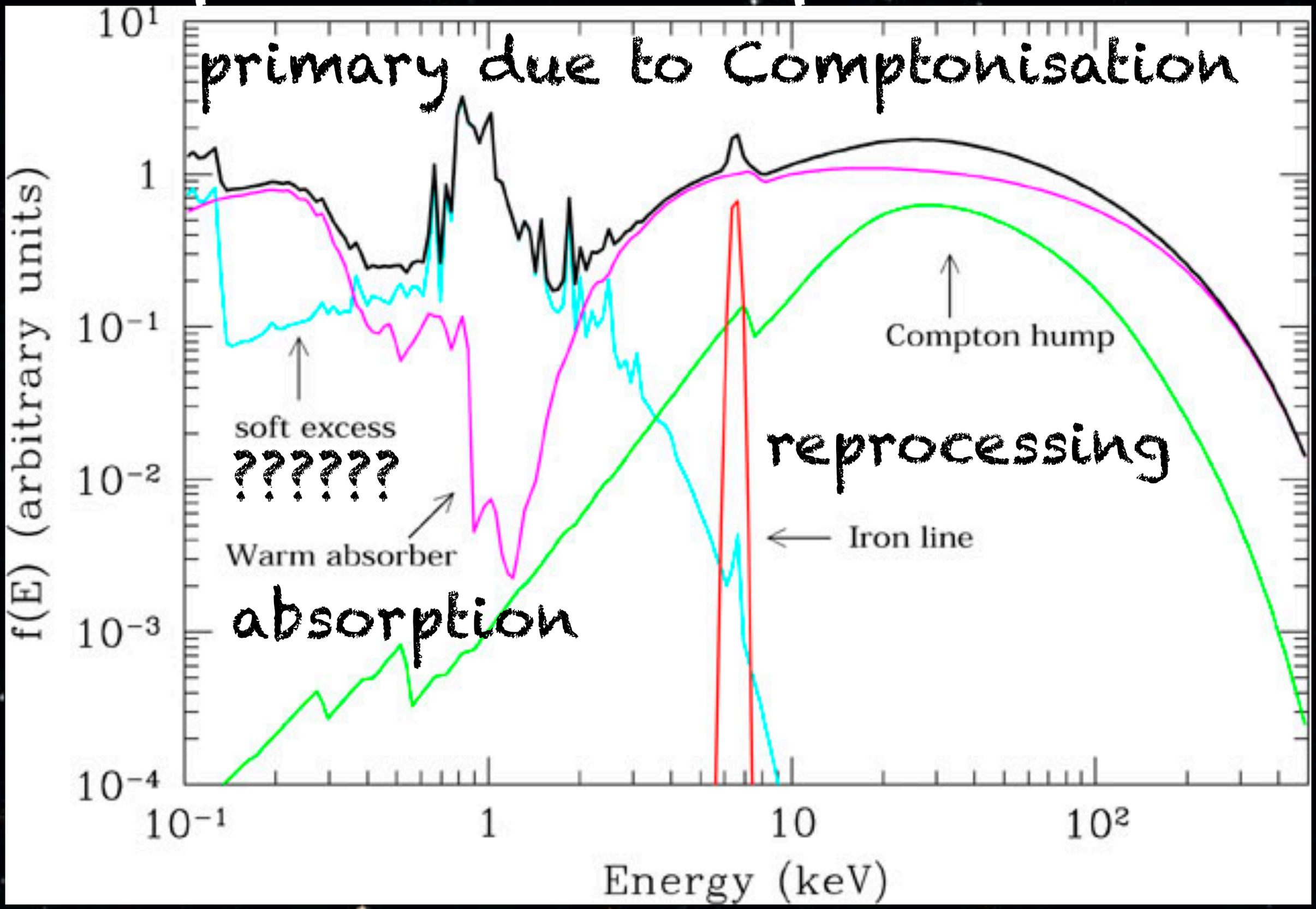
reflected emission

Inverse-Compton mechanism

reprocessed by matter

seeds photons

Spectral components



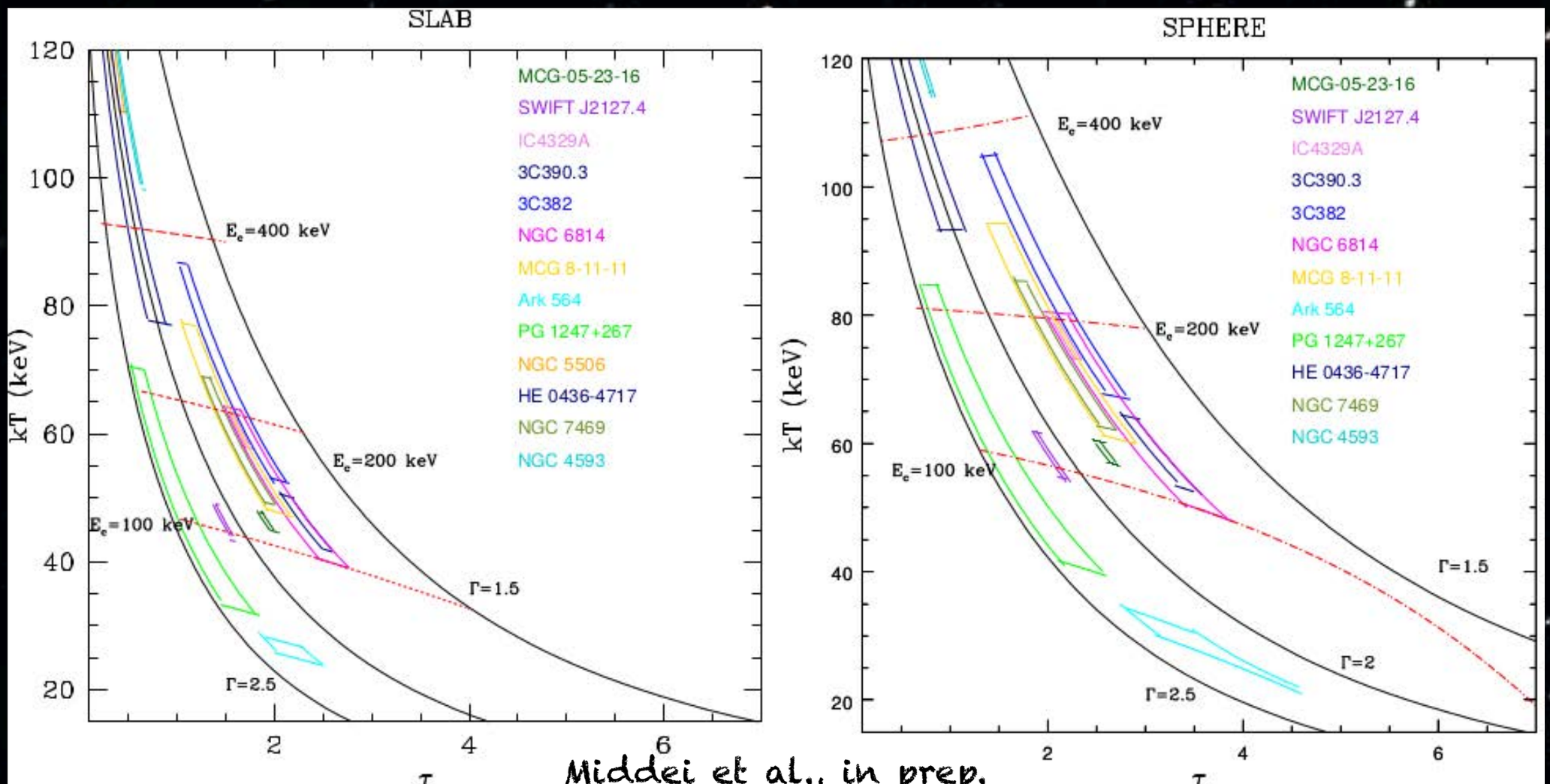
The primary continuum

Which is the coronal optical depth?
what about its temperature?
and the coronal geometry?

see e.g. Haardt+91,93,94,97

The primary continuum due to inverse-Compton of seed photons into an hot medium

information on coronal
opacity and temperature,
see also Beloborodov+99, Petrucci+00,01, Fabian+15,17, Malzac+17



Middei et al., in prep.

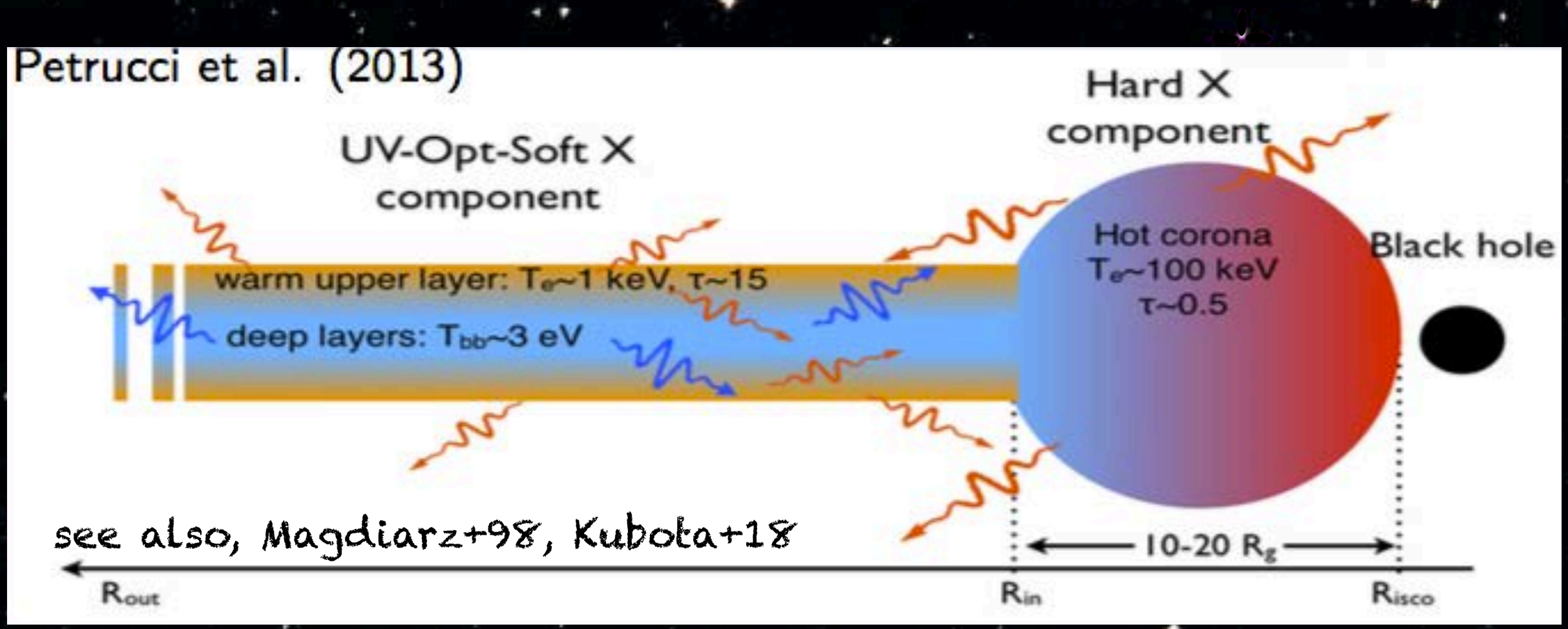
The soft-excess:

line blurring?

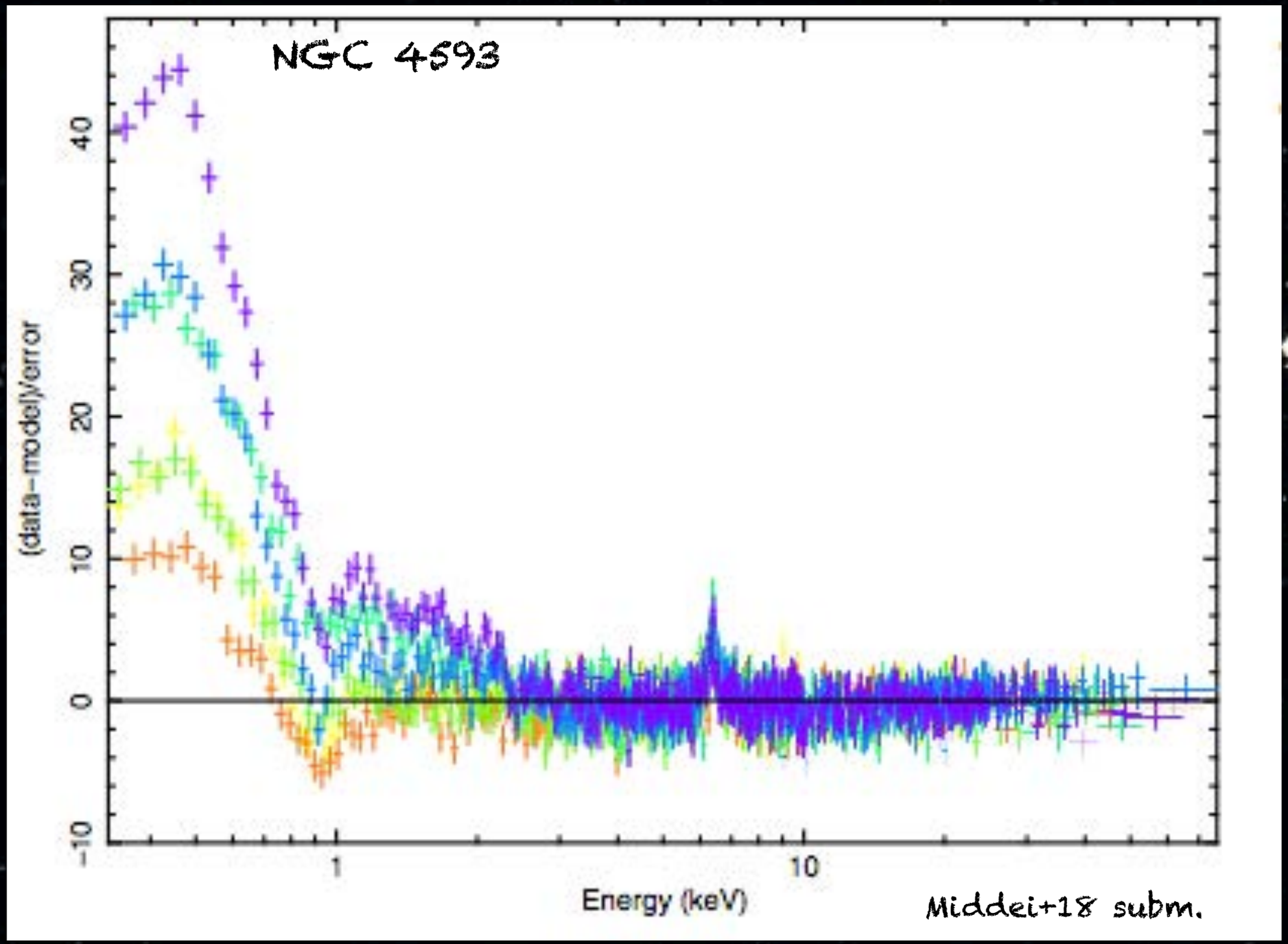
(see e.g. Crummy+06; Bonson+15)

or

two.-coronae?

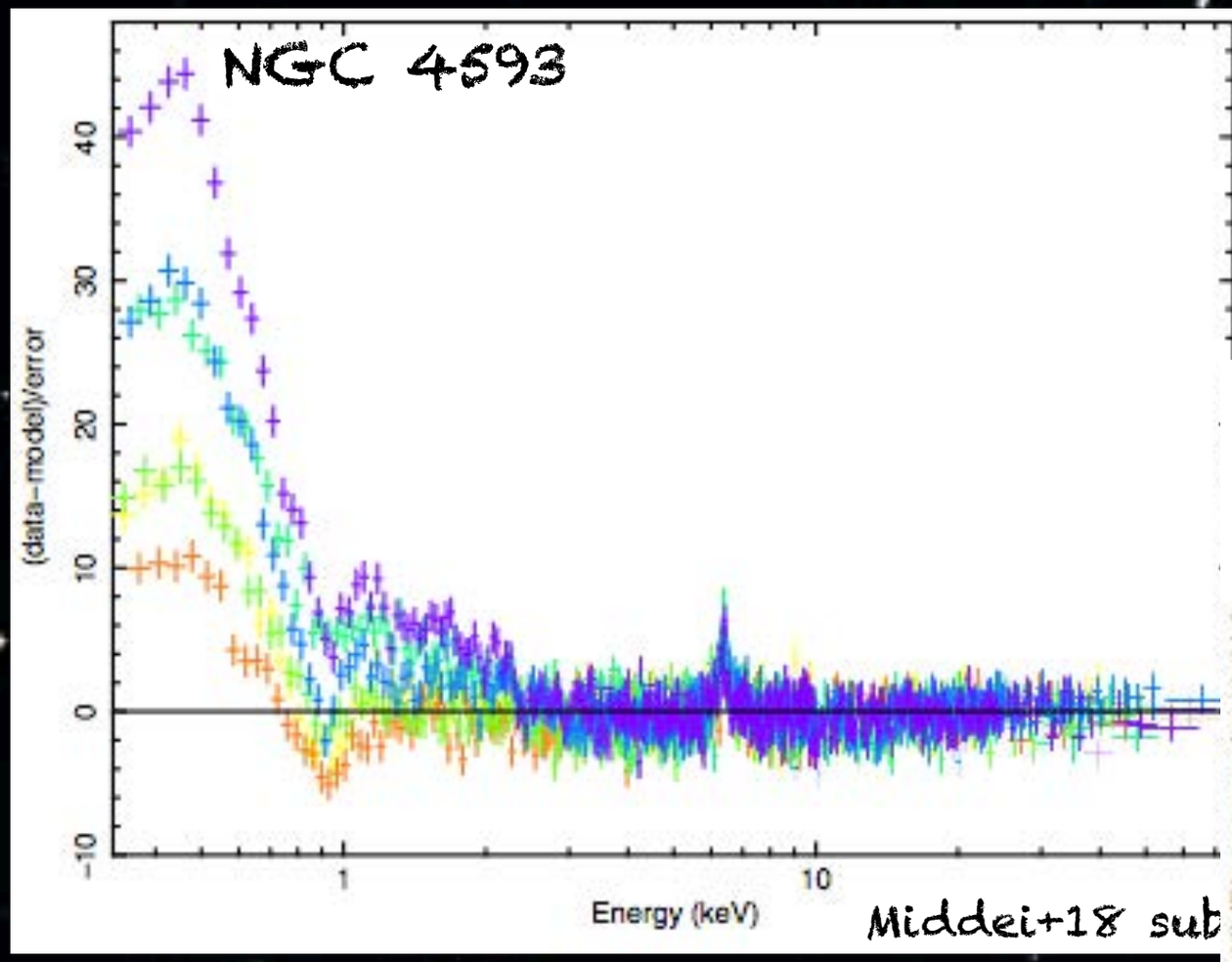


The soft-excess:

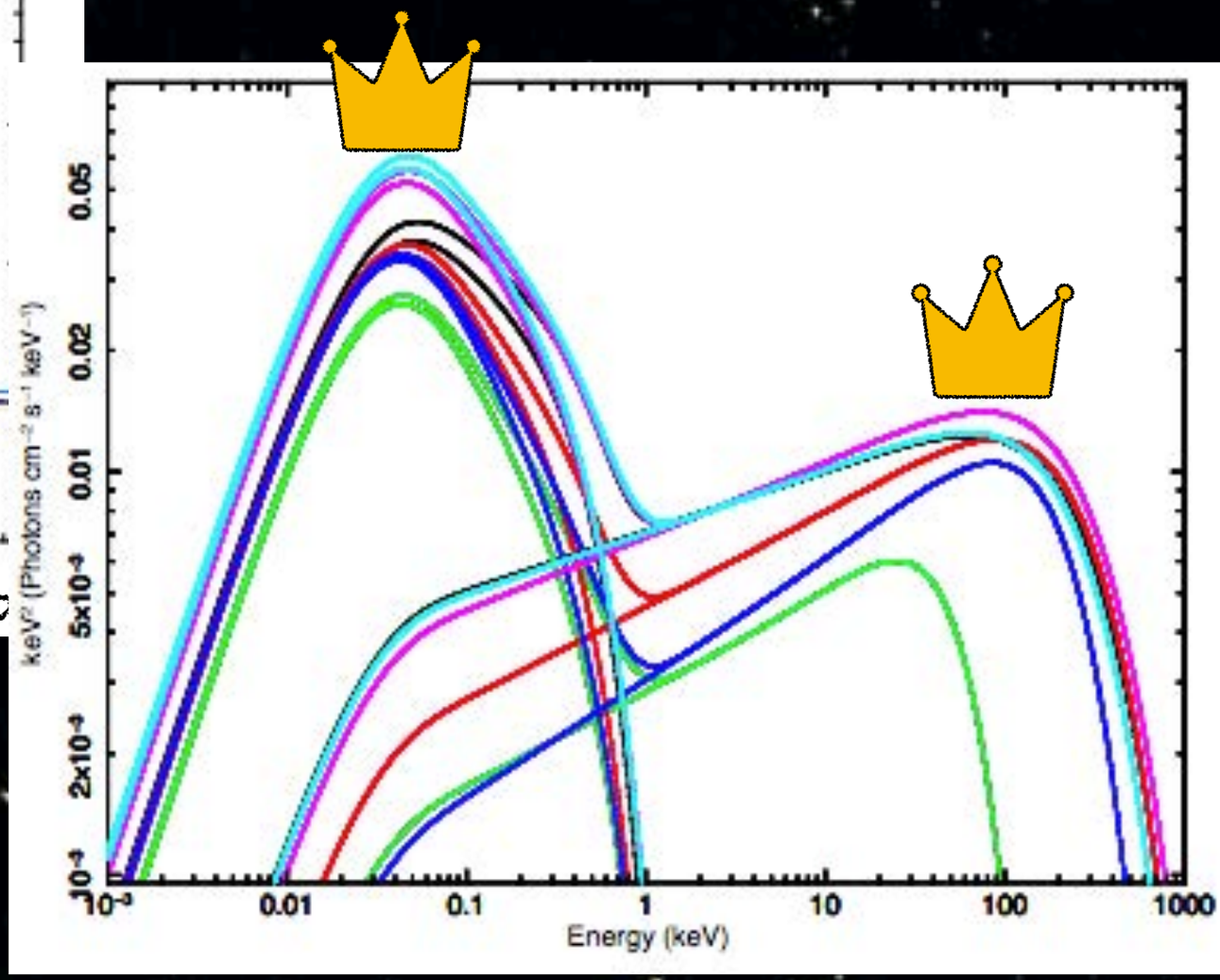


Middei+18 subm.

The soft-excess:



Middei+18 sub

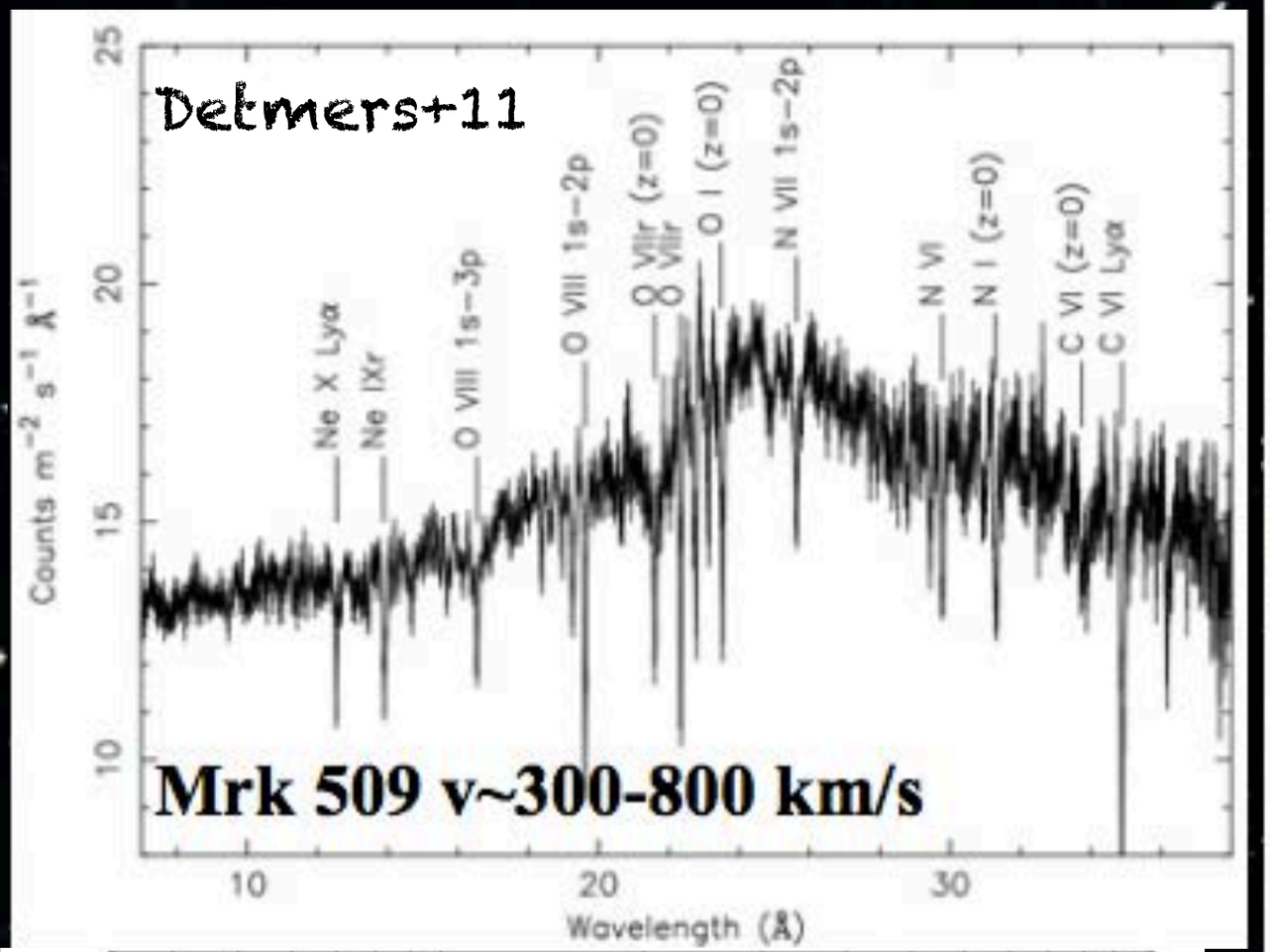


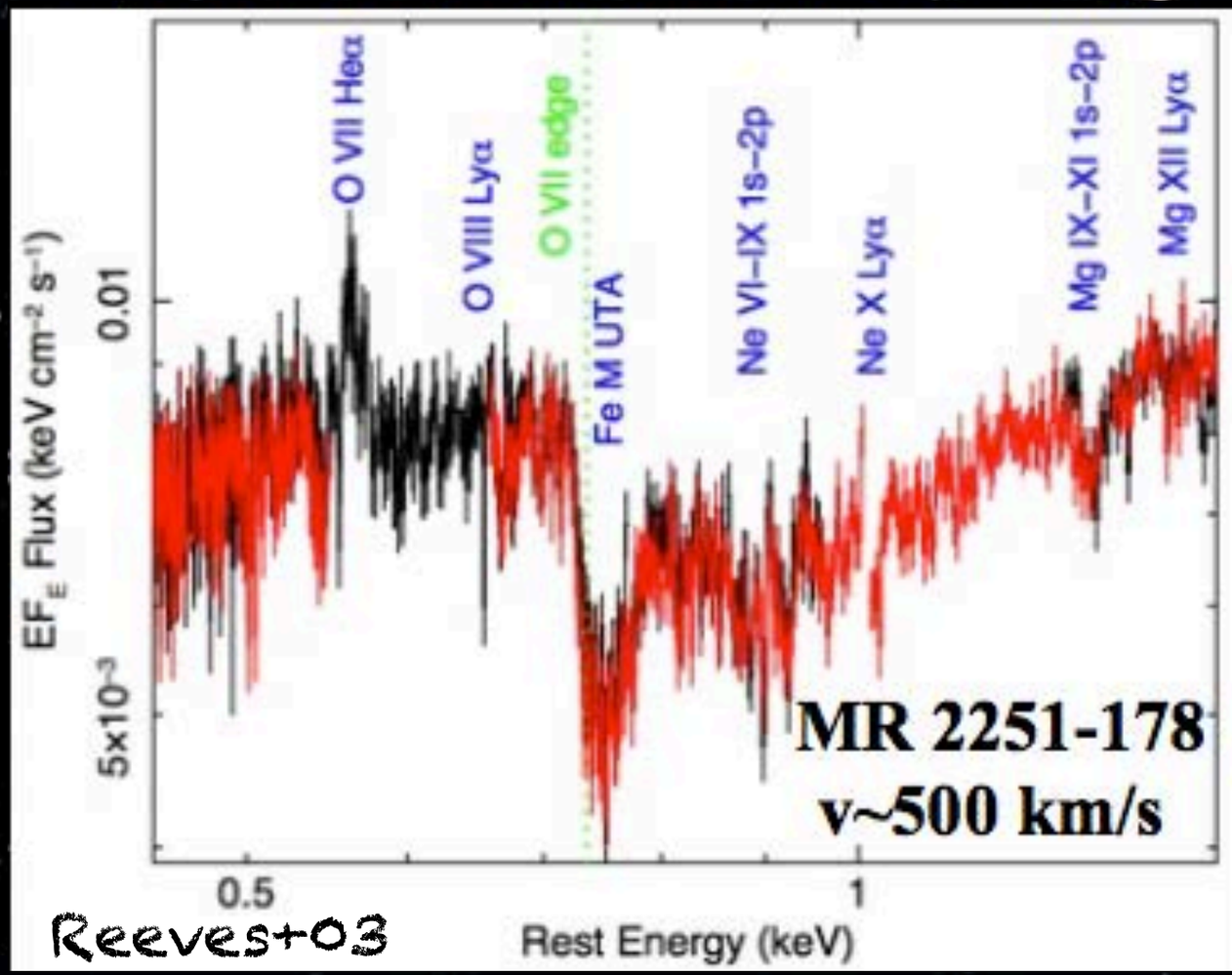
see also McHardy+18

X-ray/UV/optical variability of NGC 4593 with Swift: reprocessing of X-rays by an extended reprocessor

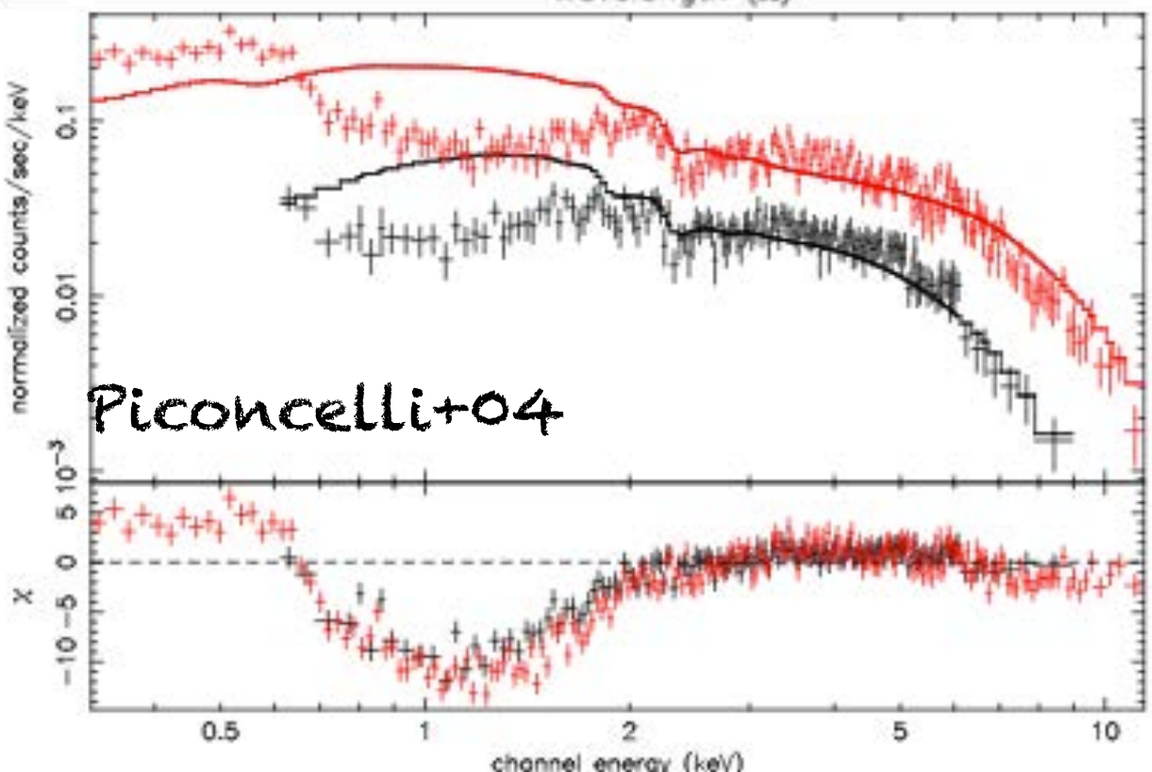
See also Petrucci+18, Porquet+18 for Ark120
Middei+18 for NGC 7469, Ursini+18 for 3c382

Warm Absorption





Reeves+03



~50% of Seyfert 1

-Outflows velocity 10^{2-3} km/s

-Wide range of Ionization states

-Column density 10^{20-22} cm^{-2}

-Location: disk, torus or NLR?

Ultra Fast Outflows (UFOs)

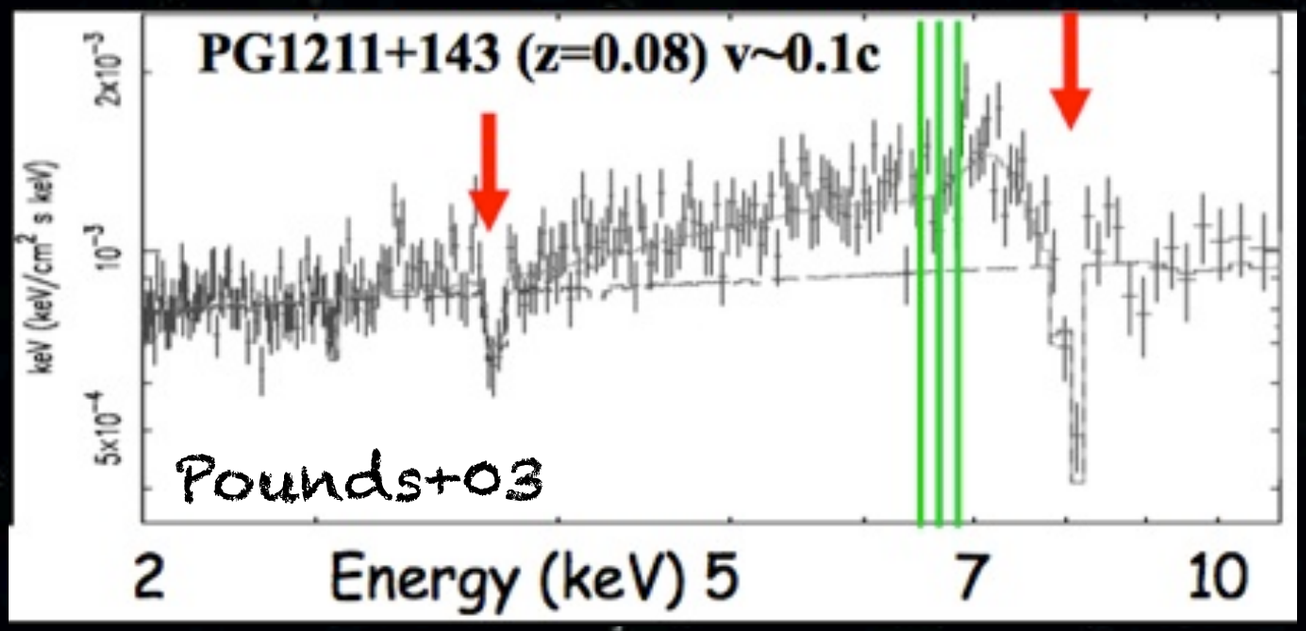
-Present in 30-40% of X-ray samples

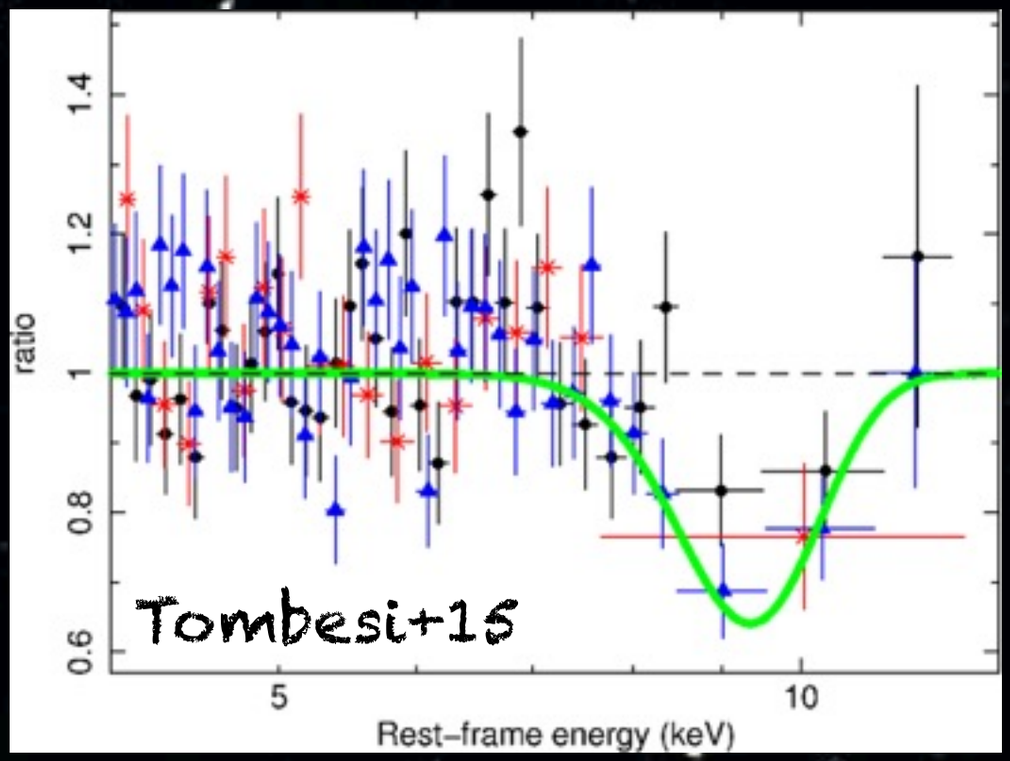
-Outflow velocity~0.1-0.3c

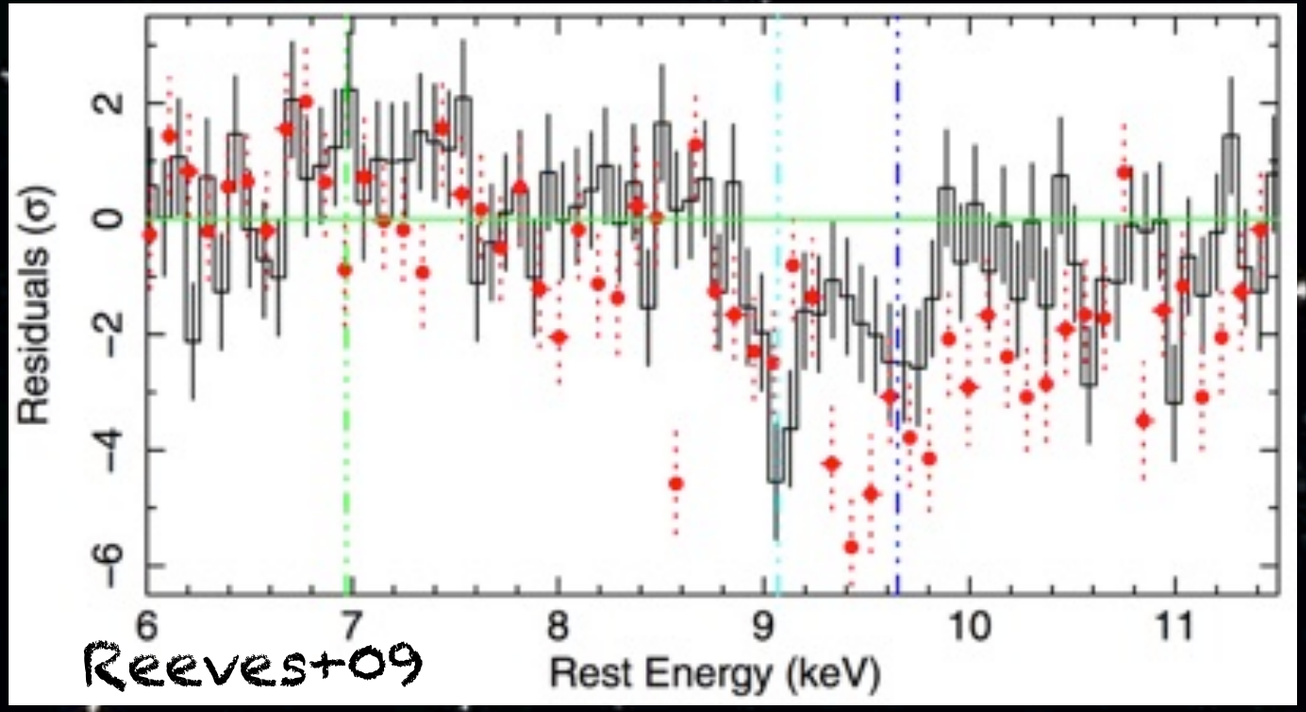
-Mass outflow rate~0.01-1 $M_\odot$ yr^{-1}

-Observed in the Fe K band as blue shifted absorption lines by highly ionized Iron

Ultra Fast Outflows (UFOs)



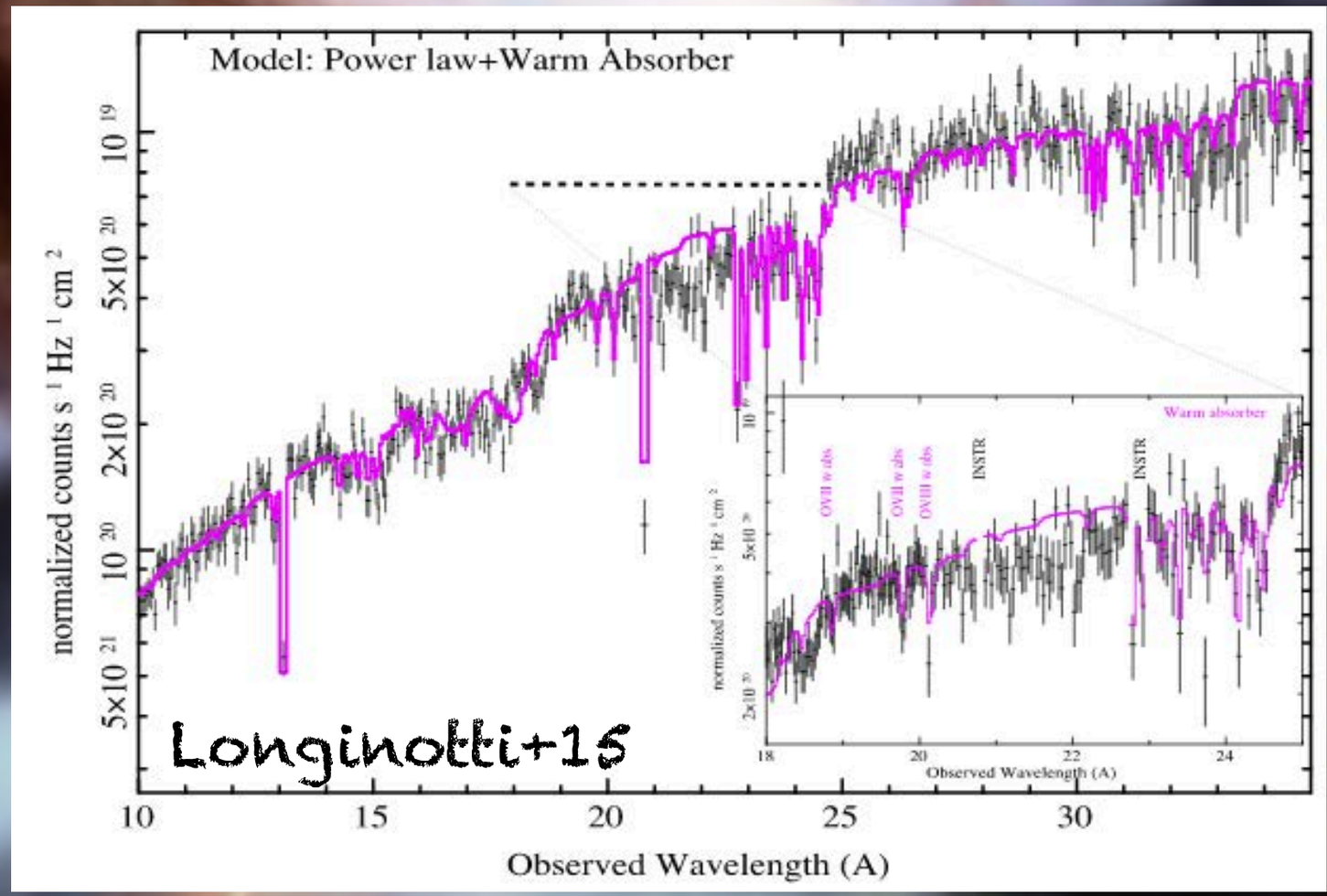




X-ray absorption spectroscopy of critical importance

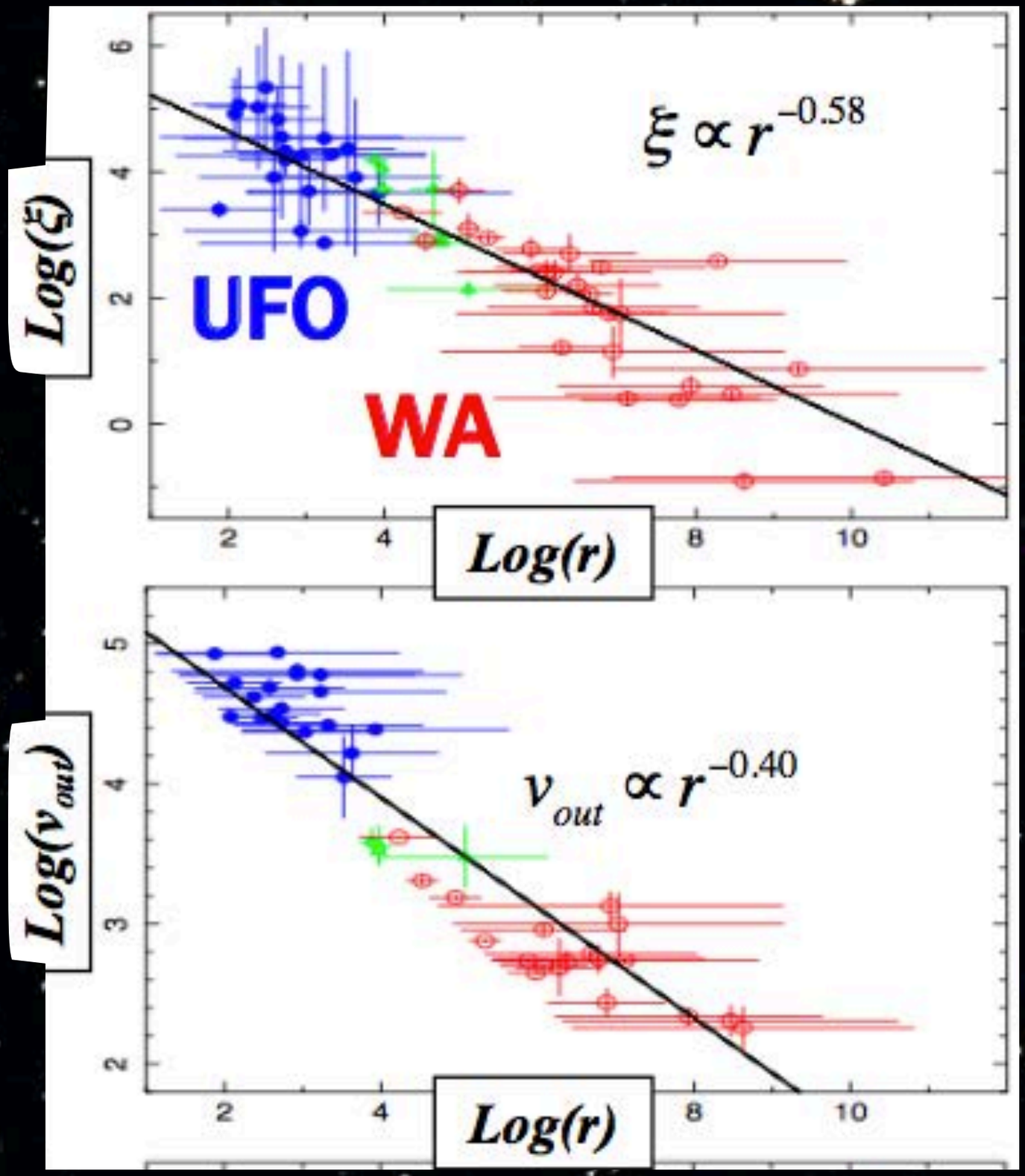
see also Parker+18

Ultra Fast Outflows (UFOs) also at high resolution



Properties from systematic studies

(Tombesi et al. 2010, 11,13; Gofford et al. 2013)

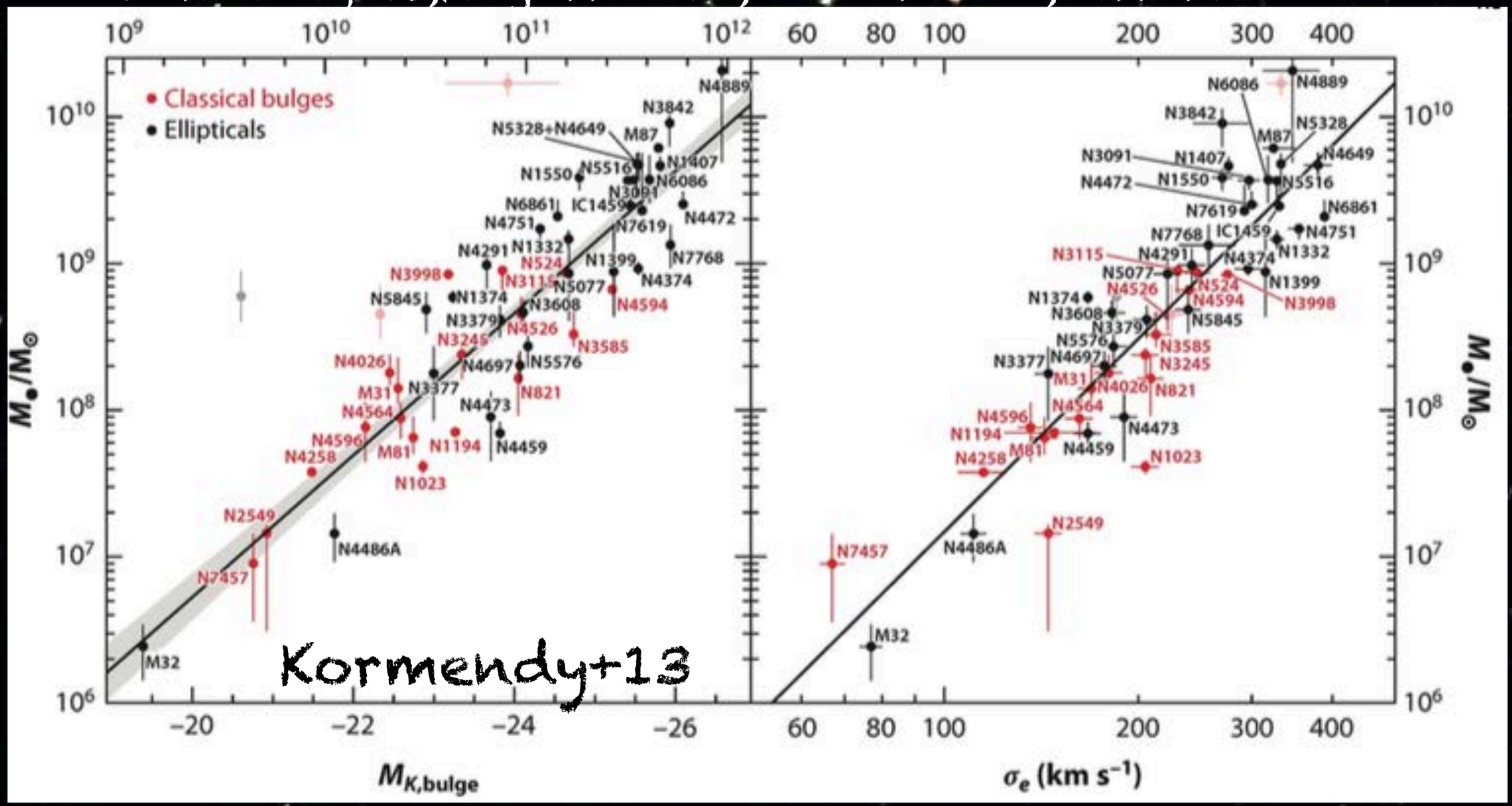


UFOs—> outflows—>host

A deep link between BH and host galaxy

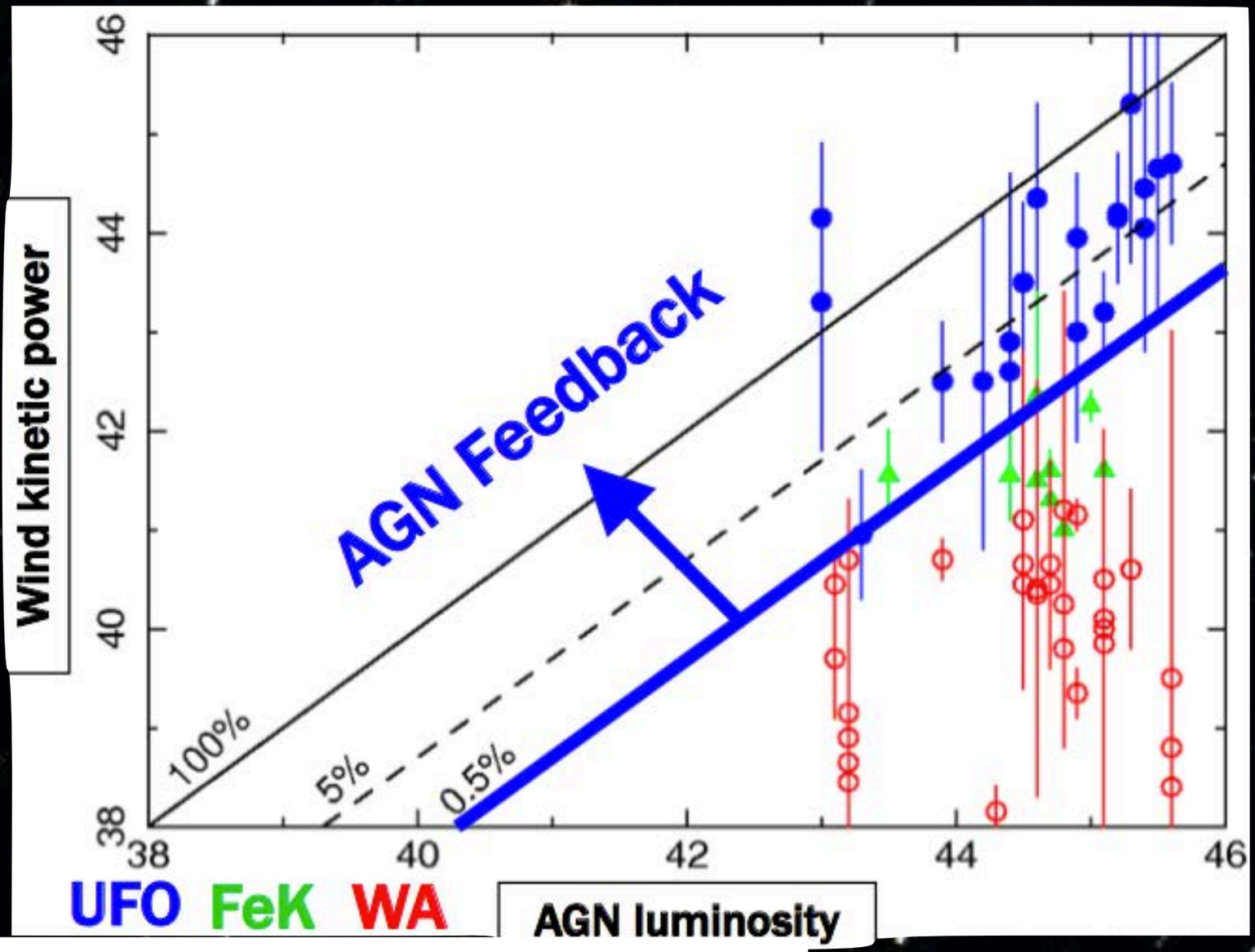
long time quest:

Kormendy+95,Mogorrian98,Gebhardt+00,Ferrarese+00



see also De Nicola+18

Feedback due to AGN winds?



The outflow can act on the host galaxy

If it is 0.5-5% of the AGN luminosity,

then AGN feedback can regulate the growth of the galaxy and the growth of the central black hole as well

see also Di Matteo+05; Hopkins+10

The complex X-ray spectrum and variability of the AGN 1E 0754.6+392

Brightest AGN in the NuSTAR serendipitous catalog

$\log L_{10-40\ keV} = 44$ erg s^{-1}

Lansbury+17

preliminary

1E0754.6+392

INFO

NLS1 at z=0.096, Enya+02

log L_{Bol}/L_{Edd}=-0.85

log L_{Bol}=45.4 erg s^{-1}, Berton+15

log $M_{BH}/M_{\odot}$=8.15, Berton+15

log $M_{BH}/M_{\odot}$=8.0, Sergeev+07

1E0754.6+392 ID

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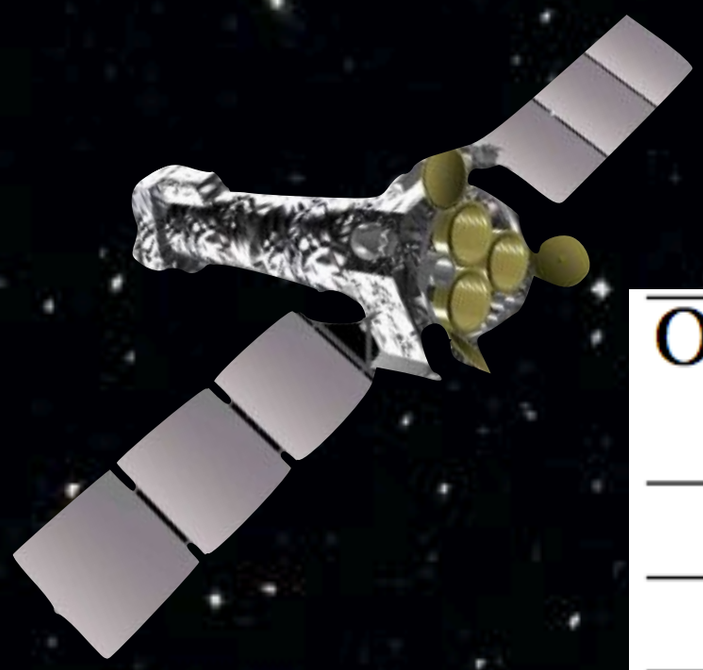

Observations Log

Obs.	Satellite	Obs. ID	Net exp. (ks)	Start-date yyyy-mm-dd
1	*XMM-Newton*	0305990101	13.5	2006-04-18
2	*XMM-Newton*	0406740101	14.7	2006-10-22

1E0754.6+392 ID

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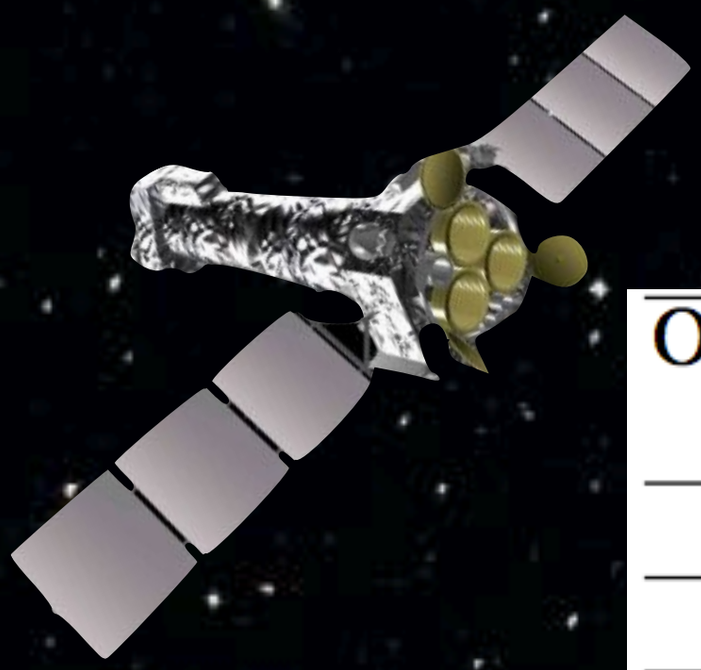
Two short observations!



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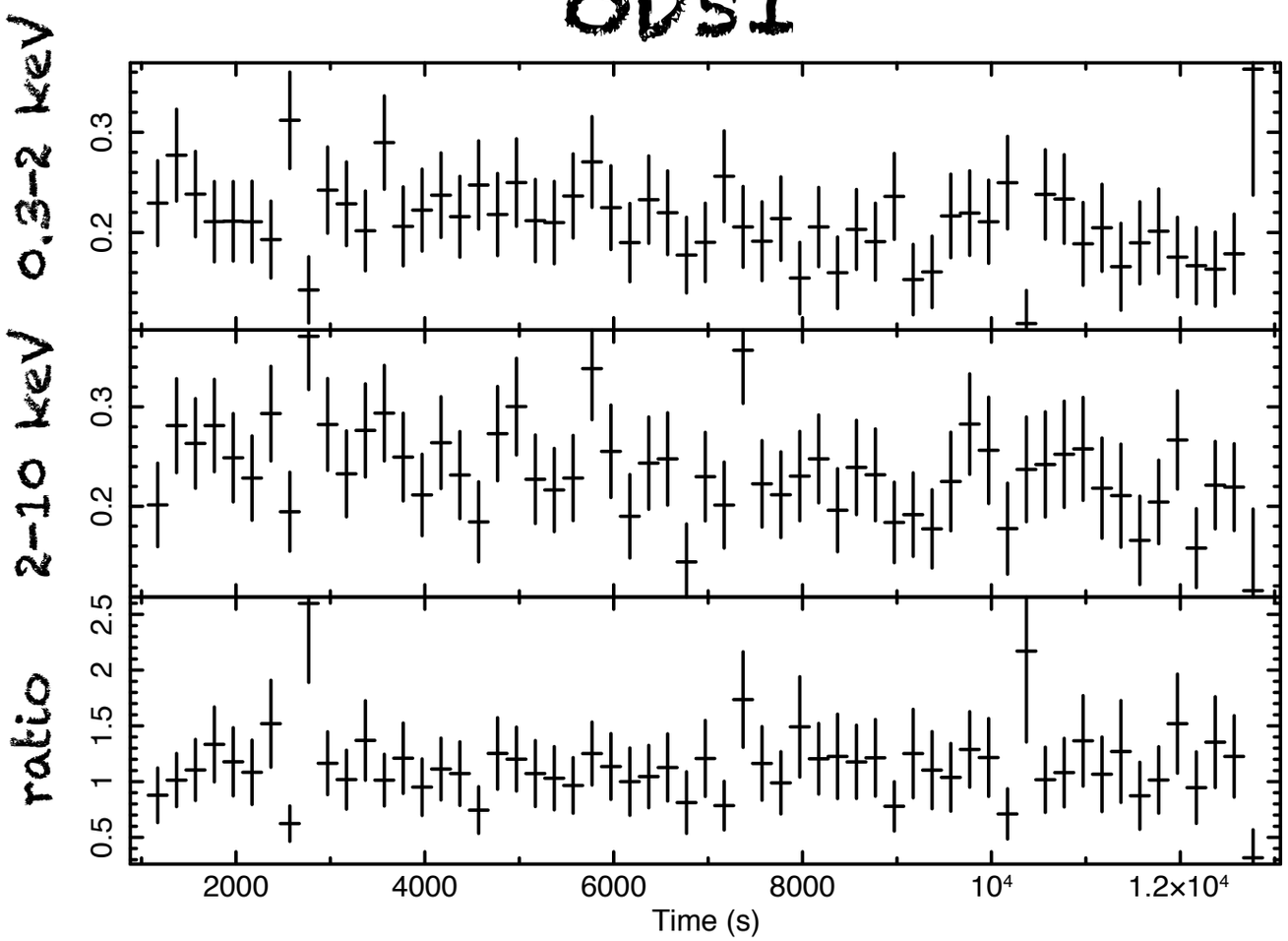
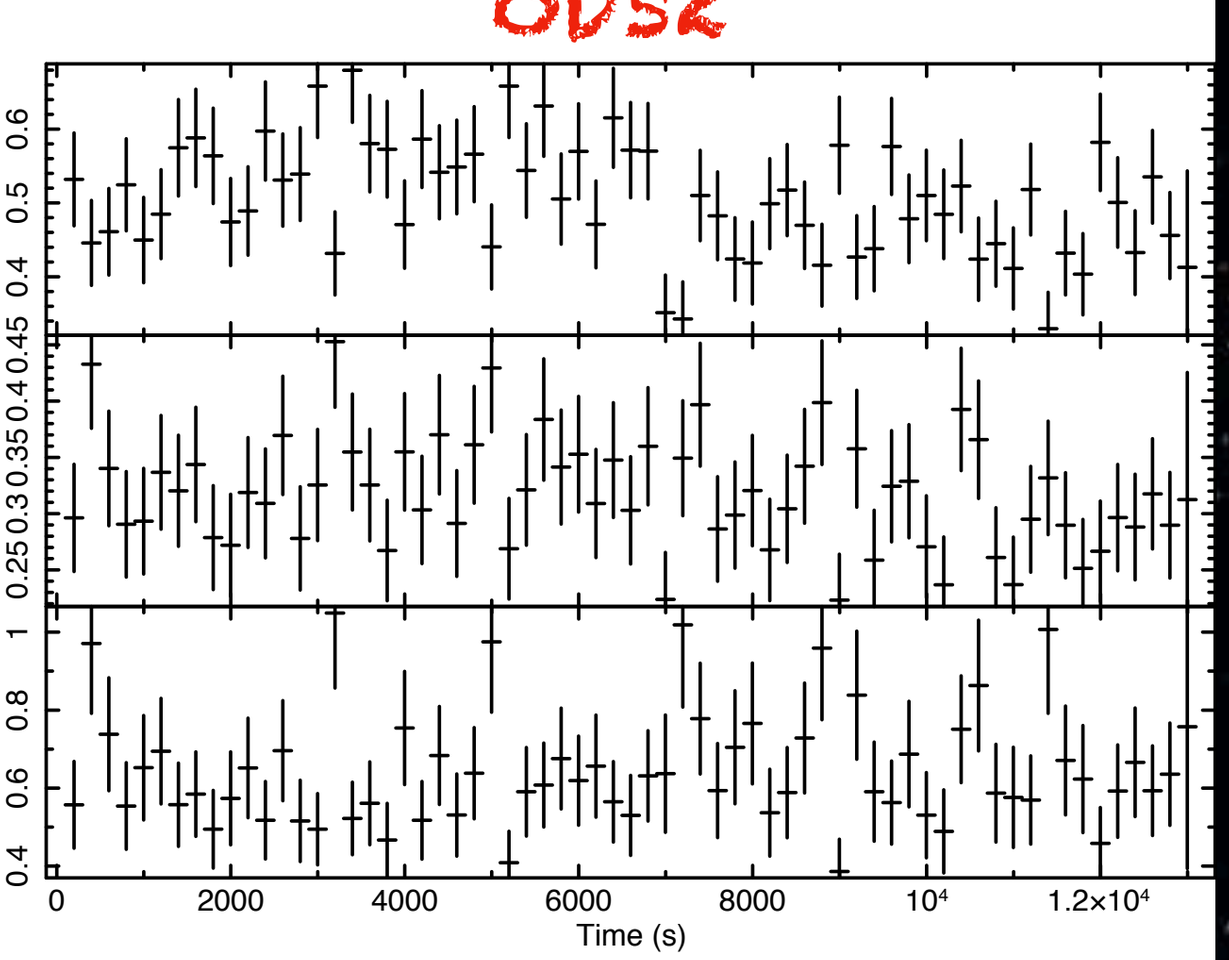
1E0754.6+392, temporal properties

obs1



obs2



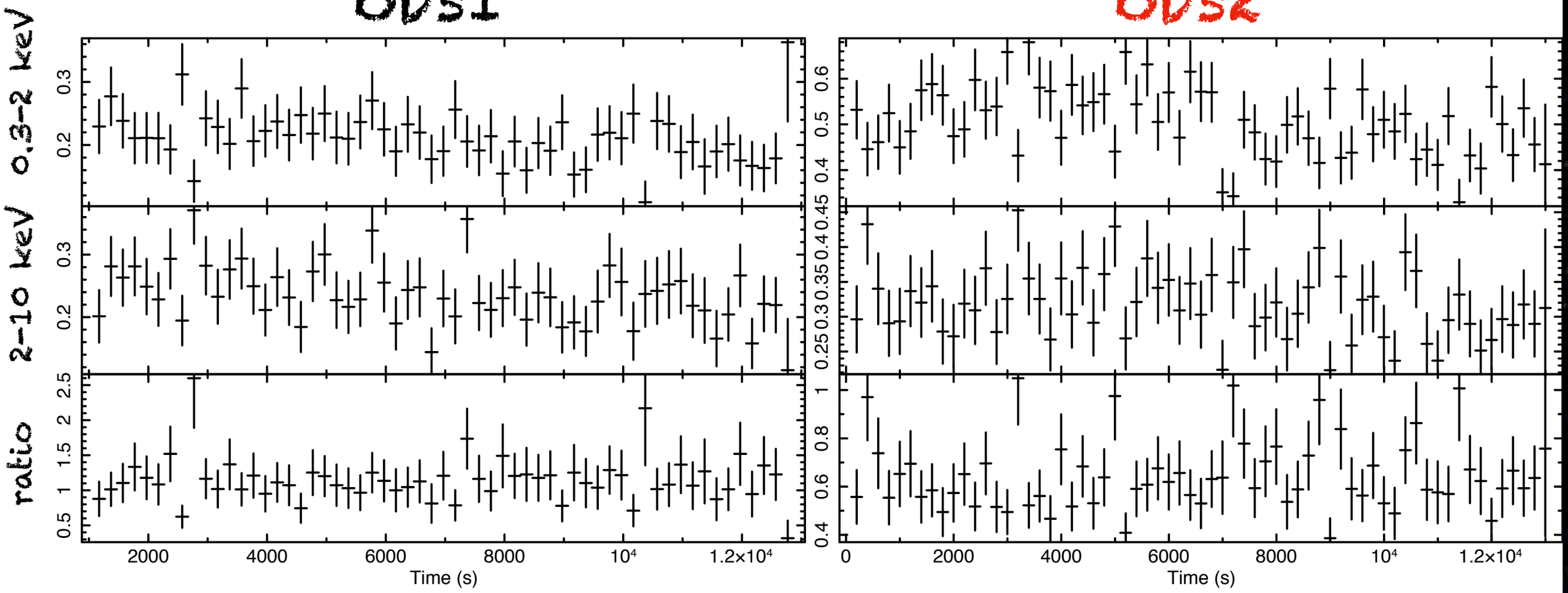
$Flux_{0.3-2}$=3.4e-13 erg/cm²/s $Flux_{2-10}$=2.1e-12 erg/cm²/s

$Flux_{0.3-2}$=7.9e-13 erg/cm²/s $Flux_{2-10}$=2.6e-12 erg/cm²/s

1E0754.6+392, temporal properties

obs1

obs2



no variability within observations

months variability

$Flux_{0.3-2}$=3.4e-13 erg/cm²/s $Flux_{2-10}$=2.1e-12 erg/cm²/s

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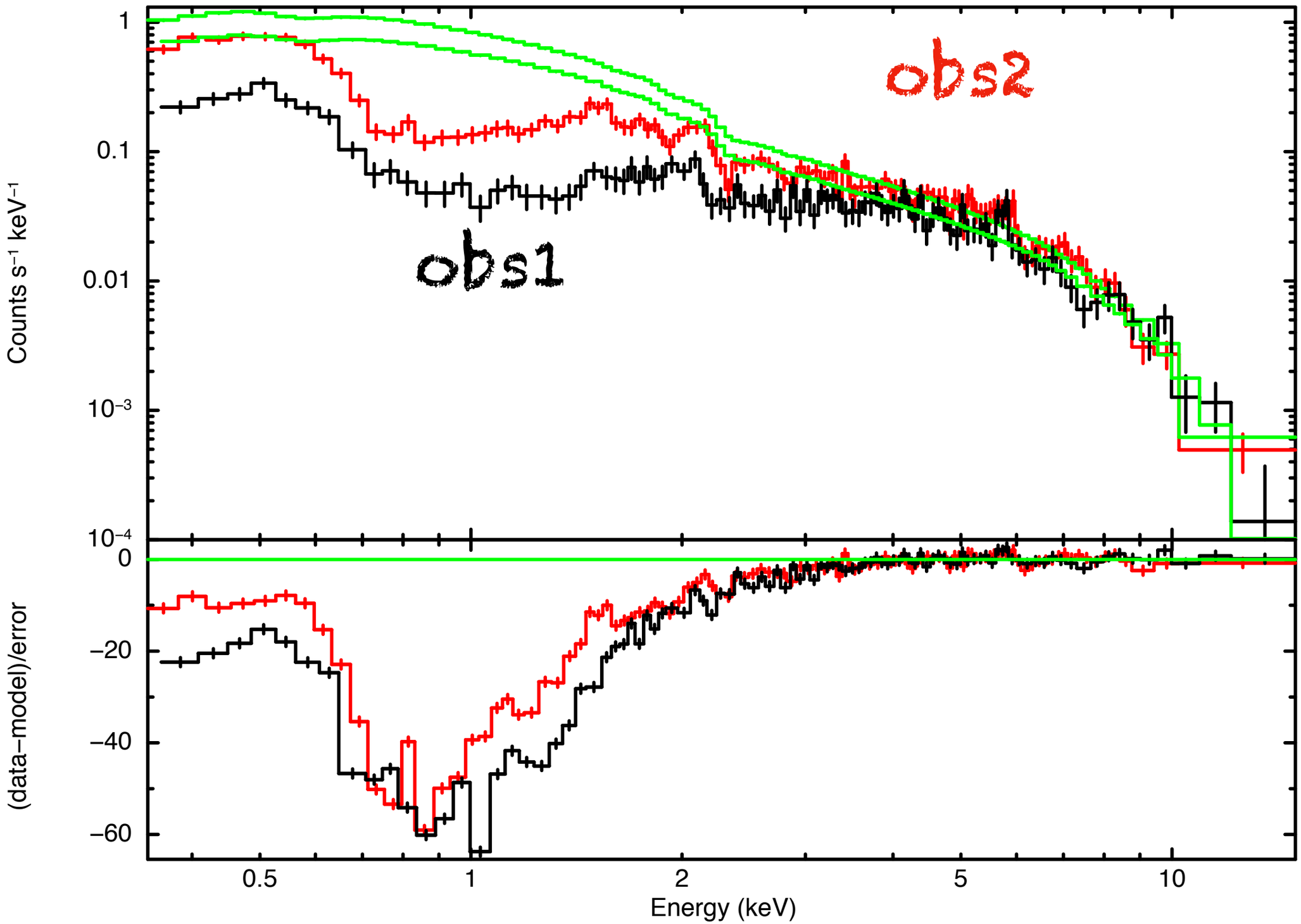
More than a simple power-law



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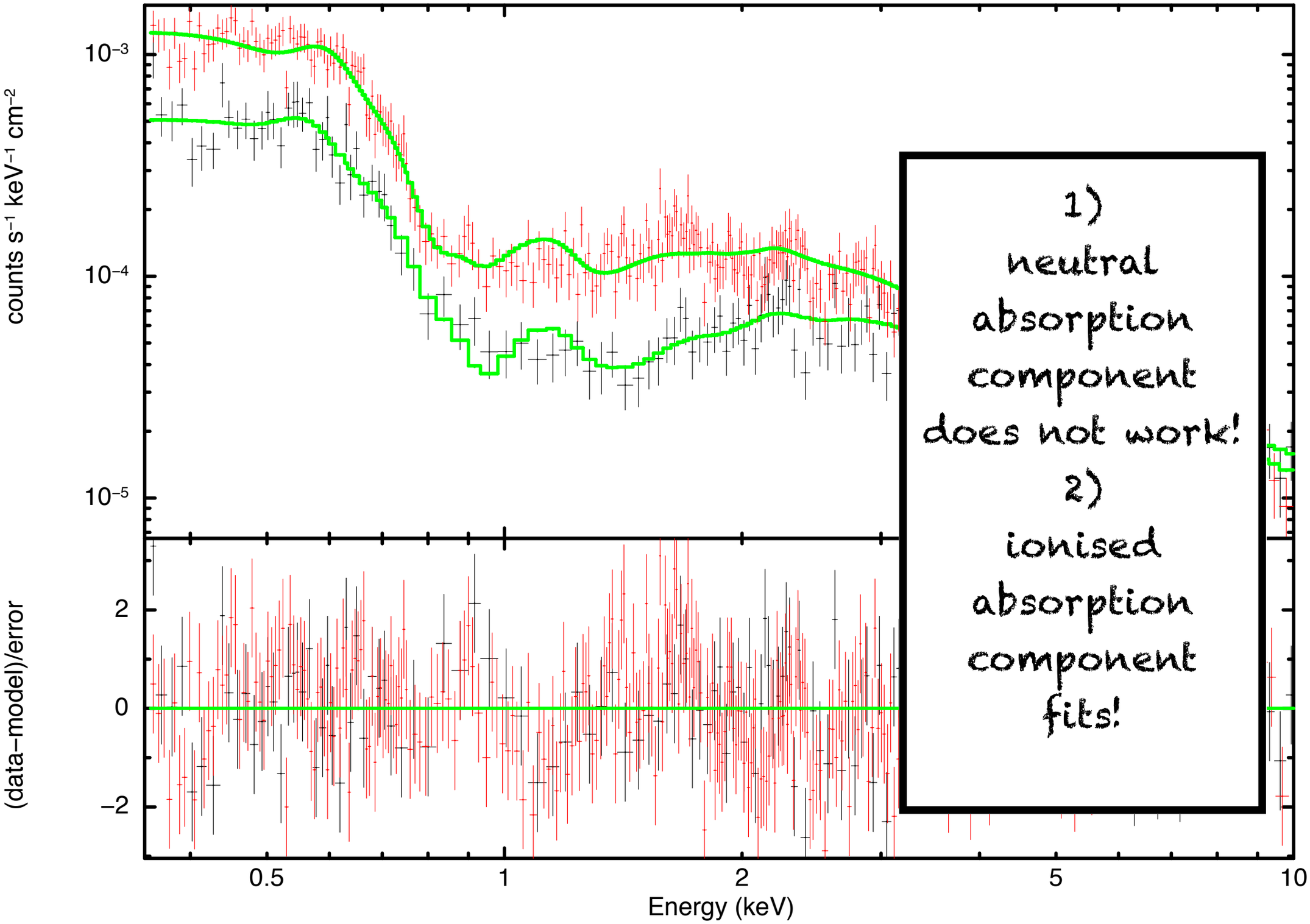
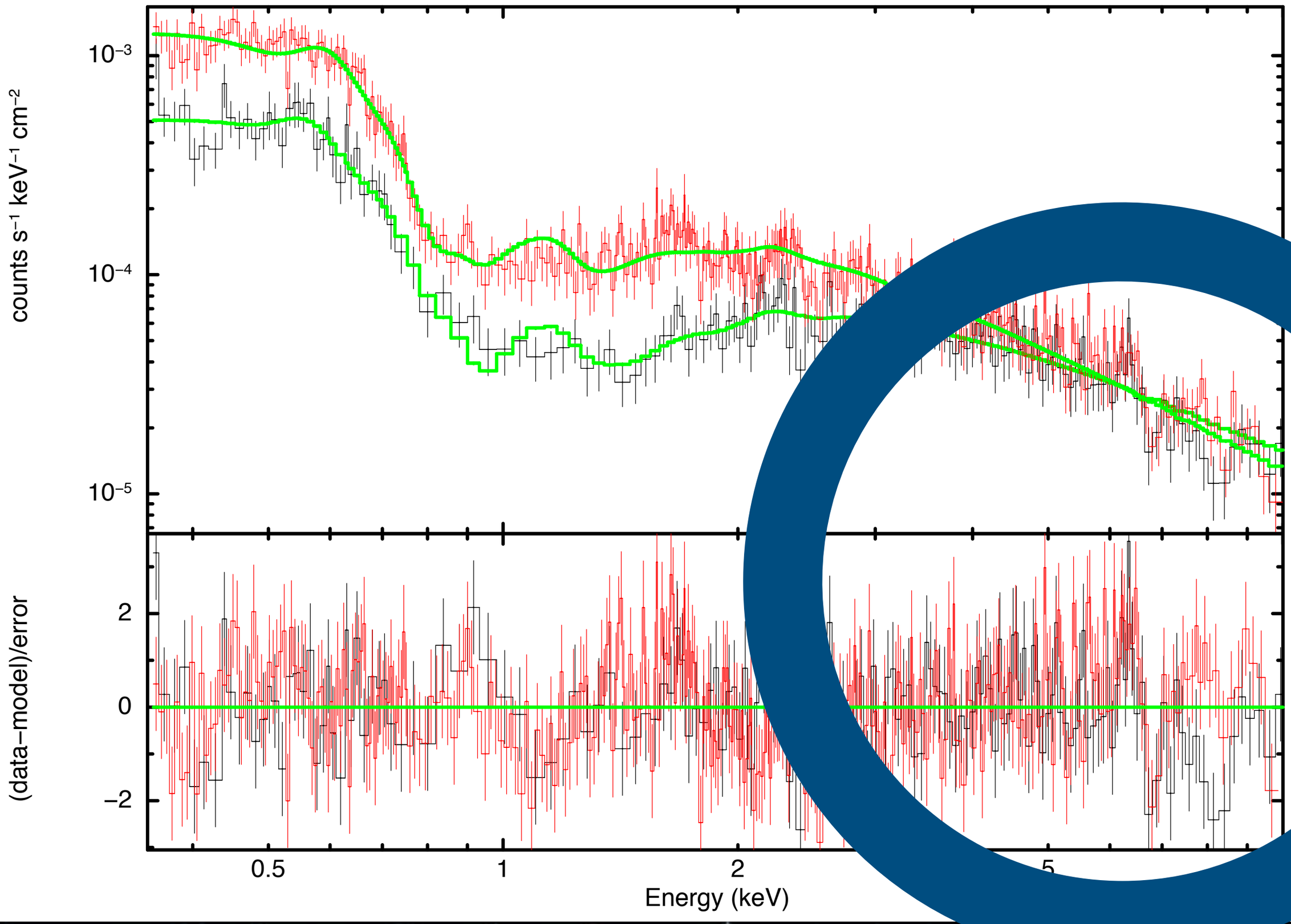
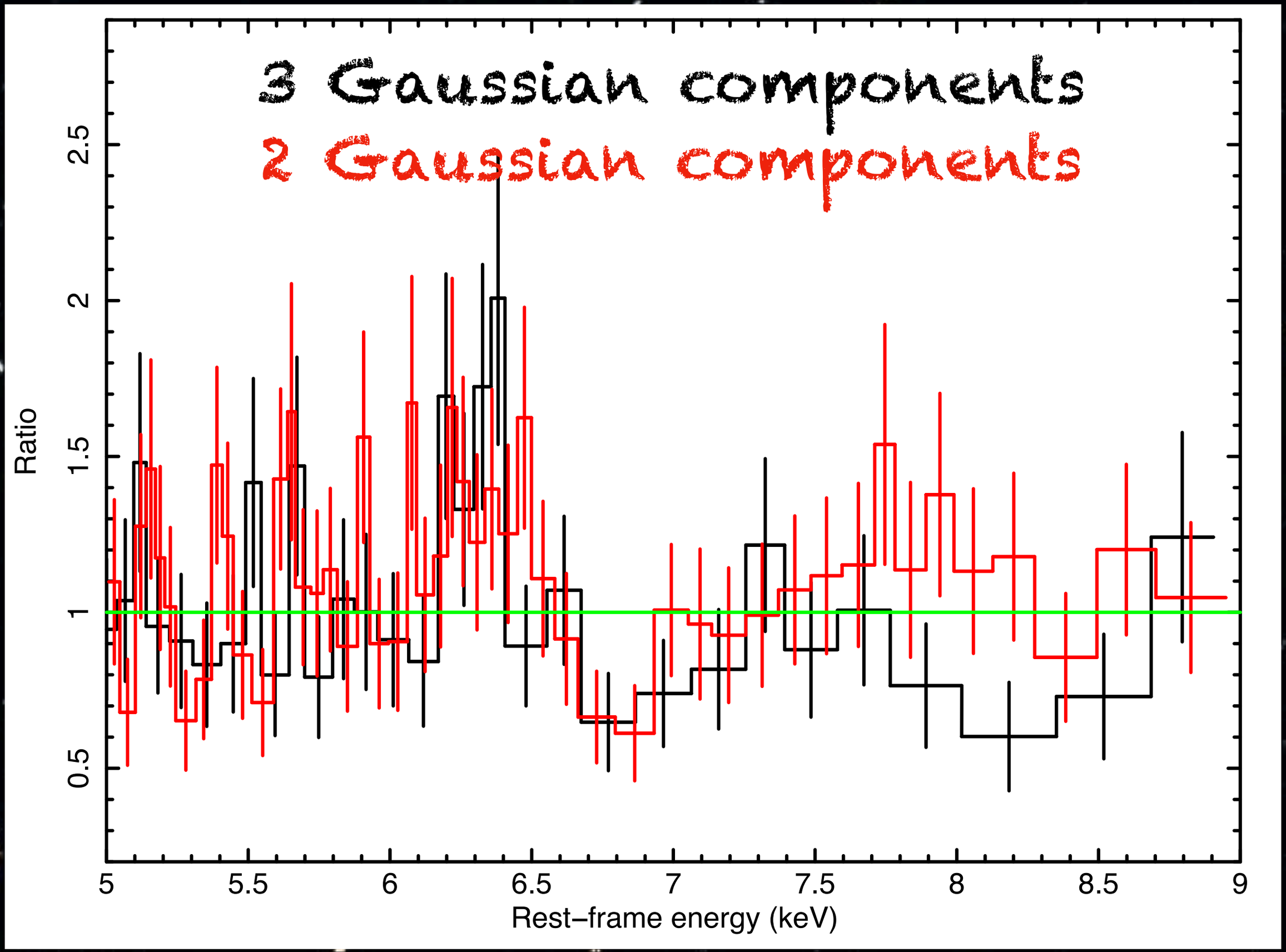


Much more than a simple power-law



Much more than a simple power-law



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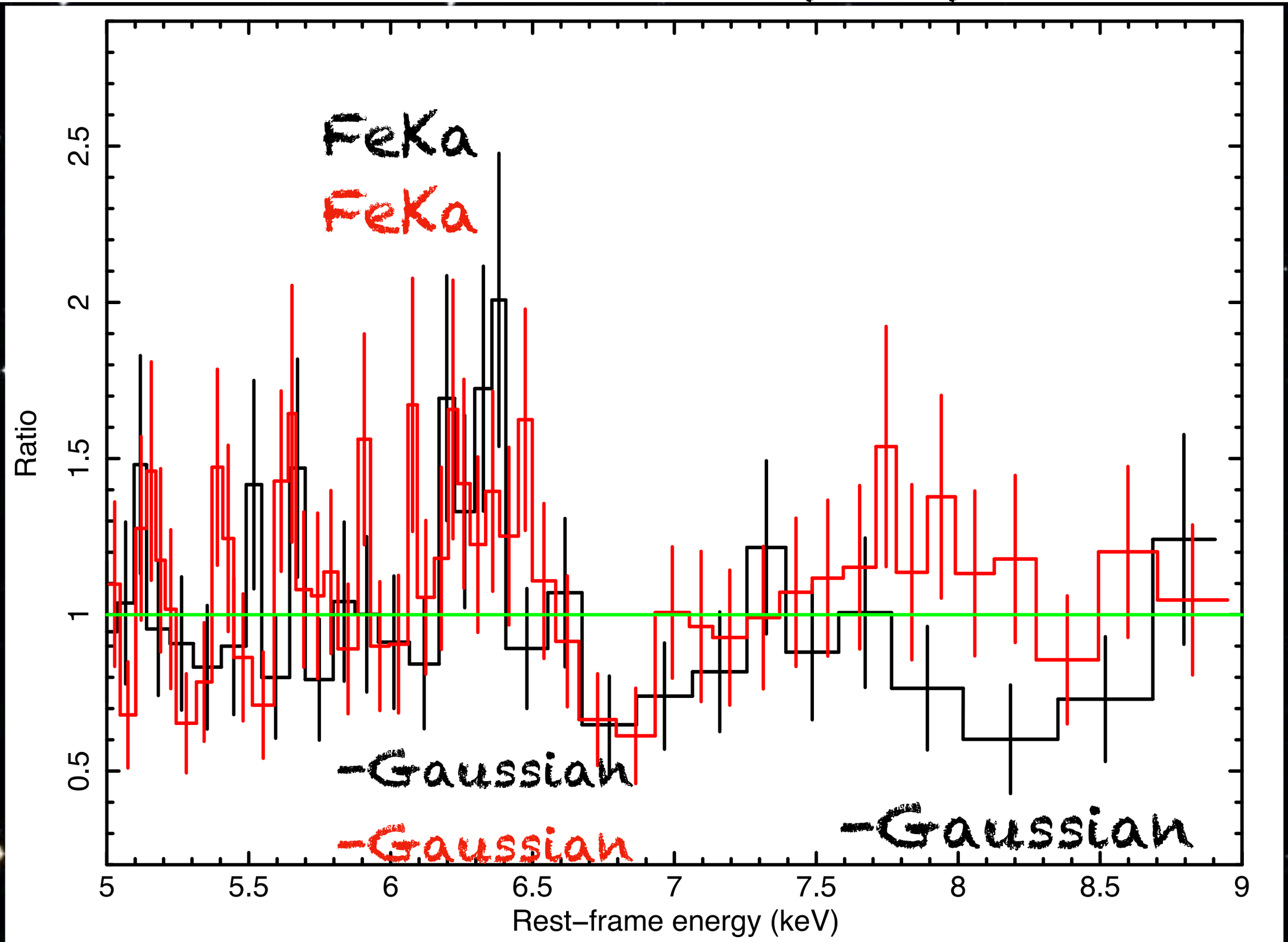

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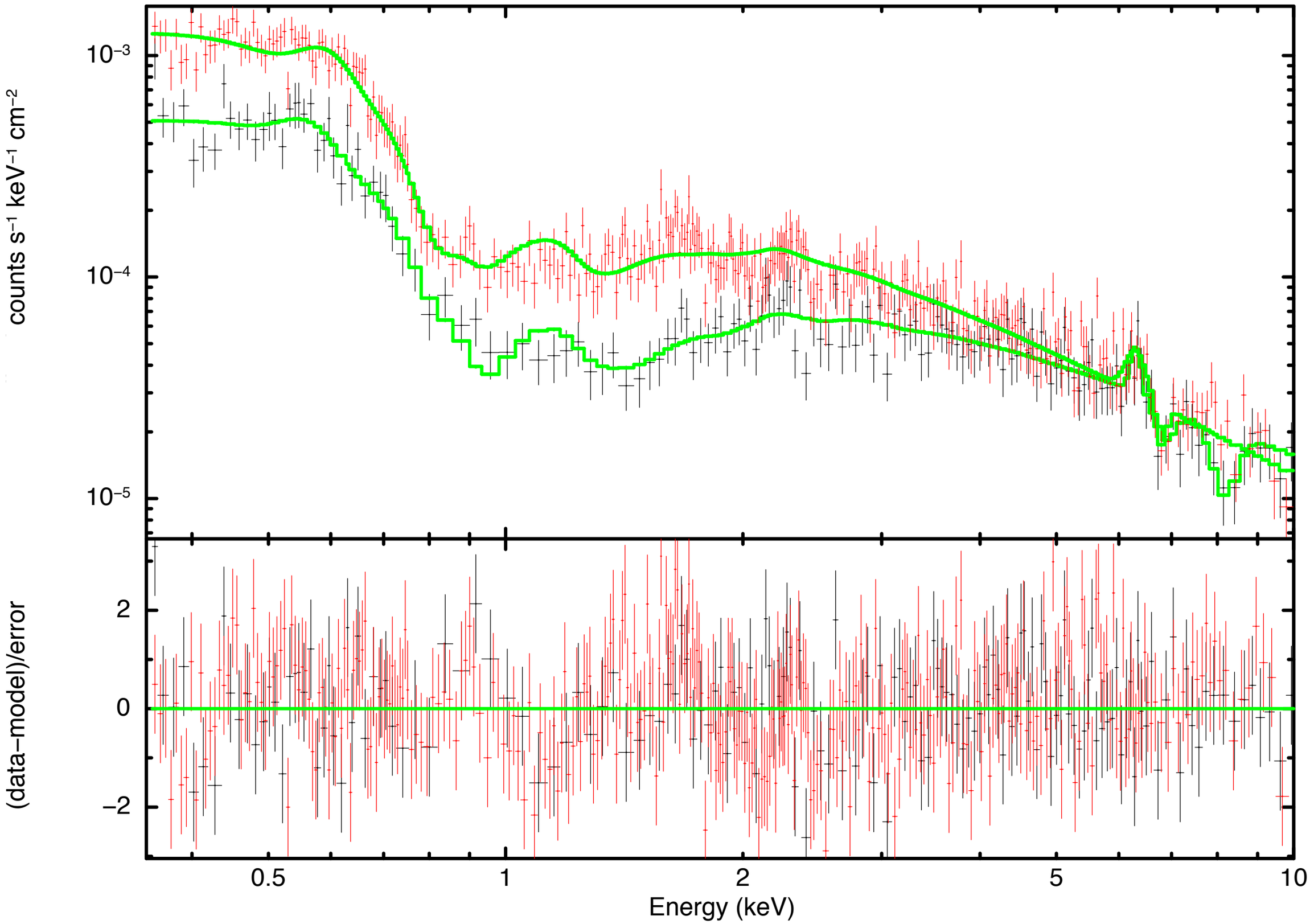
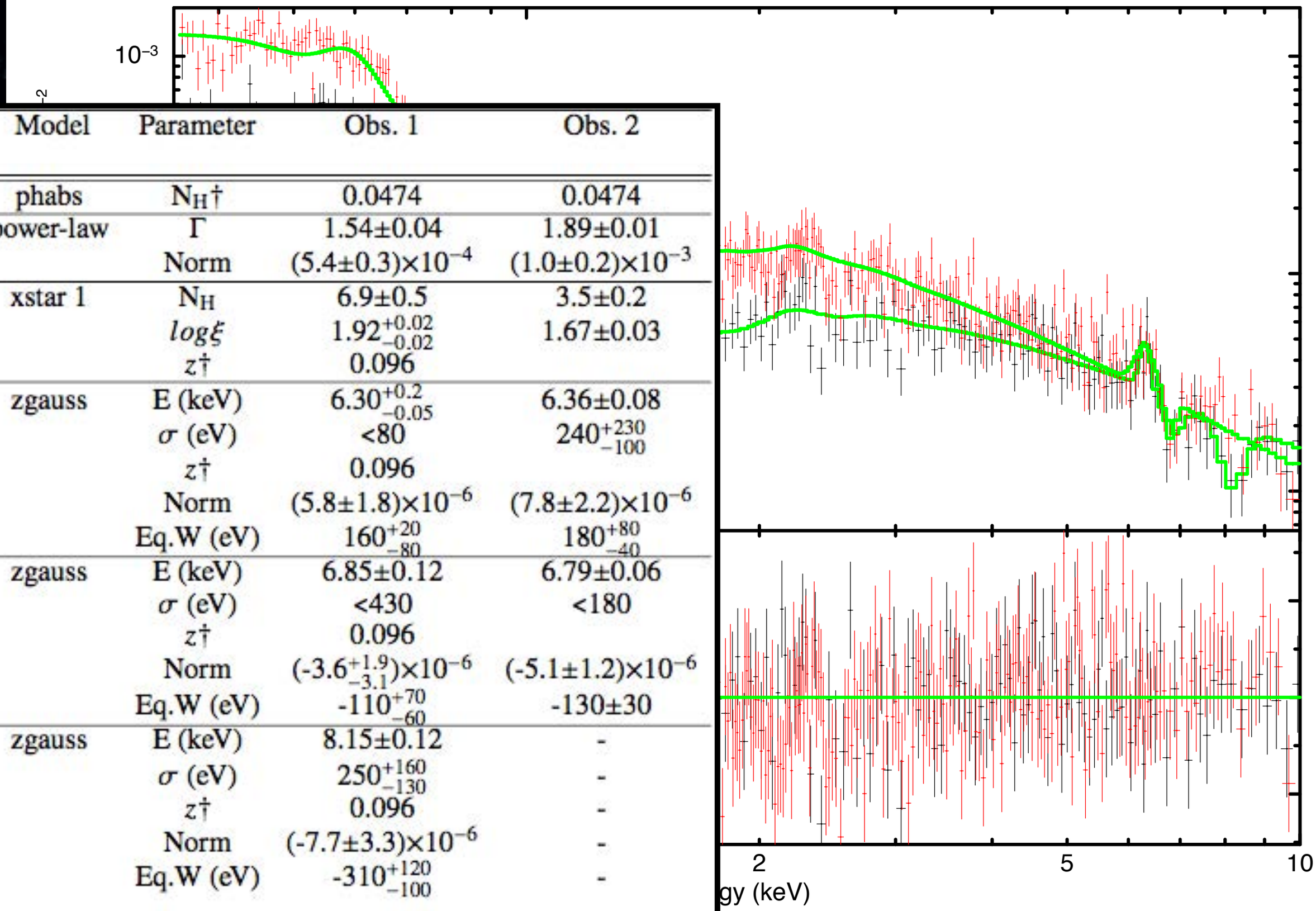


best-fit parameters

Model	Parameter	Obs. 1	Obs. 2
phabs	N_H†	0.0474	0.0474
power-law	Γ	1.54±0.04	1.89±0.01
	Norm	$(5.4\pm0.3)\times10^{-4}$	$(1.0\pm0.2)\times10^{-3}$
xstar 1	N_H	6.9±0.5	3.5±0.2
	$log\xi$	$1.92^{+0.02}_{-0.02}$	1.67±0.03
	z†	0.096	
zgauss	E (keV)	$6.30^{+0.2}_{-0.05}$	6.36±0.08
	σ (eV)	<80	240^{+230}_{-100}
	z†	0.096	
	Norm	$(5.8\pm1.8)\times10^{-6}$	$(7.8\pm2.2)\times10^{-6}$
	Eq.W (eV)	160^{+20}_{-80}	180^{+80}_{-40}
zgauss	E (keV)	6.85±0.12	6.79±0.06
	σ (eV)	<430	<180
	z†	0.096	
	Norm	$(-3.6^{+1.9}_{-3.1})\times10^{-6}$	$(-5.1\pm1.2)\times10^{-6}$
	Eq.W (eV)	-110^{+70}_{-60}	-130±30
zgauss	E (keV)	8.15±0.12	-
	σ (eV)	250^{+160}_{-130}	-
	z†	0.096	-
	Norm	$(-7.7\pm3.3)\times10^{-6}$	-
	Eq.W (eV)	-310^{+120}_{-100}	-



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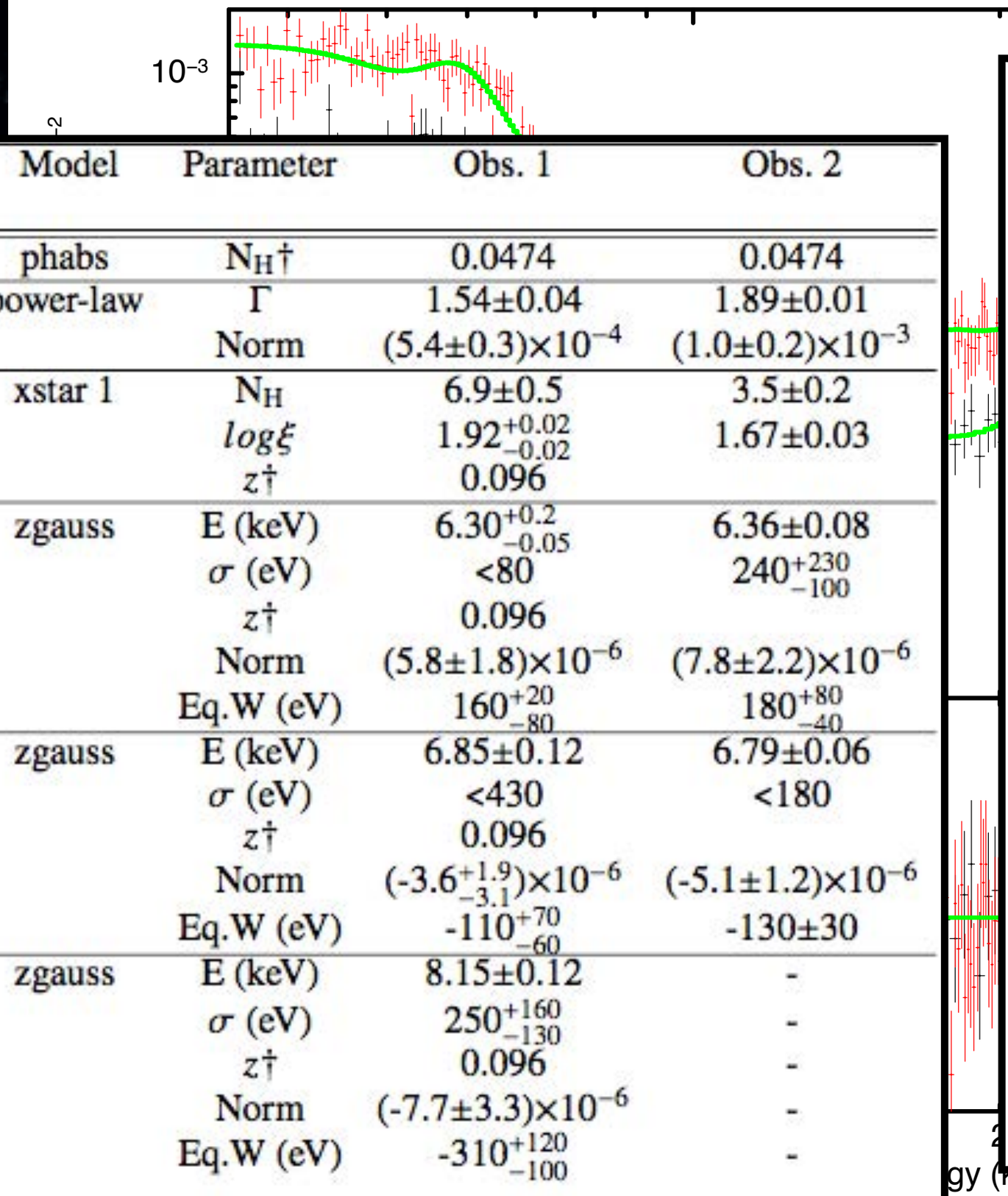

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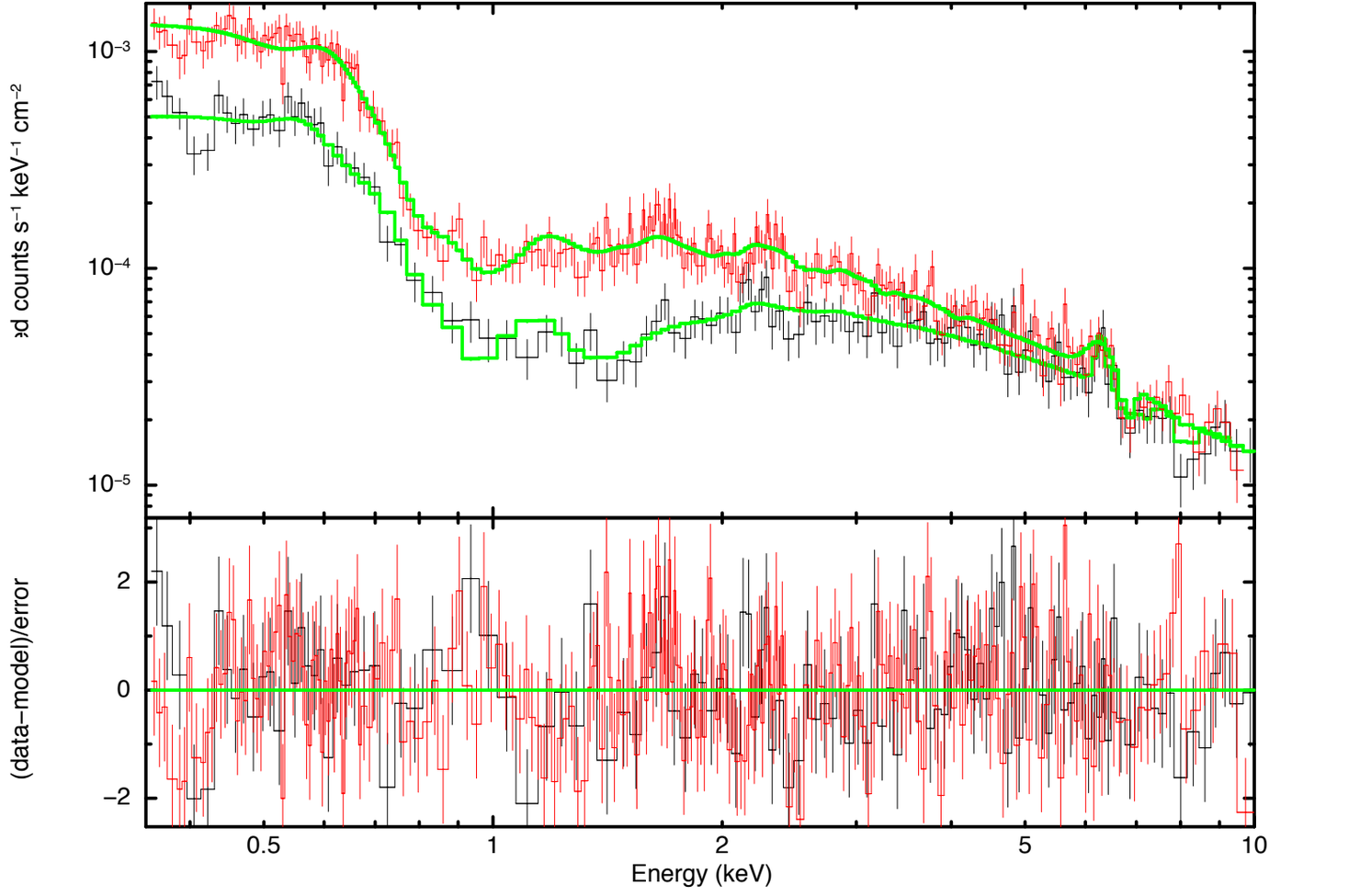
	Eq.W (eV)	160^{+20}_{-80}	180^{+80}_{-40}
zgauss	E (keV)	6.85±0.12	6.79±0.06
	σ (eV)	<430	<180
	z†	0.096	
	Norm	$(-3.6^{+1.9}_{-3.1})\times10^{-6}$	$(-5.1\pm1.2)\times10^{-6}$
	Eq.W (eV)	-110^{+70}_{-60}	-130±30
zgauss	E (keV)	8.15±0.12	-
	σ (eV)	250^{+160}_{-130}	-
	z†	0.096	-
	Norm	$(-7.7\pm3.3)\times10^{-6}$	-
	Eq.W (eV)	-310^{+120}_{-100}	-

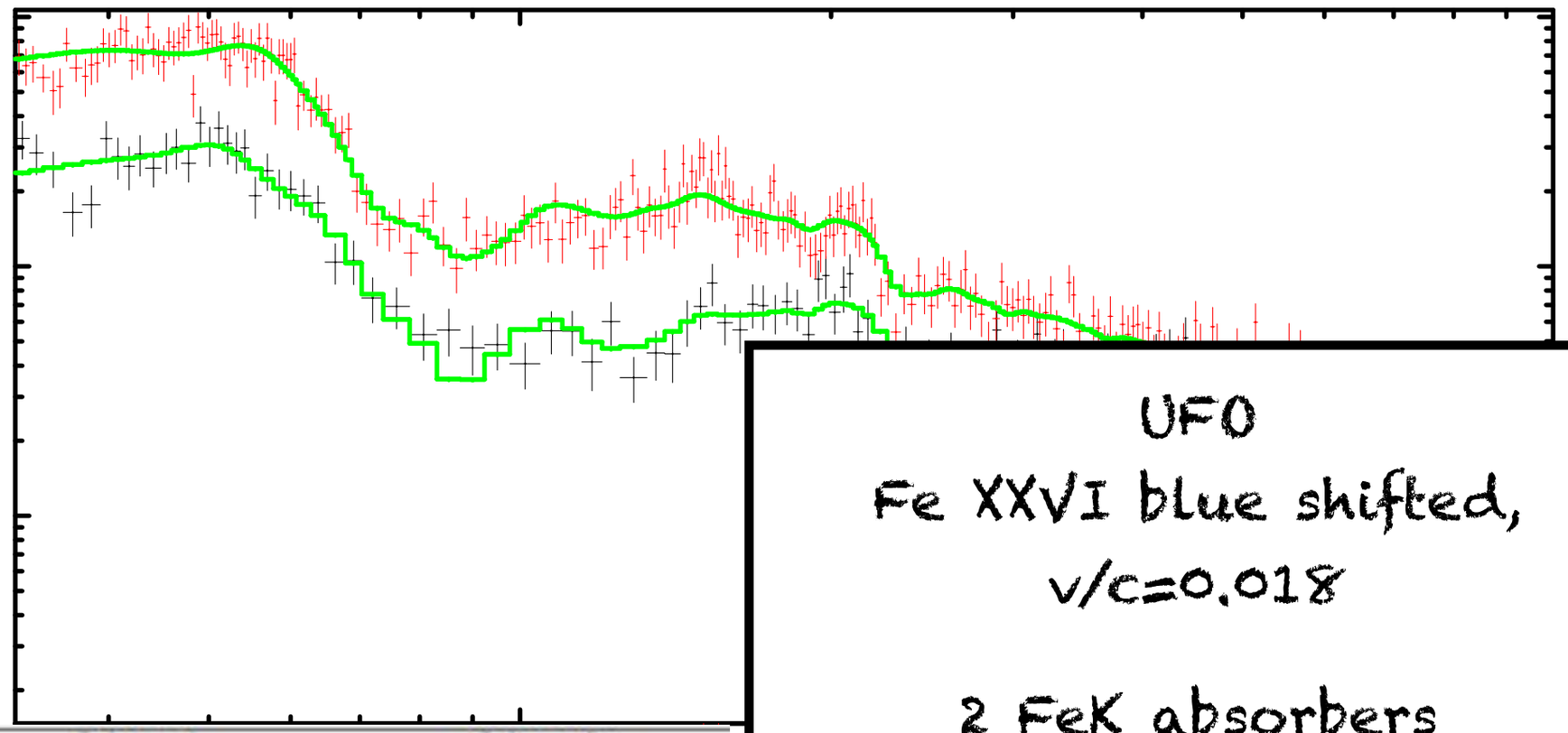
- warm-absorber displays a variable ξ and N_H
- spectral slope strongly varies
- Fe Kalpha narrow (obs1)/ broad(obs1)
- Fe XXV lowly blue-shifted
- Fe XXVI highly blue-shifted

best-fit parameters using XSTAR tables



		obs1	obs2
xstar (FeKα) (Fe XXV)	N_H (cm^{-2})	$(9.9^{+2.7}_{-6.4})\times10^{22}$	$(1.4^{+0.2}_{-0.2})\times10^{23}$
	logξ	3.4±0.2	2.9±0.1
	z_{obs}	$(5.7\pm0.9)\times10^{-2}$	$(5.3^{+0.4}_{-0.6})\times10^{-2}$
	v_{out}/c	0.037±0.008	0.042±0.005
xstar (UFO) (Fe XXVI)	N_H (cm^{-2})	$(1.0^{+0.2}_{-0.4})\times10^{24}$	-
	logξ	$4.0^{+0.3}_{-0.1}$	-
	z_{obs}	$(-6.2^{+1.4}_{-1.6})\times10^{-2}$	-
	v_{out}/c	0.18±0.02	-

best-fit parameters using XSTAR



free zWA->
DeltaC=7 for 2
d.o.f. less
i.e. 2 sigma
(~96.8% prob.)

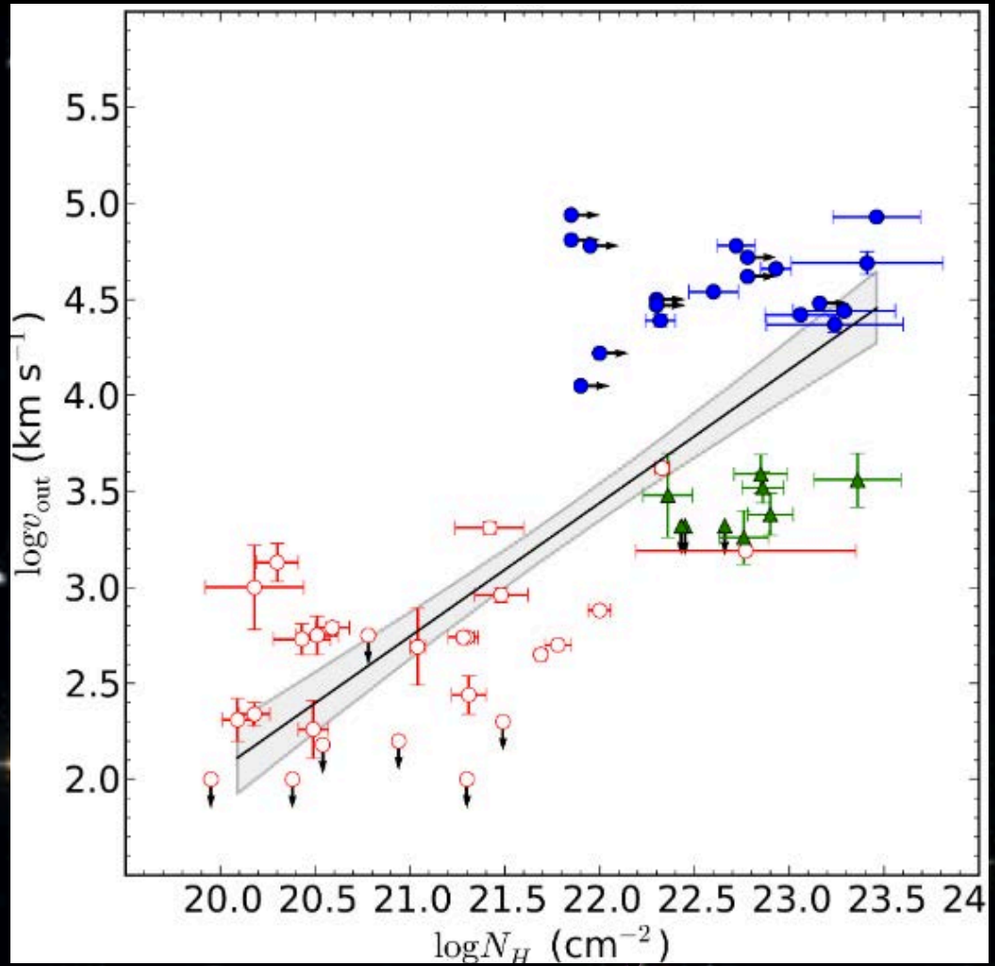
UFO
Fe XXVI blue shifted,
v/c=0.018

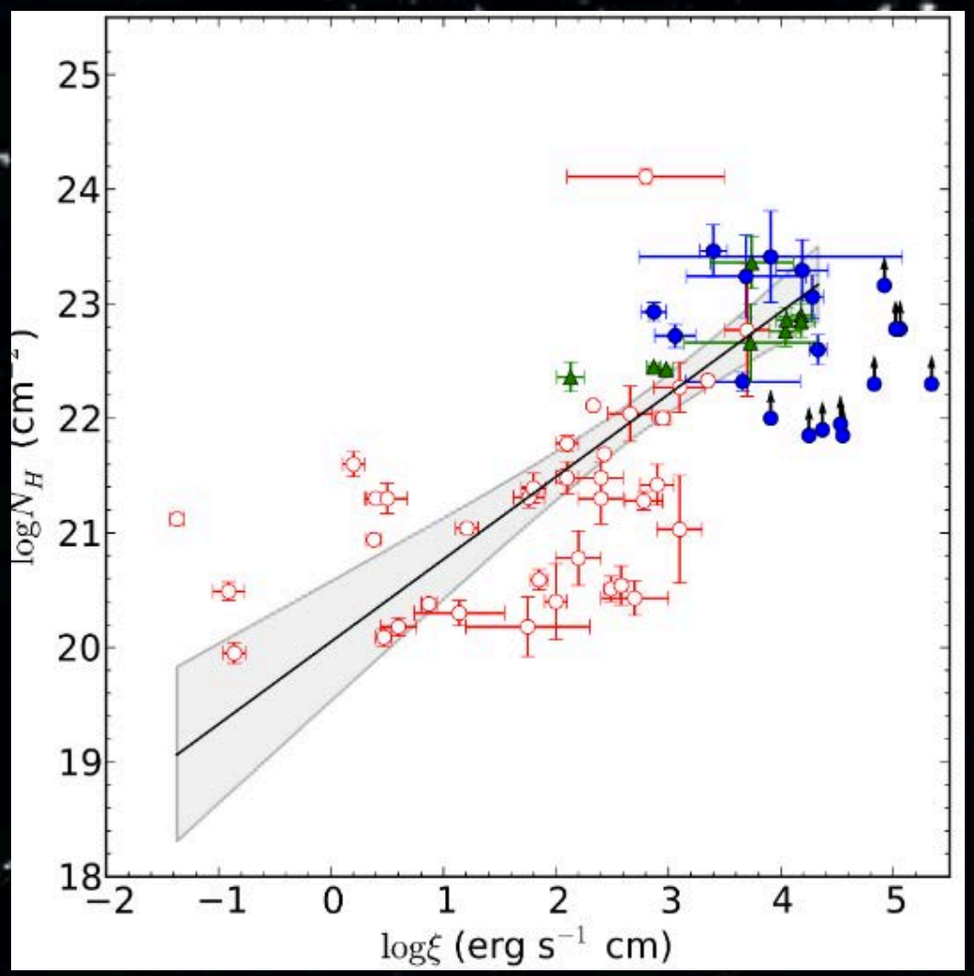
2 FeK absorbers
consistent column density
(but not ξ !)
likely outflowing

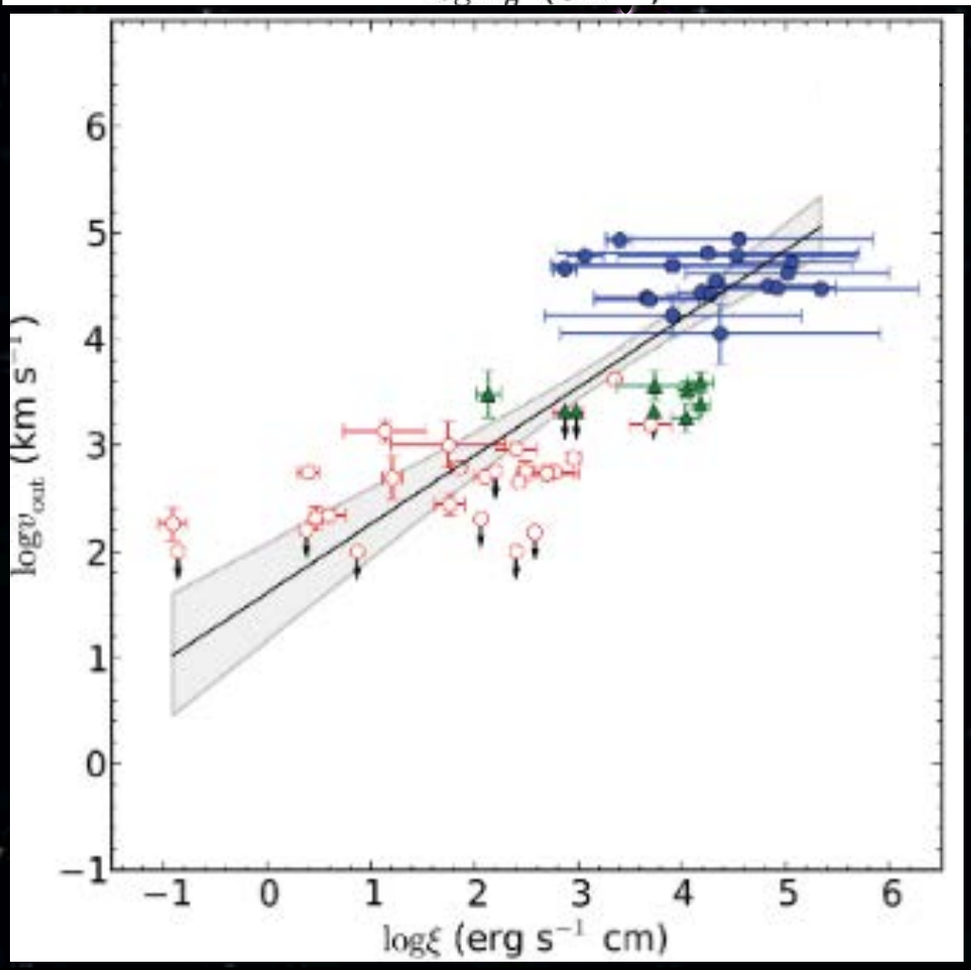
outflowing WA?

Model	Parameter	Obs. 1	Obs. 2
xstar (WA)	z_{obs}	$(6.8\pm1)\times10^{-2}$	$(6.6\pm1.0)\times10^{-2}$
	v_{out}/c	0.036 ± 0.010	0.038 ± 0.010
xstar (FeKα) (Fe XXV)	N_H (cm^{-2})	$(9.9^{+2.7}_{-6.4})\times10^{22}$	$(1.4^{+0.2}_{-0.2})\times10^{23}$
	logξ	3.4 ± 0.2	2.9 ± 0.1
	z_{obs}	$(5.7\pm0.9)\times10^{-2}$	$(5.3^{+0.4}_{-0.6})\times10^{-2}$
	v_{out}/c	0.037 ± 0.008	0.042 ± 0.005
xstar (UFO) (Fe XXVI)	N_H (cm^{-2})	$(1.0^{+0.2}_{-0.4})\times10^{24}$	-
	logξ	$4.0^{+0.3}_{-0.1}$	-
	z_{obs}	$(-6.2^{+1.4}_{-1.6})\times10^{-2}$	-
	v_{out}/c	0.18 ± 0.02	-

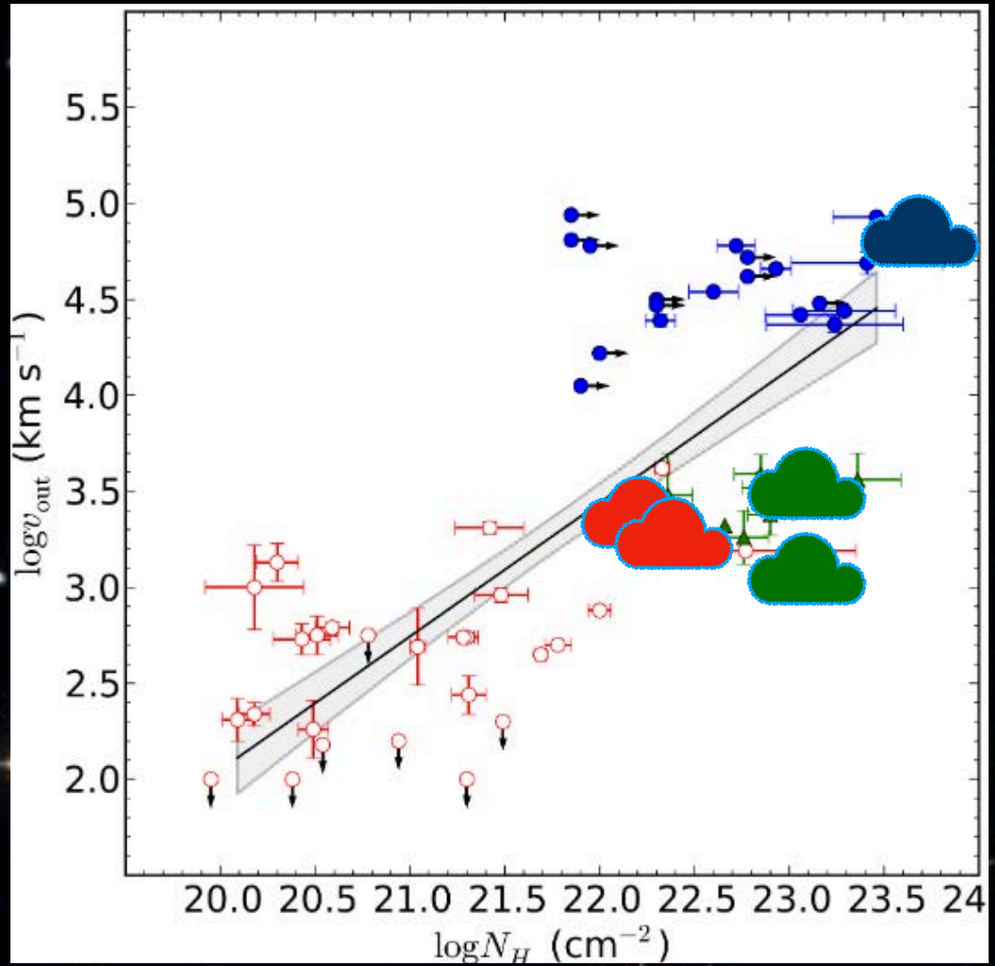
Comparing with other absorbers

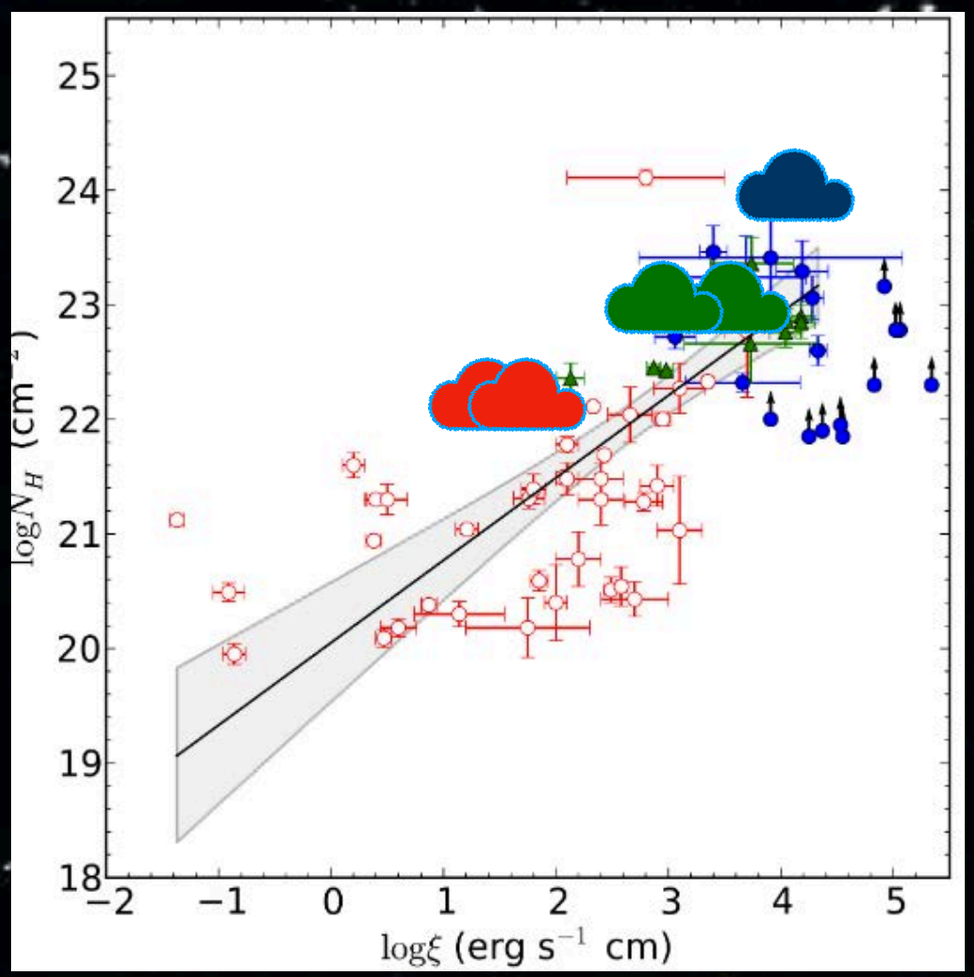


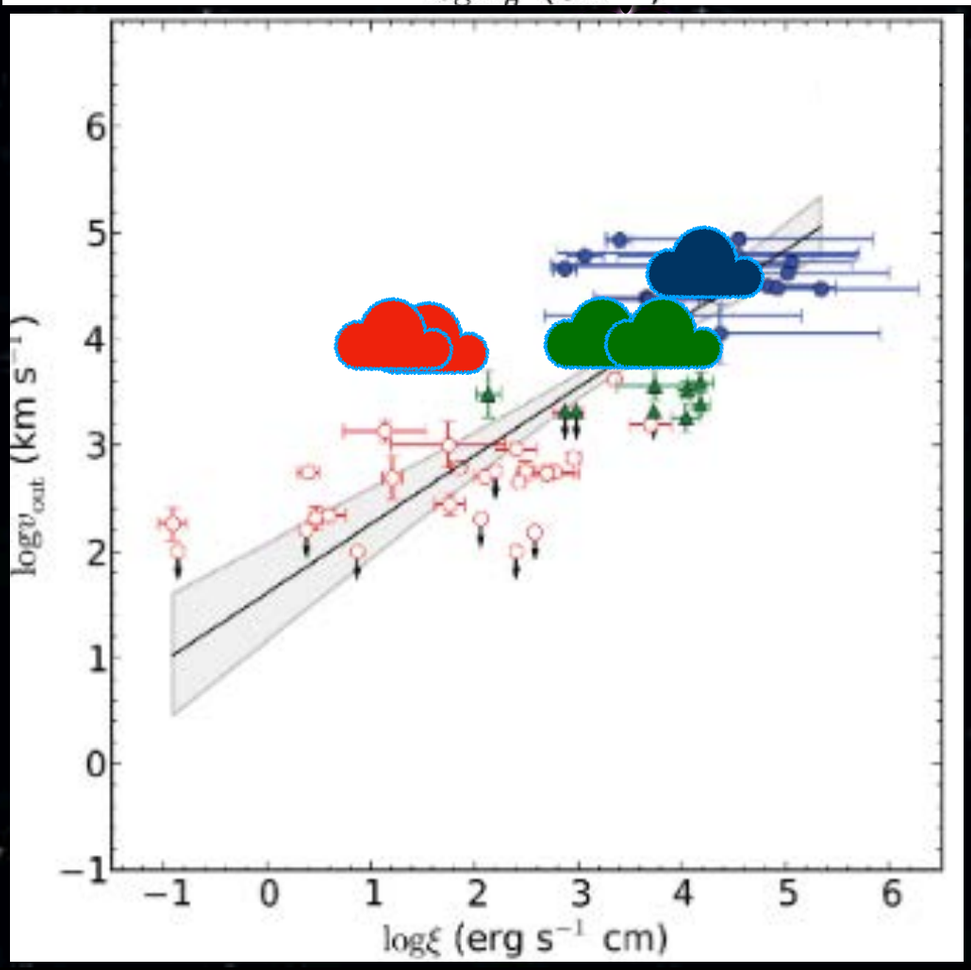




Comparing with other absorbers





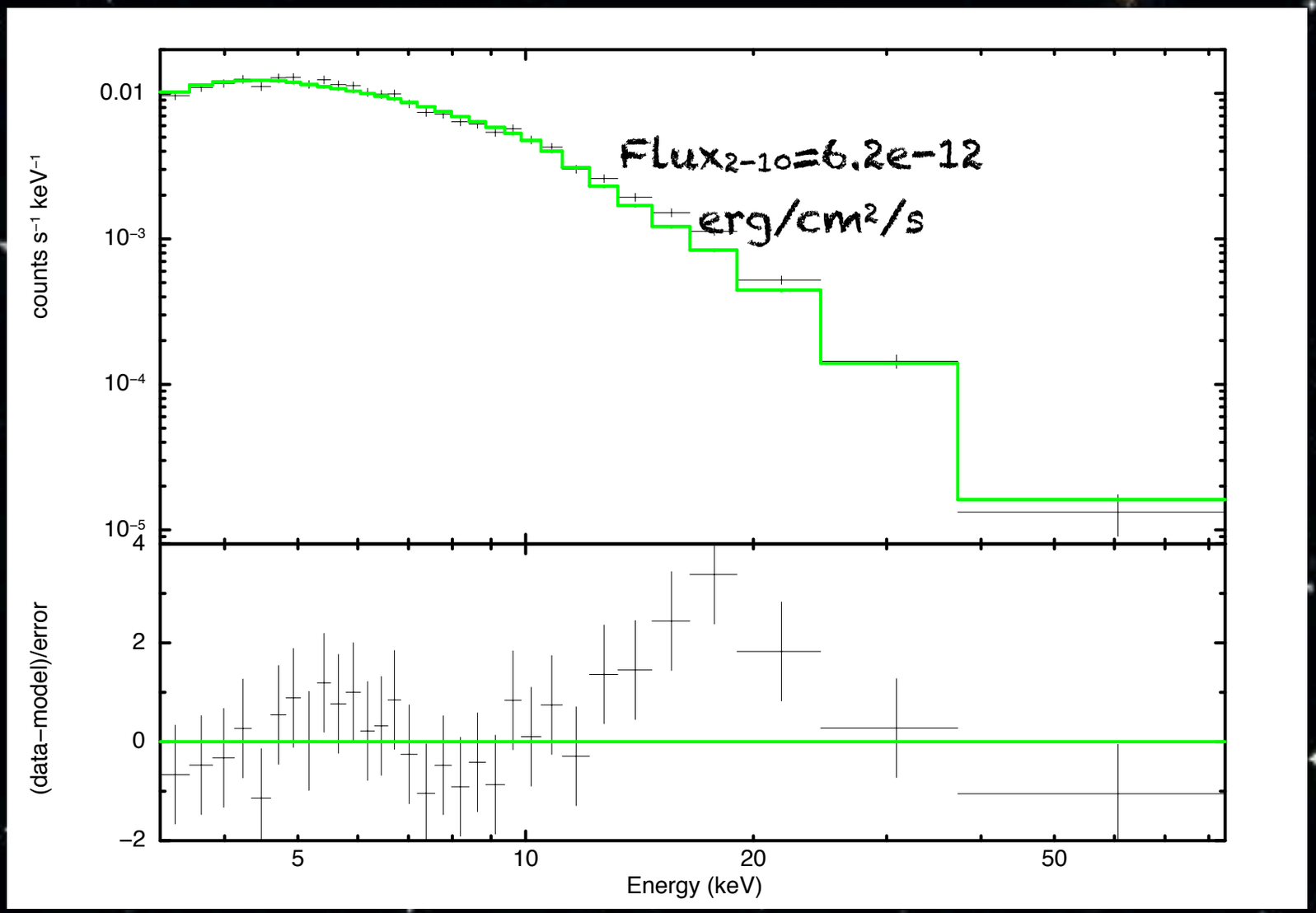


To do...

refine Xstar spectral fitting

Computing the energetics of the outflow in 1E 0754.6

A 40 ks NuSTAR observation
about 8 years later XMM-Newton



Information on
the hot
Comptonisation
component,
reprocessed emission

conclusions

1E 0756 displayed complex absorption spectra

flux and spectral variations observed on months timescales

Variable FeKalpha, narrow in obs1 broad in obs2

UFO with v/c~0.018 (3sigma confidence level) detection in 1 out of 2 observations

Fe Kalpha absorbers likely in outflow (v/c=0.03-0.04)

WAs (in outflow?) with variable column density and ionisation parameter

Longer observations are needed

Proposal A018...fingers crossed.

Thank you for the attention

P.S.
After ~18 years XMM-Newton archive is still rich of poorly known sources.