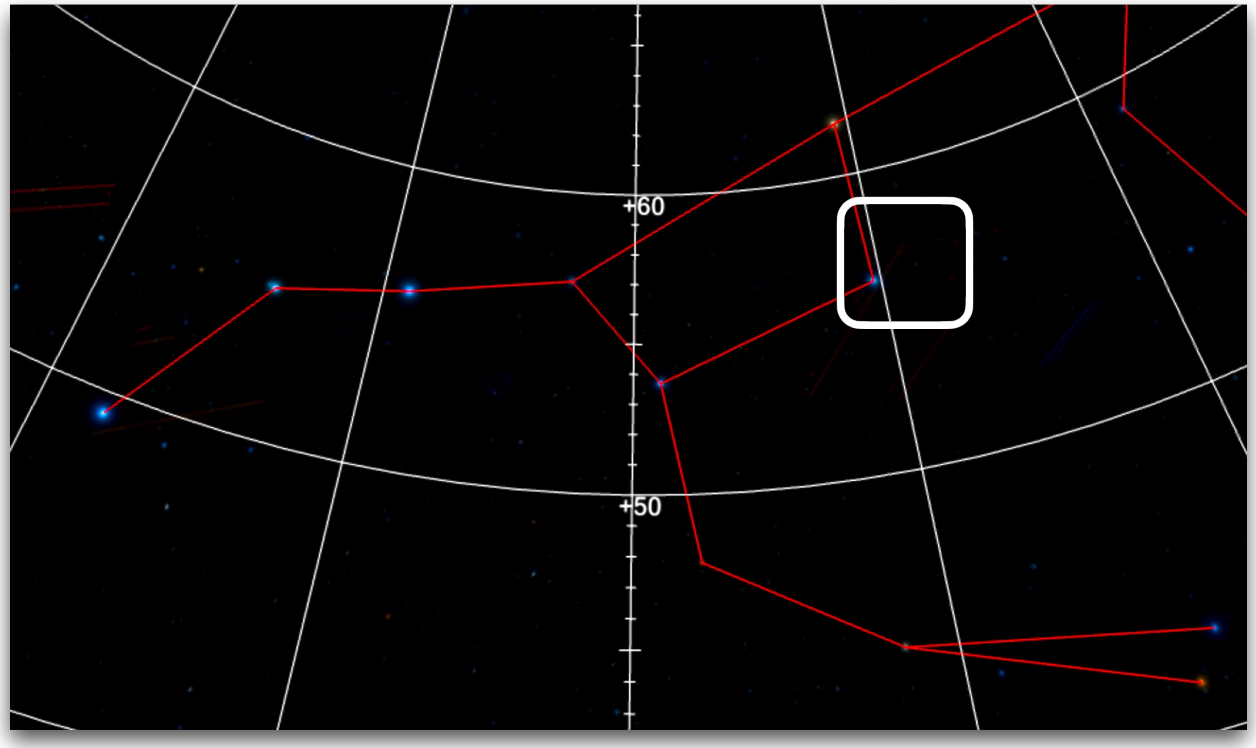
SPACE RESEARCH INSTITUTE
RUSSIAN ACADEMY OF SCIENCES

Reflection-dominated Compton-thick AGN Candidates in the SRG/eROSITA Lockman Hole Survey

M. I. Belvedersky, S. D. Bykov, M. R. Gilfanov,
P. S. Medvedev, R. A. Sunyaev

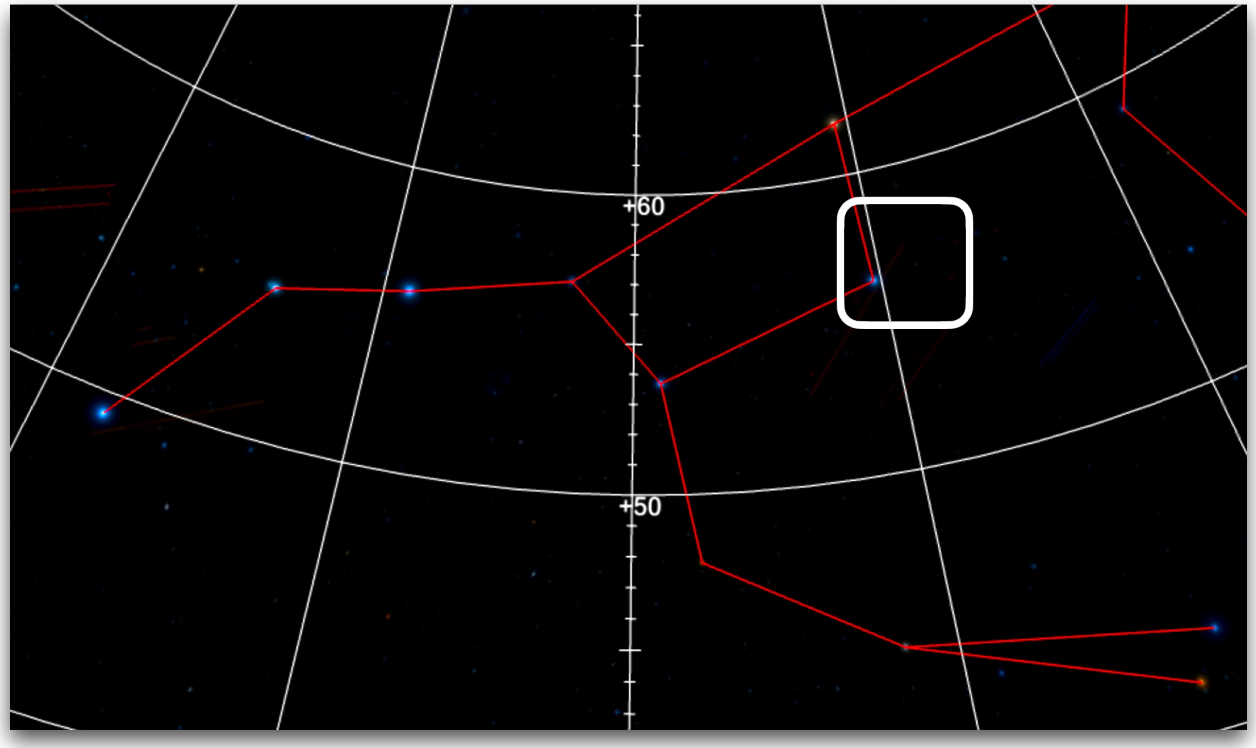
HEACOSS 2024

SRG/eROSITA Lockman Hole survey



SRG/eROSITA Lockman Hole survey

- Galactic absorption complicates observations



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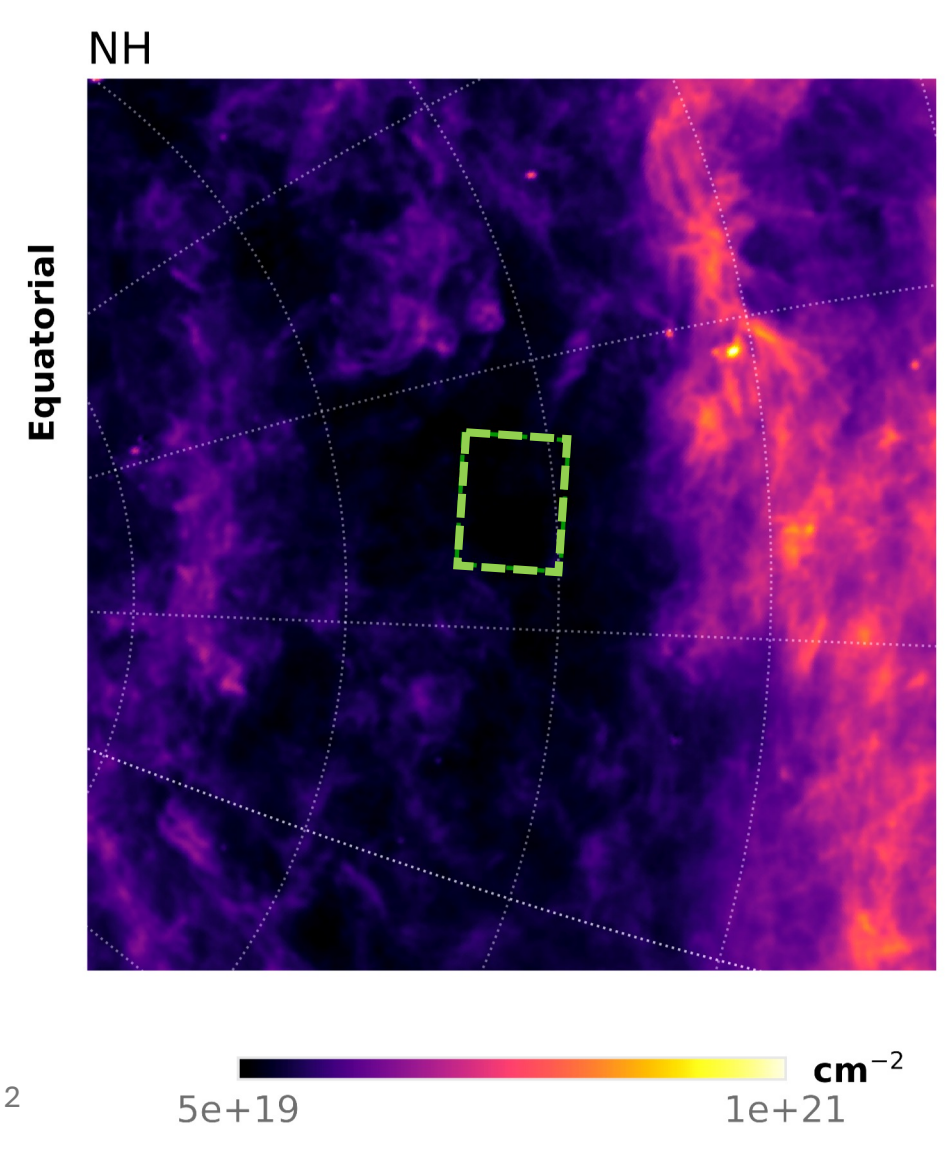
- Galactic absorption complicates observations
- N_H in LH is very low* ⟶ natural choice for the extragalactic studies



*Lockman et al., 1986
HI4PI, 2016

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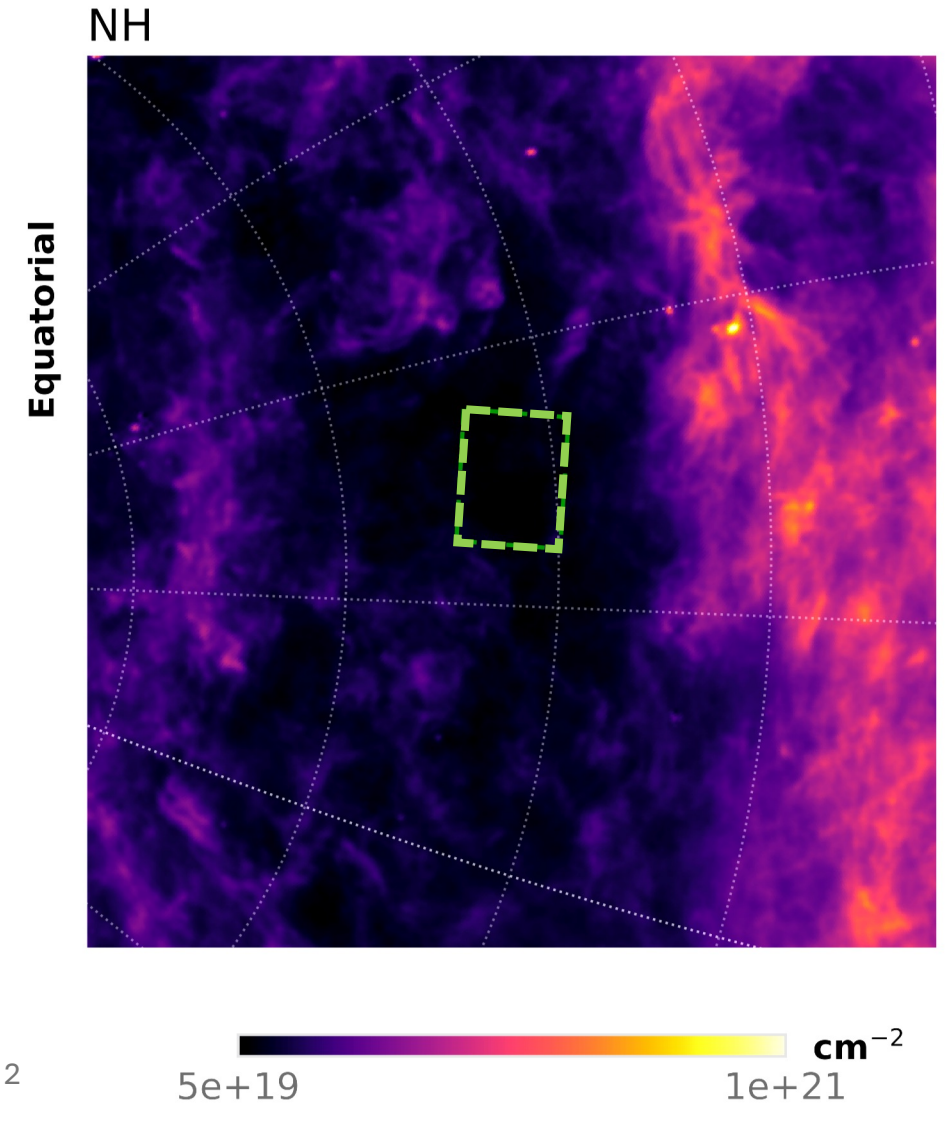
- 6885 X-ray sources, 28 sq. degrees



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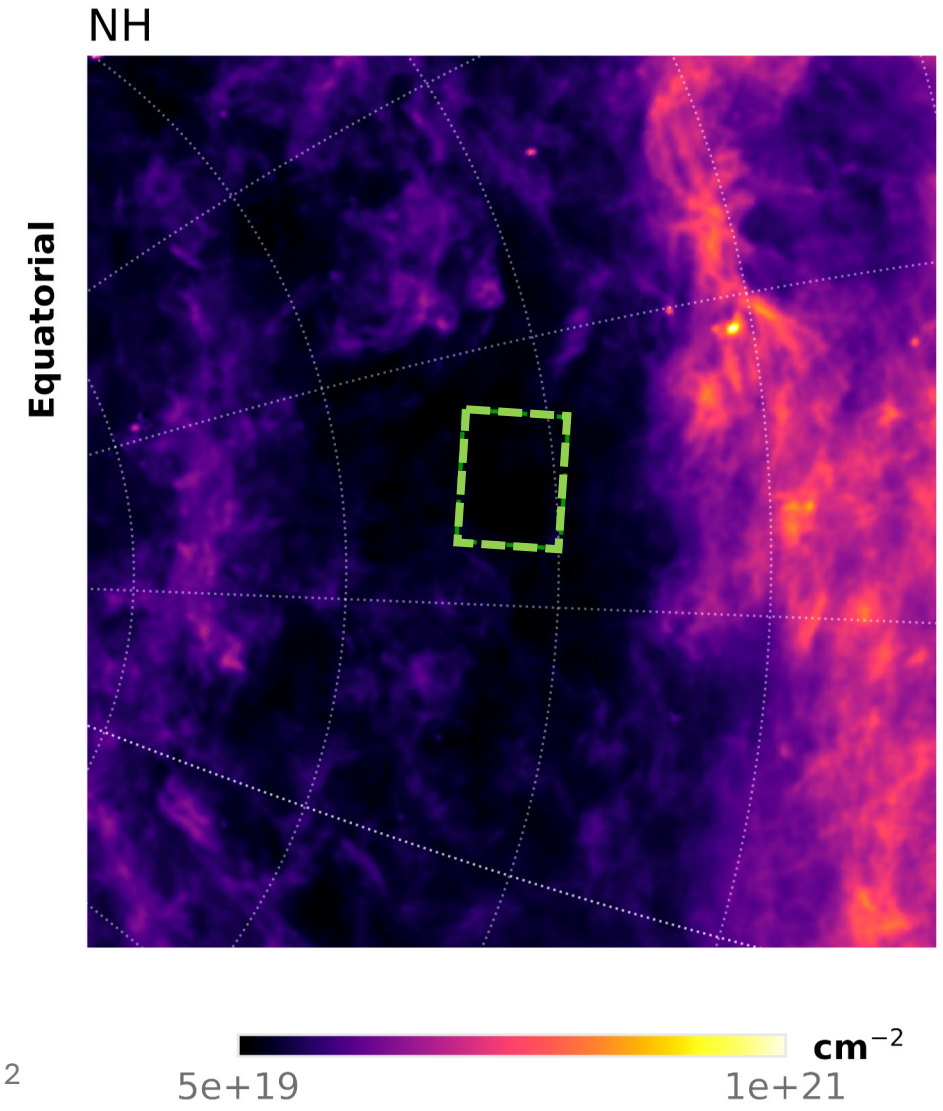

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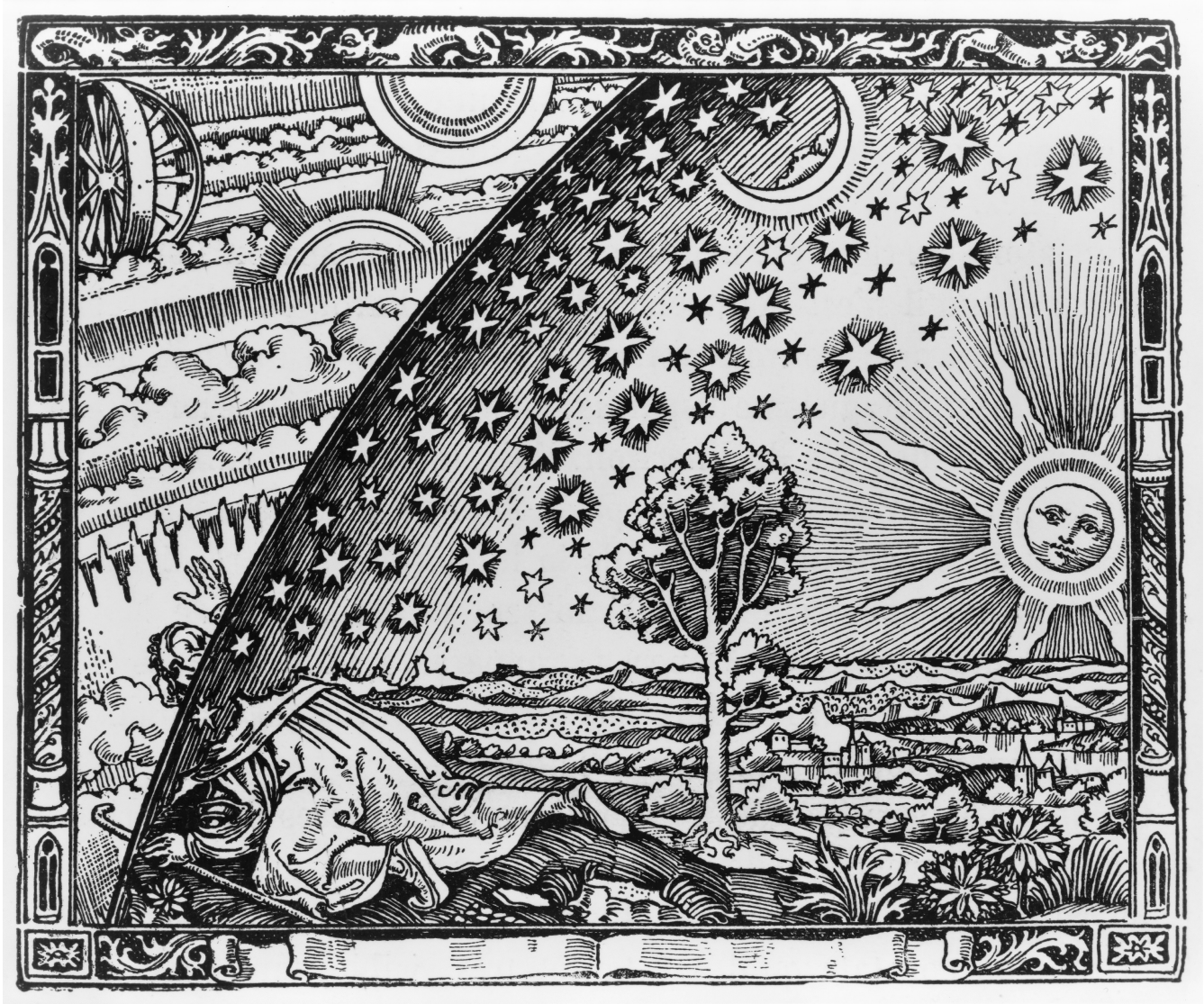
Unknown artist



Previous works

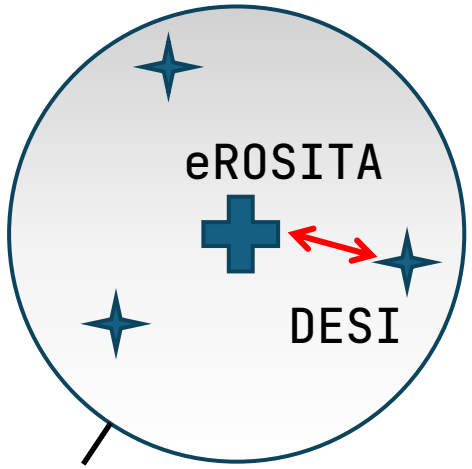
1. X-ray catalog

Gilfanov et al.

2. Cross-match

arXiv:2302.13689

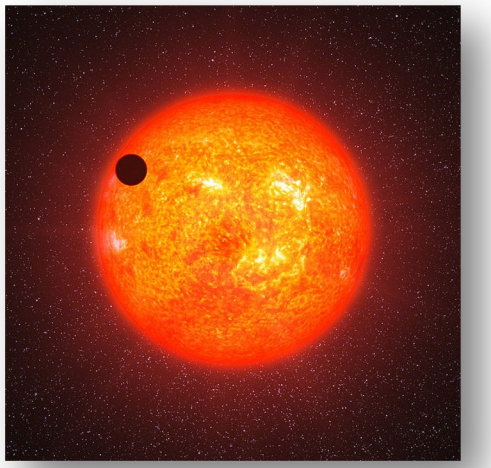
Bykov et al.



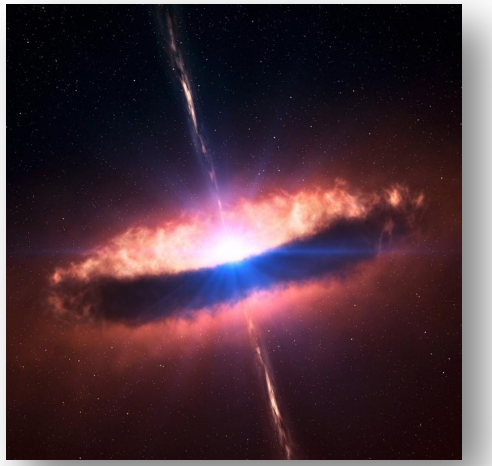
3. Classification

arXiv:2307.14737

Belvedersky et al.



Galactic sources



AGNs

Galaxies

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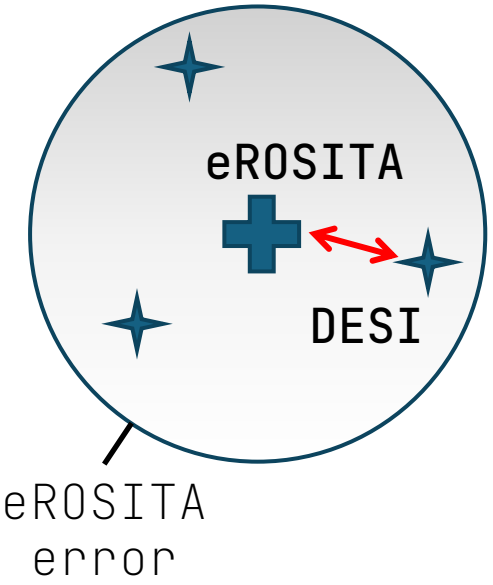

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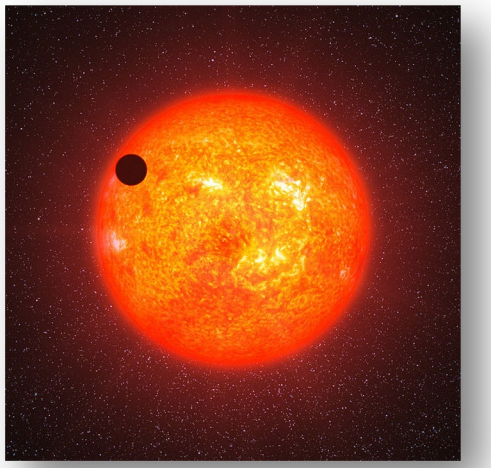

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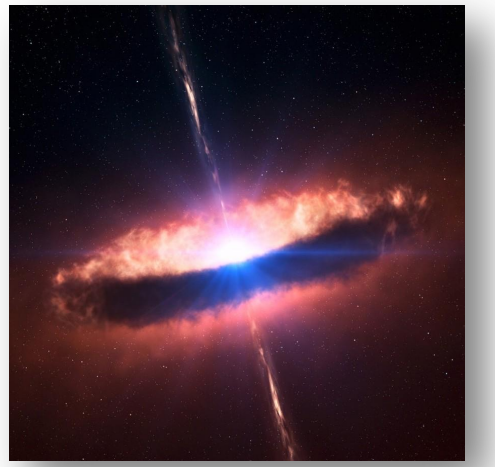
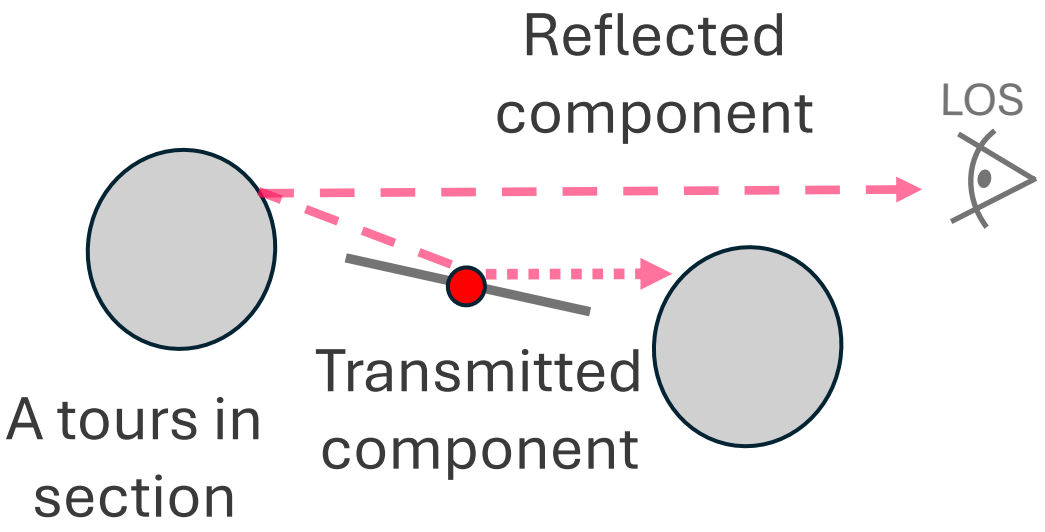


AGNs

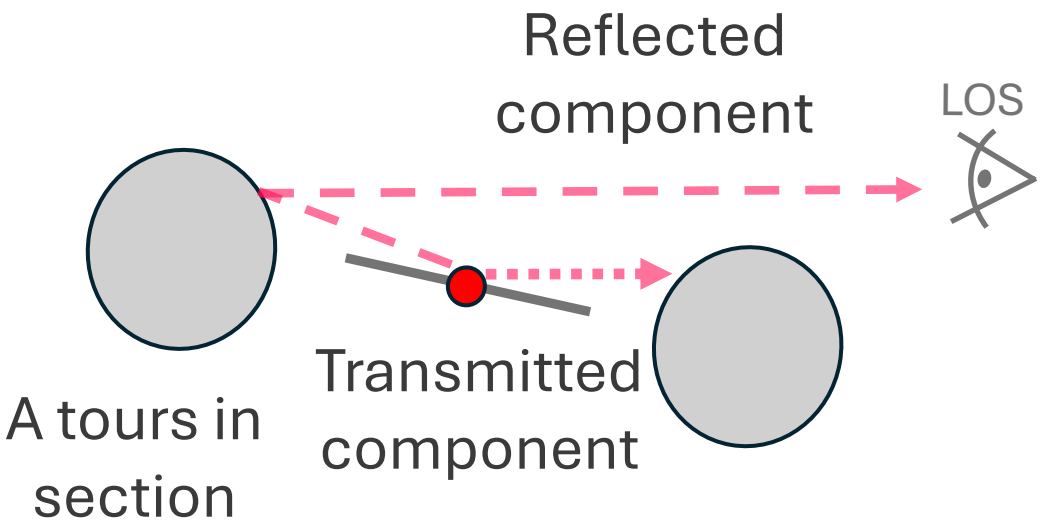
Galaxies

Observational features of Compton-thick reflection-dominated AGNs



Observational features of Compton-thick reflection-dominated AGNs

- Rising spectrum below 10 keV
- Hard X-ray emission above 10 keV
- Iron emission line
  (~1 keV equivalent width)



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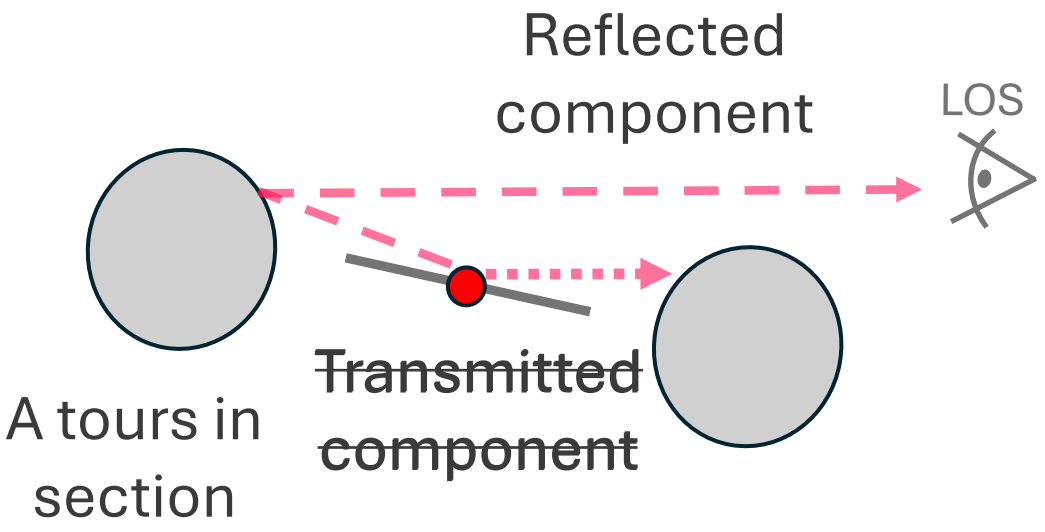

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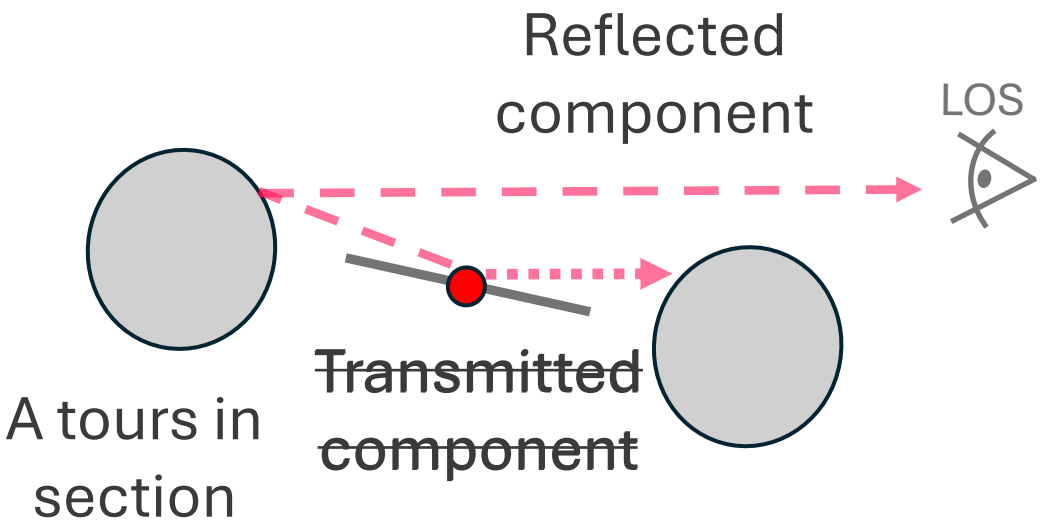
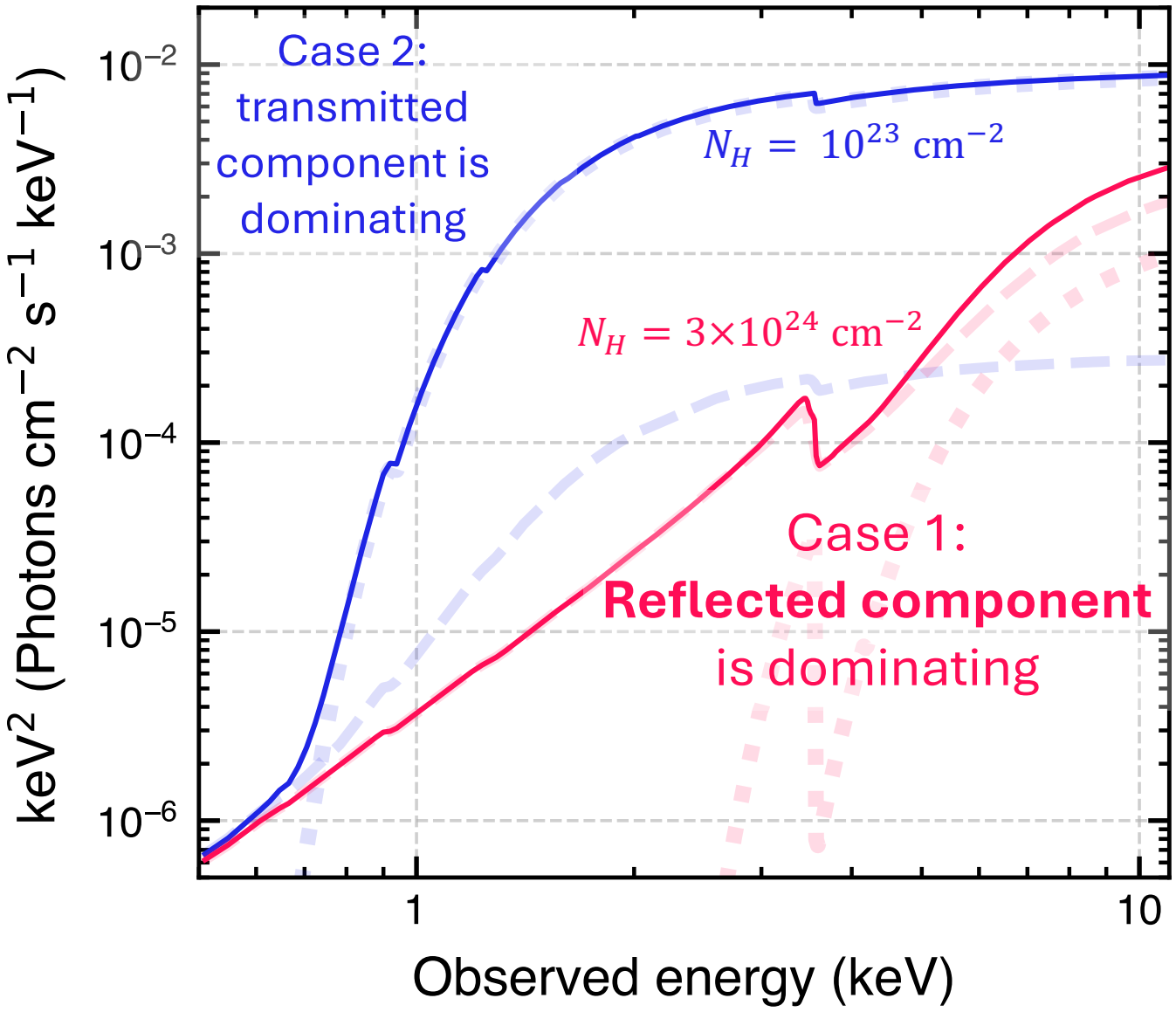


`mytorus` model (Yaqoob 2012)



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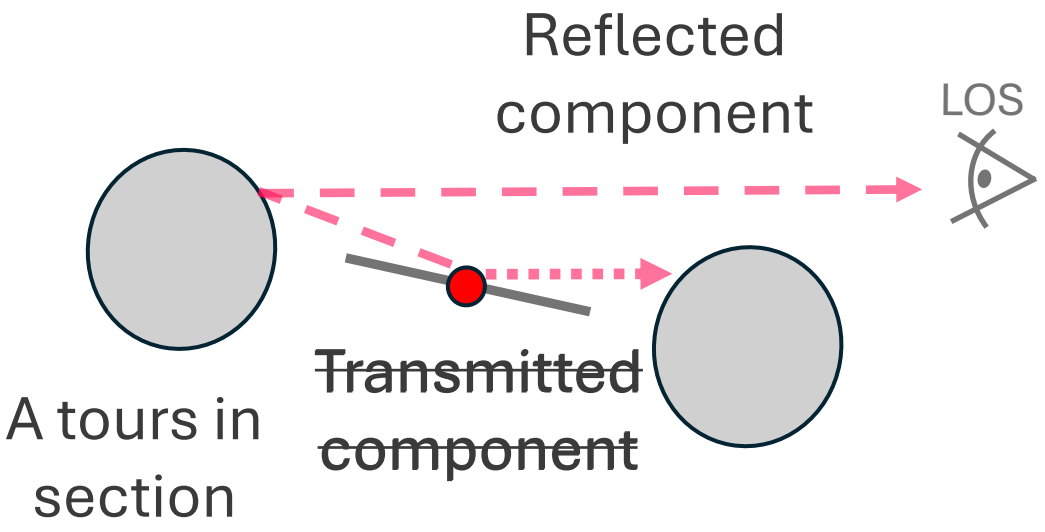

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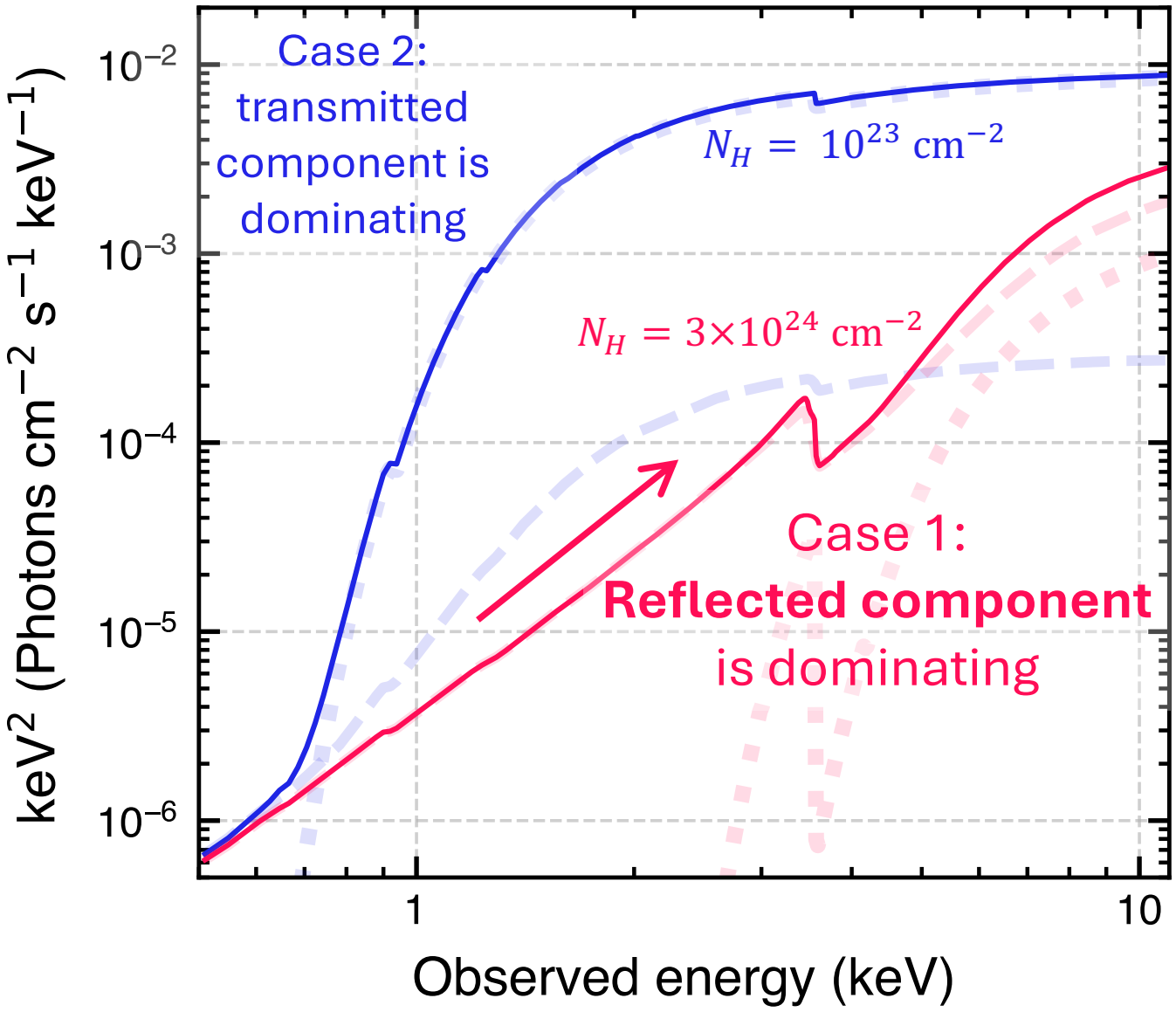

Spectral characteristics of the SRG/eROSITA LH catalog

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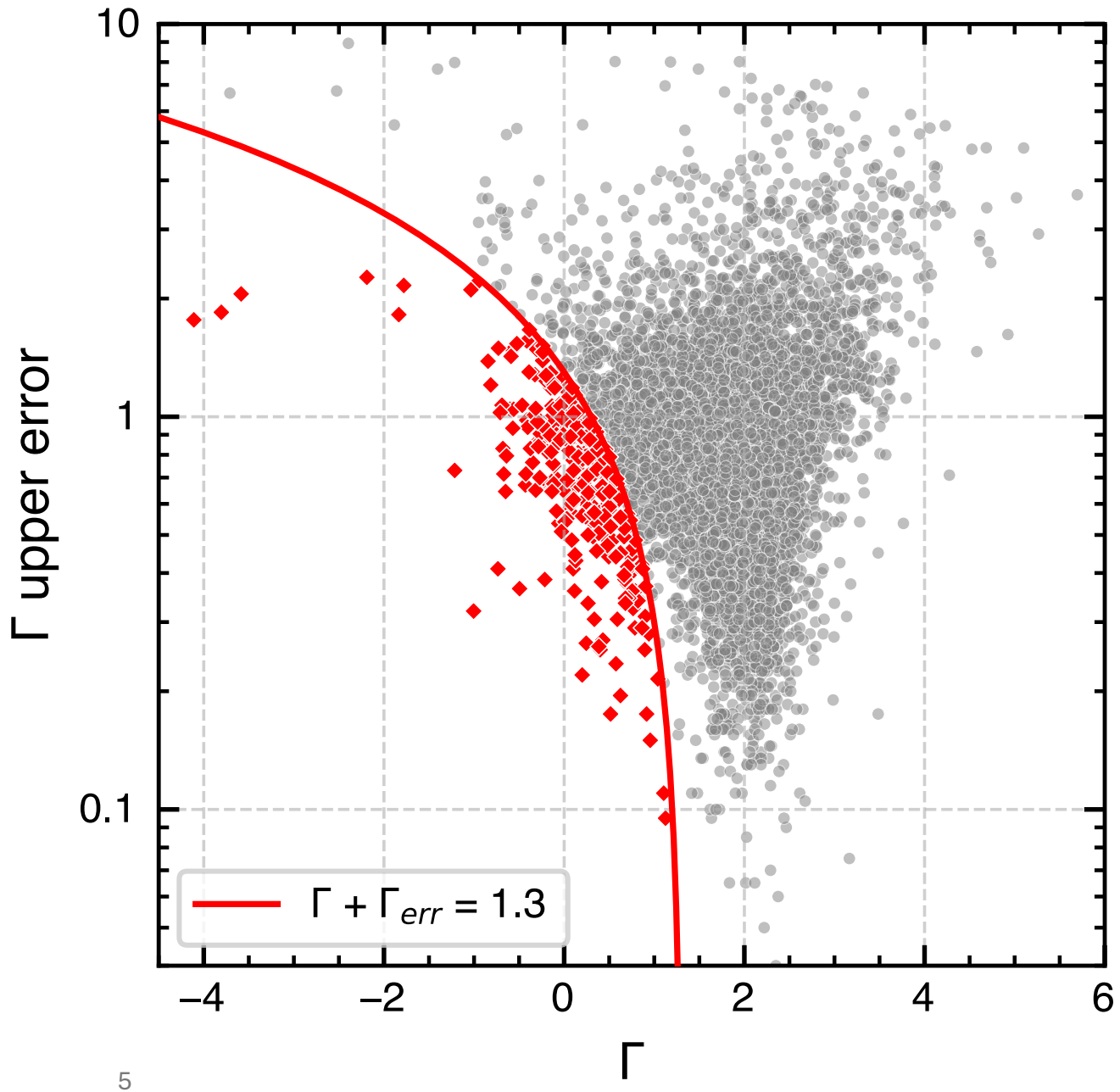
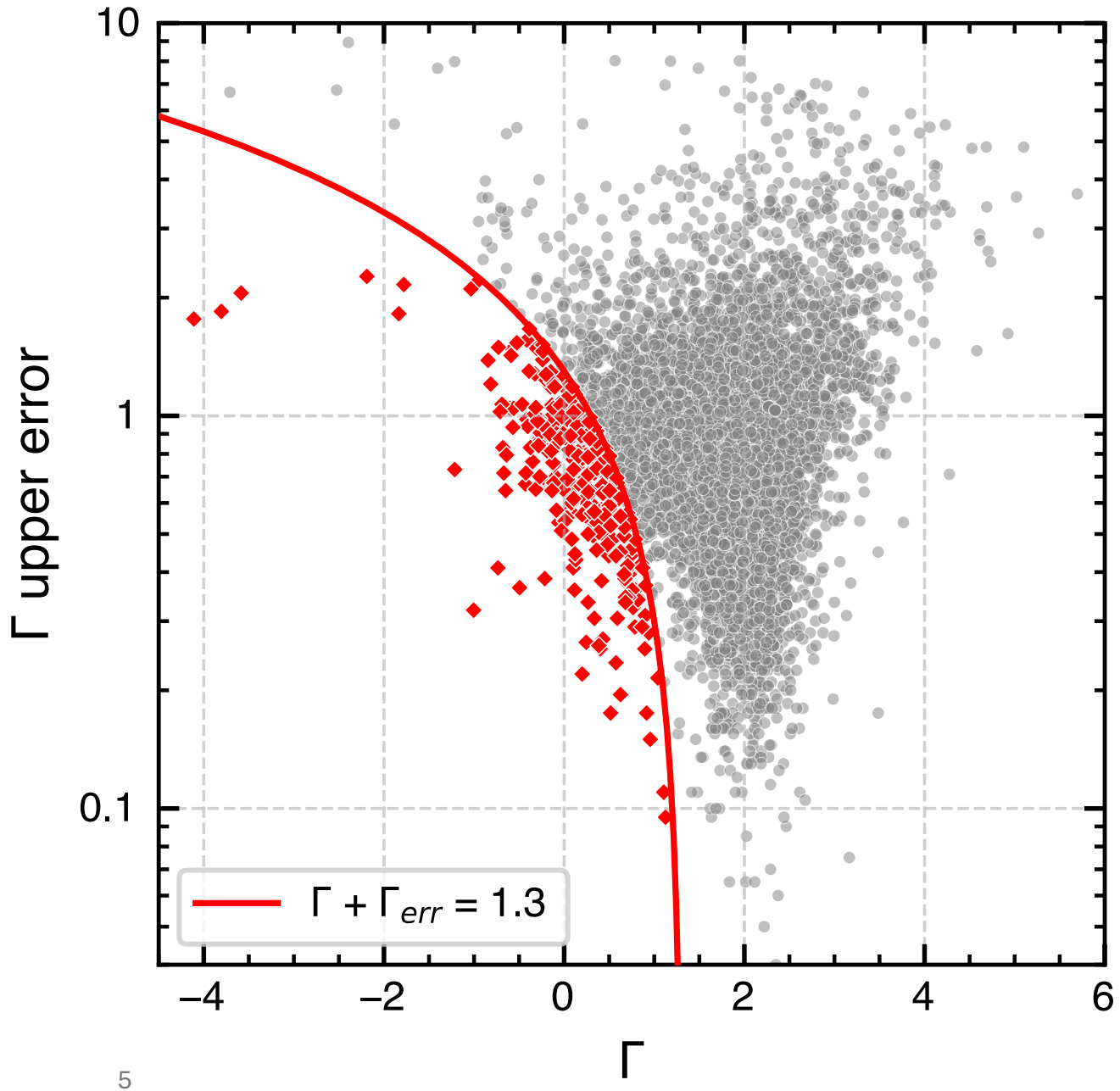


Spectral characteristics of the SRG/eROSITA LH catalog

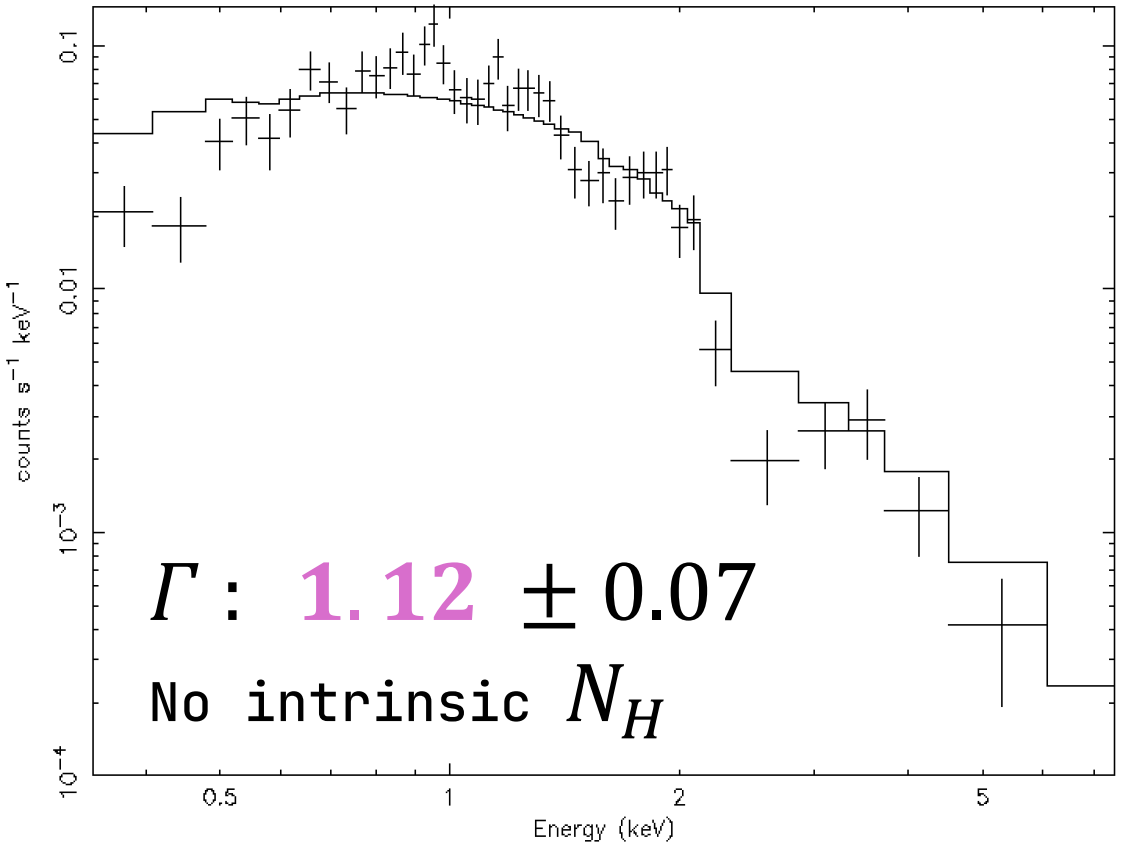
- 6500 point-like extragalactic sources, DL > 10
- Median of source counts is ~40, complex models are inapplicable
- phabs*po model: 291 sources have Γ upper limit below 1.3
- We need redshift to apply a model with the intrinsic absorption (N_H)

SRGz: Meshcheryakov et al., 2023



Intrinsic N_H can make spectral index lower

The model *without* intrinsic N_H



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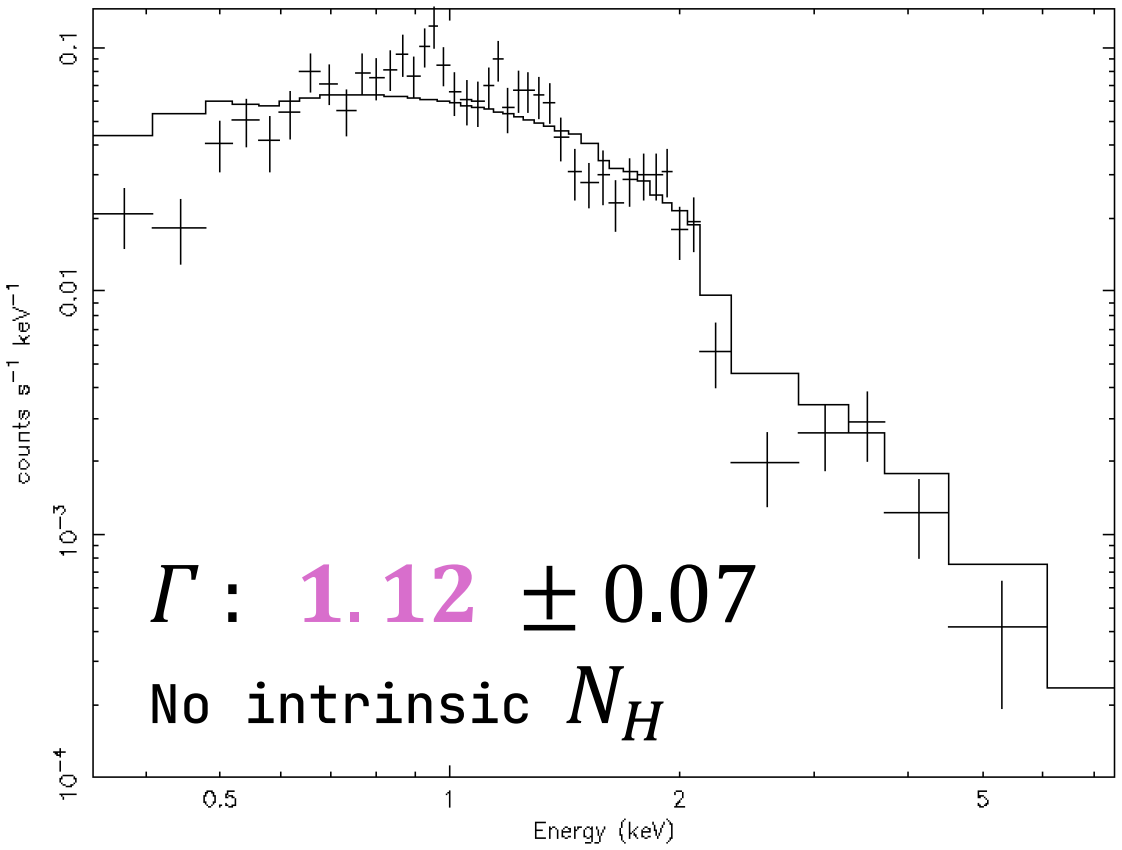
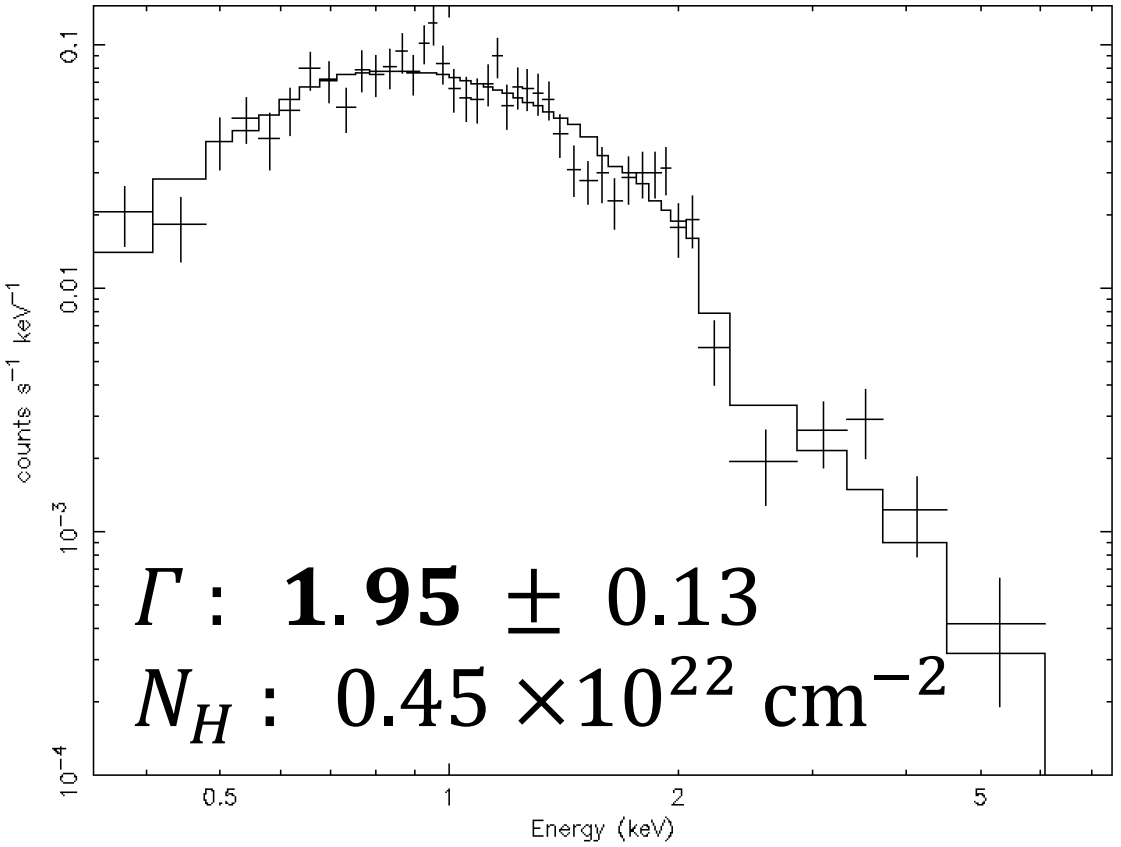
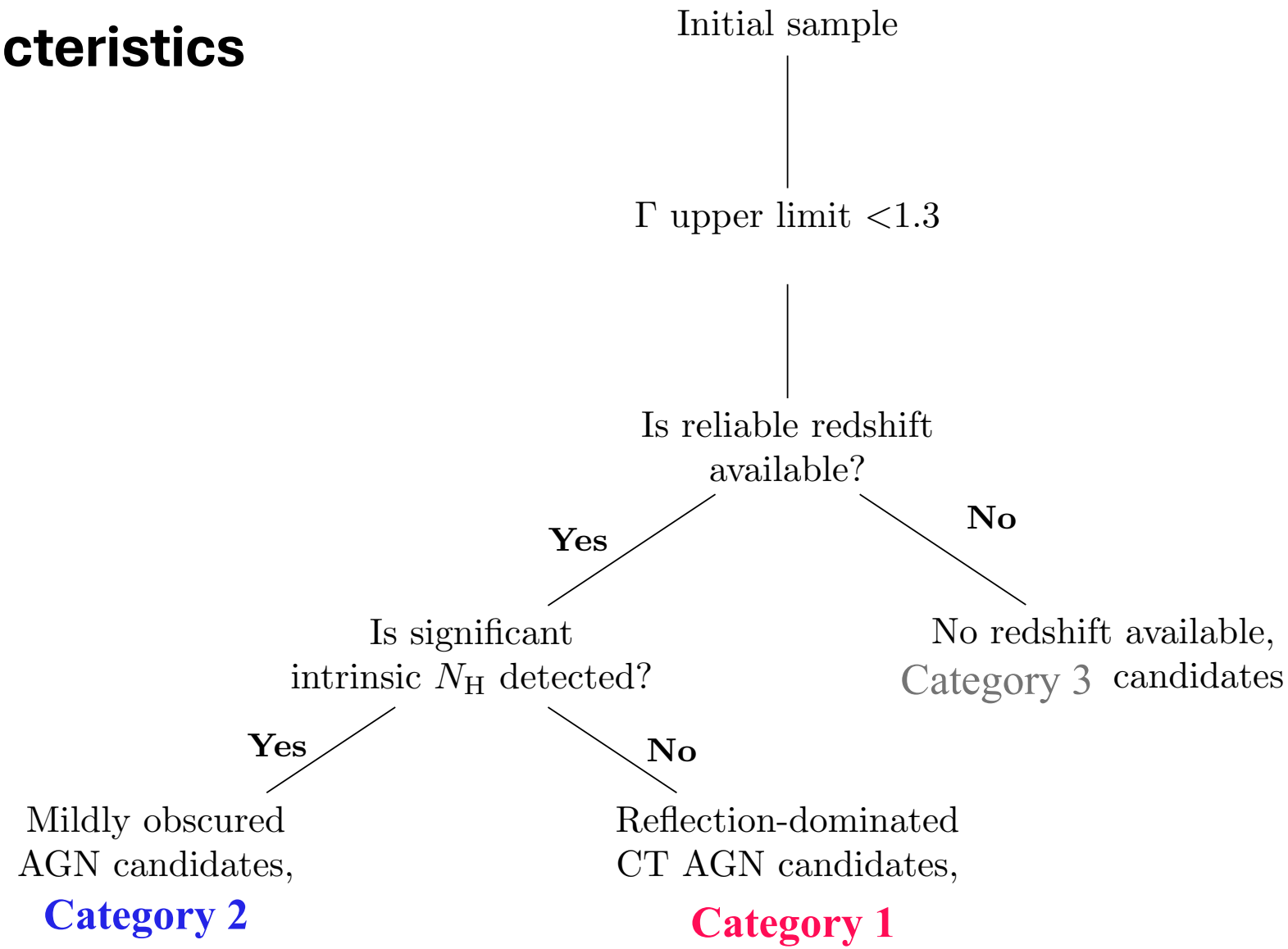


The model *with* intrinsic N_H (better fit)



Source classification based on spectral characteristics



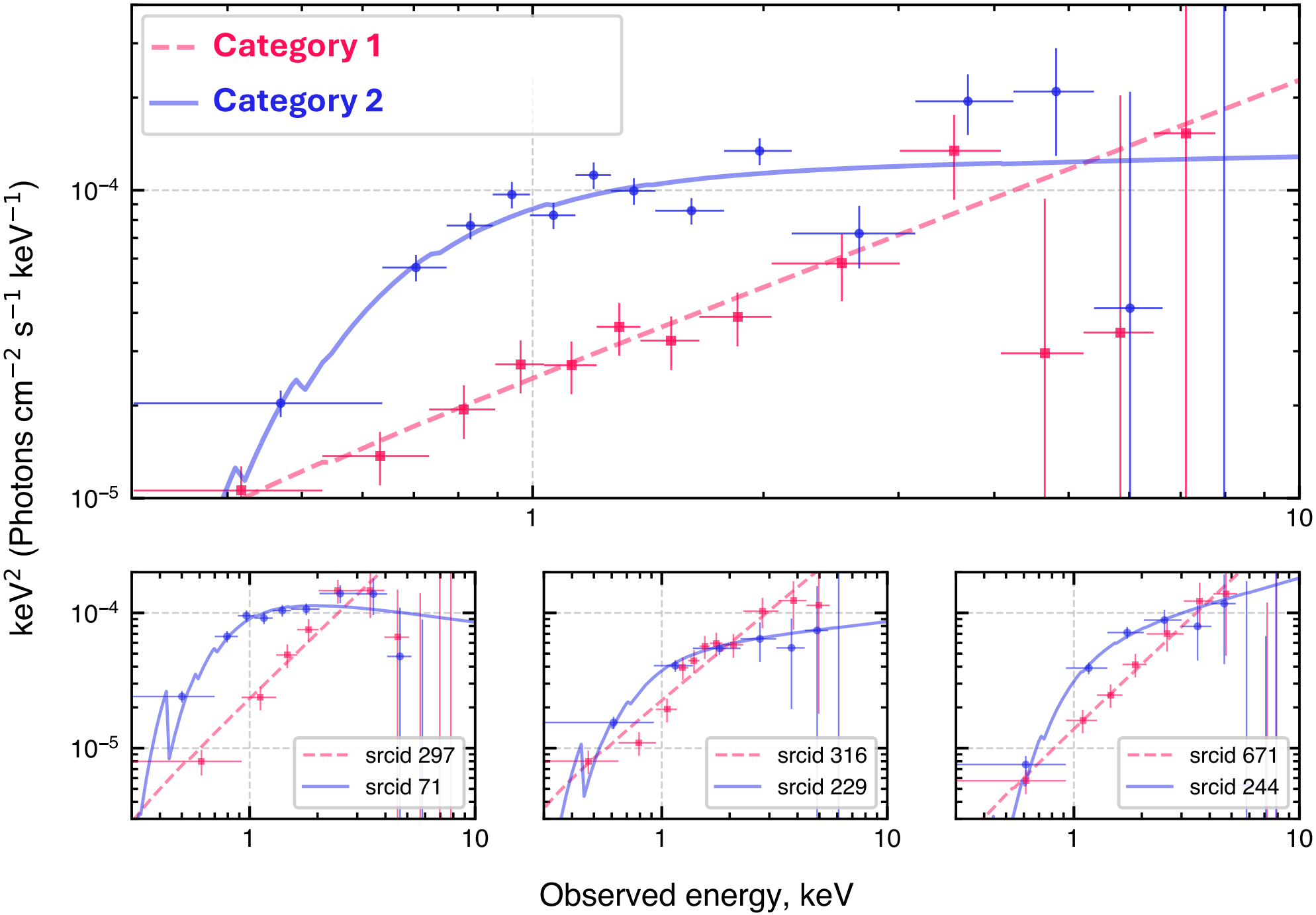
Source classification based on spectral characteristics

Source category	Description	Total
Category 1	Reflection-dominated CT AGN candidates (intrinsic $N_{\rm H}$ is consistent with zero)	**81**
Category 2	Mildly obscured AGN candidates (intrinsic $N_{\rm H}$ is inconsistent with zero, but less than 10^{24} cm^{-2})	49
Category 3	No redshift available (model without intrinsic $N_{\rm H}$ is applied)	161

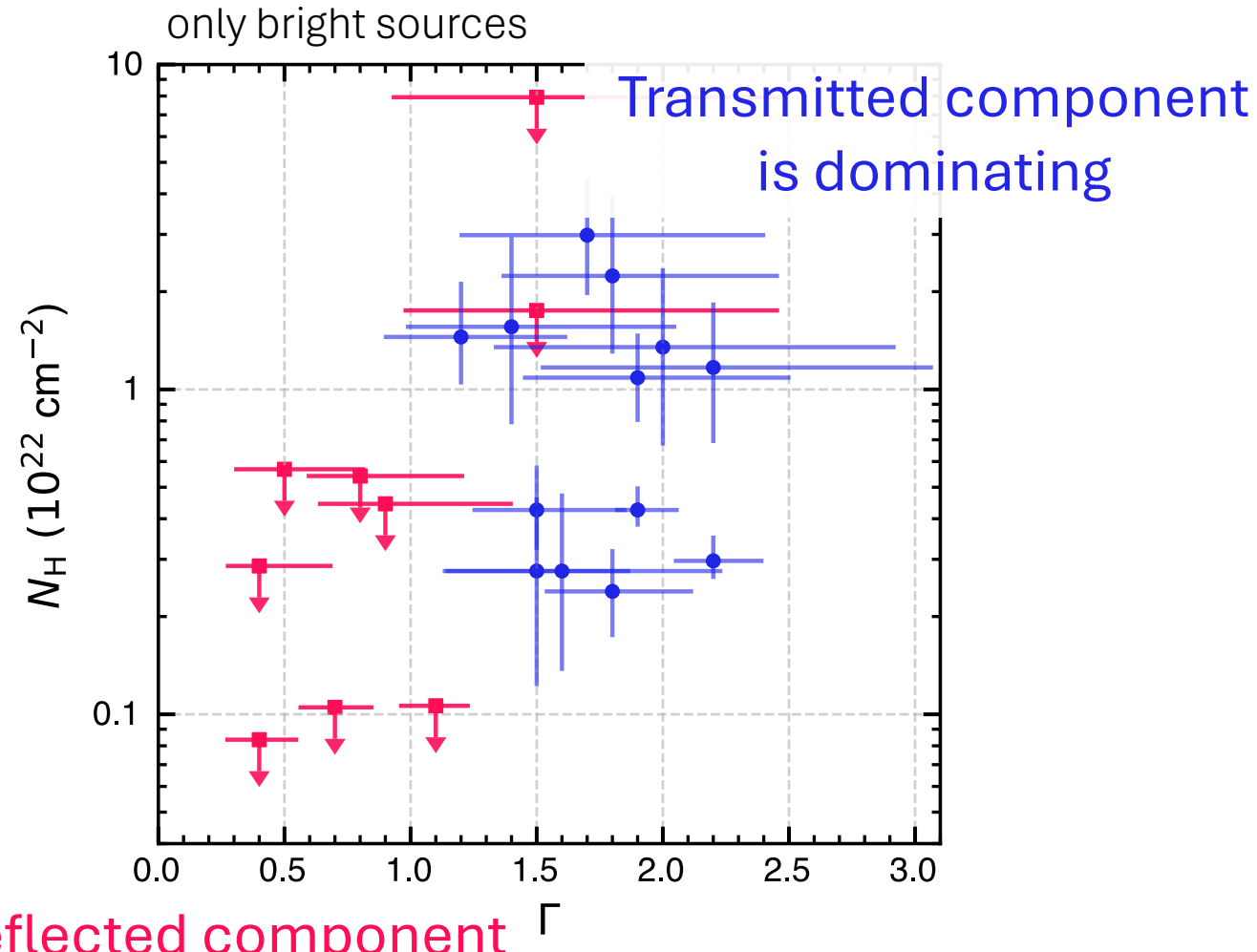
Source classification based on spectral characteristics

Source category	Description	Total	Bright
Category 1	Reflection-dominated CT AGN candidates (intrinsic $N_{\rm H}$ is consistent with zero)	**81**	**9**
Category 2	Mildly obscured AGN candidates (intrinsic $N_{\rm H}$ is inconsistent with zero, but less than 10^{24} см$^{-2}$)	49	14
Category 3	No redshift available (model without intrinsic $N_{\rm H}$ is applied)	161	14

Bright sample contains objects with more than 100 source counts in 0.3 – 9 keV range

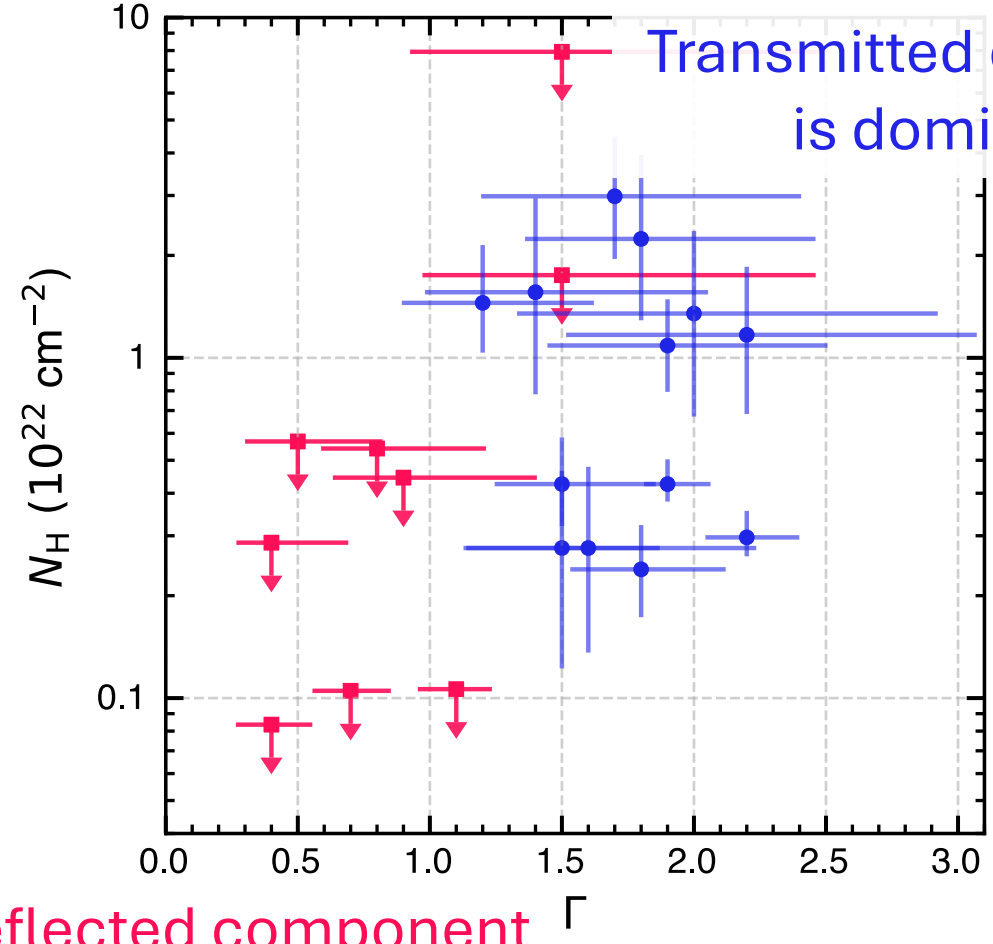

Category 1
Category 2
10^{-4}
10^{-5}
1
10
keV^2 (Photons cm^{-2} s^{-1} keV^{-1})
srcid 297
srcid 71
srcid 316
srcid 229
srcid 671
srcid 244
Observed energy, keV

Spectral characteristics of Category 1 and Category 2 sources



Spectral characteristics of Category 1 and Category 2 sources

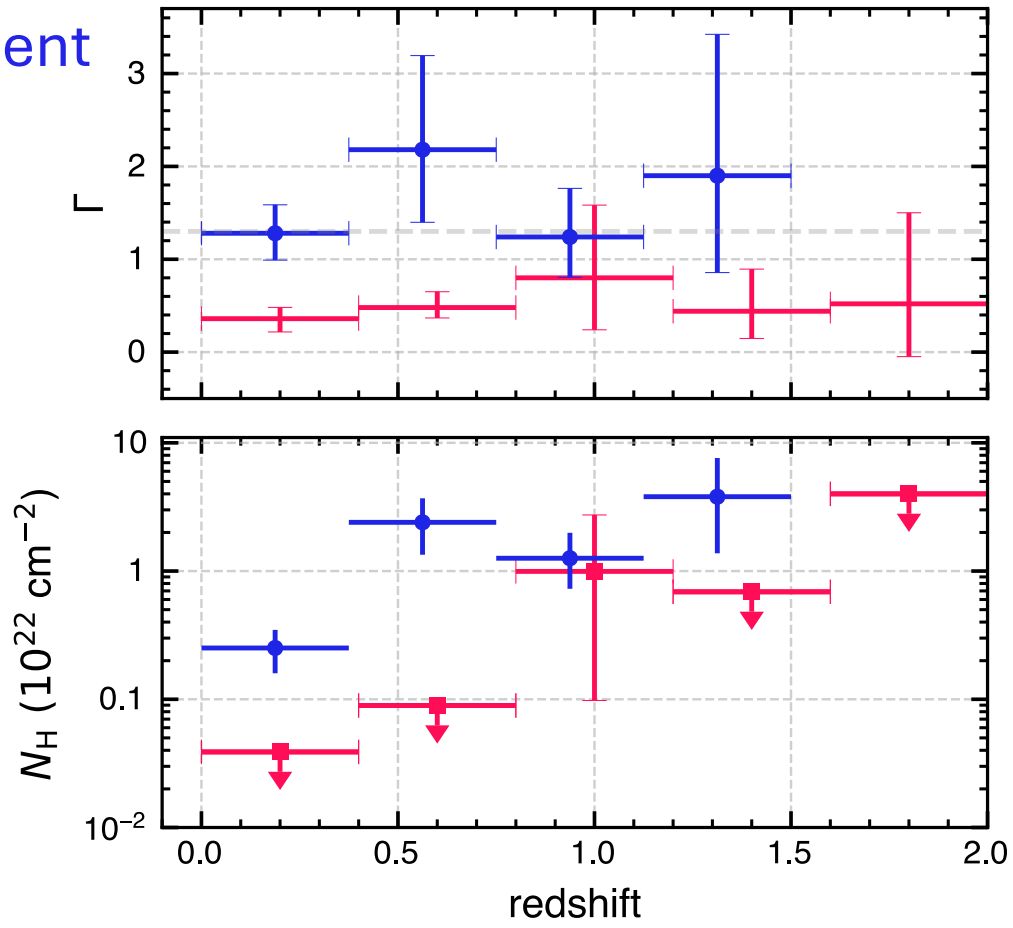
only bright sources



Transmitted component is dominating

Reflected component is dominating

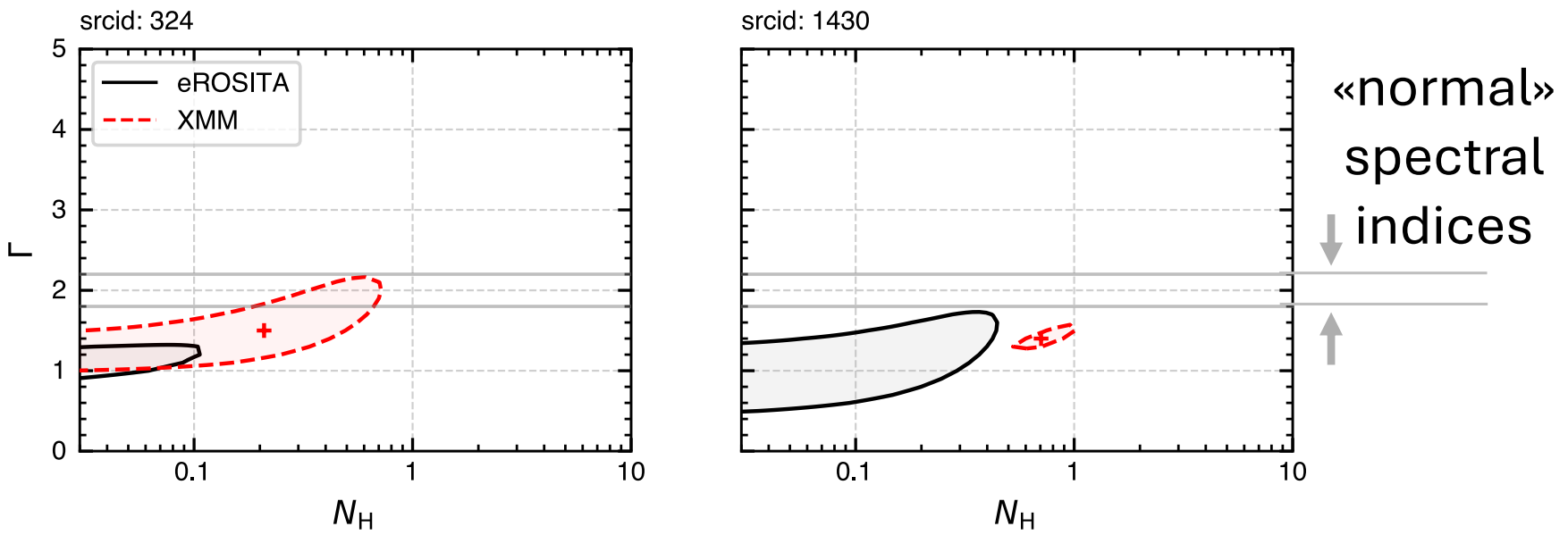
all sources with spec z



Comparison with the XMM-Newton

only bright sources,
only spec z

Category 1



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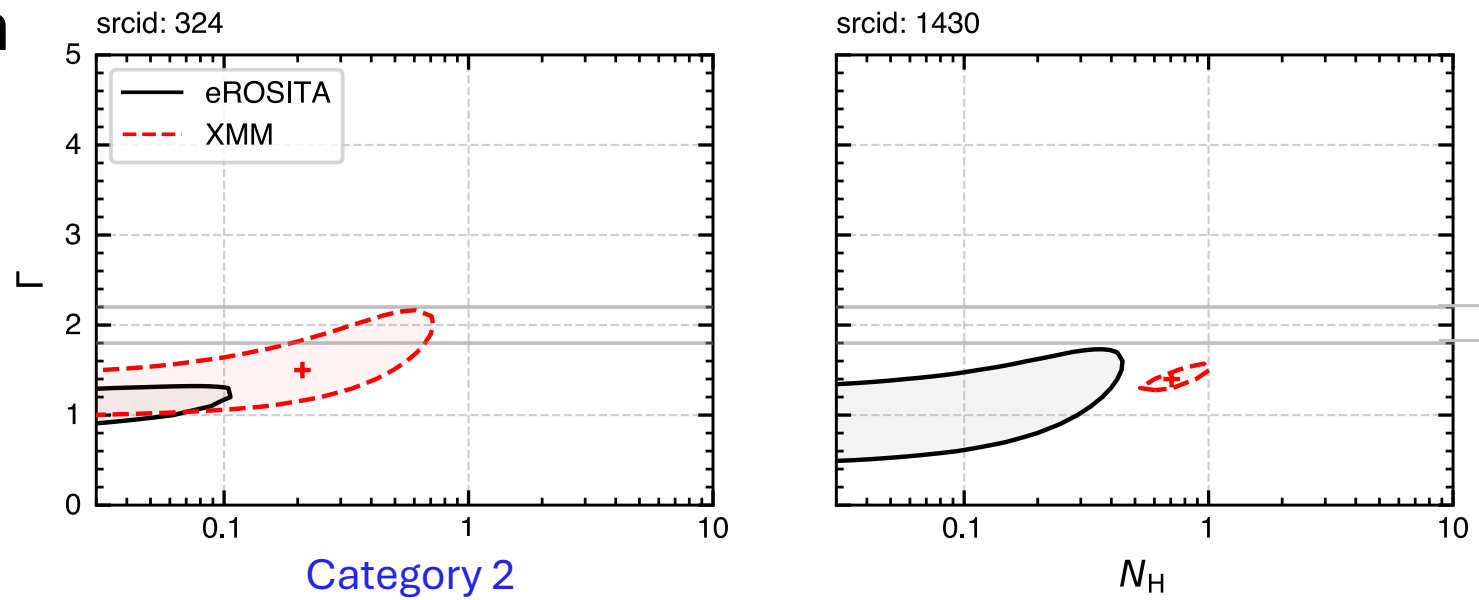
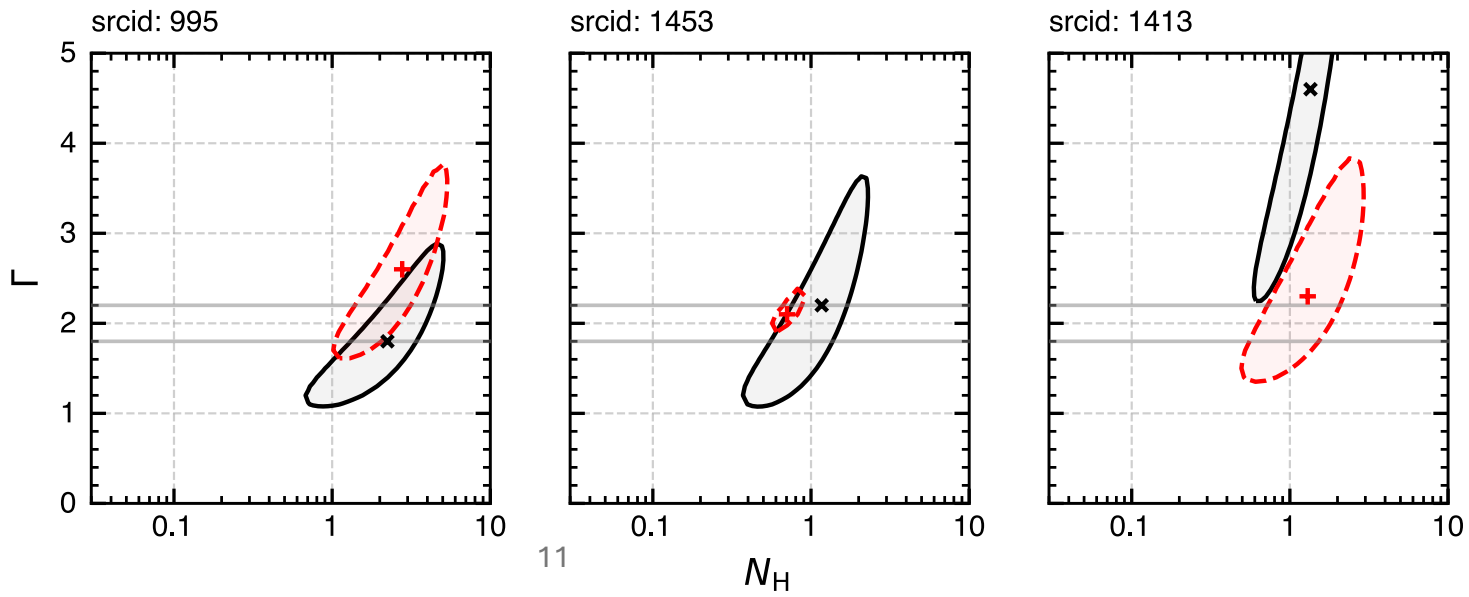


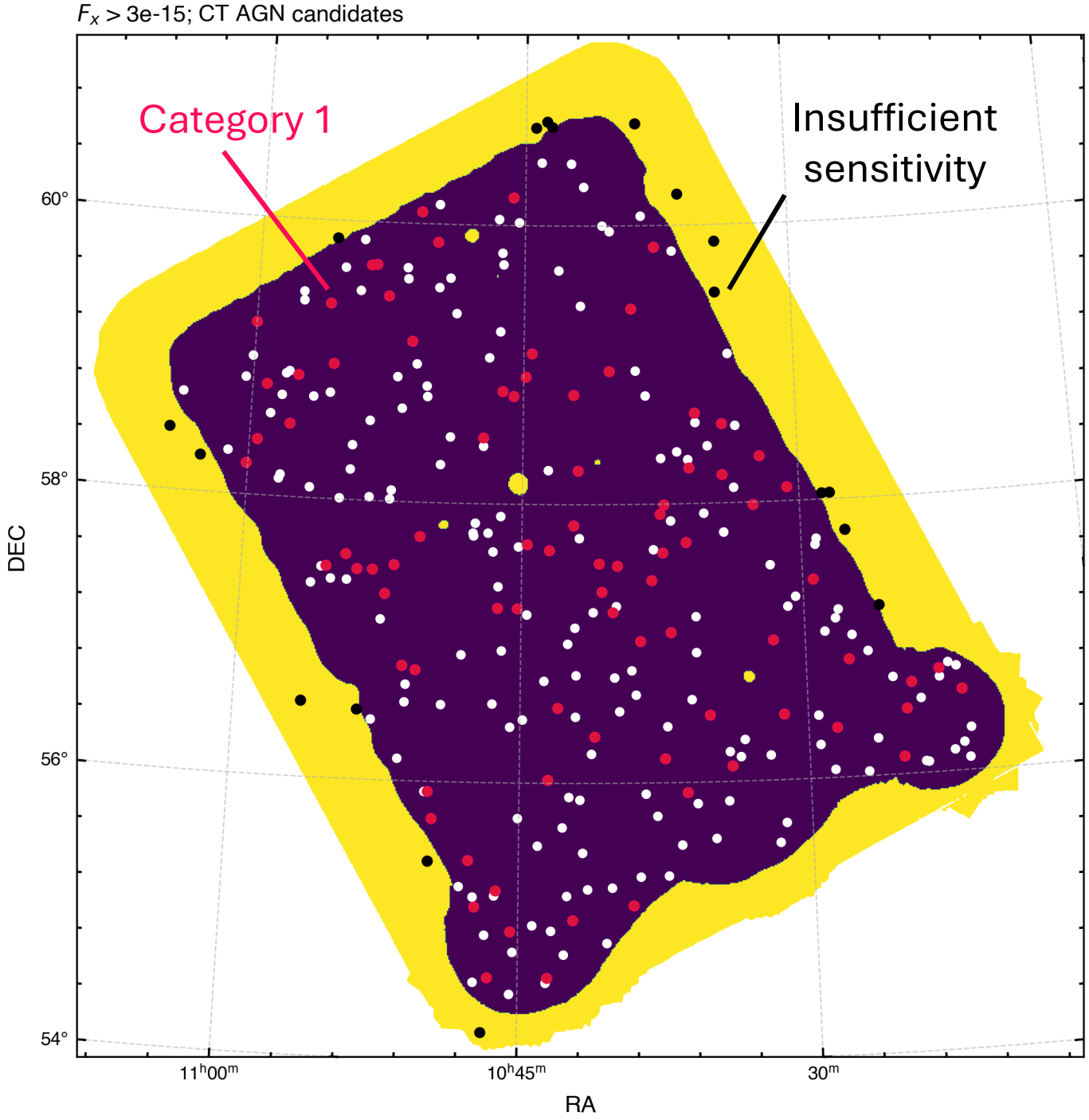
«normal» spectral indices

Category 2



Reflection-dominated CT AGN sky density estimation

$F_{x,\,0.5-2} > 1.5\times10^{-14}\ \mathrm{erg\ s^{-1}cm^{-2}}$



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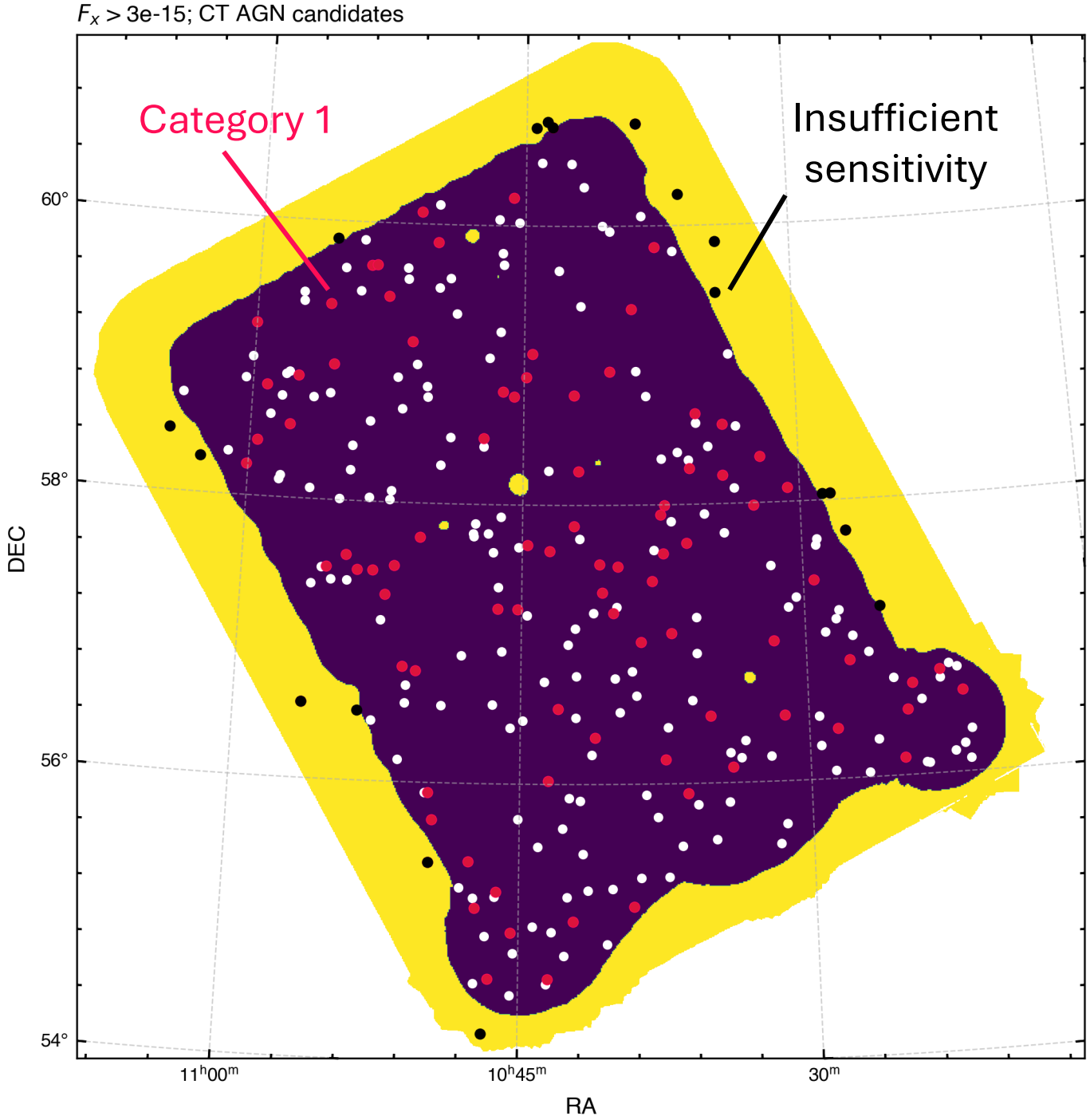
	limit	N_{CT}	$\rho_{,\,\mathrm{deg}^{-2}}$	f (%)
Category 1	lower	10	0.35	0.85 ± 0.27
	upper	311	10.86	26.51 ± 1.29

All sources without soft ones (where $\Gamma_{lower} > 1.3$)



Results

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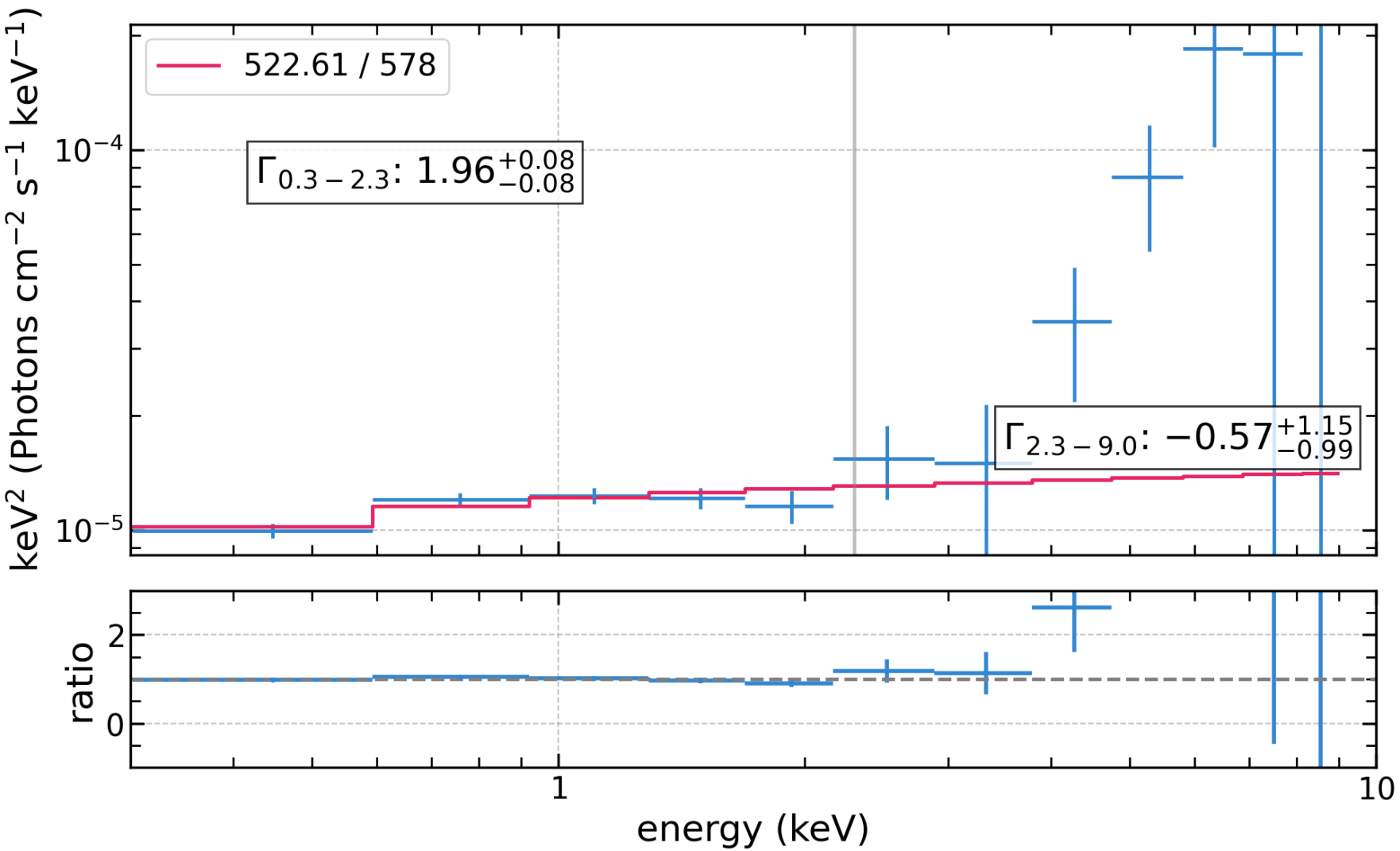
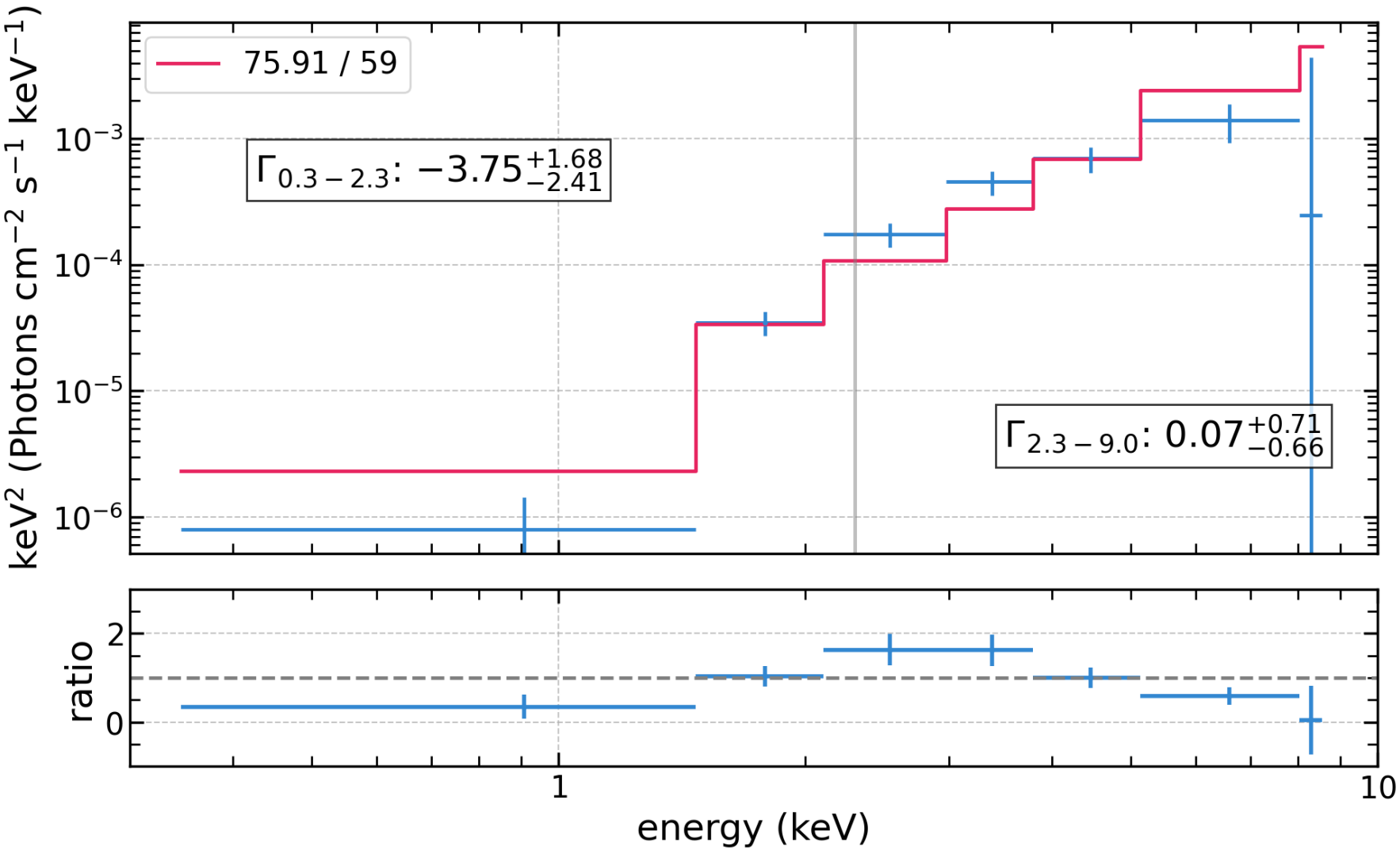
- Sky density of reflection-dominated Compton-thick AGN is estimated


522.61 / 578
$\Gamma_{0.3-2.3}$: $1.96^{+0.08}_{-0.08}$
$\Gamma_{2.3-9.0}$: $-0.57^{+1.15}_{-0.99}$
keV^2 (Photons cm^{-2} s^{-1} keV^{-1})
10^{-4}
10^{-5}
ratio
2
0
1
10
energy (keV)


75.91 / 59
$\Gamma_{0.3-2.3}: -3.75^{+1.68}_{-2.41}$
$\Gamma_{2.3-9.0}: 0.07^{+0.71}_{-0.66}$
keV^2 (Photons cm^{-2} s^{-1} keV^{-1})
10^{-3}
10^{-4}
10^{-5}
10^{-6}
ratio
2
0
1
10
energy (keV)